Infiltration Basin

Practice Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater into the soil. This practice is believed to have a high pollutant-removal efficiency and can also help recharge the groundwater, thus increasing baseflow to stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Planning Considerations

Infiltration basins have select applications. Their use is often sharply restricted by concerns over groundwater contamination, soils, and clogging at the site. They work best in relatively small drainage areas and in drainage areas that are completely impervious or stable (to minimize the amount of sediment going to the BMP). Infiltration basins 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 it is washed into the device. Another approach is to construct infiltration devices 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 Considerations

When designing infiltration basins, designers need to carefully consider both the restrictions on the site and design features to improve the long-term performance of the practice.

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 basin designs. These design features can be divided into five basic categories: pretreatment, treatment, conveyance, outlet, and landscaping.

Pretreatment

Pretreatment devices for removing sediment and solids must be used to protect infiltration devices from clogging. A few options for pretreatment include filter strips, grassed swales with check dams, concrete sumps, and forebays (sediment traps).

Consideration should be given to the inlet when infiltration facilities are designed. The type of inlet will depend on whether the upgradient source of runoff is overland flow or a concentrated source of discharge. Infiltration trenches require relatively even distribution over their length. An infiltration basin can be designed to accommodate a concentrated influent flow; however, an energy dissipater and/or level spreader may be needed.

Treatment

Treatment design features enhance the pollutant removal of a practice. For infiltration practices, designers need to stabilize upland soils to ensure that the basin does not become clogged with sediment. In addition, the facility needs to be sized so that the volume of water to be treated infiltrates through the bottom in a given amount of time. Because infiltration basins are designed in this manner, infiltration basins designed on less permeable soils should be significantly larger than those designed on more permeable soils.

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. In general, infiltration basins should be designed to treat only small storms (i.e., only for water quality). Thus, these practices should be designed “off-line,” using a flow separator to divert only small flows to the practice.

Outlet Design

Infiltration devices, by their very nature, do not have regular outlet devices. (The stormwater entering the BMP leaves through the soils.) They should, however, be designed with dewatering provisions in the event of failure. It can be dewatered by pumping out or allowed to gravity-drain through a pipe. If a dewatering outlet pipe is installed to facilitate emergency draining, a lockable watertight valve must be installed and kept closed at all times.

Landscaping

Landscaping can enhance the aesthetic value of stormwater practices or improve their function. In infiltration basins, the most important purpose of vegetation is to reduce the tendency of the practice to clog. Upland drainage needs to be properly stabilized with a thick layer of vegetation, particularly immediately following construction. In addition, providing a thick turf at the basin bottom helps encourage infiltration and prevent the formation of rills in the basin bottom.

Siting Considerations

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

Converting Erosion- and Sediment-Control Devices

Often, the same basin can be used during construction as an erosion- and sediment-control device and later converted to an infiltration basin. Before conversion, all accumulated sediment must be removed and properly disposed of. Then, the appropriate modifications to the basin depth, geometry, and hydrology, as well as inlet and outlet structures, etc., must be made. A minimum of 6 inches of bottom material (below the design bottom of the original sediment and erosion control device) must be removed prior to conversion to a stormwater BMP, so appropriate design bottom depth changes must be considered. It is essential that the site be completely stabilized before the erosion- and sediment-control devices are removed or converted.

Drainage Area

Infiltration basins have historically been used as regional facilities, serving for both water-quantity and water-quality control. In general, the practice is best applied to relatively small drainage areas (i.e., less than 10 acres).

Slope

The bottom of an infiltration basin needs to be completely flat to allow infiltration throughout the entire basin bottom.

Soils/Topography

Soils and topography are strongly limiting factors when locating infiltration practices. Soils must be significantly permeable to ensure that the practice can infiltrate quickly enough to reduce the potential for clogging. Soils that infiltrate too rapidly may not provide sufficient treatment, creating the potential for groundwater contamination. A *site-specific* hydrogeologic investigation shall be performed to establish the suitability of site soils for the BMP. 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.

Groundwater

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

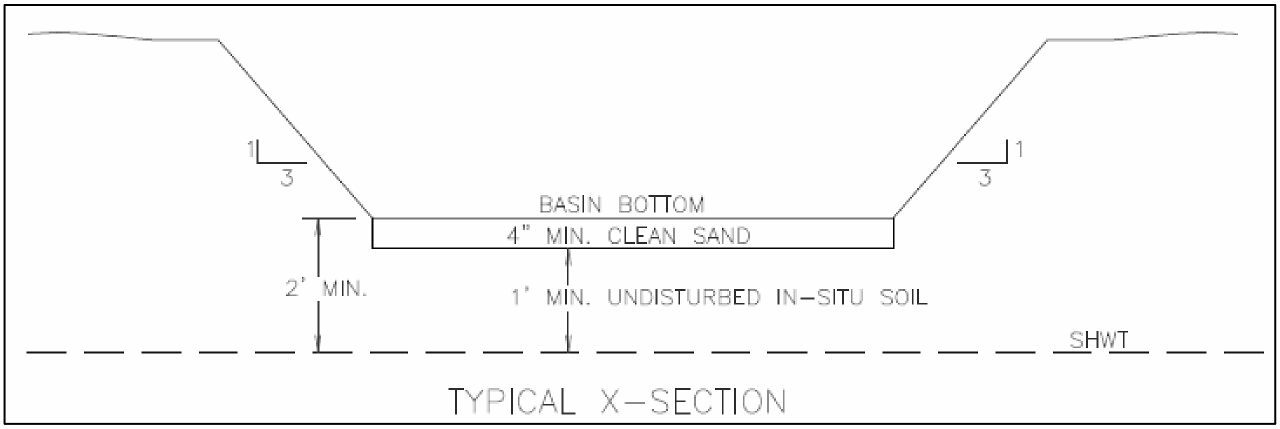

Figure 1 Typical Infiltration Basin: Cross Section
(Note: Retaining walls may be used in place of 3:1 vegetated side slopes)

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.

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.

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.

Infiltration basins may appear in a variety of geometries. Runoff frequently is piped to these devices from stormwater inlets on patios, parking areas, roofs, and other impervious areas. These devices may also receive runoff via sheet flow.

Common Problems

Although infiltration basins can be useful practices, they have several limitations. Infiltration basins are not generally aesthetic practices, particularly if they clog. If infiltration basins are designed and maintained so that standing water is left for no more than 3 days, mosquitoes should not be a problem. However, if an infiltration basin becomes clogged and takes 4 or more days to drain, the basin could become a source for mosquitoes. In addition, these practices are challenging to apply because of concerns over groundwater contamination and sufficient soil infiltration. Finally, maintenance of infiltration practices can be burdensome, and they have a relatively high rate of failure.

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins.

Immediately after the infiltration basin is established, the vegetation will be watered twice weekly if needed until the plants become established (commonly six weeks).

No portion of the infiltration basin will be fertilized after the initial fertilization that is required to establish the vegetation.

If areas of bare soil and/or erosive gullies form, regrade the soil to remove the gully, plant a ground cover, and water until it has established.

The vegetation in and around the basin will be maintained at a height of approximately six inches.

Should sediment accumulation reach 75% of the original design depth, the source of sediment should be identified and remedied. The sediment shall be removed and the basin restored to original design specifics.