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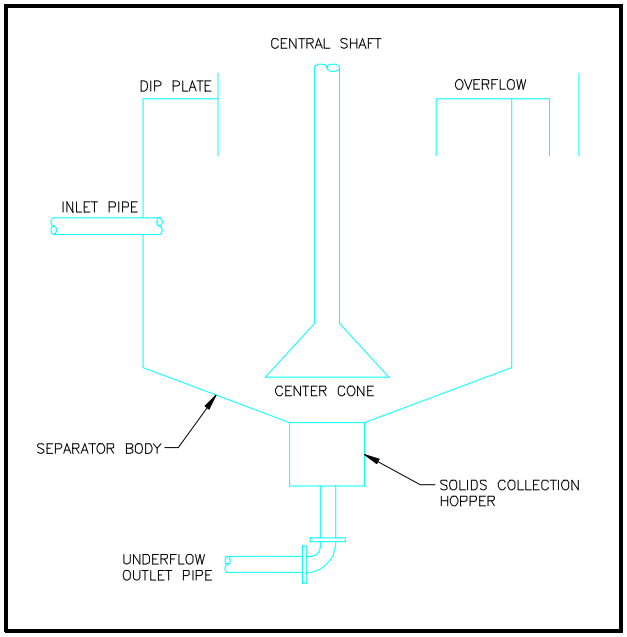
Storm Water Technology Fact Sheet
Hydrodynamic Separators

DESCRIPTION

Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments and other pollutants that are widely used in storm water treatment. No outside power source is required, because the energy of the flowing water allows the sediments to efficiently separate. Depending on the type of unit, this separation may be by means of swirl action or indirect filtration. A generalized schematic of a unit is shown in Figure 1. Variations of this unit have been designed to meet specific needs.



Source: Fenner and Tyack, 1997.

FIGURE 1 GENERALIZED HYDRODYNAMIC SEPARATOR

Hydrodynamic separators are most effective where the materials to be removed from runoff are heavy particulates - which can be settled - or floatables - which can be captured, rather than solids with poor settleability or dissolved pollutants.

In addition to the standard units, some vendors offer supplemental features to reduce the velocity of the flow entering the system. This increases the efficiency of the unit by allowing more sediments to settle out.

APPLICABILITY

This technology may be used by itself or in conjunction with other storm water BMPs as part of an overall storm water control strategy. Hydrodynamic separators come in a wide size range and some are small enough to fit in conventional manholes. This makes hydrodynamic separators ideal for areas where land availability is limited. Also, because they can be placed in almost any specific location in a system, hydrodynamic separators are ideal for use in potential storm water "hotspots"--areas such as near gas stations, where higher concentrations of pollutants are more likely to occur.

The need for hydrodynamic separators is growing as a result of decreasing land availability for the installation of storm water BMPs. This fact sheet discusses hydrodynamic separator systems from four vendors. Although there are many hydrodynamic separation systems available, these four address the major types.

They are the following:

- Continuous Deflective Separation (CDS).

- Downstream Defender™.
- Stormceptor®.
- Vortechs™.

Continuous Deflective Separation (CDS)

CDS' hydrodynamic separator technology is suitable for gross pollutant removal. The system utilizes the natural motion of water to separate and trap sediments by indirect filtration. As the storm water flows through the system, a very fine screen deflects the pollutants, which are captured in a litter sump in the center of the system. Floatables are retained separately. This non-blocking separation technique is the only technology covered in this fact sheet that does not rely on secondary flow currents induced by vortex action.

The processing capacities of CDS units vary from 3 to 300 cubic feet per second (cfs), depending on the application. Precast modules are available for flows up to 62 cfs, while higher flow processing requires cast-in-place construction. Every unit requires a detailed hydraulic analysis before it is installed to ensure that it achieves optimum solids separation. The cost per unit (including installation) ranges from $2,300 to $7,200 per cfs capacity, depending on site-specific conditions and does not include any required maintenance.

Maintenance of the CDS technology is site-specific but the manufacturer recommends that the unit be checked after every runoff event for the first 30 days after installation. During this initial installation period the unit should be visually inspected and the amount of deposition should be measured, to give the operator an idea of the expected rate of sediment deposition. Deposition can be measured with a calibrated "dip stick". After this initial operation period, CDS Technologies recommends that the unit should be inspected at least once every thirty days during the wet season. During these inspections, the floatables should be removed and the sump cleaned out (if it is more than 85 percent full). It is also recommended that the unit be pumped out and the screen inspected for damage at least once per year.

A recently completed study by UCLA for CDS Technologies evaluating the effectiveness of four different sorbent materials in removing used motor oil at concentrations typically found in storm water runoff. They applied the sorbents in a CDS unit separation chamber and reported captures of 80-90 percent. The test found that polypropylene or co-polymer sorbents to be the most effective in the capture of the used motor oil.

Downstream Defender

The Downstream Defender, manufactured by H.I.L. Technology, Inc., regulates both the quality and quantity of storm water runoff. The Downstream Defender is designed to capture settleable solids, floatables, and oil and grease. It utilizes a sloping base, a dip plate and internal components to aid in pollutant removal. As water flows through the unit, hydrodynamic forces cause solids to begin settling out. A unique feature of this unit is its sloping base (see Figure 1), which is joined to a benching skirt at a 30-degree angle. This feature helps solids to settle out of the water column. The unit's dip plate encourages solids separation and aids in the capture of floatables and oil and grease. All settled solids are stored in a collection facility, while flow is discharged through an outlet pipe. H.I.L. Technology reports that this resulting discharge is 90 percent free of the particles greater than 150 microns that originally entered the system.

The Downstream Defender comes in predesigned standard manhole size, typically ranging from 4 to 10 feet in diameter. These units have achieved 90 percent removal for flows from 0.75 cfs to 13 cfs. To meet specific performance criteria, or for larger flow applications, units may be custom designed up to 40 feet in diameter. (These are not able to fit in conventional manholes.) The approximate capital and installation costs, range from $10,000 to $35,000 per pre-cast unit.

Inspecting the Downstream Defender periodically (once a month) over the first year of operation will aid in determining the rate of sediment and floatables accumulation. A probe (or dipstick) may be used to help determine the sediment depth in the collection facility. (With this inspection information a maintenance schedule may be established.) A

sump vac (commercial or municipally-owned) may be used to remove captured floatables and solids. With proper upkeep, H.I.L. Technology reports the Downstream Defender will treat storm water for more than 30 years.

Stormceptor

Stormceptor Corporation is based in Canada and has licensed manufacturers throughout Canada and the United States. Stormceptor is designed to trap and retain a variety of non-point source pollutants, using a by-pass chamber and treatment chamber. Stormceptor reports that it is capable of removing 50 to 80 percent of the total sediment load when used properly.

Stormceptor units are available in prefabricated sizes up to 12 feet in diameter by 6 to 8 feet deep. Customized units are also available for limited spaces. Stormceptor recommends its units for the following areas:

- Redevelopment projects of more than 2,500 square feet where there was no previous storm water management (even if the existing impervious area is merely being replaced).
- Projects that result in doubling the impervious area.
- Projects that disturb at least half of the existing site.

The cost of the Stormceptor unit is based on the costs of two important system elements:

- A treatment chamber and by-pass insert.
- Access way and fittings.

Typically, the cost for installation of a unit for a one acre drainage area is $9,000. This cost will vary depending on site-specific conditions. Stormceptor units range from 900 to 7,200 gallons and cost between $7,600 and $33,560. Cleaning costs depend on several factors, including the size of the installed unit and travel costs for the cleaning crew. Cleaning usually takes place once per year and costs approximately $1,000 per structure.

Vacuum trucks are used to clean out the Stormceptor unit. Although annual maintenance is recommended, maintenance frequency will be based on site-specific conditions. The need for maintenance is indicated by sediment depth; typically, when the unit is filled to within one foot of capacity, it should be cleaned. Visual inspections may also be performed and are especially recommended for units that may capture petroleum-based pollutants. The visual inspection is accomplished by removing the manhole cover and using a dipstick to determine the petroleum or oil accumulation in the unit.

If the Stormceptor unit is not maintained properly, approximately 15 percent of its total sediment capacity will be reduced each year.

Vortechs

The Vortechs™ storm water treatment system, manufactured by Vortechnics™ of Portland, Maine, has been available since 1988. Like the other hydrodynamic separators, Vortechs removes floating pollutants and settleable solids from surface runoff. This system combines swirl-concentrator and flow-control technologies to separate solids from the flow. Constructed of precast concrete, Vortechs uses four structures to optimize storm water treatment through its system. These are:

- *Baffle wall*: Situated permanently below the water line, this structure helps to contain floating pollutants during high flows and during clean outs.
- *Circular grit chamber*: This structure aids in directing the influent into a vortex path. The vortex action encourages sediment to be caught in the swirling flow path and to settle out later, when the storm event is complete.
- *Flow control chamber*: This device helps keep pollutants trapped by reducing the forces that encourage resuspension and washout. This chamber also helps to

eliminate turbulence within the system.

- *Oil chamber*: This structure helps to contain floatables.

Vortechnics manufactures nine standard-sized units. These range from 9 feet by 3 feet to 18 feet by 12 feet. The unit sizes depend on the estimated runoff volume to be treated. For specific applications, dimensions of the runoff area are used to customize the unit. Vortechnics reports that Vortechs systems are able to treat runoff flows ranging from 1.6 cfs to 25 cfs. The cost for these units ranges from $10,000 to $40,000, not including shipment or installation.

As with other hydrodynamic separator systems, maintenance of the Vortechs system is site-specific. Frequent inspections (once a month) are recommended during the first year and whenever there may be heavy contaminant loadings: after winter sandings, soil disturbances, fuel spills, or sometimes, intense rain or wind.

The Vortechs unit requires cleaning only when the system has nearly reached capacity. This occurs when the sediment reaches within one foot of the inlet pipe. The depth may be gauged by measuring the sediment in the grit chamber with a rod or dipstick. To clean out the system, the manhole cover above the grit chamber is lifted and the sediment is removed using as vacuum truck. Following sediment removal, the manhole cover is replaced securely to ensure that runoff does not leak into the unit.

Hydrodynamic separators are most effective where the separation of heavy particulate or floatable from wet weather runoff is required. (The typical concentrations of heavy particulate and floatable pollutants found in storm water are shown in Table 1.) They are designed to remove settleable solids and capture floatables; however, suspended solids are not effectively removed. Most units are small (depending on the flow entering needing to be treated) and may be able to fit into pre-existing manholes. For this reason, this technology is particularly well suited to locations where there is limited land available.

TABLE 1 CONCENTRATION OF POLLUTANTS IN STORM WATER

Pollutant	Concentration
TSS	100 mg/L
Total P	0.33 mg/L
TKN	1.50 mg/L
Total Cu	34 µg/L
Total Pb	144 µg/L
Total Zn	160 µg L

Source: U.S. EPA, 1995.

The units designed for hydrodynamic separators are generally prefabricated in set sizes up to twelve feet in diameter, but they may be customized for a specific site if needed. Some structures are available in concrete or fiberglass. (Fiberglass is recommended for areas of potential hazardous material spills.) These materials are both suitable for retrofit applications.

Hydrodynamic separators are also good for potential storm water "hotspots" or sites that fall under industrial NPDES storm water requirements. "Hotspots" are areas such as gas stations, where a higher concentration of pollutants is more likely to be found.

ADVANTAGES AND DISADVANTAGES

The use of hydrodynamic separators as wet weather treatment options may be limited by the variability of net solids removal. While some data suggest excellent removal rates, these rates often depend on site-specific conditions, as well as other contributing factors. Pollutants such as nutrients, which adhere to fine particulates or are dissolved, will not be significantly removed by the unit.

Site constraints, including the availability of suitable land, appropriate soil depth, and stable soil to support the unit structurally, may also limit the applicability of the hydrodynamic separator. The slope of the site or collection system may

necessitate the use of an underground unit, which can result in an extensive excavation.

Observable improvements in waterways are often attributable to the use of hydrodynamic separators. This is due to the reduction of sediments, floatables, and oil and grease in the flow out of the unit. These positive impacts are only achievable when proper design and O&M of the unit are implemented.

PERFORMANCE

Hydrodynamic separators are designed primarily for removing floatable and gritty materials; they may have difficulty removing the less-settleable solids generally found in storm water. The reported removal rates of sediments, floatables, and oil and grease differ depending on the vendor. Proper design and maintenance also affect the unit's performance.

OPERATION AND MAINTENANCE

Hydrodynamic separators do not have any moving parts, and are consequently not maintenance intensive. However, maintaining the system properly is very important in ensuring that it is operating as efficiently as possible. Proper maintenance involves frequent inspections throughout the first year of installation. The unit is full when the sediment level comes within one foot of the unit's top. This is recognized through experience or the use of a "dip stick" or rod for measuring the sediment depth. When the unit has reached capacity, it must be cleaned out. This may be performed with a sump vac or vacuum truck, depending on which unit is used. In general, hydrodynamic separators require a minimal amount of maintenance, but lack of attention will lower their overall efficiency.

COSTS

The capital costs for hydrodynamic separators depend on site-specific conditions. These costs are based on several factors including the amount of runoff (in cfs) required to be treated, the amount of land available, and any other treatment technologies that are presently being used. Capitol costs can range from $2,300 to $40,000 per pre-cast unit. Units which are site-specifically designed, typically cost more and the price is based on the individual site.

Total costs for hydrodynamic separators often include predesign costs, capital costs, and operation and maintenance (O&M) costs. Again, these costs are site-specific. The predesign costs depend upon the complexity of the intended site. O&M costs vary based on the company contracted to clean out the unit, and may depend on travel distances and cleaning frequency. These costs generally are low (maximum of $1,000 a year) and vary from year to year.

The individual unit prices are discussed in the current status section previously mentioned. This covers a more in depth price range of the various systems.

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