Infiltration Trench

Practice Description

An infiltration trench (a.k.a. infiltration galley) is a rock-filled trench with no outlet that receives stormwater runoff. Stormwater runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. The primary pollutant removal mechanism of this practice is filtering through the soil.

Planning Considerations

Infiltration trenches have select applications. Although they can be applied in a variety of situations, the use of infiltration trenches is restricted by concerns over groundwater contamination, soils, and clogging.

Infiltration trenches are frequently used to infiltrate runoff from adjacent impervious surfaces, such as parking lots. In these cases, a filter strip should be installed between the pavement and the device to trap sediment and litter before they are washed into the device. Another approach is to construct infiltration trenches at the downgradient edges of areas with permeable pavement. In this case, the permeable pavement is the inlet to the device. Because water also will infiltrate through the base of the pavement, the size of the infiltration devices can be reduced significantly.

Design Criteria

Infiltration trenches are filled with large crushed stone or other media to create storage for the stormwater in the voids between the media. Other versions use precast concrete vaults with open bottoms to provide a large storage volume to hold stormwater for infiltration into the soil. Infiltration trenches are usually used to manage the runoff from parking lots and buildings.

Converting Erosion- and Sediment-Control Devices

Infiltration trenches shall not be used as sediment- and erosion-control devices.

Siting Considerations

Infiltration practices need to be sited extremely carefully. In particular, designers need to ensure that the soils on site are appropriate for infiltration and that designs minimize the potential for groundwater contamination and long-term maintenance.

Drainage Area

Infiltration trenches generally can be applied to relatively small sites (less than 5 acres), with relatively high impervious cover. Application to larger sites generally causes clogging, resulting in a high maintenance burden.

Slope

Infiltration trenches should be placed on flat ground, but the slopes of the site draining to the practice can be as steep as 15 percent.

Soils/Topography

Soils and topography are strongly limiting factors when locating infiltration practices. Soils must be significantly permeable to ensure that the stormwater can infiltrate quickly enough to reduce the potential for clogging. In addition, soils that infiltrate too rapidly may not provide sufficient treatment, creating the potential for groundwater contamination. To be suitable for infiltration, underlying soils must have an infiltration rate of 0.52 inch per hour or greater, as initially determined from NRCS soil textural classification (typically hydrologic soil groups A and B) and subsequently confirmed by field geotechnical tests. The infiltration rate and textural class of the soil need to be confirmed in the field; designers should not rely on more generic information such as a soil survey. Finally, infiltration trenches may not be used in regions of karst topography, due to the potential for sinkhole formation or groundwater contamination.

Groundwater

Designers always need to provide significant separation (2 to 5 feet) from the bottom of the infiltration trench and the seasonally high groundwater table, to reduce the risk of contamination. In addition, infiltration practices should be separated from drinking water wells.

Design Considerations

Specific designs may vary considerably, depending on site constraints or preferences of the designer or community. There are some features, however, that should be incorporated into most infiltration trench designs. These design features can be divided into five basic categories: pretreatment, treatment, conveyance, maintenance reduction, and landscaping.

Pretreatment

Pretreatment refers to design features that provide settling of large particles before runoff reaches a management practice, easing the long-term maintenance burden. Pretreatment is important for all structural stormwater-management practices, but it is particularly important for infiltration practices. To ensure that pretreatment mechanisms are effective, designers should incorporate "multiple pretreatment," using practices such as grassed swales, vegetated filter strips, detention, or a plunge pool in series.

Treatment

Treatment design features enhance the pollutant removal of a practice. During the construction process, the upland soils of infiltration trenches need to be stabilized to ensure that the trench does not become clogged with sediment. Furthermore, the practice should be filled with large clean stones that can retain the volume of water to be treated in their voids. Like infiltration basins, this practice should be sized so that the volume to be treated can infiltrate out of the trench bottom in 24 hours.

Conveyance

Stormwater needs to be conveyed through stormwater management practices safely, and in a way that minimizes erosion. Designers need to be particularly careful in ensuring that channels leading to an infiltration practice are designed to minimize erosion. Infiltration trenches should be designed to treat only small storms, (i.e., only for water quality). Thus, these practices should be designed "off-line," using a structure to divert only small flows to the practice. Finally, the sides of an infiltration trench should be lined with a geotextile fabric to prevent flow from causing rills along the edge of the practice.

Maintenance Reduction

In addition to regular maintenance activities, designers also need to incorporate features into the design to ensure that the maintenance burden of a practice is reduced. These features can make regular maintenance activities easier or reduce the need to perform maintenance. As with all management practices, infiltration trenches should have an access path for maintenance activities. An observation well (i.e., a perforated PVC pipe that leads to the bottom of the trench) can enable inspectors to monitor the drawdown rate. Where possible, trenches should have a means to drain the practice if it becomes clogged, such as an underdrain. An underdrain is a perforated pipe system in a gravel bed, on the bottom of filtering practices, installed to collect and remove filtered runoff. An underdrain pipe with a shutoff valve can be used in an infiltration system to act as an overflow in case of clogging.

Landscaping

In infiltration trenches, there is no landscaping on the practice itself, but it is important to ensure that the upland drainage is properly stabilized with thick vegetation, particularly following construction.

Length, Width, Depth and Geometry

The sizing of an infiltration device is determined by the dewatering requirements. Infiltration devices must be able to completely dewater within 5 days. The time to dewater can be estimated roughly as the runoff capture volume for the device divided by the product of the hydraulic conductivity and the effective infiltrating area. This can be rearranged to produce the following equation for determining the effective infiltrating area needed:

$$A = \frac{V}{2 * (K * T)}$$

where:

A = effective infiltrating area (ft^2)
V = volume of water requiring infiltration (ft^3)
K = hydraulic conductivity of soil (in/hr)
T = dewatering time (days)

The volume of water requiring infiltration (V) is prescribed by the specific stormwater program that applies to the site, and the runoff characteristics of the site. If the infiltration device is not going to meet the volume control requirements, it is simply the volume of water that is diverted and stored for infiltration. The runoff capture storage volume of an infiltration device that is filled with a drainage medium is equal to the volume of the facility, multiplied by the porosity of the medium, plus any temporary ponding that may be allowed before the facility overflows.

The hydraulic conductivity of the soil (K) is the resultant value from the field testing performed on the site. The dewatering time (T) for infiltration devices must be 5 days or less. A value of less than 3 days is recommended for use in the formula.

Once the effective infiltrating area (A) is obtained from the formula, it can still be somewhat difficult to translate that into actual infiltration device dimensions. The value for A used in the formula is actually the larger of either the bottom surface area or one-half of the total (wetted) wall area. The determination of the length, width, and depth dimensions is therefore often an iterative process using the effective infiltrating area (A); the correction factor for true surface areas of the in situ soil interface; and typical length, width, and depth recommendations.

Trench depths shall be no more than 8 feet. It is recommended that the width of a trench (perpendicular to influent flow direction) be less than 25 feet. Broad, shallow trenches reduce the risk of clogging by spreading the runoff over a larger area for infiltration.

Construction Considerations

Care should be used during installation to minimize compaction of soil on the bottom and walls of infiltration devices, since this will reduce the permeability at the soil interface. To avoid compacting the drainage media, lighter weight equipment and construction techniques that minimize compaction should be used.

Runoff shall not be directed into an infiltration device until the drainage area is stabilized. A construction sequence must be followed that reflects the need to stabilize the infiltration device. The longevity of infiltration devices is strongly influenced by the care taken during construction.

Infiltration trenches should not be covered by an impermeable surface unless there is suitable maintenance access, the design specifies an H-20 loading capacity, and the application includes a cross section of the H-20 design. Direct access must be provided to all infiltration devices for maintenance and rehabilitation. OSHA safety standards should be consulted for trench excavation.

A minimum of one observation well shall be included in the design of an infiltration system to periodically verify that the drainage media are fully draining. The monitoring well shall consist of a 4- to 6-inch-diameter, perforated polyvinyl chloride (PVC) pipe with a locking cap. The well should be placed near the center of the facility or in the general location of the lowest point within the facility, with the invert at the excavated bottom of the facility.

Common Problems

Although infiltration trenches can be a useful management practice, they have several limitations. While they do not detract visually from a site, infiltration trenches provide no visual enhancements. Their application is limited due to concerns over groundwater contamination and other soils requirements. Finally, maintenance can be burdensome, and infiltration practices have a relatively high rate of failure.

Maintenance

Regular maintenance of infiltration trenches is needed to reduce the likelihood of BMP failure.

If grass filter strips are present, they should be monitored for areas of bare soil and/or erosive gullies. These items should be repaired immediately by re-grading the area and re-planting. The planted area should be protected using mulching until vegetation can be established.

Sediment accumulation can clog the filter strip, the flow diversion structure, or the trench itself. First, the source of the sediment should be identified and the erosion issues addressed. Then, the sediment should be removed and the device restored to initial design standards.