Chapter 6 - Infiltration BMPs

Infiltration measures control stormwater quantity and quality by retaining runoff on-site and discharging it into the ground through absorption, straining, microbial decomposition and trapping of particulate matter. Infiltration systems should not be used if the intercepted runoff is anticipated to contain pollutants that can affect groundwater quality, such as hydrocarbons, nitrate, and chloride.

When the subsoils are appropriate, an infiltration basin can be suitable for treating and controlling the runoff from very small to very large drainage areas. However, some commercial or industrial sites may have contaminants that may not be treatable by soil filtration and should be avoided. Figure 6-1 shows a typical infiltration basin.

IMPORTANT:
This chapter describes three common Infiltration BMPs: infiltration basins, dry wells, and infiltration trenches. In addition to these infiltration techniques, there are several Low Impact Design (LID) techniques that rely on infiltration in small systems dispersed throughout a site, rather than an end-of-pipe technique such as the infiltration basin.

Sizing: Infiltration systems must be designed to retain a runoff volume equal to 1.0 inch times the subcatchment's impervious area plus 0.4 inch times the subcatchment's landscaped developed area and infiltrate this volume into the ground. The infiltration system must drain completely within 24 to 48 hours following the runoff event. Complete drainage is necessary to maintain aerobic conditions in the underlying soil to favor bacteria that aid in pollutant attenuation and to allow the system to recover its storage capacity before the next storm event.

Site Suitability: The following are some recommendations on the suitability of a site:

- *Soil Permeability:* The permeability of the soil at the depth of the base of the proposed infiltration system should be no less than 0.50 inches per hour and no greater than 2.41 inches per hour. Permeability should be consistent across the proposed infiltration area and should be determined by in-place well or permeameter testing, or by analyses of soil gradation.
- *Industrial Sites:* Infiltration measures should not be used in manufacturing and industrial areas because of the high potential for soluble and toxic pollutants and petroleum products.
- *Site Slopes:* Infiltration should not be located on slopes greater than 20%.
- *Fill Soils:* Do not install infiltration systems in a newly filled area or a site designated as "made land" without a geotechnical evaluation of the subgrade stability and permeability rates.
- *Construction Sites:* Construction site runoff should not be directed to infiltration areas because of the high concentration of suspended solids, which will clog infiltration surfaces.

Siting: The proper location of an infiltration basin is the most important aspect for its effectiveness:

- *Subsurface Investigation:* Subsurface explorations (test pits or borings) should be made within the basin area to identify depths to seasonal high groundwater and bedrock. Explorations should extend to below the proposed basin bottom elevation.
- *Separation from Seasonal High Water Table:* The bottom of the infiltration system, including any stone layer or other material below the depth of any manufactured components of the system, must be at least three (3) feet above the seasonal high water table.
- *Separation from Bedrock:* Infiltration systems serving one (1) acre or more of impervious area should be located in areas with more than five feet of saturated overburden above the bedrock surface, as measured during the seasonal low water table. This restriction does not apply to runoff from areas of non-asphalt roofing on structures in which no manufacturing or processing occurs, other than for home-based industries. Separation from bedrock and depth to the water table may be demonstrated

by means of test pits, borings, or similar invasive explorations, or by non-invasive geophysical methods such as seismic surveys.

- *Impact on Depth to Groundwater:* Infiltration of stormwater may not increase the elevation of the seasonal high water table beneath a surface-irrigation site, land-disposal area for septage or other waste, or other waste or wastewater management facility, without approval by the DEP and, if applicable, the Department of Health Human Services.
- *Impact on Groundwater Flow:* Stormwater infiltration may not affect the direction of groundwater flows so as to impair any groundwater monitoring programs or cause the migration of existing contaminated groundwater that would result in unreasonable adverse impact on the quality of surface water, groundwater, or drinking water supplies.
- *Mounding and Seepage:* Infiltration of stormwater may not cause effects that will adversely affect the stability of slopes in the vicinity of the activity. When requested for a large system or where groundwater is at risk from contamination or impact from high infiltration rates, a qualified professional will need to assess the potential for seepage and reduction in slope stability, and submit a report of findings, including logs of test borings or other subsurface explorations, modeling, or other means of analysis as determined to be necessary and applicable.
- *Conveyance of Overflow:* Infiltration systems should include measures to convey overflow to a stable discharge location.
- *Access:* Access to any infiltration area should be controlled during and after construction to prevent compaction of the soil. Limit access to the site to only that equipment needed to construct the infiltration system. Avoid placement of heavy objects or traffic on stone areas or chamber areas not H-20 rated.
- *Dry Weather Effluent:* Dry weather storm drain effluent should not be directed to infiltration areas due to probable high concentrations of heavy metals, pesticides, pathogens, and other pollutants.
- *Site Construction:* Infiltration practices may not be used as sediment control devices during site construction. Plans must clearly indicate how sediment will be prevented from entering the infiltration device during construction.
- *Snowmelt:* Snowmelt runoff from areas subject to or adjacent to road traffic or parking should not be directed to infiltration areas because of the high concentrations of salts.

Setbacks:

- *From Water Supplies:* Unless approved by the DEP and the Department of Health and Human Services' Drinking Water Program, locate the infiltration system at least 300 feet from any private water supply well, outside the delineated contributing area of a public water supply well, and as far downgradient of any water supply well as practical.
- *From Wastewater Disposal Systems:* An infiltration system is considered a major watercourse for the purposes of the Maine Subsurface Wastewater Disposal Rules, 10-144 CMR 241; and additional setback distances may be required by the local plumbing inspector or the Department of Health and Human Services' Subsurface Wastewater Team. Allowance for lesser setbacks for onsite disposal systems or other disposal systems owned or controlled by the developer may be requested from the DEP, the Department of Health and Human Services, and the local plumbing inspector. Infiltration systems must be located as far downgradient of any component of a subsurface wastewater disposal system as practical.
- *From Water Supply Lines:* 10 feet from any water supply pipe.
- *From Steep Slopes:* 50 feet from downhill slopes greater than 3:1.
- *From Flood Plains:* 10 feet from a 10 year floodplain.
- *From Property Lines:* At least 25 feet from any property line.

Pretreatment: Pretreatment devices such as grassed swales, underdrained swales, filter strips, and sediment traps should be provided to minimize the discharge of sediment to an infiltration system.

- Sizing: Pretreatment structures should be sized to hold an annual sediment loading of a sand application rate of 500 lbs/acre for sanding of roadways, parking areas, and access drives within the

subcatchment area, a sand density of 90 lbs per cubic foot and a minimum frequency of ten storms per year.

- *Petroleum Pretreatment:* Infiltration systems receiving runoff from asphalt or concrete paved areas should include sump skimmers, sorbent booms, or similar devices to remove petroleum products from runoff.

Design and Construction: The following are some design and construction recommendations for infiltration systems:

- *Soil Amendment:* If amending soils to meet permeability, the added soils must be at least six inches thick, with the bottom three inches tilled into the native soil.
- *Emergency Drainage:* A means to dewater the infiltration system in the event of failure should be provided. This will allow for easier repair of the system.
- *Geotextile Lining:* A geotextile fabric may be placed between any stone layer and adjacent soil as the fabric will prevent the surrounding soil from migrating into the system. Use an appropriate geotextile fabric that is compatible with the surrounding soil or it will clog. The filter fabric should be free of tears, punctures, and other damage. Overlap seams a minimum of 12 inches.
- *Stone Fill:* Stone fill should be clean, washed, 1½ to 3-inch aggregate. A porosity value of 0.4 should be used in the design of stone reservoirs for infiltration practices.
- *Fill Placement:* Limit fill compaction to the work necessary to uniformly spread the fill within the structure. Do not drive rollers or other equipment over the fill to compact it.
- *Landscaping:* The drip-line of any existing or newly planted trees should not extend over the infiltration system. New trees should be planted away from the infiltration system to account for future crown and root growth. Any tree seedlings in the vicinity of an infiltration system should be removed to prevent roots from intruding into the system
- *Insulation:* Unlike wastewater disposal systems, which are less likely to freeze due to the effluent temperature and to biological activity, a stormwater infiltration system may freeze if located above the depth of frost penetration. Shallow subsurface systems should be insulated.
- *Site Construction:* Infiltration practices may not be used as sediment control devices during site construction as sediment will clog the device.

Erosion Control: Construct an infiltration system after the upgradient drainage area is stabilized with vegetation and erosion controls are installed to prevent sedimentation. An infiltration basin receiving flow from an unstabilized site will reduce its working life, and may clog prior to the completion of the development. The contractor should use sod to vegetate a filter strip or a sediment barrier should be installed between the basin and filter strip until fully vegetated. The contractor should install a pretreatment drop-inlet sediment filter around the pretreatment inlet and keep in place until the drainage area is fully stabilized with pavement and vegetation.

Groundwater Monitoring: Groundwater quality monitoring of infiltration systems is important if the runoff is from areas of heavy turf-chemical use (golf courses, certain athletic fields), and large connected impervious areas (parking lots and runways). Groundwater quality monitoring will generally not be required for systems infiltrating water from low use lawn areas and other vegetated areas, residential developments, playing fields, and roofs of residential and commercial structures

- *Observation and Monitoring Wells:* Observation wells to determine the system's performance and access points to allow for the removal of accumulated sediment should be included in the design of infiltration systems. Monitoring wells should extend into the groundwater to enable sample extraction if necessary to track groundwater quality. Dry wells and infiltration basins should have staff gauges, marked rods, or similar instrumentation to measure the accumulation of sediment and determine how quickly the system drains after a storm. The maintenance plan must indicate the expected rate of drainage of the infiltration system and provide for the removal of sediment from the infiltration system.
- *Groundwater Testing:* Groundwater samples taken from monitoring wells should be analyzed quarterly for indicator parameters such as pH, specific conductance, dissolved oxygen, metals and chloride. Zinc has been found to be a stable heavy metal and appears anywhere from two to ten

years after operation of large systems. Sampling for extractable petroleum hydrocarbons (EPH), BTEX and MTBE, should be performed if draining large impervious areas of urbanized areas.

- *Subsurface systems:* Subsurface infiltration systems should have an observation well unless the system uses an accessible manhole-type structure. The observation well should be a 4-inch diameter, perforated PVC pipe fitted with a removable yet securable well cap, foot plate, and rebar anchor. Set the observation well prior to backfilling.

Maintenance: Preventive maintenance is vital for the long-term effectiveness of an infiltration system. Since infiltration is less conspicuous than most BMPs, it is easy to overlook during maintenance inspections. The following criteria apply to all infiltration systems.

- *Fertilization:* Fertilization of the area over the infiltration bed should be avoided unless absolutely necessary to establish vegetation.
- *Snow Storage:* Snow removed from any on-site or off-site areas may not be stored over an infiltration area, with the exception of storage on permeable pavement.
- *Monitoring and Inspections:* Inspect the infiltration system several times in the first year of operation and at least annually thereafter. Conduct the inspections after large storms to check for surface ponding at the inlet that may indicate clogging. Water levels in the observation well should be recorded over several days after the storm to ensure that the system drains within 24 to 48 hours after filling. The basin will need to be rehabilitated if it fails to drain before the next rain event or 72 hours.
- *Pollution-Control Devices:* Pollution-control devices such as oil-water separators, skimmers, and booms should be inspected regularly to determine if they need to be cleaned or replaced.
- *Sediment Removal and Maintenance of System Performance:* Sediment must be removed from the system at least annually to prevent deterioration of system performance. The pre-treatment inlets should be checked and cleaned out when accumulated sediment occupies more than 10% of the available capacity. This can be done manually or by a vacuum pump. Inlet and outlet pipes should be checked for clogging. Accumulated grease and oil from separator devices should be removed frequently and disposed of in accordance with applicable state and local regulations. The system must be rehabilitated or replaced if its performance is degraded to the point that applicable stormwater standards are not met.
- *Pretreatment Buffer Strips:* If a grass buffer strip is used in conjunction with the infiltration BMP it should have vigorous and dense vegetation. Bare spots or eroded areas should be repaired and/or re-seeded or re-sodded. Watering and/or fertilization should be provided during the first few months after the strip is established, and may be needed in times of drought. Grass filter strips should be mowed regularly to prevent the uncontrolled growth of weeds, but filter strip performance will be impaired if the grass is cut too short.

6.1 - Infiltration Basin

An infiltration basin is a water impoundment that is up to 12 feet deep, constructed over permeable soil to infiltrate runoff into the ground. The basin drains dry between storm events and, and should not release any stormwater as surface flow except for flows from larger storms through an emergency spillway. See Chapter 3.0, Detention Basins for Flood Control for more guidance.

Design and Construction: In addition to the general design and construction criteria discussed above, the following criteria must also be considered for infiltration basins:

- *Off-line Sitting:* A basin designed for water quality treatment is located off-line from the stormwater system using a flow splitter to prevent the "first flush" runoff from being diluted and pushed out the emergency spillway by the remaining runoff. Refer to Chapter 8, for a typical flow-splitter design.
- *Site Slopes:* The surface grade at the basin site should be 5% or less.
- *Setbacks:* Locate the basin at least 20 feet from any foundation upslope from the basin and at least 100 feet from any downslope foundation. Site the basin at least 75 feet away from any freshwater or coastal wetland, stream, river, or lake.
- *Heavily Used Areas:* Sites that will receive heavy use (such as playing fields) should not be considered for infiltration basins due to the limited infiltration capacity of compacted surface soils.

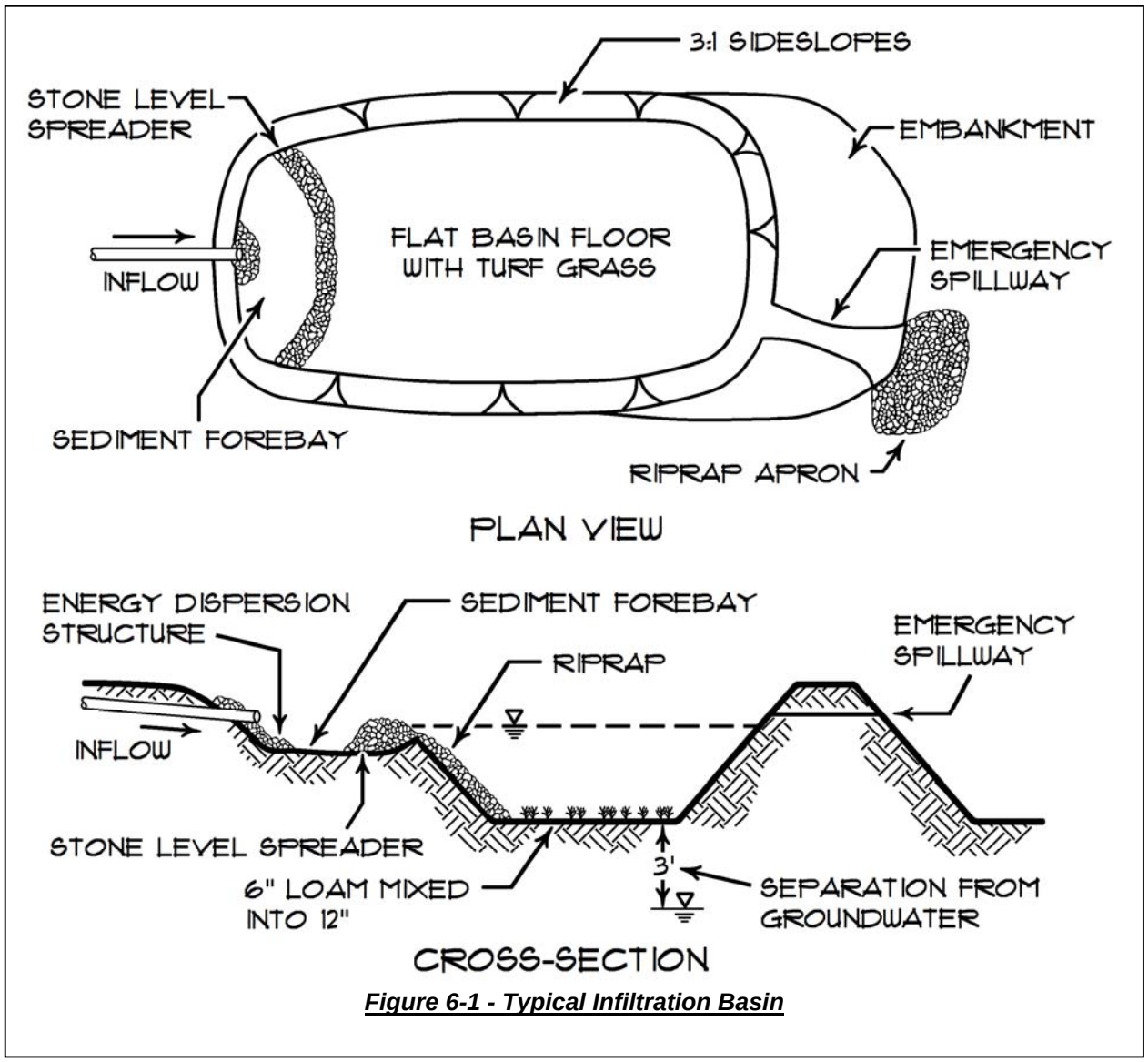

Figure 6-1 - Typical Infiltration Basin

- *Storage Volume:* The required volume of runoff to be stored in an infiltration basin consists of the volume to be treated by infiltration, plus additional capacity that may be necessary to control the peak discharge from storms exceeding the infiltration design rate. The basin storage volume should be intentionally oversized to account for the eventual total loss of infiltration capability. Only the volume in a pond above an outlet structure can be utilized on a long-term basis for the detention of the runoff from extreme storm events.
- *Storage Depths:* The maximum depth for a required recovery time can be found using the following equation:

  $$dmax = F * Tp$$

  Where: dmax = maximum storage depth (inches)
  F = final permeability rate of the basin area (inches per hour)
  Tp = maximum allowable ponding time (hours). =
  The final permeability rate is determined from field percolation tests. .
- *Emergency Outlet:* The infiltration basin should have an emergency spillway to convey overflow during extreme storm events. The spillway may be either a stone-lined or vegetated channel or a riser outlet. As a minimum, the spillway should convey a flow equal to the 25-year, 24-hour peak inflow into a drainage way while maintaining one foot of embankment freeboard above the water elevation in the basin. Spillways should be constructed on original ground (not embankment fill) and should have a stable discharge outlet.
- *Side Slopes:* The side slopes should be no steeper than 3H:1V, and be well-vegetated with species that can tolerate inundation and flooding for up to one week.
- *Basin Floor:* Design the basin floor to be flat (0% slope) for a uniform ponding depth to ensure that the full infiltrative area of the basin will be used for each storm. However maintaining micro-topography (small mounds and depressions) on the basin's floor may help delay clogging by concentrating sedimentation in the depressions. The floor should be prepared with one of the following linings.
  - *Coarse Sand or Pea Gravel:* The sand or gravel should be at least 6 inches thick. The filter layer can be replaced or cleaned when it becomes clogged.
  - *Grass Turf:* If grass is used on the basin floor, it should consist of species that can survive inundation for up to one week and still provide a dense, vigorous turf layer. Root growth continually opens up new drainage paths within the soil, and will helps delay clogging of the basin floor.
  - *Coarse Organic Material (erosion control mix or composted mulch):* These materials should be tilled into the soil. The basin floor should then be soaked or inundated for a brief period and allowed to dry. This induces the rapid decay of organic material, increasing the soil's permeability and its ability to remove soluble pollutants from the runoff.

Maintenance: Infiltration basins can have long life spans if they are properly maintained.

- *Basin Inspections:* Inspections of infiltration basins should be conducted on a semi-annual basis and following major storms. Timely maintenance is critical, as poor maintenance practices can result in loss of infiltration capacity.
- *Drainage Area:* Inspect the basin's drainage area semi-annually for eroding soil and other sediment sources and repair eroding areas immediately or control sediment sources (such as stockpiles of winter sand, by removing them from the basin's drainage area or surrounding them with sediment control BMPs).
- *Mowing:* A basin with a turf lining should have its side-slopes and floor mowed no more than twice a year to prevent woody growth. Mowing operations may be difficult since the basin floor may remain wet for extended periods. If a low-maintenance vegetation is used, basin mowing can be performed in the normally dry months. Clippings should be removed to minimize the amount of organic material accumulating in the basin.
- *Pedestrian Access:* Limit access to turf lined basins to passive recreational activities. Do not use the basin for a playing field, as heavy foot traffic can compact the soil surface.

6.2 - Dry Well

A dry well is a small, stone-filled pit or structure surrounded by stone, typically 3 to 12 feet deep, that stores and infiltrates runoff from a very limited contributing area. Runoff enters the dry well by an inflow pipe, inlet grate, or by surface infiltration, and infiltrates through the bottom and sides of the pit. When a dry well is properly sited and designed, most runoff pollutants will become bound to the soil under the well while the water percolates to the groundwater table.

Dry wells can also be used in combination with catch basins on roadways to promote infiltration of smaller storms, while providing conveyance of larger storms. These can be designed with deep sumps to capture sediments, while still providing for infiltrating through the walls above the sump. See Chapter 7.5 Filtration BMP, Roof Dripline Filter for another use of a drywell.

Design and Construction: In addition to the general design and construction criteria discussed above, the following criteria must also be considered for dry wells.

- *Overflow Measures:* Design and build a dry well to include measures for controlling overflow. In a roof-drain application, a surcharge pipe can outlet to a splash block or directly onto the lawn. In a leaching catch basin, pipes can be connected to allow the discharge of larger storms as they would with standard catch basins.
- *Setbacks:* Locate dry wells at least 10 feet from the building foundation and at least 100 feet from buildings downslope from the device; and site the dry well at least 25 feet away from any freshwater or coastal wetland, stream, river, lake.
- *Inlet Connection:* The runoff diverted to a dry well can enter through below-ground pipes to avoid intercepting any sediment from surface runoff. Pipes should enter as close as practicable to the top of the dry well and through a clamped watertight boot, or be securely mortared in place.

Maintenance: Dry wells can have life span of up to 10 to 15 years, depending on how often the gutters are cleaned, the type of roofing material, and the choice of filter fabric used to line the well.

- *Gutter Cleaning:* Remove any leaves, seeds, and other debris from the roof's gutters every spring and every fall. A coarse screen or grate should be installed at the head of each downspout leading to the dry well. Replace the screen or grate if it is broken.
- *Rehabilitation:* Relieve clogging by excavating away the turf and soil over the well; removing the existing stone and perforated pipe; and rebuilding the dry well. Dig out the soil at the bottom of the dry well and replace it with a six-inch layer of clean sand. The original stone can be reused if washed. To minimize the eventual cost of rehabilitation, the dry well should be located in a lawn area as close as possible to the ground surface.

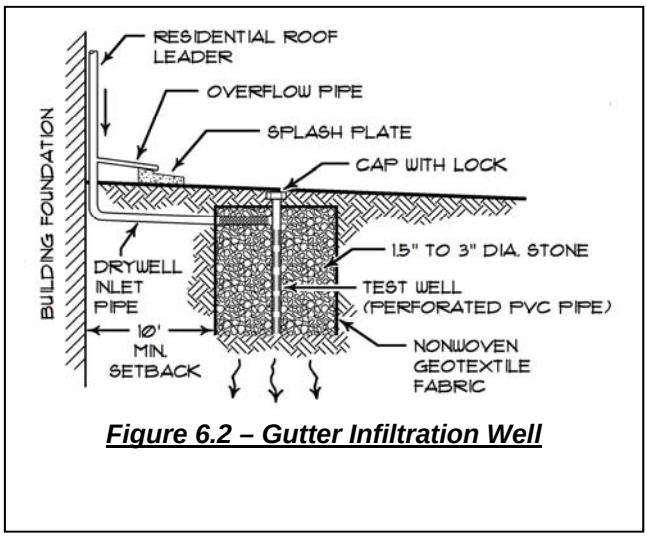

Figure 6.2 – Gutter Infiltration Well

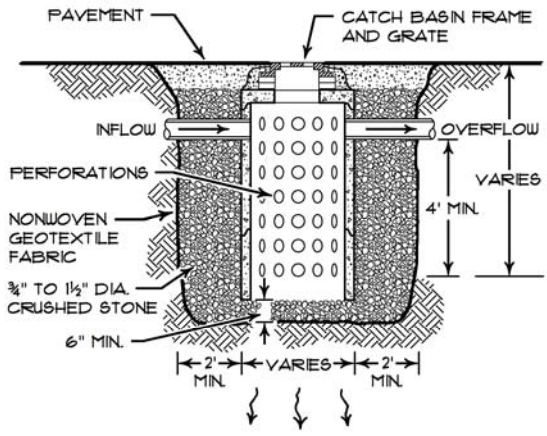

Figure 6.3 – Dry Well

6.3 - Infiltration Trench

An infiltration trench is a stone-filled excavation where runoff is collected so that it can infiltrate into the ground. There are two types of infiltration trenches: surface trenches and subsurface trenches. A surface trench is open and exposes the trench's top layer of stone and runoff enters as overland flow. Turf or pavement will cover a subsurface trench into which runoff is distributed by a perforated pipe. Storage pipes or manhole structures may be included to increase the storage capacity while minimizing the footprint of the infiltration system.

Design and Construction: In addition to the general design and construction criteria discussed above, the following criteria must also be considered for infiltration trenches.

- *Site Slopes:* The surface grade at the trench site should be 20% or less for an subsurface trench and 5% or less for a surface trench.
- *Trench Grade:* The grade of the bottom of the trench should be as close to 0% as possible. Always install the trench parallel to elevation contours.
- *Setbacks:* Locate a trench at least 20 feet from a building foundation and at least 100 feet from buildings downslope from the device. Site the dry well at least 75 feet away from any freshwater or coastal wetland, stream, river, or lake.

Figure 6.4 - Photo of Infiltration Trench

Maintenance: It is probable that a trench can have a life span of up to 10 to 15 years, depending on the maintenance of the pretreatment BMPs, and the amount of fines in the sediment load. Proper design and long-term maintenance will extend the life of an infiltration trench.

- *Surface Trench:*
  - *Inlet Maintenance:* Remove any fallen leaves and other debris from the trench's surface inlet at least every fall after leaf drop and every spring after snow melt. If left in place, the trash and leaves will clog the trench inlet.
  - *Rehabilitation:* Clogging in a surface trench is most likely to occur within the top layer of stone. Relieve this surface clogging by carefully removing the layer of stone and replacing with clean stones. The old stone may be re-used if washed to remove any fine sediment.

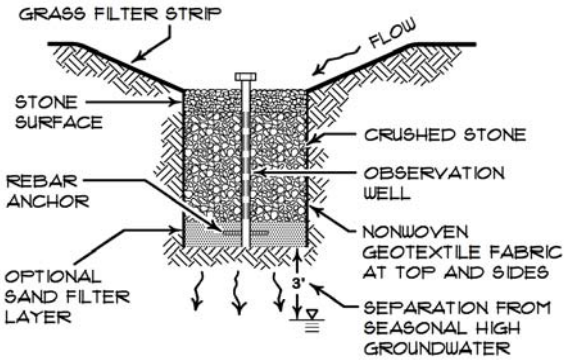

Figure 6.5 – Infiltration Trench

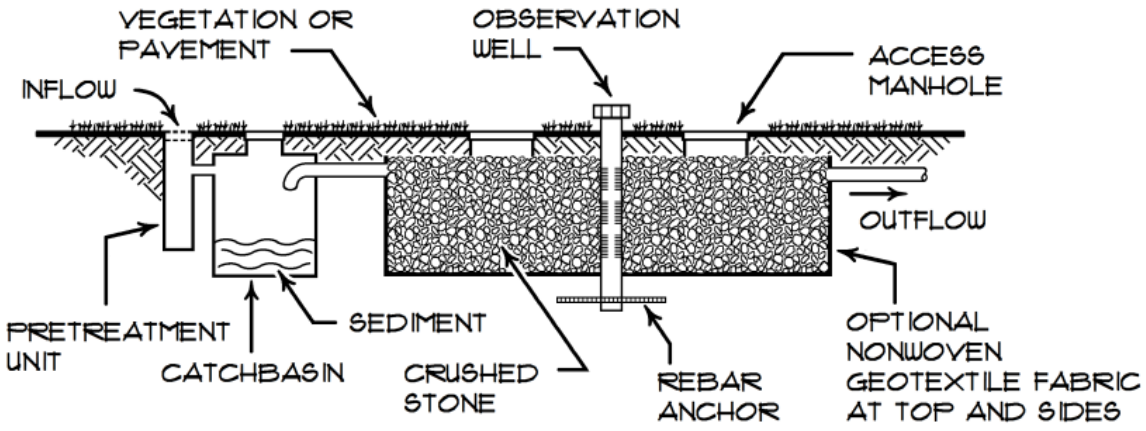

Figure 6.6 – Subsurface Infiltration Trench

- *Subsurface Trench:*
  - *Inlet Maintenance:* Annually check the pretreatment inlets to subsurface trench and clean out any sediment, trash, oil, and grease when these materials fill more than 10% of the inlet structure's capacity.
  - *Rehabilitation:* Clogging of a subsurface trench is likely to occur at the bottom of the trench and it will require excavation and reconstruction to restore its proper function. Scarify the soil at the bottom of the trench with a tiller or excavate the clogged soil and replace it with a six-inch layer of sand. The old stone may be re-used if washed to remove any fine sediment.