Infiltration Trenches

Description: Excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench.

Components:

- Soil infiltration rate of 0.5 in/hr or greater required
- Excavated trench (3 to 8 foot depth) filled with stone media (1.5- to 2.5-inch diameter)**;** pea gravel and sand filter layers
- A sediment forebay and grass channel, or equivalent upstream pretreatment, must be provided
- Observation well to monitor percolation

Advantages/Benefits:

- Provides for groundwater recharge
- Good for small sites with porous soils

Disadvantages/Limitations:

- Potential for groundwater contamination
- High clogging potential; should not be used on sites with fine-particled soils (clays or silts) in drainage area
- Cannot be used in karst soils
- Geotechnical testing required, two borings per facility

Design considerations:

- 5 acres maximum drainage area
- Space Required – Will vary depending on the depth of the facility
- Site Slope – No more than 6% slope (for pre-construction facility footprint)
- Minimum Head – Elevation difference needed at a site from the inflow to the outflow: 1 foot
- Minimum Depth to Water Table – 4 feet recommended between the bottom of the infiltration trench and the elevation of the seasonally high water table.
- Soils – Infiltration rate of 0.5 inches per hour or greater required (typically hydrologic group "A", some group "B" soils)

Selection Criteria:

- ✓ **Water Quality 80 % TSS Removal**
- ☐ **Accepts Hotspot Runoff**
- ✓ **Residential Subdivision**
- ✓ **High Density / Ultra Urban Use**

Maintenance:

- Inspect for clogging
- Remove sediment from forebay
- Replace pea gravel layer as needed

H — **Maintenance Burden**

L = Low M = Moderate H = High

General Description

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for stormwater runoff (see Figure 14.1). The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a 2-day period and eventually reaches the water table. By diverting runoff into the soil, an infiltration trench not only treats the water quality volume, but also helps to preserve the natural water balance on a site and can recharge groundwater and preserve baseflow. Due to this fact, infiltration systems are limited to areas with highly porous soils where the water table and/or bedrock are located well below the bottom of the trench. In addition, infiltration trenches must be carefully sited to avoid the potential of groundwater contamination.

Infiltration trenches are not intended to trap sediment and must always be designed with a sediment forebay and grass channel or filter strip or other appropriate pretreatment measures to prevent clogging and failure. Due to their high potential for failure, these facilities must only be considered for sites where upstream sediment control can be ensured.

Using the natural filtering properties of soil, infiltration trenches can remove a wide variety of pollutants from stormwater through sorption, precipitation, filtering, and bacterial and chemical degradation. Sediment load and other suspended solids should be removed from runoff by pretreatment measures on-site before they reach the trench surface.

Site and Design Considerations

Infiltration trenches are generally suited for medium-to-high density residential, commercial and institutional developments where the subsoil is sufficiently permeable to provide a reasonable infiltration rate and the water table is low enough to prevent groundwater contamination. They are applicable primarily for impervious areas where there are not high levels of fine particulates (clay/silt soils) in the runoff and should only be considered for sites where the sediment load is relatively low.

Infiltration trenches can either be used to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches can be adapted to many different types of sites and can be utilized in retrofit situations. Unlike some other structural stormwater controls, they can easily fit into the margin, perimeter, or other unused areas of developed sites.

To protect groundwater from potential contamination, runoff from designated hotspot land uses or activities must not be infiltrated. Infiltration trenches should not be used for manufacturing and industrial sites, where there is a potential for high concentrations of soluble pollutants and heavy metals. In addition, infiltration should not be considered for areas with a high pesticide concentration. Infiltration trenches are also not suitable in

Site and Design Considerations (Continued)

areas with karst geology without adequate geotechnical testing by qualified individuals and in accordance with local requirements.

1. To be suitable for infiltration, underlying soils should have an infiltration rate (f_c) of <u>0.5 inches per hour or greater</u>, as initially determined from NRCS soil textural classification and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 5,000 square feet, with a minimum of two borings per facility (taken within the proposed limits of the facility). Infiltration trenches cannot be used in fill soils.
2. Infiltration trenches should have a contributing drainage area of 5 acres or less.
3. Soils in the drainage area tributary to an infiltration trench should have a clay content of less than 20% and a silt/clay content of less than 40% to prevent clogging and failure.
4. There should be at least 4 feet between the bottom of the infiltration trench and the elevation of the seasonally high water table.
5. Clay lenses, bedrock or other restrictive layers below the bottom of the trench will reduce infiltration rates unless excavated.
6. Suggested minimum setback requirements for infiltration trench facilities:
   - From a property line – 10 feet
   - From a building foundation – 25 feet
   - From a private well – 100 feet
   - From a public water supply well – 1,200 feet
   - From a septic system tank/leach field – 100 feet
   - From surface waters – 100 feet
   - From surface drinking water sources – 400 feet (100 feet for a tributary)
7. When used in an off-line configuration, the water quality volume (WQ_v) is diverted to the infiltration trench through the use of a flow splitter. Stormwater flows greater than the WQ_v are diverted to other controls or downstream using a diversion structure or flow splitter.
8. To reduce the potential for costly maintenance and/or system reconstruction, it is strongly recommended that the trench be located in an open or lawn area, with the top of the structure as close to the ground surface as possible. Infiltration trenches shall not be located beneath paved surfaces, such as parking lots.
9. Infiltration trenches are designed for intermittent flow and must be allowed to drain and allow aeration of the surrounding soil between rainfall events. They must not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.

Site and Design Considerations (Continued)

General Design
A well-designed infiltration trench consists of:

(1) Excavated shallow trench backfilled with sand, coarse stone, and pea gravel, and lined with a filter fabric;
(2) Appropriate pretreatment measures; and
(3) One or more observation wells to show how quickly the trench dewaters or to determine if the device is clogged.

An example of an on-line infiltration trench is shown in Figure 14.1. Figure 14.2 provides a plan view and profile schematic for the design of an off-line infiltration trench facility.

Physical Specifications/Geometry

10. The required storage volume in the gravel trench is equal to the water quality volume (WQ_v).
11. A trench must be designed to fully dewater the entire WQ_v within 24 to 48 hours after a rainfall event. The slowest infiltration rate obtained from tests performed at the site should be used in the design calculations.
12. Trench depths should be between 3 and 8 feet, to provide for easier maintenance. The width of a trench must be less than 25 feet.
13. Broader, shallow trenches reduce the risk of clogging by spreading the flow over a larger area for infiltration.
14. The surface area required is calculated based on the trench depth, soil infiltration rate, aggregate void space, and fill time (assume a fill time of 2 hours for most designs).
15. The bottom slope of a trench should be flat across its length and width to evenly distribute flows, encourage uniform infiltration through the bottom, and reduce the risk of clogging.
16. The stone aggregate used in the trench should be washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a void space of about 40%. Aggregate contaminated with soil shall not be used. A porosity value (void space/total volume) of 0.32 should be used in calculations, unless aggregate specific data exist.
17. A 6-inch layer of clean, washed sand is placed on the bottom of the trench to encourage drainage and prevent compaction of the native soil while the stone aggregate is added.
18. The infiltration trench is lined on the sides and top by an appropriate geotextile filter fabric that prevents soil piping but has greater permeability than the parent soil. The top layer of filter fabric is located 2 to 6 inches from the top of the trench and serves to prevent sediment from passing into the stone aggregate. Since this top layer serves as a sediment barrier, it will need to be replaced more frequently and must be readily separated from the side sections.

Site and Design Considerations (Continued)

19. The top surface of the infiltration trench above the filter fabric is typically covered with pea gravel. The pea gravel layer improves sediment filtering and maximizes the pollutant removal in the top of the trench. In addition, it can easily be removed and replaced should the device begin to clog. Alternatively, the trench can be covered with permeable topsoil and planted with grass in a landscaped area.
20. An observation well must be installed in every infiltration trench and should consist of a perforated PVC pipe, 4 to 6 inches in diameter, extending to the bottom of the trench (see Figure 14.3 for a schematic of an observation well). The observation well will show the rate of dewatering after a storm, as well as provide a means of determining sediment levels at the bottom and when the filter fabric at the top is clogged and maintenance is needed. It should be installed along the centerline of the structure, flush with the ground elevation of the trench. A visible floating marker should be provided to indicate the water level. The top of the well should be capped and locked to discourage vandalism and tampering.
21. The trench excavation should be limited to the width and depth specified in the design. Excavated material should be placed away from the open trench so as not to jeopardize the stability of the trench sidewalls. The bottom of the excavated trench shall not be loaded in a way that causes soil compaction, and should be scarified prior to placement of sand. The sides of the trench shall be trimmed of all large roots. The sidewalls shall be uniform with no voids and scarified prior to backfilling. All infiltration trench facilities should be protected during site construction and should be constructed after upstream areas have been stabilized.

Pretreatment/Inlets

22. Pretreatment facilities must always be used in conjunction with an infiltration trench to prevent clogging and failure
23. For a trench receiving sheet flow from an adjacent drainage area, the pretreatment system should consist of a vegetated filter strip with a minimum 25-foot length. A vegetated buffer strip around the entire trench is required if the facility is receiving runoff from both directions. If the infiltration rate for the underlying soils is greater than 2 inches per hour, 50% of the WQ_v should be pretreated by another method prior to reaching the infiltration trench.
24. For an off-line configuration, pretreatment should consist of a sediment forebay, vault, plunge pool, or similar sedimentation chamber (with energy dissipaters) sized to 25% of the water quality volume (WQ_v). Exit velocities from the pretreatment chamber must be nonerosive for the 2-year design storm.

Site and Design Considerations Continued

Outlet Structures
Outlet structures are not required for infiltration trenches.

Emergency Spillway
Typically for off-line designs, there is no need for an emergency spillway. However, a nonerosive overflow channel should be provided to safely pass flows that exceed the storage capacity of the trench to a stabilized downstream area or watercourse.

Maintenance Access
Adequate access in an easement should be provided to an infiltration trench facility for inspection and maintenance.

Safety Features
In general, infiltration trenches are not likely to pose a physical threat to the public and do not need to be fenced.

Landscaping
Vegetated filter strips and buffers should fit into and blend with surrounding area. Native grasses are preferable, if compatible. The trench may be covered with permeable topsoil and planted with grass in a landscaped area.

Additional Site-Specific Design Criteria and Issues
Not suitable for karst areas without adequate geotechnical testing.

As-Built Certification Considerations

After the infiltration trench has been constructed, an as-built certification must be performed by a registered Professional Engineer and submitted to Metro. The as-built certification verifies that the BMP was installed as designed and approved.

The following components must be addressed in the as-built certification:

1. The infiltration trench cannot be located in a sinkhole area or in karst soils.
2. Infiltration rates must be verified.
3. Proper dimensions for the trench must be verified.
4. A mechanism for overflow for large storm events must be provided.

Maintenance

Each BMP must have an Operations and Maintenance (O&M) Agreement submitted to Metro for approval and maintained and updated by the BMP owner. Refer to Volume 1 Appendix C for the Operation and Maintenance Agreement for infiltration trenches, as well as an inspection checklist. The O&M Agreement must be completed and submitted to Metro with grading permit application. The O&M agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the BMP operations and maintenance plan. At a minimum, the operations and maintenance plan must address:

1. Ensure that contributing area, facility and inlets are clear of debris.
2. Ensure that the contributing area is stabilized.
3. Remove sediment and oil/grease from pretreatment devices, as well as overflow structures.
4. Check observation wells following 3 days of dry weather. Failure to percolate within this time period indicates clogging.
5. Inspect pretreatment devices and diversion structures for sediment build-up and structural damage.
6. Remove trees that start to grow in the vicinity of the trench.
7. Replace pea gravel/topsoil and top surface filter fabric (when clogged).
8. Perform total rehabilitation of the trench to maintain design storage capacity.
9. Excavate trench walls to expose clean soil.

Design Procedures

Step 1. Compute the Water Quality Volume.

Calculate the Water Quality Volume (WQ_v). This volume must be contained in the gravel trench.

WQ_v = P x Rv x A/12

Where:
WQ_v = water quality treatment volume, ac-ft
P = rainfall for the 85% storm event (1.1 in)
Rv = runoff coefficient (see below)
A = site area, acres

Rv = 0.015 + 0.0092I

Where:
I = site impervious cover, % (for example, 50% would be 50)

Step 2. Determine if the development site and conditions are appropriate for the use of infiltration trench.

Consider the *Site and Design Considerations* in this section, above.

Step 3. Divert flows above the WQ_v flow rate (Q_{wq}).

Flows exceeding the WQ_v flow are to be diverted from the trench.

$$Qwq = C * I * A$$

Where:
Q_{wq} = the WQ_v flow rate
C = runoff coefficient
I = rainfall intensity, 2.45 inches/hour for Metro for design storm associated with WQ_v
A = the contributing drainage area for the BMP, in acres

Step 4. Size flow diversion structure, if needed.

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the infiltration trench.

Size low flow orifice, weir, or other device to pass Q_{wq}.

Design Procedures (Continued)

Step 5. Size infiltration trench.

The area of the trench can be determined from the following equation:

$$A = \frac{WQ_v}{(nd + kT/12)}$$

Where:

A = Surface Area (acres)
WQ_v = Water Quality Volume (or total volume to be infiltrated)
n = porosity
d = trench depth (feet)
k = percolation (inches/hour)
T= Fill Time (time for the trench to fill with water), in hours

A porosity value *n* = 0.32 should be used.

All infiltration systems should be designed to fully dewater the entire WQ_v within 24 to 48 hours after the rainfall event.

A fill time T=2 hours can be used for most designs.

See the Physical Specifications/Geometry section of *Site and Design Considerations* for more details.

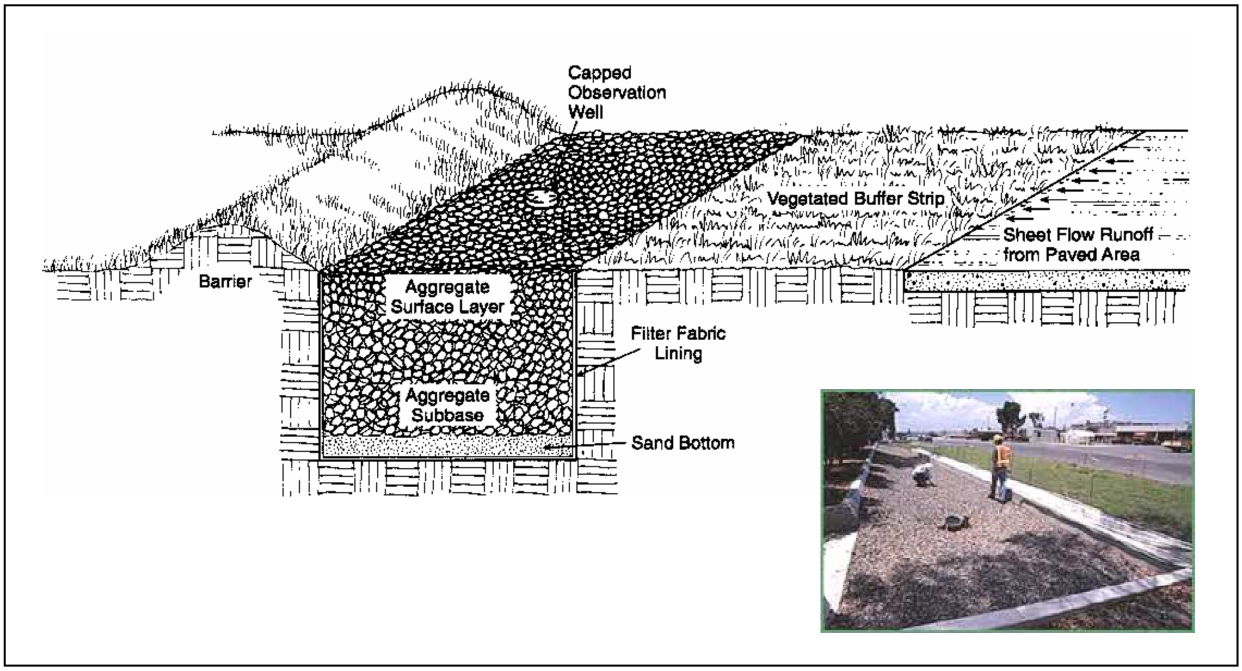
Step 6. Determine pretreatment volume and design pretreatment measures.

Size pretreatment facility to treat 25% of the water quality volume (WQ_v) for off-line configurations.

See the Pretreatment / Inlets section of *Site and Design Considerations* for more details.

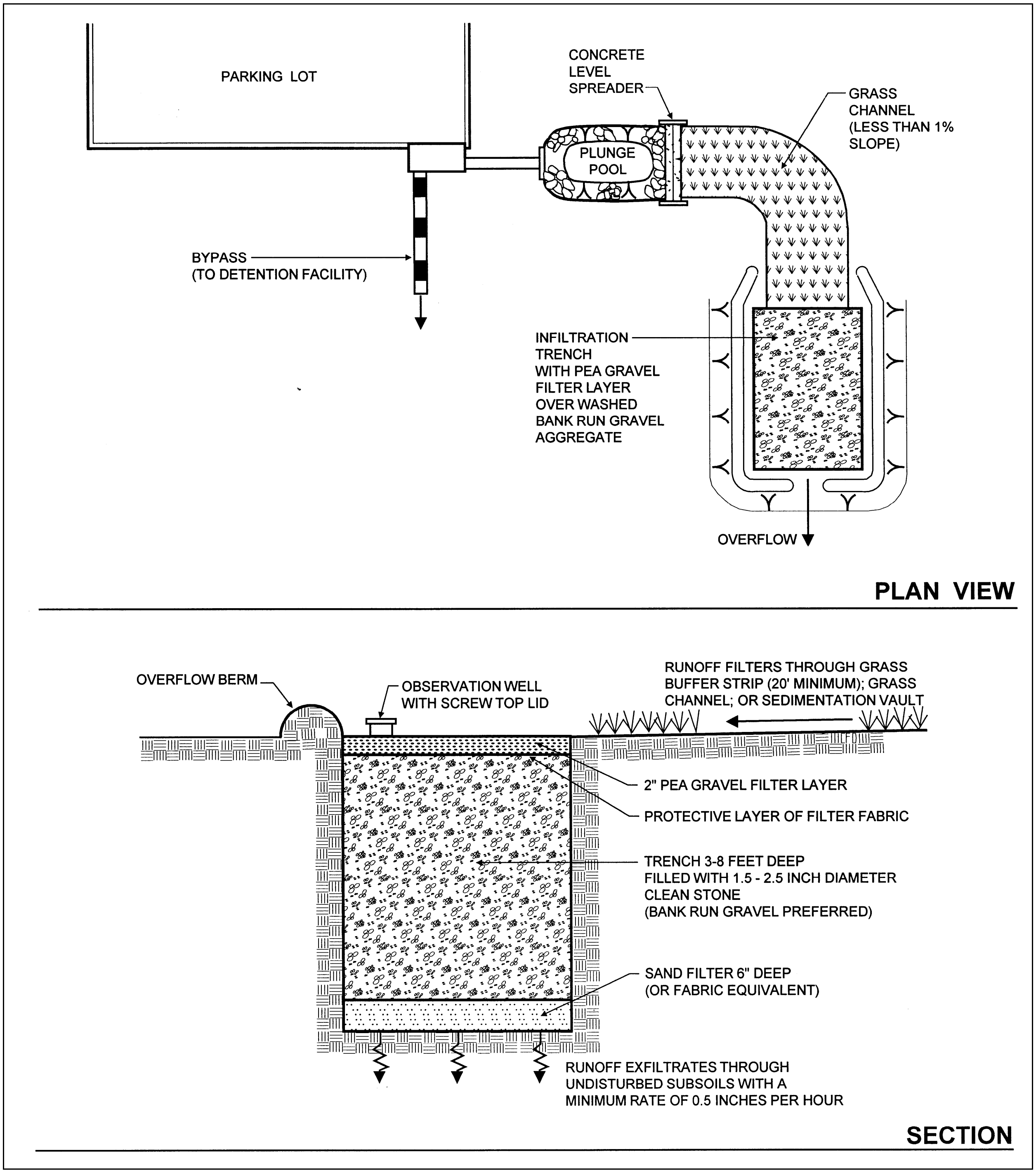
Step 7. Design spillway(s).

Adequate stormwater outfalls should be provided for the overflow exceeding the capacity of the trench, ensuring nonerosive velocities on the down-slope.



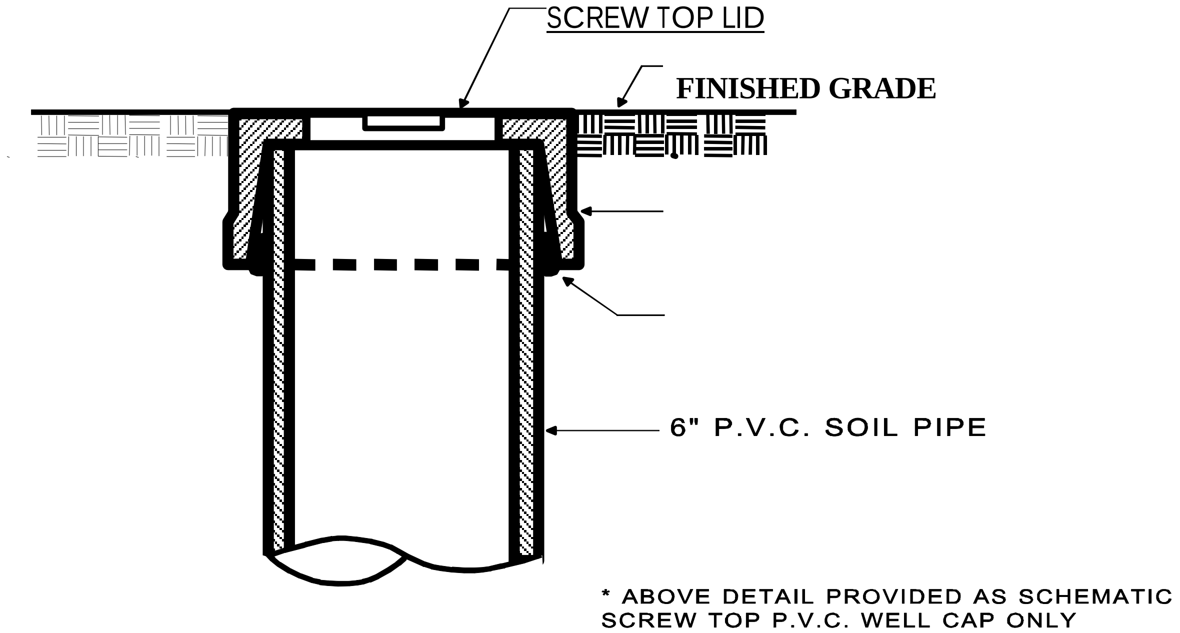
(Source: Georgia Stormwater Management Manual)

Figure 14.1 Infiltration Trench Example



(Source: Center for Watershed Protection)

Figure 14.2 Schematic of Infiltration Trench



EACH OBSERVATION WELL / CLEANOUT SHALL INCLUDE THE FOLLOWING:

1. FOR AN UNDERGROUND FLUSH MOUNTED OBSERVATION WELL / CLEANOUT, PROVIDE A TUBE MADE OF NON-CORROSIVE MATERIAL, SCHEDULE 40 OR EQUAL, AT LEAST THREE FEET LONG WITH AN INSIDE DIAMETER OF AT LEAST 6 INCHES.

2. THE TUBE SHALL HAVE A FACTORY ATTACHED CAST IRON OR HIGH IMPACT PLASTIC COLLAR WITH RIBS TO PREVENT ROTATION WHEN REMOVING SCREW TOP LID. THE SCREW TOP LID SHALL BE CAST IRON OR HIGH OMPACT PLASTIC THAT WILL WITHSTAND ULTRA-VIOLET RAYS.

OBSERVATION WELL DETAIL

(Source: Metro Stormwater Management Manual, 2000)

Figure 14.3 Observation Well Detail

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Suggested Reading

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