

Section 1500

Structural Best Management Practices

1501 INTRODUCTION

This document presents design criteria for structural Best Management Practices (BMPs) for control of surface water quality in Las Vegas Valley. These BMPs have been identified as having potential effectiveness in Las Vegas Valley based on the types of water quality conditions expected in this area, and on documented BMP performance in other areas. Criteria for the following BMPs are presented:

- Infiltration Basin
- Infiltration Trench
- Porous Pavement
- First Flush Diversion System
- Dry Extended Detention Pond
- Vegetated Swale
- Water Quality Inlet

The BMP design criteria presented in this report are offered only as suggestions at this time. There are currently no federal, state or local regulations which require the installation of specific facilities in new or existing developments in Las Vegas Valley. *Thus these BMPs should be viewed as suggestions, not as requirements, for mitigating the impacts of urban development on surface water resources in Las Vegas Valley.*

There are three general categories of conditions for which urban stormwater quality management practices may have to be applied: (1) existing urban development; (2) new urban development; and (3) construction activity. The BMPs in this document are primarily applicable to areas of new urban development, where land is available to devote to installations of this type and where design flexibility exists. In certain cases, these structural BMPs may be effective in retrofitting existing developed areas to control water quality problems. However, it is generally more cost-effective to rely on nonstructural BMPs (e.g., source controls, housekeeping practices, public education, employee training) in these applications. BMPs related to construction activity are primarily directed toward erosion control. This issue is covered separately in the Clark County Regional Flood Control District's "Hydrologic Criteria and Drainage Design Manual" and "Uniform Regulations for the Control of Drainage".

The design criteria presented below provide general guidelines for design of the selected structural BMPs. They do not represent detailed plans or specifications for the improvements. The information presented herein is intended to assist the designer in selecting the best BMP for a particular application. For each BMP the following information is provided:

Description of Facility (including schematic drawing)
Water Quality Benefits
Design Criteria
Maintenance

If more detailed design information is desired for the structural BMPs discussed in this report and others which are utilized throughout the country, reference may be made to the following documents:

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices, United States Environmental Protection Agency, Office of Wastewater Enforcement and Compliance, July 1992.

Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices, United States Environmental Protection Agency, Office of Wastewater Enforcement and Compliance, July 1992.

Manual of Standards for the New Development Management Program, County of Sacramento, November 1990 (Draft).

Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments, July 1987.

Protecting Water Quality in Urban Areas, Best Management Practices for Minnesota, Minnesota Pollution Control Agency, October 1989.

Storm water Management Manual for the Puget Sound Basin, Washington State Department of Ecology, June 1991 (Draft).

Cost of Urban Nonpoint Source Water Pollution Control Measures, Southeastern Wisconsin Regional Planning Commission, June 1991.

1502 INFILTRATION BASIN

1502.1 Description of Facility

Infiltration basins are natural or open excavated depressions of varying size in the ground surface for storage and infiltration of storm water. These basins are effective where soils are very permeable to support infiltration. The purpose of the basin is to temporarily store the surface runoff for a selected design storm or runoff volume and to maintain or increase ground water infiltration through the bottom and sides of the basin. **Figure 1501** presents a schematic plan for an infiltration basin.

1502.2 Water Quality Benefits

Properly constructed infiltration basins have a moderate to high removal capability for both soluble and small particulate pollutants associated with urban runoff. Stored runoff percolates through the soil layer, where a number of physical, chemical and biological removal processes occur. Infiltration removal efficiency depends on the amount of annual runoff volume effectively exfiltrated through the soil layer. Removal rates can be enhanced by maximizing the surface area available for exfiltration, and by limiting the draining time to avoid uncontrolled overflows due to back-to-back storms. Estimated long-term removal rates for infiltration basins are given below.

<u>Pollutant</u>	<u>Range of Long-Term Removal Efficiency</u>
Sediment	75 - 99%
Total Phosphorus	50 - 75%
Total Nitrogen	45 - 70%
Trace Metals	75 - 99%
BOD	70 - 90%
Bacteria	75 - 98%

Among the BMPs considered herein, infiltration basins most closely reproduce natural, predevelopment hydrologic conditions. Other benefits include reduction in downstream peak flows and runoff volumes, ground water recharge, low flow augmentation, and reduced downstream erosion potential.

1502.3 Design Criteria

- A minimum of 4 feet should be provided below the bottom of the basin to bedrock or the water table.
- Locate facilities a minimum of 100 feet upslope and 20 feet downslope from any building.
- Infiltration basins are not recommended for developments which have extensive cut and fill areas.
- The minimum infiltration rate allowable for design is 0.3 inches/hour. A safety factor of 2.0 should be applied to the actual infiltration rate for facility sizing.
- Infiltration basins are generally utilized for small areas. The maximum allowable drainage area is 50 acres.

- Use of pretreatment measures to minimize basin clogging is recommended. These could include upstream vegetative controls to minimize soil erosion, a pre-settling basin to allow removal of floatables, settleable solids, and oil and grease, or water quality inlets on upstream storm drain lines. A sediment forebay or riprap apron should be provided to dissipate velocity from inflow and spread the flow over the floor of the basin.
- The minimum storage volume should be equivalent to 0.5 inches of runoff from the impervious portions of the tributary drainage area.
- The minimum basin depth should be 3 feet. The maximum basin depth will be a function of the volume requirements and site conditions, and should not exceed 12 feet.
- The maximum ponding time (or dewatering time) is 72 hours.
- The basin side slopes should not be steeper than 3:1 to prevent erosion.
- The basin bottom should be graded as flat as possible.
- The basin bottom and side slopes should be lined with a healthy stand of vegetation, or with a 6- to 12-inch layer of filter material or geotextile fabric.
- The basin should be provided with a bypass system or overflow device to allow for the passage of extreme storms. Overflows must be conveyed to a safe, non-erosive outlet.
- A vegetated buffer strip with a minimum width of 25 feet should be provided between the edge of the basin floor and the nearest adjacent lot.
- The potential for adverse impacts on local shallow ground waters should be considered in the siting and design process.

1502.4 Maintenance

Sediment and other material must be removed routinely to preserve the design storage volume and infiltration rate. Fine sediments left on the basin bottom reduce infiltration capacity and limit the basin effectiveness. Proper design and maintenance of the forebay can minimize the maintenance requirements for the rest of the basin. The performance of the infiltration basin should be checked after every major storm in the first few months after construction. In particular, the drain time should be monitored to assure that the design infiltration rate is being achieved. Thereafter, the basin should be inspected annually and cleared

of debris, litter and excess vegetation at least twice per year. Sediment accumulation may be an important maintenance concern in Las Vegas Valley. Sediment removal operations should utilize light equipment to avoid unduly compacting the basin floor.

1503 INFILTRATION TRENCH

1503.1 Description of Facility

An infiltration trench is a shallow excavation (generally 2 to 10 feet in depth) which is backfilled with sand or graded aggregates. Storm water from impervious surfaces can be directed to these facilities for infiltration and limited detention. The surface of the trench can be covered with stone, gabions, sand, or grass with a surface inlet. An alternative design is to build a vault or tank without a bottom. Permeable soils are a prerequisite for this BMP. **Figure 1502** shows a schematic drawing of an infiltration trench.

1503.2 Water Quality Benefits

The infiltration trench provides adequate control for soluble and small particulate pollutants generated from small watersheds. It should not be used to trap large-sized sediments, as these will lead to premature clogging of the facility. The infiltration trench is particularly adaptable to retrofit projects for small tributary watersheds. It is easily integrated into the un-utilized portions of commercial and industrial sites. This is one of the few BMPs to provide pollutant removal on small sites.

Pollutant removal occurs through exfiltration of captured runoff into the soil layer. Removal mechanisms include sorption, precipitation, trapping, straining, and bacterial degradation or transformation. If trenches are sized to capture only low flows and initial first flush runoff volumes (the normal design condition), typical removal efficiencies can be expected in the following range.

<u>Pollutant</u>	<u>Range of Long-Term Removal Efficiency</u>
Sediment	75 - 90%
Total Phosphorus	50 - 70%
Total Nitrogen	45 - 60%
Trace Metals	75 - 90%
BOD	70 - 80%
Bacteria	75 - 90%

1503.3 Design Criteria

- The maximum tributary watershed area should be 10 acres.
- Infiltration trenches should not be located in areas receiving high sediment loads; on fill sites; within 100 feet of water supply wells; or under buildings or pavement. They should be a minimum of 20 feet downslope and 100 feet upslope from building foundations.
- The trench depth is generally between 2 and 10 feet. The bottom should be level. The normal configuration is with a long, narrow excavation. The water table should be at least 2 feet below the bottom of the trench.
- The volume should be based on accepting 0.5 inches of runoff from the tributary impervious areas. Void spaces are assumed to be in the range of 30 to 40 percent.
- Backfill material may be 1/2- to 3-inch aggregate. The trench may be backfilled to within 3 inches of the ground surface.
- A minimum 20-ft wide vegetated buffer strip should be provided to assist in removal of floatables, settleable solids, and oil and grease.
- A positive overflow pipe or bypass conveyance system should be provided for large storm events.
- An observation well should be located in the center of the facility, constructed of 4- to 6-inch PVC.
- The trench bottom and walls should be lined with a permeable geotextile filter fabric with a minimum 12-inch overlap. Filter fabric may also be installed one foot below the ground surface to trap large sediment and debris in the event the overlying cover material is removed.
- Typical trench width is 18 to 36 inches.
- The maximum infiltration or dewatering time is 72 hours.
- A minimum infiltration rate of 0.3 inches per hour should be obtainable to be effective. Use a safety factor of 2.0 when sizing the trench volume and dewatering time.
- The in-trench overflow drain should be formed of perforated or slotted pipe. Large pipes can be used to add to the storage in the trench. Typical perforations are 3/8-inch diameter holes with not less than 30

perforations per square foot of pipe. The pipe drain should be located a minimum of 2 feet above the trench bottom.

- For Median Strip Design: Sheet flow is accepted from both sides of the infiltration trench, and is filtered through a 20-ft wide vegetated buffer strip graded at a slope of 5 percent. An overflow pipe is required to pass excess flows.
- For Parking Lot Perimeter Design: Sheet flow is accepted from the lower end of the parking lot. Slotted curb spacers are used as a level spreader at the edge of the parking lot to evenly distribute flows to the 20-ft wide vegetated buffer strip.
- For Swale Design: The swale collection system longitudinal slope should not exceed 5 percent. The trench should be located in the invert of the swale. Check dams may be required across the swale to increase the retention volume and prevent “short-circuiting” of the infiltration trench. See the section on “Vegetated Swales” for more information.

1503.4 Maintenance

Maintenance requirements for infiltration trenches are not great, consisting primarily of annual surface and water level inspections, buffer strip maintenance, and periodic surface sediment and debris removal. However, their small size and inconspicuous design can tend to leave them forgotten. Course sediment must be kept out of the trench to prevent premature clogging. If clogging does occur, a substantial portion of the backfill aggregate may have to be removed and replaced.

1504 POROUS PAVEMENT

1504.1 Description of Facility

Porous pavement is constructed of a special asphaltic or concrete paving material which allows storm water to infiltrate at a relatively high rate. Infiltrated water is stored below the pavement surface in a high-void aggregate base (stone reservoir) similar to an infiltration trench. This practice provides for storm water retention and increases infiltration into the ground. **Figure 1503** shows a typical porous pavement installation.

1504.2 Water Quality Benefits

Porous pavement generally provides significant reduction only in dissolved constituents, with a lesser reduction in fine particulate pollutants. Porous pavement is primarily designed to remove pollutants deposited on the pavement surface from the atmosphere; these pollutants are normally either very fine

grained or soluble. The long-term removal efficiencies, based on limited field monitoring, is summarized below.

<u>Pollutant</u>	<u>Range of Long-Term Removal Efficiency</u>
Sediment	80 - 95%
Total Phosphorus	65%
Total Nitrogen	80 - 85%
COD	80 - 85%
Zinc	90 - 99%
Lead	90 - 98%

Porous pavement is useful as a substitute for conventional asphalt in parking areas and low traffic volume roads. Additional benefits include skid resistance, enhanced visibility, increased safety, and reduction of drainage system costs (e.g., related to curb and gutter). It is a reasonable cost-effective BMP where offsite runoff is not great, slopes are flat, soils are permeable, and depth to bedrock or the water table is relatively great.

1504.3 Design Criteria

- The soil subgrade should have adequate load-carrying capacity when wet, be well drained, and have high permeability.
- Maximum pavement slope is 5 percent; effectiveness is maximized when the slope is as flat as possible.
- A minimum clearance of 4 feet between the bottom of the underlying stone reservoir and bedrock or the water table is required.
- Porous pavement should be located no closer than 100 feet upslope from a building foundation, no closer than 10 feet downslope from a building foundation, and no closer than 100 feet from a drinking water well.
- Use is restricted to small drainage areas, with a maximum tributary area of 10 acres.
- The minimum storage residence time in the stone reservoir should be 12 hours; the maximum dewatering time should be 72 hours.
- Asphalt pavement thickness is determined by conventional soil strength/bearing and traffic load capacity design criteria. A minimum pavement thickness from the top of pavement to soil subgrade will generally be 9 inches. Construction requires an open graded type

aggregate in contrast to dense graded aggregate which is capable of close packing. A typical section consists of the following layers:

1. Porous asphalt course 2-4 inches thick
 2. Filter aggregate course
 3. Stone reservoir course with 0.5- to 3.0-inch diameter stone
 4. Filter fabric (geotextile)
- If concrete paving is used, then the following materials may be used: open graded mix, gap graded mix, draincrete, popcorn mix, or porous concrete. Use a low water-cement ratio of 0.20 to 0.40, and develop a pore space of at least 15 percent. Guarantee zero slump. Pavement can be placed directly on the subgrade, and can be expected to have permeability values of 2-3 gallons per minute.
 - Subsoils should have a minimum infiltration rate of 0.5 inches per hour. A safety factor of 2.0 should be applied to the actual infiltration rate for facility sizing.
 - The storage capacity should be based on retention of the first 0.5 inches of runoff from the impervious surfaces in the drainage area.
 - A system is required to remove excess storage volume. This may consist of a french drain, sand drain, two-layer system, or pipe drain.
 - An observation well should be installed consisting of a well-anchored, vertically perforated PVC pipe located at the downslope end of the pavement.
 - If the facility accepts flows from offsite areas, pretreatment may be required in the form of sand filters, vegetated buffer strips, water quality inlets, or other methods of separating oil, grit, and sediments.

1504.4 Maintenance

Porous pavement surfaces should be swept at least 4 times per year followed by jet hosing to prevent excess buildup of surface sediments and debris. If the pavement becomes clogged it is difficult and costly to rehabilitate. Applications should avoid areas where wind erosion supplies large amounts of dust and sediment. Because wind-borne particulates are found in significant quantities in the Las Vegas Valley environment, porous permanent installations should be in protected areas to the extent possible. Pavement should be inspected annually, checking for potholes, cracking, or surface ponding which might indicate clogging.

1505 FIRST FLUSH DIVERSION SYSTEM

1505.1 Description of Facility

First flush diversion systems are designed to divert the more polluted first flush of storm water and non-storm water flows from their normal conveyance paths and hold them for later water quality treatment. The diverted first flush and low flows are not discharged to surface water, but are stored until they are gradually removed by infiltration, evaporation, or some other form of treatment or removal. **Figure 1504** shows a typical first flush diverter installed in a storm drain line.

1505.2 Water Quality Benefits

First flush diversion is one of the most effective ways of enhancing storm water quality. Potentially polluted waters are separated from the cleaner flows, and thus whatever treatment or management systems are employed can deal with a smaller volume of water. Diversion systems can readily be installed in existing storm drain lines, as long as locations for off-line storage and treatment can be identified. First flush diversion systems are appropriate “pretreatment facilities” for other BMPs such as infiltration basins, infiltration trenches, and detention basins.

1505.3 Design Criteria

- The hydraulic capacity of the diversion structure should be set such that it does not represent a bottleneck to the storm drain system.
- The diversion line (i.e., first flush and low flows diverted out of the main storm drain line) should be designed to convey the runoff from 0.5 inches of rain over the tributary area.
- The overflow baffle should be designed to pass the full storm drain design flow in case the diversion line is plugged or the treatment facility is full and backflowing to the diversion structure.
- The diversion structure should be provided with a manhole access for cleaning and inspection.

1505.4 Maintenance

First flush diversion structures should be cleaned at least twice per year. The facilities should be inspected after large storms and after all significant “first flush storms” occurring after an extended dry period.

1506 DRY EXTENDED DETENTION POND

1506.1 Description of Facility

A dry extended detention pond is similar to a standard dry detention pond (i.e., a detention pond without a permanent pool of water), but the outlet control structure is modified to extend the detention time for low flows. This extended detention time leads to higher pollutant removal rates than in standard detention basins. Typical outlet control structures can be modified through use of devices which reduce outflow rates at low pond stages, but which preserve high outflow rates at high stages. Extended dry detention ponds are not recommended for small areas (less than 20 acres); other infiltration-based BMPs should be used for these smaller applications. **Figure 1505** shows a typical dry extended detention pond.

1506.2 Water Quality Benefits

Dry extended detention ponds remove pollutants through the settling process. Sediments and the pollutants adhered to them, such as trace metals, are the constituents most effectively controlled by dry detention basins. If the storm water is detained for 24 hours or more, as much as 90 percent of particulate pollutant removal is possible. The majority of pollutant removal occurs within the first 6 hours of detention. Extended detention is extremely cost effective where a basin is required for flood control, and seldom costs more than 10 percent more than costs reported for conventional dry ponds.

The degree of pollutant removal is dependent on whether a given pollutant is in particulate or soluble form. Unfortunately, some of the urban pollutants of greatest concern occur primarily in soluble forms (e.g., nitrate and orthophosphorus). Improved removal of soluble pollutants may be obtained by managing the shallow portion of the pond as a wetland to utilize natural biological removal processes. Long-term pollutant removal efficiencies for approximately 6 to 48 hours of detention time are estimated below.

<u>Pollutant</u>	<u>Range of Long-Term Removal Efficiency</u>
Sediment	60 - 90%
Total Phosphorus	15 - 50%
Total Nitrogen	25 - 40%
BOD/COD	25 - 50%
Trace Metals	30 - 90%
Hydrocarbons	50 - 70%

1506.3 Design Criteria

- The treatment volume should be equivalent to the runoff volume produced by a 2-year, 6-hour storm over the tributary area. Additional “active storage” volume may need to be provided to meet flood control objectives.
- A minimum detention time of 24 hours should be provided for the design storm. Additional time up to 40 hours will improve pollutant removal efficiency. Smaller events (e.g., 0.1 inch storms) should be detained a minimum of 6 hours.
- In general, pond depths should not exceed 6 feet, particularly in multiuse park or school sites.
- Aforebay should be provided at the pond inlet to capture incoming large sediment and debris.
- Common types of extended detention outlet control devices include: (1) internally controlled perforated pipe; (2) perforated riser; (3) inlet-controlled perforated pipe. All extended detention devices should be surrounded by a filter of gravel or coarse stone and filter fabric. The minimum perforation diameter should be 0.5 inches.
- Minimum setbacks should be 20 feet from any structure or property line; 100 feet from septic tanks or drainfields; and 50 feet from any steep slope. The 20-ft buffer setback should be landscaped using low-maintenance vegetation.
- Pond geometry should be selected to maximize mixing and detention time. This should include use of irregular shorelines; length-to-width ratios of no less than 3:1; and baffles or islands.
- Side slopes should be a minimum of 3:1 to provide bank stability, and a maximum of 20: 1.
- The pond overflow system should provide for the controlled release of the 100-year storm runoff. This can be accomplished using open end risers. In addition, an overflow spillway should be provided to pass the full 100-year peak discharge for in-line or in-channel basins.
- If soils at the site are highly permeable (e.g., SCS hydrologic soil groups A or B), then it may be necessary to line the pond bottom and sides with an impermeable geotextile or a 6-inch clay liner.

- Extended detention ponds should be designed in two levels. The upper level should be sized and graded (2 percent minimum slope) to be dry except during large, infrequent storm events. The lower level, near the riser or outlet works, should be designed to be inundated regularly. Ensure that no low points or sumps develop in the upper level that might fill with standing water. The volume of the lower level should be sized to store the runoff produced from the mean annual (2-year) storm.
- A lined low flow channel should be designed to drain the upper level to the lower level, and to drain the lower level to the outlet works.

1506.4 Maintenance

Dry extended detention ponds have moderate to high maintenance requirements. The primary maintenance problem in dry extended detention ponds results from the accumulation of sediment and debris, particularly near the riser or outlet works. Design of a proper forebay can minimize this problem. Nonetheless, routine removal of sediment, vegetation and other debris will be necessary. Facilities should be inspected annually and after each major storm to assure that the system is operating as designed. Inspections should check to assure that: (1) the pond is draining properly; (2) subsidence or erosion of the pond bottom have not occurred; (3) nuisance conditions associated with litter, weeds or odor have not developed. The landscaped buffer strip will require routine maintenance, depending on the landscaping material selected.

1507 VEGETATED SWALE

1507.1 Description of Facility

This BMP involves using vegetated (normally grass) channel surfaces for runoff conveyance to reduce flow velocities, enhance filtration, and remove runoff contaminants. Grassed swales consist of a mildly sloping cross section with check dams to increase infiltration and flow attenuation. Typical applications are along roadways in place of curb and gutter, and adjacent to large parking areas. A sketch of a typical vegetated swale is shown in **Figure 1506**. In the arid Las Vegas Valley climate, vegetated swales will only be practical where they can be easily incorporated into irrigated landscaped areas. This will likely limit their application in Las Vegas Valley.

1507.2 Water Quality Benefits

Vegetated swales generally provide reductions in sediment load and the constituents which typically adhere to sediments (e.g., heavy metals). Pollutants are removed by the filtering action of the grass, deposition in low velocity areas, and infiltration into the subsoil. Biofiltering action can reduce loads of soluble constituents if the height of the vegetation is sufficient as compared to the

design flow depth and contact times are long. Performance of swales for pollutant removal varies widely, with generally low to moderate removal efficiencies reported. If used, every effort should be made to maximize swale effectiveness through proper siting and design.

1507.3 Design Criteria

- The design flow should be limited to 5-10 cfs. The velocity should be limited to 2 ft/sec. The flow depth should be limited to 12 inches.
- Side slopes should not be steeper than 3:1. Longitudinal slopes should not exceed 4 percent. For slopes less than 2 percent, underdrains may be required.
- The minimum swale length for desirable water quality benefit is 100 feet.
- Below the design water depth, an erosion control blanket should be installed along with at least 4 inches of topsoil and the selected biofiltration mix. Above the design water depth, an erosion control seed mix with mulch or sod should be used. The topwidth-to-depth ratio should generally be 6:1 or greater.
- Check dams may be constructed of a variety of materials, varying from earthen berms to concrete. Check dam spacing should be selected to keep the longitudinal slope below 4 percent. Upstream ponding volume at the check dams should be limited to drain within 24 hours. Check dam height should not exceed 18 inches. It should be recognized that use of hard check dams in swales along roadways may represent a safety hazard to vehicles; in these applications dam heights should be minimized and below-surface grade control measures should be considered.
- Alkaline soils and subsoils promote metals removal. Metal removal efficiency can also be enhanced by spreading a layer of organic material on the natural soil. Soil infiltration rates exceeding 0.3 inches per hour are preferred.
- In Las Vegas Valley, selection of vegetation should be made on the basis of what will survive best in the local conditions. Fine, close-growing, water resistant grasses are preferred. Local entities have developed lists of recommended grasses and vegetation for landscaping with water conservation in mind. Prevent bare areas by avoiding gravel, rocks, and hardpan near the surface. Irrigation and fertilization will be required to maintain healthy vegetation on a year-round basis. Subdrains may be required to prevent excess irrigation runoff.

1507.4 Maintenance

Primary maintenance activities involve removal of accumulated sediment and debris, and care of the vegetation. In Las Vegas Valley the second factor will probably be most important. Irrigation, fertilization, and mowing will be required to develop the healthy vegetation necessary to develop an effective biofilter. It is noted that over irrigation and over fertilization can be detrimental to downstream water quality.

1508 WATER QUALITY INLET

1508.1 Description of Facility

The water quality inlet (also known as an oil-grit or oil-water separator) is designed to remove sediment and hydrocarbon loadings from parking lot runoff or areas contributing potential oil or grease. The structures generally consist of multi-chambered underground vaults (usually three chambers) which can be installed in place of conventional catch basins or inlets. The first chamber acts as a sediment trap, the second chamber collects oil and grease floating on the surface of the water, and the third chamber directs flow to a storm drain outlet. Water quality inlets generally serve areas less than one acre in size. **Figure 1507** shows a schematic diagram of a typical water quality inlet.

1508.2 Water Quality Benefits

Water quality inlets are designed to separate relatively heavy sediments and floating hydrocarbons from the runoff stream. Typical application areas include industrial machinery yards, vehicle storage yards, petroleum bulkstorage areas, gas stations, retail merchandise stores, and fast food stores. They have no significant storage volume and operate on an essentially flow-through basis. As a result, they are not effective in controlling dissolved constituents or those not attached to the sediment particles. In addition, they are effective only for small drainage areas. Water quality inlets are useful in retrofitting existing industrial areas by replacing conventional inlets. They are also useful as “pretreatment” facilities for infiltration basins or trenches.

Pollutant removal capability of water quality inlets has not been extensively tested in the field, so numerical efficiency estimates are largely a matter of speculation. Factors working against performance include the small storage volume, low detention time, and resuspension of pollutants for multiple storms occurring between clean-out operations.

1508.3 Design Criteria

- Use for impervious areas of less than one acre. Any rooftop drainage is not likely to be significantly contaminated, and can be discharged downstream of the water quality inlet.
- A temporary pool 3 to 4 feet deep should be created in the first chamber for gravity settling and capture of floatables.
- The second chamber also has a temporary pool, and is connected to the first chamber by a pair of screened 6-inch holes.
- The third chamber is connected to the second by an inverted pipe to prevent transfer of floating hydrocarbons to the third chamber.
- Combined wet storage volume in the temporary pools in the first and second chambers should be sized based on 400 cubic feet per tributary acre. The remaining dry storage area must pass the design storm.
- After the storm, the first two chambers are drained by 6-inch weep holes in the floor.
- Each chamber should be provided with removable covers or manhole access.
- The floor of each chamber should be sloped slightly away from the outlet to the next chamber to minimize resuspension of settled particles. Vertical baffles on the floor of the first and second chamber may also be effective in preventing resuspension.

There are several special adaptations of the standard water quality inlet design. These include:

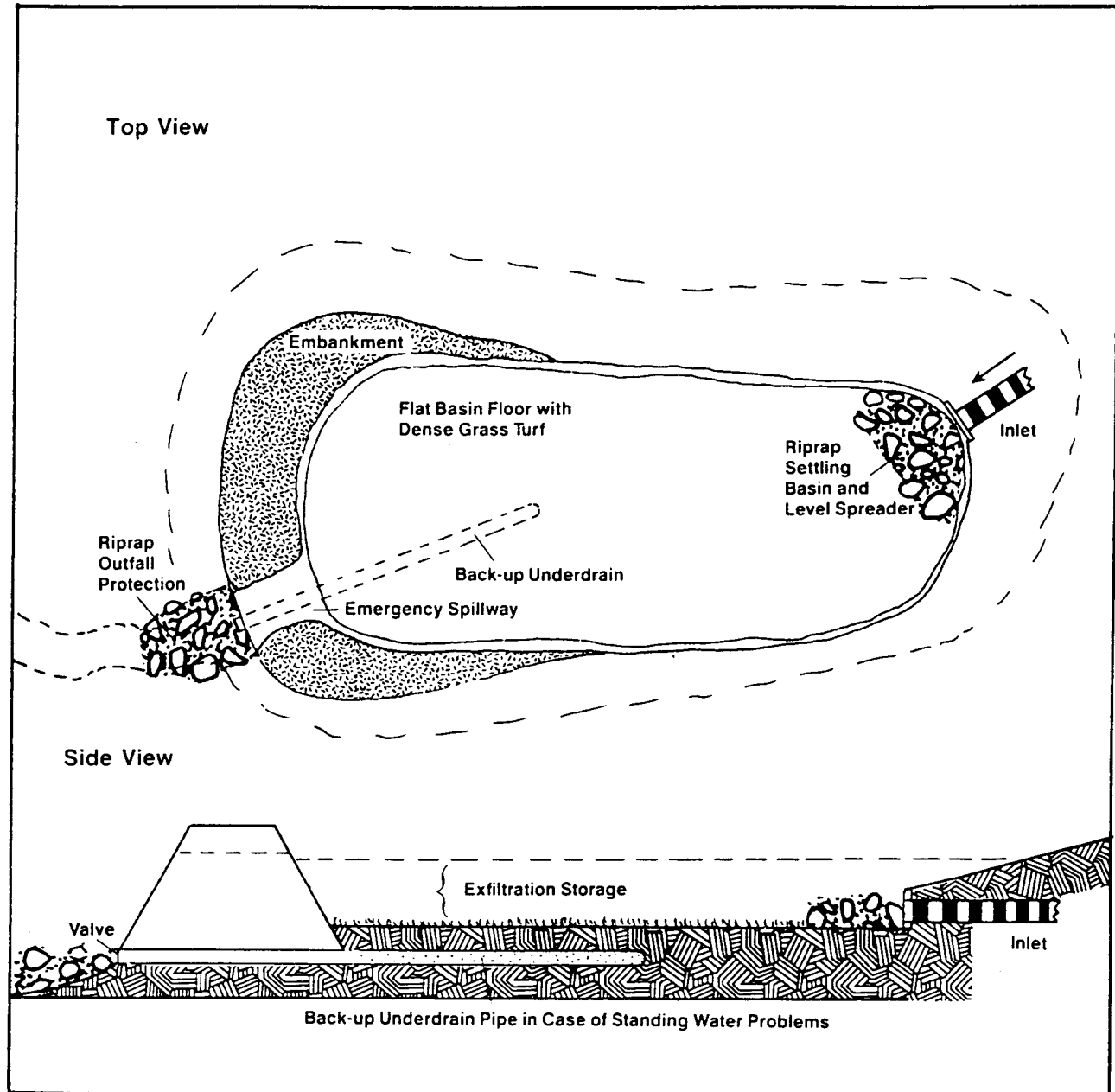
- a. The American Petroleum Institute (API) Separator, consisting of a long vault with baffles to improve hydraulic conditions for treatment. It is designed to remove oil droplets 150 microns and larger in size.
- b. The Coalescing Plate interceptor (CPI), which contains a bundle of closely spaced plates made of fiberglass or polypropylene. It can be designed to remove oil droplets 60-90 microns and larger in size.

More detailed design criteria can be obtained for these special oil-water separators.

1508.4 Maintenance

Water quality inlets should be cleaned out a minimum of twice per year with a vacuum truck. Accumulations of sediments and hydrocarbons will reduce the effectiveness of the facility, through resuspension of material from previous storms and pass-through of material from new storms. In addition to normal twice-per-year cleanings, inlets should be cleaned after “first flush storms” occurring after extended dry periods when concentrations of oil/grease and heavy metals are expected to be highest. Due to the small storage volume involved, facility performance is very dependent on frequent and thorough cleaning operations.

**SCHEMATIC DRAWING OF A
TYPICAL INFILTRATION BASIN**

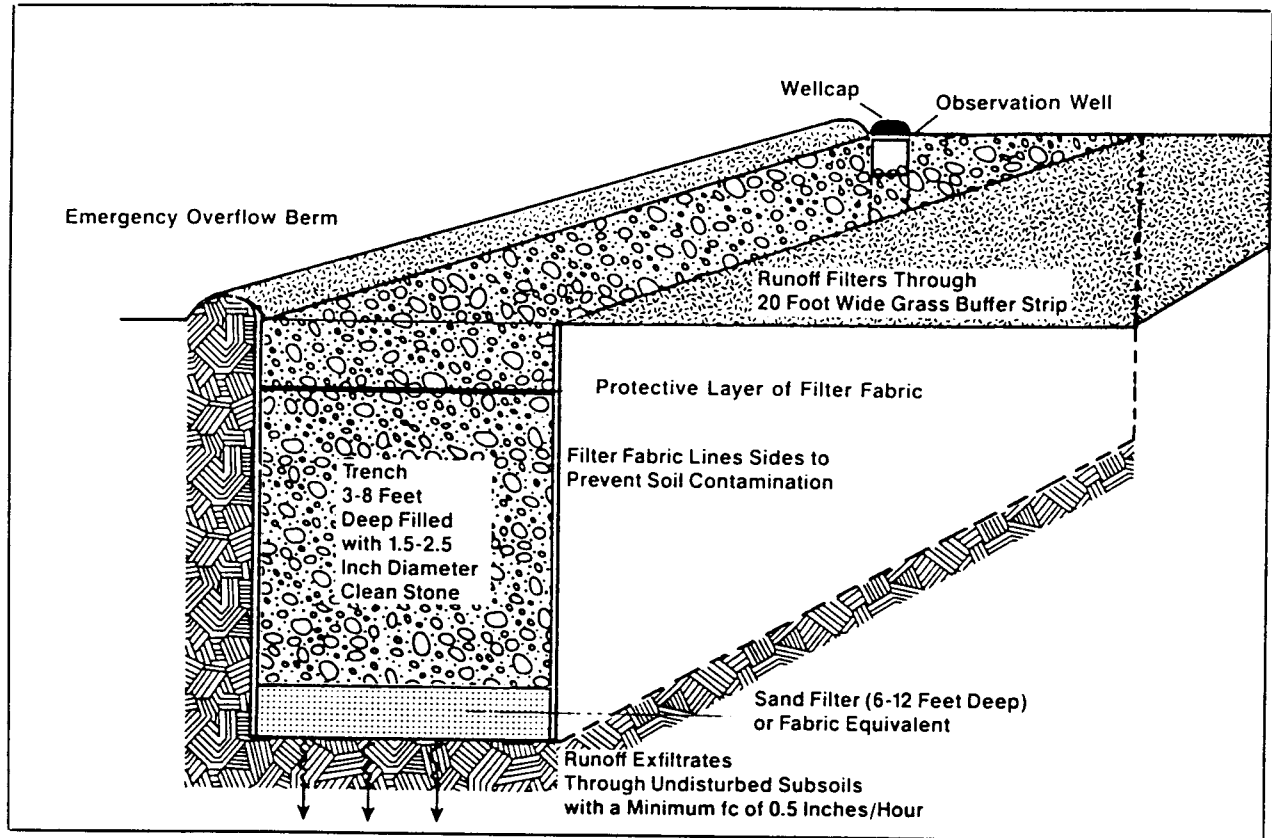


Revision	Date

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1501

**SCHEMATIC DRAWING OF A
TYPICAL INFILTRATION TRENCH**

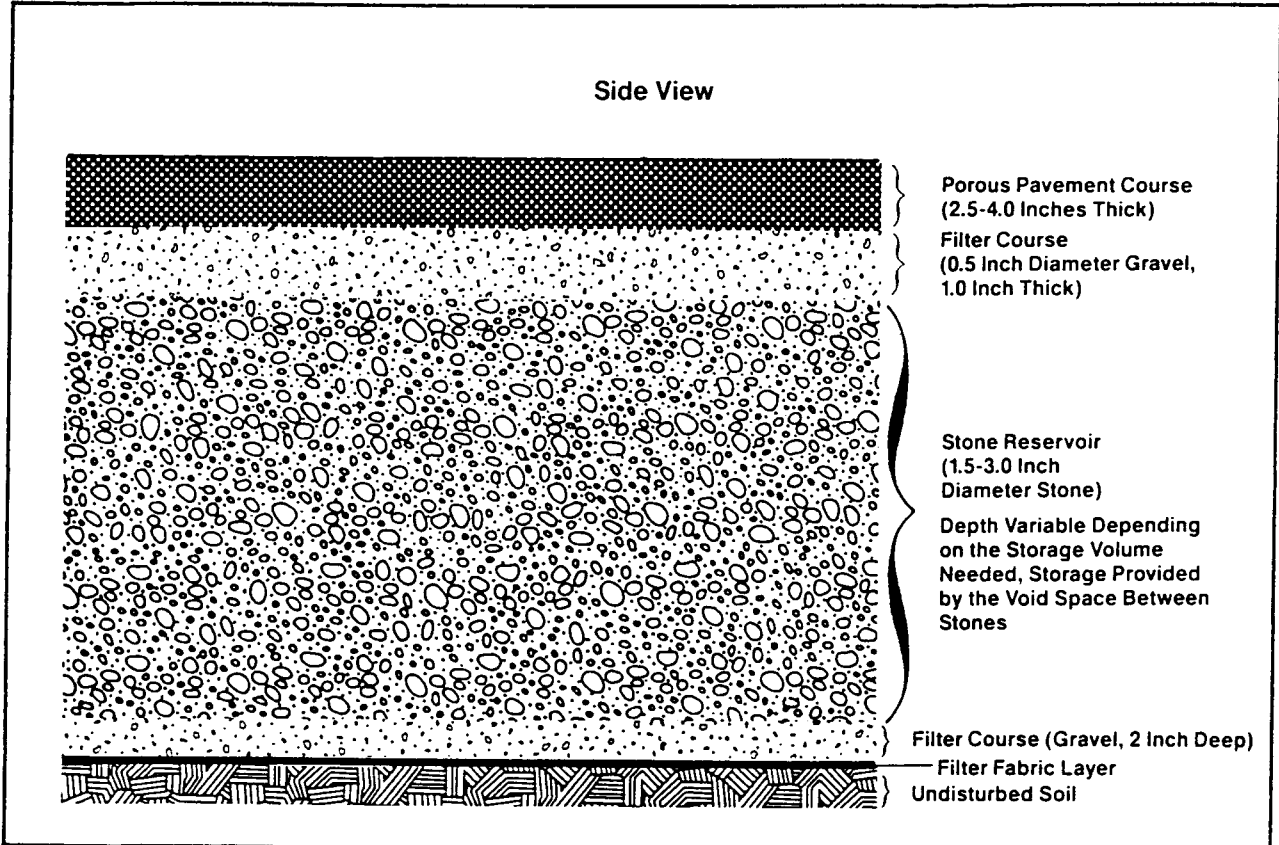


Revision	Date

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1502

**SCHEMATIC DRAWING OF A
TYPICAL POROUS PAVEMENT SECTION**

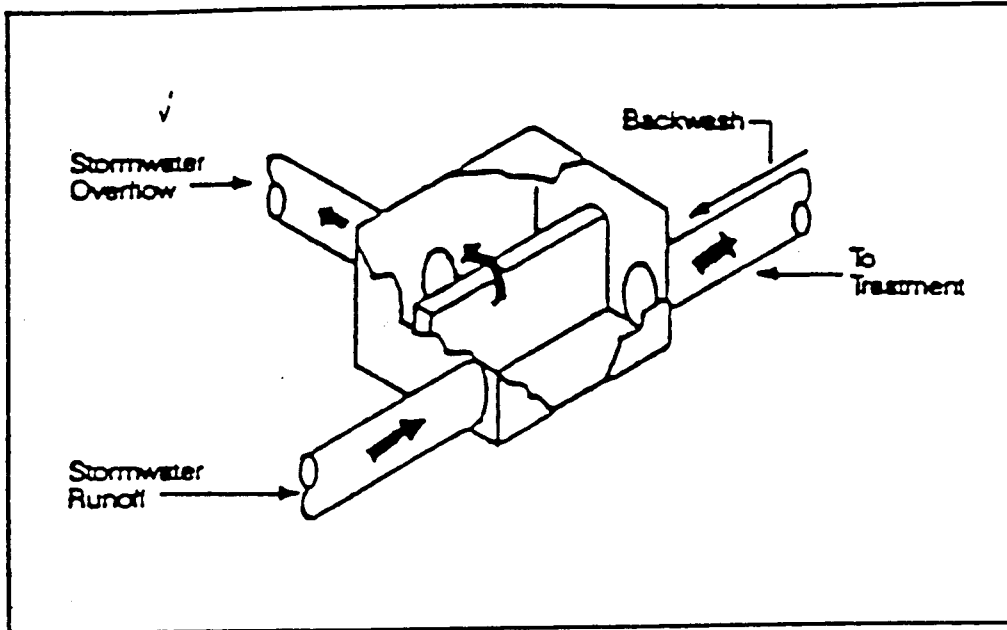


<i>Revision</i>	<i>Date</i>

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1503

**SCHEMATIC DRAWING OF A
TYPICAL FIRST FLUSH DIVERSION BOX**

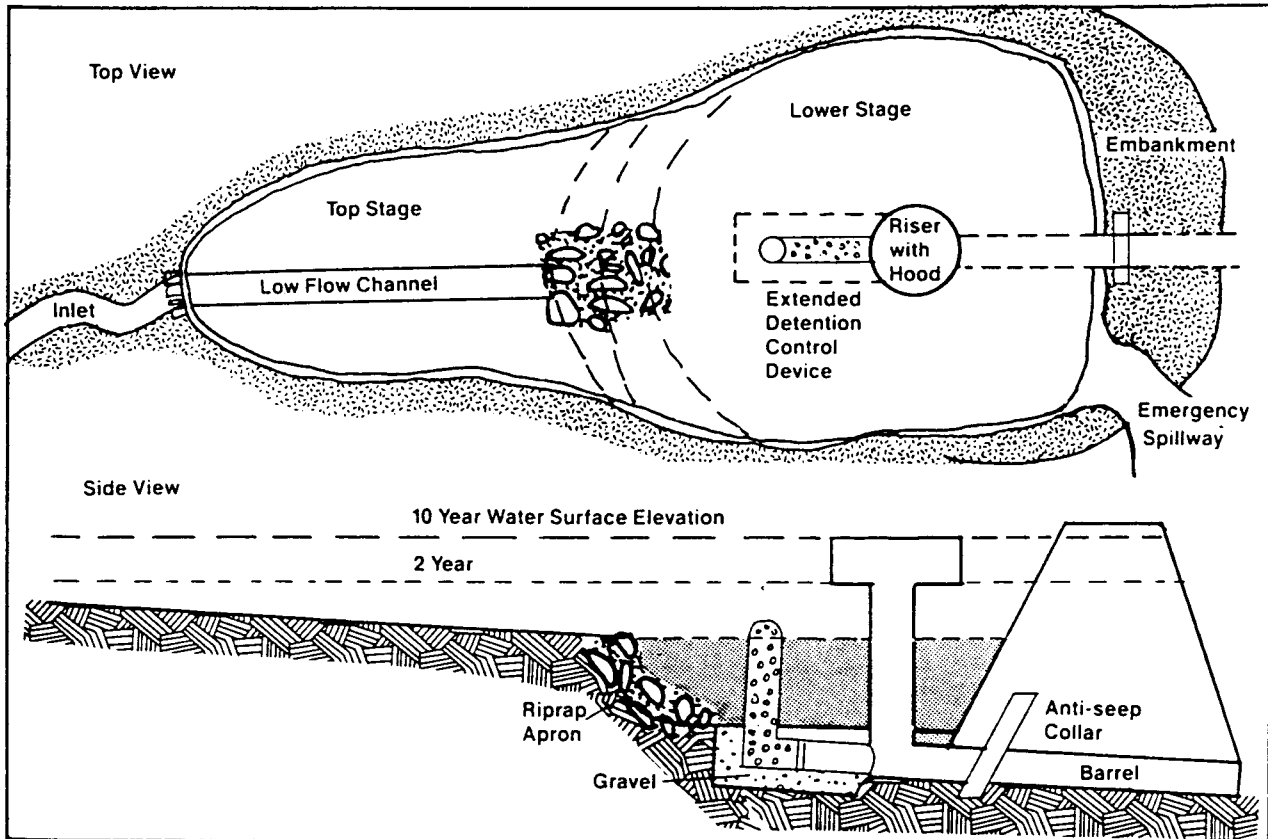


<i>Revision</i>	<i>Date</i>

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1504

**SCHEMATIC DRAWING OF A
TYPICAL DRY EXTENDED DETENTION POND**

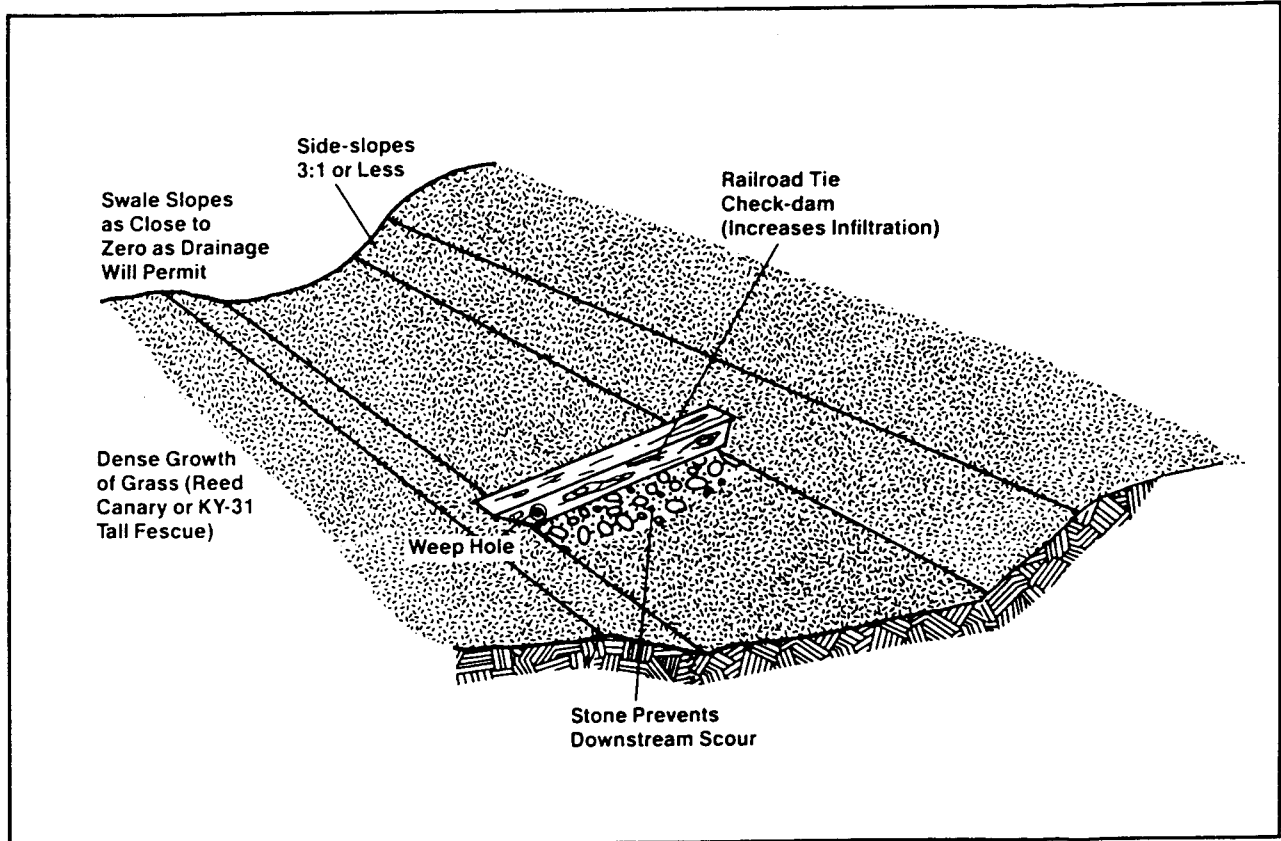


Revision	Date

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1505

**SCHEMATIC DRAWING OF A
TYPICAL GRASSED SWALE**

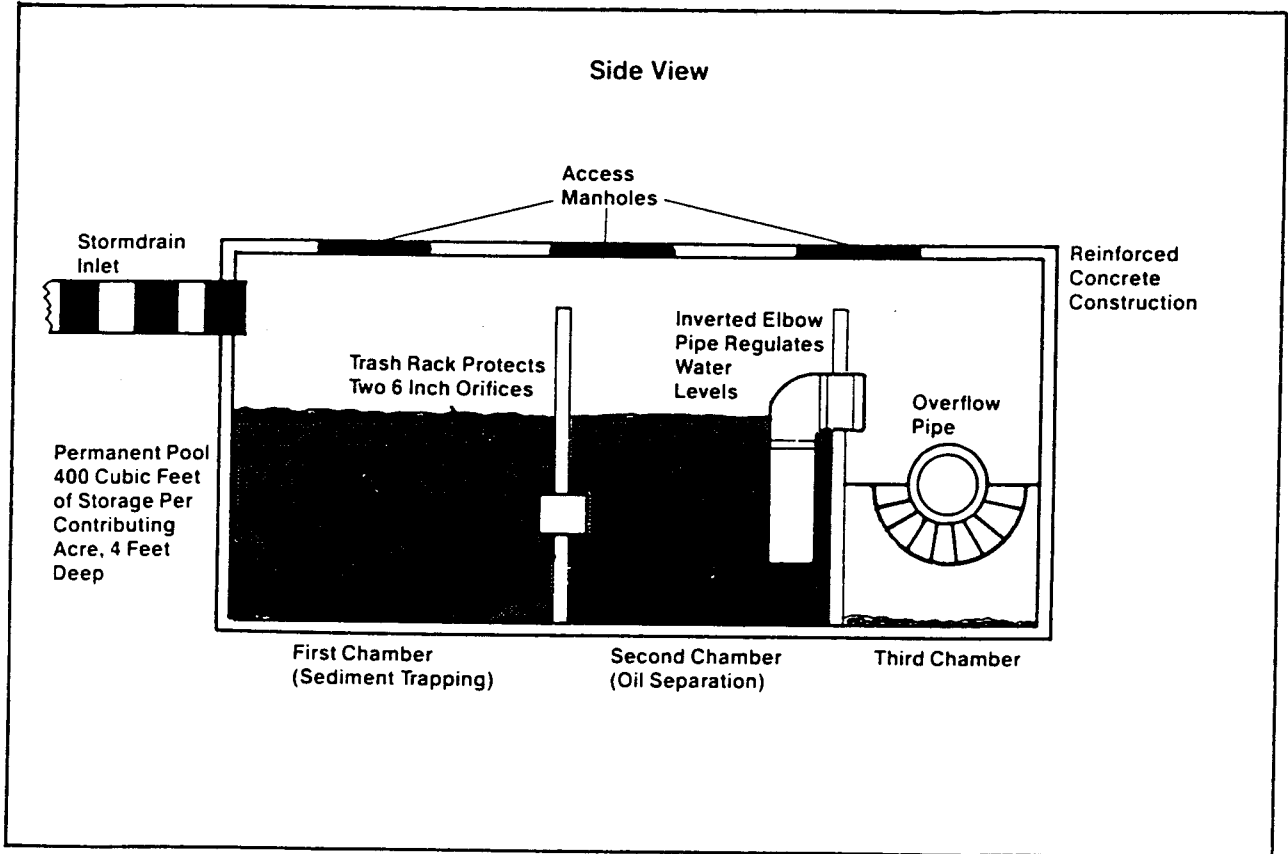


Revision	Date

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1506

**SCHEMATIC DRAWING OF A
TYPICAL THREE-CHAMBER WATER QUALITY INLET**



Revision	Date

REFERENCE: Controlling Urban Runoff:
A Practical Manual for Planning and Designing
Urban BMPs, July 1987

FIGURE 1507