Infiltration Trenches & Dry Wells

Purpose & Benefits

- Stormwater runoff reduction and treatment
- High pollutant removal
- Can help control localized drainage problems

Description

Infiltration Trenches and Dry Wells are gravel-filled trenches or pits that store runoff temporarily until it seeps into the ground through the bottom of the trench or pit. Unlike most of the other practices described in this manual, these practices do not necessarily incorporate vegetation into their design. Instead, they rely on natural soils to absorb runoff and filter pollutants.

What to Expect

Infiltration Trenches are installed by digging a trench which is then filled with a 1.5 to 4 foot layer of clean gravel, and a top layer of pea gravel or topsoil and grass. Small-scale, residential practices will likely use the shallower depth. With Dry Wells, roof drains are piped directly into the gravel layer of a gravel-filled pit. When designing Infiltration Trenches and Dry Wells, it is important to make sure that the native soils allow water to percolate, and that the practice is set back from buildings to avoid foundation damage or flooding. If the underlying soils are not suitable for the practice, it can lead to nuisance conditions, such as standing water. Karst topography may make these practices infeasible or even dangerous (see section 4.2). However, given the right conditions, these practices are simple, cost-effective, and relatively easy to maintain.

Roadside Infiltration Trench

(Source: Flickr Creative Commons, Wendy Cutler)

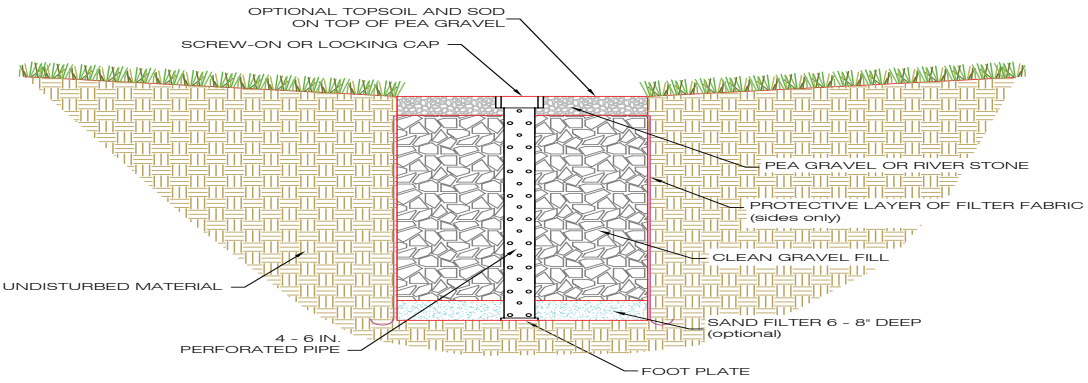

Figure 4.2. *Typical Infiltration Trench*

(Source: Virginia DEQ, Specification #8, 2013)

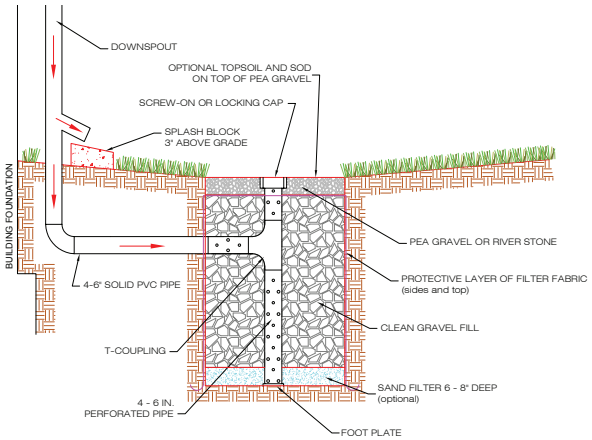

Figure 4.3. *Typical Dry Well with Optional Observation Well*



4.1. Complexity

Infiltration Trenches and Dry Wells are relatively small and simple practices that capture runoff from rooftops or very small paved areas. As the practices get larger and are designed to capture more area, the design can become more complex. Additional guidance is provided in **Table 4.1.**

Table 4.1. Design Complexity for Infiltration Trenches and Dry Wells

Design Complexity	Description	Guidance
Simple	• Small-scale, typically designed to treat water from one or two roof downspouts	• Design can be completed using simple design tools included in this manual • Ensure the soil will allow for stormwater infiltration (see **Appendix B**) • Ensure the practice is separated from any building foundation • Up to 3 feet deep
Moderate	• A bit larger in scale, treating impervious areas over 2,000 square feet • Typical design would be an Infiltration Trench that treats water from rooftops, driveway, and maybe small parking lots or other impervious areas	• Design should be provided by a professional, such as an experienced landscape contractor, licensed landscape architect, engineer, or design/installation specialist • May include vegetation and more sophisticated ways to convey and slow down runoff as it enters the practice and to manage overflow from larger rain events • A formal soil test should be completed by an engineer, landscape architect, or soils specialist • Up to 5 feet deep
Complex	• Infiltration Trench or basin treating commercial or institutional site; up to about ½ acre of drainage area	• Design requires a professional engineer or landscape architect and adherence to detailed stormwater design manual specifications • Pretreatment often includes a formal forebay cell • May require more maintenance than other Infiltration Trenches

Understand the Complexity of the Infiltration Project

The intent of this guide is for practices in the SIMPLE (or low end of MODERATE) categories. In general, Infiltration Practices that capture larger areas become more complex. Larger drainage areas need channels and pipes to get stormwater to and from the practice safely. These higher-volume practices require more features to filter grit and sediment to prevent clogging or groundwater pollution.

Infiltration Practices should be designed and constructed by a contractor with experience and knowledge about this practice. The design and construction details provided in this chapter may allow Stewards and homeowners to better understand the practice, but not to construct this practice without the help of an experienced contractor.



4.2. Location & Feasibility

Where NOT to Locate Permeable Hardscapes

1. Within 10 feet of a building foundation
2. Over Utilities
3. Near the edge of steep slopes or bluffs
4. Near an existing or reserve septic drainfield or tank
5. In low spots that do not drain well
6. Within 2 feet of high ground water level
7. In areas that would require disturbing healthy native soils and vegetation like under existing tree canopy
8. Where there is high groundwatrer during the winter
9. Near Wells- Stay back 50 feet from confined wells, or 100 feet from unconfined wells

Figure 4.4. *Examples of site constraints for locating an Infiltration Practice*
(Original graphic source: Washington State University Extension, 2013)

When deciding where to build an Infiltration Practice, consider the siting constraints illustrated in **Figure 4.4,** as well as the following:

Soils When installing an Infiltration Practice, it is important to ensure soils can infiltrate the water directed to them. For small-scale practices, this testing can be based on observations described in **Appendix B,** with a result of at least 1 inch per hour, and preferably a sandy or sandy-loam texture. Since the performance and longevity of these practices depend on adequate infiltration, the 1 inch per hour threshold should be considered a bare minimum, with recommended levels exceeding 2 inches per hour. For larger practices, the designer should perform a soil infiltration test in accordance with the applicable state stormwater management manual. When testing the soils, make sure to test the soils below the surface, at the depth of the bottom of the trench.

Make Sure the Soils are Right for Infiltration

If the soils on the site are clay and/or do not allow water to infiltrate at an adequate rate of 1 inch per hour, consider using a Conservation Landscape (**Chapter 1**) or Rain Garden (**Chapter 2**).

These practices have similar applications as Infiltration Practices, but use plants and a filtering soil medium to remove pollutants. They are generally more adaptable to a site with soils that will not support a full infiltration design.



Groundwater Depth Infiltration Trenches filter pollutants as runoff flows through the natural soils. If the groundwater comes too close to the bottom of the trench, pollutants can flow through to the groundwater. In addition, Infiltration Trenches that come too close to groundwater may drain slowly, creating a drainage or standing water problem. The grounwater should be at least 2 feet below the bottom of the trench in most areas. **Appendix B** has some tips for determining groundwater levels throughout the year.

Karst Topography – Do Not Create a Problem While Trying to Solve Another

Karst topography (or Karst terrain) is geology that is characterized by soluble rocks that can dissolve to form sinkholes and caves. Water and associated pollutants can travel very quickly in Karst, and Infiltration Practices are potentially problematic. If the site is in a confirmed Karst area, practices such as bioretention cells *with underdrains* are recommended. Check local and/or state design standards to determine what practices are restricted in Karst.

Setbacks To avoid the risk of seepage into basements, do not install Infiltration Practices directly adjacent to building foundations. Recommended setbacks from foundations are:

- 10 feet if Infiltration Trench is downhill from building (preferred).
- At least 25 feet if the Infiltration Trench is uphill from the building. This option is discouraged, but can be used if an overflow channel directs water away from the building to a downhill channel, driveway, or street.
- 100 feet away from a drinking water well
- 50 feet away from the edge of a septic drain field
- Also, keep Infiltration Practices outside the drip line of existing trees to avoid damaging tree roots during excavation.

Be Careful About Setbacks

If you are near a finished basement, make sure you understand if and how the building is waterproofed.

Proximity to Utilities Always call Miss Utility before digging the Infiltration Trench. Interference with underground utilities should be avoided whenever possible, particularly water, sewer, and gas lines. Conflicts with water and sewer lateral pipes (e.g., house connections) might be unavoidable, in which case excavation should be done very carefully to avoid damaging the pipes. Check the proposed site for existing utilities prior to finalizing the Infiltration Trench location.

Shape of the Land Infiltration Practices should never be located near slopes greater than 15% and the practice itself should be nearly or completely flat.

Land Area Being Treated Stabilize the area being treated before the practice is used, since soil particles carried by runoff from bare soils will clog the practice. Do not use Infiltration Practices to treat areas that will remain as bare soil for a long period of time, or to treat runoff from any areas where vehicles are maintained (except the roof of a covered garage).

Consider a Dry Well for a Small Roof

Dry Wells (sometimes called "soak-away pits") are very similar to Infiltration Trenches, but are configured as a stone-filled pit rather than a trench (see **Figure 4.3**). With most Dry Wells, the roof downspout is piped directly into the underground gravel/stone layer. This practice typically includes a leaf screen or debris filter in the gutter or downspout, and a surface overflow pipe for larger rain events.



4.3. Design

The materials used to design Infiltration Trenches are readily available, and the design is fairly simple when the practice is designed to treat small areas.

Practice Size Infiltration Trenches are sized to hold the runoff from 1 inch of rain. Since the practices are usually filled with sand, rounded stone, and gravel, this runoff is stored in the porous spaces between the stones in the reservoir. The surface area needed will depend on the depth of the stone reservoir and the area of impervious cover treated, using the following rule:

Surface Area (square feet) = 0.20 x Impervious Area Treated (square feet) / Stone Depth (feet)

Surface Area (square feet) = 0.20 x Impervious Area Treated (square feet) / Stone Depth (feet)
– 1.5 x Chamber Volume (cubic feet) / Stone Depth (feet)

Click here to download the Dry Well Worksheet. This spreadsheet can calculate and recommend certain areas and volumes for an infiltration BMP, provide material quantities, approximate material costs, and pollutant removal effectiveness.

Pre-Treatment Pre-treatment refers to something that will remove leaves and grit from the roof, and larger particles of dirt from the runoff before it enters the practice, helping to keep the infiltration area from clogging and not draining properly. The type of pretreatment depends on the scale of infiltration. For practices that treat rooftop only, the biggest concern is leaf litter that can clog the practice. For this scale, the only pretreatment needed is leaf screens installed at the roof gutter. For practices that treat somewhat larger areas (including from small areas of pavement), runoff must first flow through a simple grass strip or channel before it reaches the infiltration area.

Excess Soil Plan for a place to dispose of or use excess dirt that will come out of the ground when the Infiltration Practice is excavated. If some of the excavated soil is used on the lot, add some topsoil, as that will help grass or other vegetation to establish.

Inflow If the Infiltration Trench receives stormwater from roof downspouts, incorporate a pad of river cobble stone or some other means to reduce flow velocity at the mouth of the downspout. For other areas that drain to the Infiltration Practice, it is best if the flow is spread out and diffuse (referred to as "sheetflow"), and not concentrated in a pipe or channel. Where a sidewalk, patio driveway, or other impervious area is flowing into an Infiltration Trench, add a strip of river cobble or stone at the edge to prevent erosion and undercutting of the impervious surface. This stone strip should run the entire length of the Infiltration Trench where it meets the hard surface, be underlain with filter fabric that extends under the hard surface, and be approximately 12 inches wide and 12 inches deep.

Do:

- Locate any utilities present when planning location of Dry Wells
- Plan for removal, disposal or use of excess soil
- Size the Infiltration Trench or Dry Well properly, or plan carefully for overflows

Don't:

- Install close to building foundation, especially if uphill from building
- Locate near water wells or septic fields
- Use filter fabric on the bottom of the excavation.



Filter Fabric is Used Differently for Infiltration Trenches vs. Dry Wells

An important design consideration is whether incoming water will flow to the practice over the surface of the ground (typical for Infiltration Trenches) OR be piped directly into the underground gravel/stone layer (typical of Dry Wells).

When water enters from the surface, highly porous filter fabric can be used on the sides of the excavation, but not on any horizontal surface, including at the bottom of the excavation or between the gravel and pea gravel layers. Use of filter fabric on these horizontal planes can lead to clogging.

Alternately, if water is piped directly into the gravel/stone layer underground, it is recommended that the filter fabric layer be used on the sides and wrapped around the top of the gravel layer to serve as a separation barrier, especially if covered with topsoil and turf. However, do not use filter fabric at the bottom of the excavation, as this can interfere with proper infiltration.

Filter Fabric is often referred to as geotextile and comes in many forms, depending on the application. Select the right geotextile for the job. While most practices in this manual employ non-woven, Class C geotextile, some situations call for different products. Check with an engineer or geotextile vendor to select the right material.

See **Figures 4.2 and 4.3** for details.

Overflow During large storm events, the Infiltration Practice will fill with water. The remaining runoff needs to flow safely from the site and not towards building foundations or other structures that can be damaged. Ideally, this is a gently-sloping, vegetated, and stable area in the yard that slopes away from the house or neighboring houses.

Incorporating Into the Site Infiltration Trenches are typically long, rectangular-shaped practices. As a result, they can be incorporated into the site without changing the appearance of the existing land. They work well when aligned with edges, such as rooftops or pathways. Dry Wells are usually square or circular in shape and placed close to each downspout.

4.4. Materials

Table 4.2. Material Specifications for Infiltration Trenches: From Bottom to Top

Material	Specifications	Size	Depth	Notes
Filter fabric	Non-woven, Class C geotextile or standard filter fabric	N/A		See notes above – use on sides of excavation; wrap around top of gravel ONLY IF water is piped directly into gravel layer (Dry Well)
Gravel	Washed gravel or stone, preferably rounded, "bank run"	1 ½ - 3 ½ inch diameter #1, #2, or #3 stone	18-48 inches (1.5-4 feet)	Can also be used as erosion prevention at inlets and outlets Use filter fabric or weed-block under the stone
Pea gravel	#8 or #78 stone	⅜ - ½ inch	2-4 inches	Must be washed clean at quarry
Observation well (optional)	4 to 6 inch Schedule 40 PVC pipe, with ⅜" perforations (see notes)	4-6 inches	Deep enough to extend from the bottom of the gravel layer to extend about 6 inches above the surface.	Also includes a cap and footplate. Pipe above gravel layer should *not* be perforated.
Cobble/Stone	Washed river rock, large gravel, or small rip-rap	3 - 5 inch diameter stone	1 or 2 layers deep	Use at downspouts, inlets, outlets, and along hardscape edges as needed to dissipate flow and prevent soil erosion Use filter fabric under stone

4.5. Construction

Step 1 - Outline the Project & Mark Utilities Mark the excavation area for the Infiltration Trench. Call Miss Utility before excavating. Confirm the flow of water into the Infiltration Trench, checking the areas that will contribute runoff to the practice. In some cases, this may require using a survey level or hand level and a survey rod to check spot elevations and confirm flow paths. The best method is direct observation during a rain event.

Step 2 - Erosion Control & Excavation It is best to dig the trench when the weather is expected to be dry for several days. It is recommended to put a row of silt fence below the area that will be excavated. Excavate the trench at least 18 inches wide. Use only light weight (i.e., walk-behind) machinery and hand tools, or work from the side of the trench.



Step 3 - Rake or Till Rake, till, or otherwise scarify the bottom soils to promote greater infiltration.

Step 4 - Filter Fabric Line the SIDES ONLY of an Infiltration Trench with non-woven geotextile. Do not put geotextile horizontally across the bottom of the excavation. For Dry Wells where water is piped into the gravel layer, leave enough extra fabric at the edges to fold over the top of the gravel layer (for Step 7).

Step 5 - Install Well If using an observation well, install with the footplate at the bottom of the trench.

Step 6 - Install Stone Install the amount of cobble or gravel stone called for in the plans to within 2-4 inches of the ground surface. **Figure 4.5** shows a Dry Well installation at the stage between Step 6 and Step 7.

Figure 4.5. *Dry Well installation with an observation well, shown after gravel is placed, before pea gravel*
(Source: Lancaster Counter Conservancy - Urban Greening Program)

Do:

- Call Miss Utility to locate any utility lines before digging
- Scarify (roughen) the bottom of the trench or basin
- Place gravel in 4-12 inch layers

Don't:

- Line the bottom of the trench or well
- Compact the soils in the trench
- Rush if the excavation is near utilities – a little extra time could save a lot

Step 7 - Fold Fabric Fold the top edges of the filter fabric from the sides over the top of the stone, only if the design calls for water to be piped directly into the gravel layer (typical of Dry Wells). If water will enter the practice by flowing over the ground surface, do not wrap filter fabric over the top.

Step 8 - Add Pea Gravel Install a 2-4 inch layer of pea gravel. It is also acceptable to top the stone layer with soil and sod as an alternative. Do not compact the top layer.

Step 9 - Add Pre-Treatment Install any pre-treatment features associated with the plan, such as a stone pad at the mouth of downspouts. A stone pad, sometimes called an apron, should be installed lower than the surrounding grade. Dig a 1-2 foot wide channel, approximately 4-6 inches deep at the edges, and 6-8 inches deep through the center. Line this with filter fabric or "weed block" (secured with landscape staples), and backfill with one or two layers of 3-5 inch diameter cobble. See Chapter 1, Conservation Landscapes, Section 1.3, for more information on the cobble apron. Seed and straw or landscape all side slopes, berms, and disturbed areas.

Step 10 - Inspect Inspect the trench after several rain events to look for any needed adjustments. Ensure runoff is entering the practice properly and draining properly. Ensure inlets and outlets have no erosion.

Be Careful When Digging

This practice relies on soils at the site to work properly. When digging the trench, ensure the soils at the bottom of the trench are not smeared, which will seal the soils and limit infiltration. Do not allow muddy water to flow to the trench during construction, and do not compact the soil by running equipment back and forth across

4.6. Maintenance

Clogging is the Biggest Maintenance Concern

The most important part of maintaining Infiltration Trenches is to make sure that debris and grit do not enter the trench or Dry Well, causing it to clog. If using an observation well, the well can be checked after a rain event to ensure that all the water is percolating into the soil. Ideally, all the water would be gone within 48 hours after the end of a rain event. It should take no more than 72 hours after the end of a rain event to drain the practice.

Table 4.3. Recommended Maintenance for Infiltration Trenches

Maintenance Tasks	Schedule
• Ensure the contributing drainage area is stabilized, and repair any areas that are eroding • Check downspouts and channels leading to the trenches, and remove any accumulated debris	Quarterly
• Check observation wells (if any) 3 days after a rain event with ½ inch of rainfall or greater. • Treat the practice for clogging if standing water is still present after 3 days • If no observation wells are included, but the practice is very shallow, observe ponding by removing some pea gravel at the surface of the trench	Twice/year
(Clogging troubleshooting) • If the Infiltration Trench starts to drain slowly, remove the top pea gravel or topsoil/turf layer. If filter fabric is present, this may be the source of the clogging. Remove this layer of filter fabric. Check to see if the trench will draw down and replace the overlying material with clean pea gravel or topsoil. • If a Dry Well does not drain properly, dig down to check inflow points for excessive leaves or debris.	Once/year or as needed
(Overhaul) • If the Infiltration Trench or Dry Well is clogged from the bottom, and water stands on the surface, then the practice will need to be reconstructed. If the issue is the underlying soils, the practice should be replaced with a Rain Garden or Conservation Landscape.	Once/year or as needed

4.7. Resources

Maryland Department of the Environment. 2009. *2000 Maryland Stormwater Design Manual – Rev. 2009.* Baltimore, MD. Available at: http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Pages/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.aspx

Virginia Department of Environmental Quality. 2013. *Virginia Stormwater BMP Specifications – Rev. 2013 (DRAFT).* Richmond, VA. Available at: http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx

West Virginia Department of Environmental Protection (WVDEP). 2012. *West Virginia Stormwater Management and Design Guidance Manual.* Prepared by: Center for Watershed Protection.