A worker inserts a catch basin insert for oil and grease, trash, debris, and sediment removal from stormwater as it enters the storm drainage system (Source: Ab Tech Industries, 2001)

MeF

Media-Sand Filter

Description

Media and sand filters provide water quality treatment using a variety of water quality enhancing inlets, consisting of modified catch basins and media filtration inlets. Section 8.1 Floatables Skimmers address removal of floatable fluids and other floating debris.

Modified catch basins contain an oversized sump, and also some type of inflow and outflow control to remove coarse sediments and floatable materials. Modified catch basins are effective as a pretreatment measure for other BMPs, but are not sufficient to provide stormwater treatment as a stand-alone measure.

Catch basin inserts are a relatively new type of technology in the realm of stormwater quality best management practices (BMP's). This technology involves the placement of devices that contain a filtering media (a sorbent) just under the inlet of a storm drain. Runoff flows into the inlet and through the filter where the targeted contaminants are removed. They can be an effective means of petroleum hydrocarbon control, thereby reducing non-point source pollution.

Media filtration inlets use materials such as sand, peat, screens, patented sorbent paper media, or cloth to filter stormwater runoff. Sand filtration inlets can be constructed in a variety of layouts using precast vaults, paved trenches, or in earthen or concrete basins. Media filtration systems are available commercially with a wide range of materials and methods for easy installation and operation. **Media filtration inlets will create a partial reduction in most pollutants only if they are inspected, cleaned and maintained on a regular basis.** A layer of organic material (such as peat moss) or potentially some types of clay can increase the removal of metallic ions and organic pollutants from stormwater runoff.

Selection Criteria

There are several models or designs of catch basin inserts on the market, which can meet site specific conditions. The various types of water quality inlets discussed below and shown in Figures should be selected according to targeted constituents, site area constraints, cost and frequency of maintenance, and inspection requirements. See Section 3.1 BMP Selection Guidelines for pollutants by land use and removal rates for BMP designs.

Special consideration should be given to products requiring media replacement to assure the availability of replacement media. Catch basin inserts are not designed to be a stand-alone BMPs but rather to be used as **a first flush treatment (See Section 3.3 First Flush/Water Quality Treatment)** prior to a storm drain network, detention/retention facility, infiltration practice, or some other form of water quantity control measure. They are often used in highly urbanized areas where space is limited.

Modified catch basins (with enhanced capability to capture coarse sediments and floating debris) and media filtration inlets may be used on commercial and industrial properties that have parking lots and vehicle traffic. This type of land use is likely to receive salts and sands for removing ice and snow, trash from vehicles, leaking oil and grease, and leaves and dirt from landscaping.

Water quality enhancing inlets may be used for most impervious areas with parking lots and vehicle traffic. They are highly recommended for commercial and industrial sites that generate fine particles, sediment, tailings, sawdust or other pollutants for which a media filtration inlet would be effective.

Design Considerations

Media Filters

Media filtration inlets can essentially be designed to filter any particle size and particle type at low to moderate flow rates. Many filtration systems are readily available from commercial vendors in a variety of sizes, layouts, and targeted pollutants. Water quality inlets can be designed for new property uses or can often be retrofitted onto existing stormwater drainage systems.

Catch basin inserts are not capable of handling large amounts of runoff volume, but are sufficient in providing water quality improvement in low-density areas. Catch basin inserts generally perform best when they serve parking lots less than 1 acre in size or urban roadways. In most situations, they must be used in conjunction with other water quantity BMPs to meet stormwater management criteria.

A very important decision to be evaluated is the ability to bypass or convey large storm events that have the potential to damage the BMP system or re-suspend collected pollutants. Figure 1 shows one method for allowing high-flow stormwater to bypass the BMP system; there are many other types of flow-splitting structures that allow the BMP system to function “off-line” rather than “on-line”. The minimum requirement for water quality inlets (including media filtration inlets) is to treat the first flush volume.

Due to the precast nature of this BMP, the engineer or planner who is responsible for the installation and operation of the catch basin insert needs only to be concerned with determining the site-specific characteristics. The minimum volume of the water that is to be treated is the first flush (1st 3/4 inch of rainfall runoff). The dimensions of the catch basin that is collecting the runoff must be determined in order for the manufacturer to correctly fabricate the BMP and assure that the insert will not be the limiting factor when it comes to passing the design flow. The design engineer needs to determine the types and amounts of pollutants the catch basin will trap as required.

Water Quality Inlets:

- Are suitable for smaller catchments including parking lots and roadways.
- Can provide reduction of hydrocarbons from areas with high traffic/parking volumes.
- Can be retrofitted into most existing catch basins without additional construction.

A typical modified catch basin will capture coarse sediments and floating debris. A modified catch basin could have many variations that will essentially perform the same function. The modified catch basin must have removable elements to allow inspection and cleaning of all pipes.

Figure 2 shows a manufactured BMP media filtration system. It is similar to the

sand filter vault except it uses media cartridges instead of sand. The internal valving, hardware and cartridges are installed into a precast concrete vault. Media cartridges are especially useful for industrial sites where specific types of particles can be targeted. Media cartridges can be designed to target specific pollutants such as sediments, oil and grease, organics, heavy metals, and soluble nutrients.

Media filtration systems are most effective under smaller flow volumes such as the first flush volume. Although media filtration systems must have a buildup of water above the media in order to function, they are generally not effective under conditions of heavy rainfall or floods. Furthermore, some systems can be damaged or the pollutants could be resuspended if operating under high-flow or flooding conditions. To prevent overloading filtration systems, there should be a mechanism to bypass or divert large flows. Commercially available systems may have a high-flow bypass built into the equipment. Other systems may require construction of an overflow bypass weir or other structure.

There are no design requirements for a modified catch basin, other than the minimum dimensions. Extra attention may be required for multiple inlet pipes or special flow conditions, possibly requiring a larger size for a catch basin.

When using commercial products such as water quality inlets, the manufacturer's recommendations should be considered in the product sizing and applicability. Verify that adequate stormwater treatment is provided and that high-flow bypass methods do not hinder the system from adequately treating the first flush volume.

A major drawback for a media filtration inlet is the need for elevation differences in the storm drainage system. A media filtration typically needs at least 5 feet of head loss available across the system, in order to accommodate live pool storage and sand filter thickness.

Sand Filters

A surface sand filter system, which is easier to inspect and usually less costly than an underground sand filter system can be sized to handle several acres. Filter cartridges or other media may also be acceptable alternatives to using sand if maintenance and operation considerations are addressed.

Two different types of underground sand filter layouts are also included as details. Underground filtration systems are more difficult to inspect and maintain. On the other hand, underground filtration systems are protected from weather and other hazards, and do not take up valuable real estate. Underground systems may exhibit odor problems during the summer because of a lack of bacterial degradation of accumulated organic matter and a lack of aeration within the wet pool.

The Delaware sand filter (Figure 3) may be suitable for overland sheet flow from paved areas such as commercial properties or industrial sites. It has two parallel concrete trenches or vaults. The first concrete trench serves as a sedimentation basin and storage facility to evenly distribute water across the sand filter in the second concrete trench. A clearwell is located at the end, with room for an overflow weir and underdrain system to outlet.

Manufactured systems should be selected on the basis of good design, suitability for desired pollution control goals, durability of materials, ease of installation, and reliability. Photo 1 shows a grate inlet filter insert that uses trays to improve

stormwater quality.

NOTE: The products listed here are not intended to be a specific endorsement or recommendation. It is incumbent upon the property owner and developer to carefully investigate the suitability and overall trustworthiness of each manufacturer and/or subcontractor.

The liner or concrete shell of the sand filter should be placed at least 2 to 4 feet above the seasonally high ground water table or bedrock. This minimizes the infiltration of groundwater into the filter.

Filtration Volume

The volume of the live pool for a sand filtration or other media filtration system shall usually be the first flush volume, which is intended to be slowly released through the filtration device after being treated. The live pool may include any storage capacity of incoming pipes and catch basins that is clearly not part of the dead pool volume. The dead pool volume is the portion of the filtration system, which always has water (such as underground sand filters). Larger filtration volumes are typically much easier to accommodate within an open system such as the surface sand filter.

Filtration Surface Area

Many equations have been proposed to determine the surface area of a sand filter (Austin 1989) (Virginia 1999). Proper gradation of sand filter must be achieved. Additional design criteria for the surface sand filter include:

- Size the control orifice or perforated riser pipe to allow for a 24-hour drawdown time, in conjunction with allowable sand filtration loading rate.
- Provide an energy dissipater prior to the sedimentation basin to reduce turbulence. Consider using some type of flow-splitter immediately upstream of a surface sand filter.
- Typical length-to-width ratio of the sedimentation basin should be at least 3:1 (L:W) to prevent possible shortcutting. Allow 6 inches minimum freeboard. Provide easy vehicle access to basin for maintenance and cleaning.
- Additional design criteria for the Delaware sand filter (Figure 3) and the underground sand filter include:
  - Provide adequate live pool volume (typically the most stringent requirement
  - An adjacent vault may be needed to provide additional live pool volume
  - Ensure flow is distributed evenly in the sand filter
- Structural design should be performed by a professional engineer in areas where traffic loading is a concern. Otherwise, prevent vehicles from driving onto any type of underground structure while ensuring nearby access.
- Provide baffled walls to reduce entrance velocities. The front portion of the structure should contain a dead storage pool to retain floatable materials and sediment. For ease of inspection and maintenance, limit the depth of the dead pool volume to less than 4 feet.
- Provide adequate access for inspection, cleaning and maintenance activities for each chamber. Removable access covers are recommended for chambers that do not have adequate standing room. Provide steps or rungs as needed.
- Use geotextile fabric on top of the sand layer to prevent displacement. Use

geotextile fabric beneath the sand layer to prevent loss of material through the gravel underdrain layer. A typical underdrain pipe is 4 inch diameter schedule 40 PVC pipe, with 3/8 inch perforations around the pipe diameter at 6" spacing. Place underdrains at 5 feet lateral spacing with a 1% to 2% positive grade.

A pretreatment sedimentation basin is essential to avoid rapid clogging of the filter medium. Since peat seems to be very effective at removing dissolved contaminants such as heavy metals, there has been research into using peat/sand mixtures (Galli 1990) (Tomasak 1987) which are subject to clogging problems. Research has also indicated that compost made from leaves is very effective at removing dissolved phosphorus and metals, and oil and grease (Stewart, 1989). Field research at Austin, Texas in 1990 indicates that the surface sand filter has a removal efficiency of total suspended solids that is similar to wet and dry detention basins: about 70 to 90%. Removal rates for heavy metals, oil and grease vary from 20% to 80%, depending on the application. Consult references for additional design and maintenance criteria. Inspection and maintenance frequency will also greatly affect pollutant removal rates.

Catch Basin Inserts

Catch basin inserts are ideal for industrial sites as they fit into existing catch basins, and therefore may avoid the need for an "end-of-pipe" facility. A typical catch basin insert consists of a series of trays or sorbent roles/tubes. The top trays are designed to capture coarse sediments, and lower trays may capture finer sediments or specific pollutants. Inserts made from fiberglass insulation materials can achieve up to 90% removal for heavy metals, oils and grease (McPherson 1992). Since catch basin inserts require frequent inspection and maintenance, they should only be used where a full-time maintenance person is located on the site (typically at large commercial or industrial facilities). A typical insert design may have a high-flow bypass and should be hydraulically designed to allow stormwater runoff into the drain system without danger of local flooding.

Some forms of temporary inlet protection may encroach onto access roads, streets, parking lots, driveways or highway traffic. Designs should be modified to allow for emergency overflow or bypass for large storms, which may endanger traffic or cause property damage.

Maintenance

At a minimum, catch basins should be cleaned once or twice per year (Aronson, 1993). Catch basin inserts will not function properly if clogged with sediment and debris, and therefore most of the designs are not recommended near construction areas without appropriate sediment control. There are some inserts that are designed especially for the removal of high sediment loads from construction sites.

Inspect modified catch basins and media filtration systems on a regular basis, typically every month and after heavy rainfalls. Record observations in an inspection log and take pictures as necessary to document conditions. Make immediate repairs as needed. Clean or replace filtration media as needed to prevent clogging.

Perform cleanout on a regular basis using confined-space procedures and equipment as required by OSHA regulations, such as no sparking electrical equipment, oxygen meter, flammable gas meter, etc. Remove trash, debris,

sediments or clogged media as needed, and then dispose of them properly. Sediments or clogged media may contain heavy metals or other toxic substances and should be handled as hazardous waste. Removal of sediment or clogged media depends on the accumulation rate, available storage, watershed size, nearby construction, industrial, or commercial activities upstream, etc. Sediment or clogged media should be tested for identification of pollutants prior to disposal.

Some sediment may contain contaminants for which the Tennessee Department of Environment and Conservation (TDEC) requires special disposal procedures. Consult TDEC - Division of Water Pollution Control with concerns about sediments and contaminants. Give special attention or sampling to sediments accumulated in industrial or manufacturing facilities, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants are suspected to accumulate.

It is generally more cost efficient to clean the filtration media. For sand filters, cleaning or replacement of the top few inches may restore the permeability rate. Failure to clean the filter surface regularly may result in the need to replace the entire media because of penetration of fines into the filter. It is important to keep the filters clean. Any debris, sediment, grass clippings, etc. should be removed from the system and properly disposed.

A very important consideration is the allocation of long-term resources for inspection, maintenance and repair. Water quality enhancing inlets should only be constructed if:

1. There is a maintenance plan to regularly inspect and maintain inlets on a long-term basis
2. There is an agreement or fiscal guarantee that the required maintenance resources will be available throughout the operation life of the water quality inlets. Without regular inspection and maintenance, a water quality inlet will fail and generally create a worse pollution problem than having no inlet at all.

Routine maintenance procedures, although frequent, are not overly time consuming relative to other practices such as retention/detention ponds, infiltration trenches, and constructed wetlands.

Limitations

Media filtration systems and modified catch basins will require more frequent inspection and maintenance than most other stormwater treatment BMPs. Filtration media will need to be cleaned and/or replaced frequently. There is very high potential for severe clogging or reduced pollutant removal efficiency in filtration systems, particularly if there are unstabilized soil surfaces upstream.

Do not operate filtration systems until upstream erosion areas are controlled. Media filtration systems cause a large head loss that may require special consideration in the hydraulic design of the overall stormwater collection system. Systems may typically require vertical filtration through at least 18 inches of sand and 6 inches of underdrain material, for an absolute minimum head loss of 2.5 feet.

There is a possibility of pulse loadings due to resuspension of pollutants from dirty filters during intense storms.

It is difficult to dispose of spent filter media in methods that are environmentally sound and cost-effective.

Figure 1
Typical Stormwater High-Flow Bypass Manhole

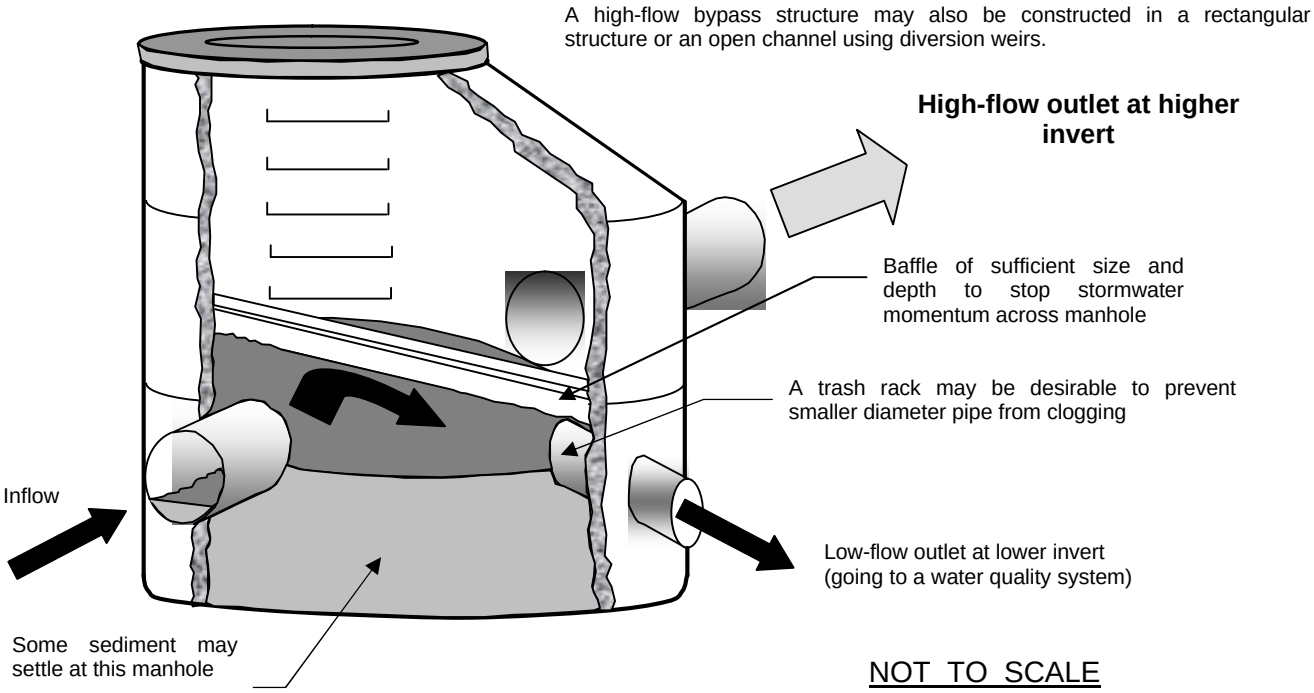


Figure 2
Manufactured BMP Media Filtration System

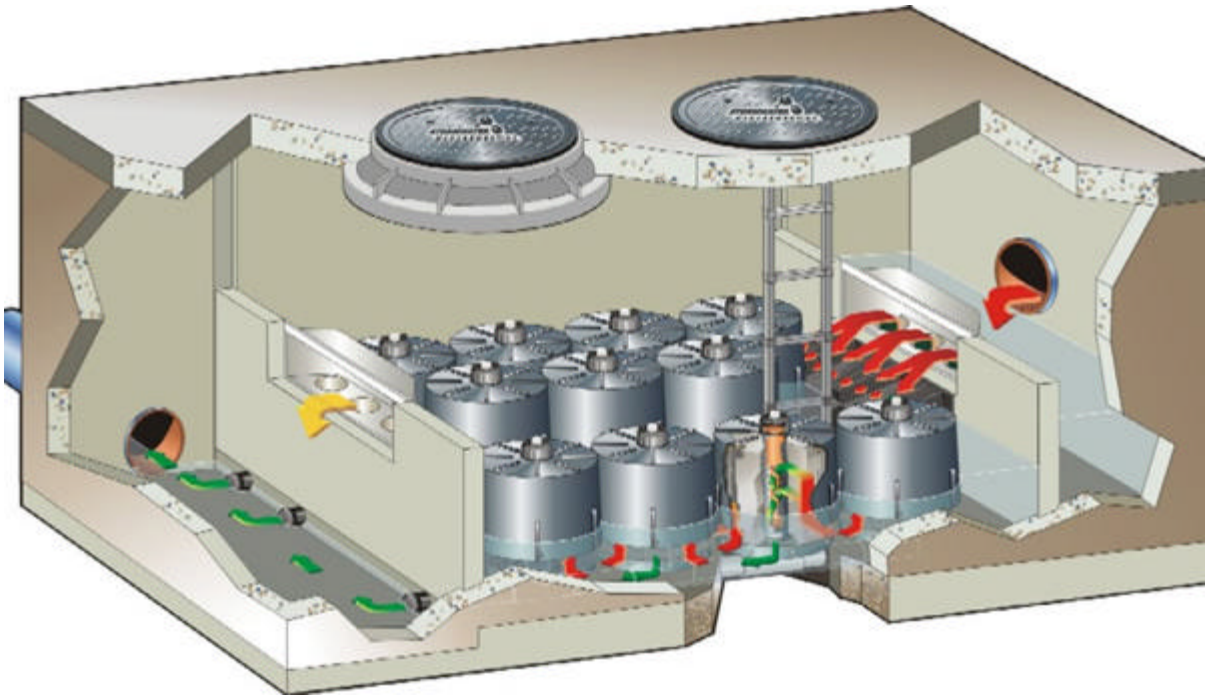
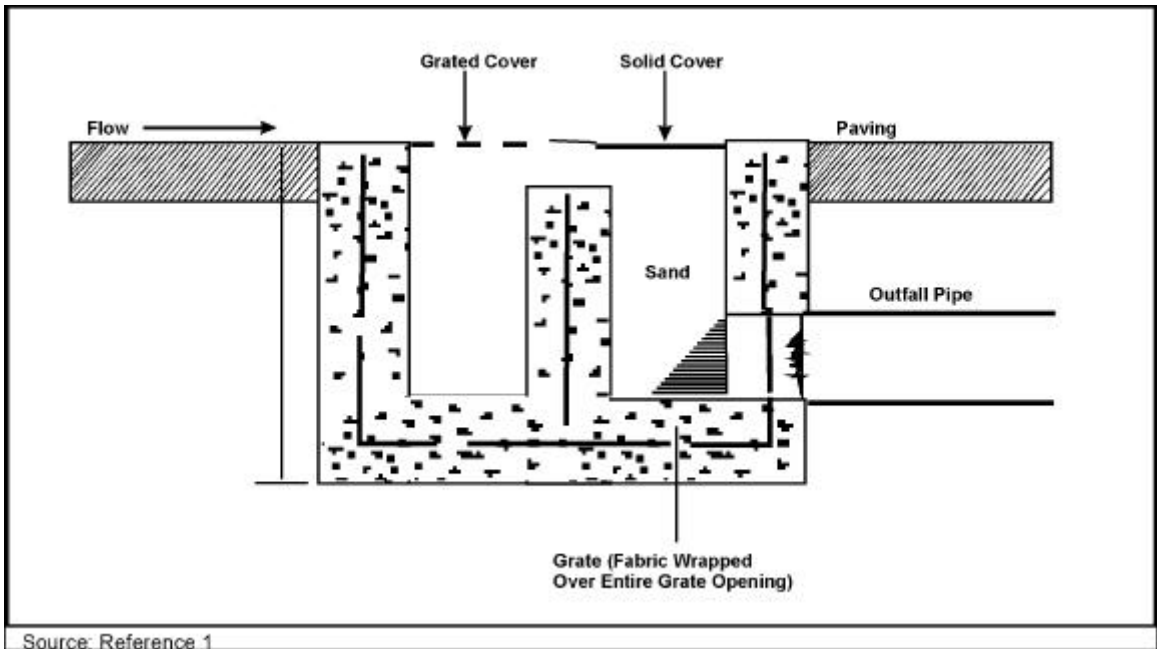


Photo 1
Grate Inlet Filter http://www.siltsaver.com/

Figure 3
Delaware Sand Filter



Source: Reference 1

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