Stormwater Best Management Practice

Infiltration Trench

Minimum Measure: Post Construction Stormwater Management in New Development and Redevelopment
Subcategory: Infiltration

Description

An infiltration trench typically consists of a gravel-filled trench that allows stormwater to soak into the ground. Various infiltration trench designs exist; a design may include an overflow, an underdrain or vegetation. To reduce clogging, design engineers often use settling basins or other pretreatment components in conjunction with the infiltration trench.

Applicability

Infiltration trenches are appropriate for most regions of the country, but site-specific conditions—such as soil type, water table, drainage area and slope—may restrict their use. Also, infiltration may be less feasible in tidal areas (due to high water tables) or in karst regions (due to concerns with sinkhole formation).

Urban Areas

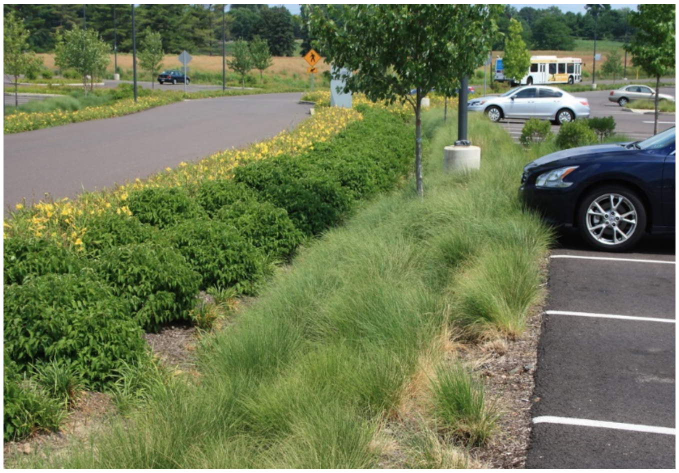
Infiltration trenches are sometimes suitable for the urban environment, particularly when paired with other stormwater controls. Two site characteristics that can restrict their use are the potential for infiltrated water to interfere with existing infrastructure and the relatively poor infiltration capacity of most urban areas. Additionally, infiltration trenches may need more frequent maintenance in urbanized areas, where they can become clogged with trash and debris.

Stormwater Hot Spots

Infiltration trenches should not receive discharge from stormwater hot spots, unless another stormwater control has already treated the stormwater. Direct infiltration of discharge from stormwater hot spots may lead to groundwater contamination.

Siting and Design Considerations

Design engineers need to site infiltration trenches carefully. They should ensure that the soils on-site are appropriate for infiltration and that there is minimal



Infiltration trenches at Einstein Hospital in East Norriton.
Photo Credit: Montgomery County Planning Commission/Flickr CC

potential for groundwater contamination and long-term maintenance problems.

Design engineers generally use infiltration trenches for drainage areas smaller than 5 acres and with relatively high impervious cover (MDE, 2009). For larger applications, designers should consider infiltration basins. An infiltration trench should be on flat ground, but the slopes of the site draining to the trench can be as steep as 15 percent.

Common Terms

Stormwater hot spots are areas where land use or activities generate highly contaminated stormwater discharges, with concentrations of pollutants exceeding those typically found in stormwater. Examples include gas stations, vehicle repair areas and waste storage areas.

Soils are a strongly limiting factor in the siting of infiltration trenches. Soils that infiltrate too rapidly may not provide sufficient treatment, creating the potential for groundwater contamination. The infiltration rate should range between 0.5 and 3 inches per hour. In addition, the soils should have no greater than 20 percent clay content and less than 40 percent silt/clay content (MDE, 2009). Design engineers should confirm the infiltration rate and textural class of the soil in the field; generic information such as soil surveys is only suitable for preliminary siting considerations. Finally, design engineers should not use infiltration trenches in regions of karst topography due to the potential for sinkhole formation or groundwater contamination.

Design engineers should design infiltration trenches to maintain at least 4 feet of separation between the bottom of the trench and the seasonal high groundwater table. For areas close to large waterbodies, this minimum distance may be as low as 2 feet. In either case, designers should follow local standards. Additional variables to consider may include the location of nearby drinking wells or sites with groundwater contamination.

Pretreatment

Pretreatment is particularly important for infiltration-based stormwater controls. To ensure that pretreatment systems are effective, designers can consider a treatment train approach using multiple stormwater controls—such as grassed swales, vegetated filter strips, rock swales, detention basins or plunge pools—in series.

Common Terms

Pretreatment plays an important role in stormwater treatment. Pretreatment structures, installed immediately upgradient to a stormwater control, reduce flow rates and remove sediment and debris before stormwater enters the stormwater control. This helps to improve the stormwater control's pollutant removal efficiency and reduces maintenance requirements.

Offline design Offline design refers to using a flow separator structure in order to divert only a portion of flow to a stormwater control.

Treatment

Treatment design features enhance the effectiveness of an infiltration trench. During the construction process, construction staff need to stabilize the upland soils of an infiltration trench to ensure it does not clog with sediment. They should size the treatment component itself so that the treatment volume can infiltrate into surrounding soils within 48 hours (ideally within 24 hours).

Conveyance

Stormwater needs to pass safely through stormwater controls, and design engineers should ensure that channels leading to an infiltration trench minimize erosion. They should expect an infiltration trench to treat only small storms (and thus consider an offline design that uses a structure to divert only a portion of flow to the trench). If needed, design engineers can specify the sides of an infiltration trench be lined with a geotextile fabric to prevent flow from causing rills along the edge of the trench.

Arid or Semiarid Climates

Infiltration trenches are often highly suitable for arid regions because they can recharge groundwater. One concern in these environments is the potential for infiltration trenches to clog due to relatively high sediment concentrations. Design engineers need to emphasize pretreatment more heavily in drier climates.

Cold Climates

In extremely cold climates (i.e., regions that experience permafrost), infiltration trenches may be infeasible. They can be feasible in most cold climates, but there are some challenges to their use. Design engineers may need to increase a trench's capacity to accommodate additional stormwater volume from snowmelt. In addition, for a trench that controls stormwater from areas treated with deicing materials, it may be desirable to divert flow around the trench in winter to prevent the infiltration of chlorides. Finally, design engineers should set the trench back a minimum distance from roads to ensure that it does not cause frost heaving.

Maintenance Considerations

In addition to specifying regular maintenance activities, design engineers should incorporate features to reduce the infiltration trench's maintenance burden. Maintenance may be difficult if it follows an irregular schedule. The most frequent maintenance challenge with infiltration trenches is clogging. Table 1 provides a general schedule for infiltration trench maintenance.

Table 1. Typical maintenance activities for infiltration trenches.

Activity	Schedule
Replace pea gravel and topsoil (when clogged).	As needed
Clear inlets of debris, including sediment and oil/grease.	Monthly
Stabilize the surrounding area.	
Mow grass and remove grass clippings from filter strip areas, if applicable.	
Repair undercut and eroded areas at inflow/outflow structures.	
Inspect pretreatment devices and diversion structures for debris accumulation and structural integrity; take corrective action as needed.	Semiannually
Aerate pretreatment basin bottom or de-thatch basin bottom, if applicable.	Annually
Scrape pretreatment basin bottom to remove accumulated sediment and re-seed ground cover, if applicable.	Every 5 years
Totally rehabilitate the trench and restore its design storage capacity.	Upon failure
Excavate trench walls to expose clean soil, if applicable.	

Source: MPCA, 2016

As with all post-construction stormwater controls, 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, a trench should have a feature to drain clogs, such as an underdrain. An underdrain is a perforated pipe system in a gravel bed, installed on the bottom of filtering controls to collect and convey filtered stormwater. An underdrain pipe with a shutoff valve can act as an overflow in an infiltration trench in case of clogging.

Landscaping

The pretreatment components of an infiltration trench are typically the only areas with vegetation, such as a grass channel. Still, it is important to properly stabilize pretreatment components and upland drainage areas with thick vegetation, particularly after construction. When possible, design engineers should specify native vegetation to maximize rapid establishment.

Limitations

Although infiltration trenches can be a useful post-construction stormwater control, they have several limitations. While they do not detract visually from a site, infiltration trenches generally provide no visual enhancements. Their application can be limited due to concerns with groundwater contamination and other soil requirements. Finally, maintenance can be burdensome, and infiltration trenches can have a relatively high rate of failure without regular maintenance or adequate pretreatment.

Effectiveness

Performance data for infiltration-based stormwater controls are generally related to the volume of captured and infiltrated stormwater, as well as the presumed level of filtration that the soil provides for individual pollutants. For example, the New Hampshire Department of Environmental Services provided data showing that, for a 90 percent reduction in stormwater volume, stormwater trenches achieve an assumed removal efficiency of 90 percent for total suspended solids (TSS), 60 percent for total phosphorus (TP) and 10 to 55 percent for total nitrogen (NHDES, 2011). The high TSS removal efficiency is because TSS consists of relatively large particles that soil physically filters with great effectiveness. TP removal is slightly lower and is more due to soil adsorption processes, which can be effective but vary by soil type. Last, natural soil (especially soil with low organic content) generally does not filter or adsorb nitrogen well, resulting in a lower removal efficiency.

Cost Considerations[1]

Infiltration trenches can be somewhat expensive when compared to other post-construction stormwater controls like stormwater wetlands and bioretention systems (Weiss et al., 2007). Typical construction costs, including contingency and design costs, can range from $60,000 to $70,000 per acre of impervious surface treated (King & Hagan, 2011).

Using land efficiently can help save money. Infiltration trenches are typically small, taking up only about 2 to 3 percent of the site draining to them. In addition, they can fit into thin, linear areas. Thus, they can generally fit into relatively unusable portions of a site.

If improperly maintained, infiltration trenches have a high failure rate (see "Maintenance Considerations"). In general, maintaining them costs an estimated 5 to 20 percent of their construction cost. More realistic values are probably closer to the 20 percent range to ensure long-term functionality.

[1]Prices updated to 2019 dollars. Inflation rates obtained from the Bureau of Labor Statistics CPI Inflation Calculator website: https://data.bls.gov/cgi-bin/cpicalc.pl.

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

King, D., & Hagan, P. (2011). *Costs of stormwater management practices in Maryland counties*. University of Maryland Center for Environmental Science.

Maryland Department of the Environment (MDE). (2009). *2000 Maryland stormwater design manual.*

Minnesota Pollution Control Agency (MPCA). (2016). Operation and maintenance of infiltration trench. In *Minnesota stormwater manual*.

New Hampshire Department of Environmental Services (NHDES). (2011). Pollutant removal efficiencies for best management practices for use in pollutant loading analysis.

Weiss, P. T., Gulliver, J. S., & Erickson, A. J. (2007). Cost and pollutant removal of storm-water treatment practices. *Journal of Water Resources Planning and Management, 133*(3), 218–229.