Hydrodynamic Separators

Hydrodynamic separators (HDS) are small, flow-through devices that remove sediment, trap debris, and separate floating oils from runoff. UNHSC evaluated four HDS designs from 2004 through 2006: the VortSentry, the Continuous Deflection Separator (CDS), the V2B1, and the Aqua-Swirl. While their proprietary designs vary, they all primarily rely on swirl action and particle settling to remove pollutants. The 2005 UNHSC Data Report presents individual results for these systems. In this report, performance data is presented as median values reflecting the class of systems. Their ability to address water quality was marginal. They appear to be most effective when used for pretreatment in areas where runoff is expected to contain sediment particles greater than 100 microns in diameter.

Where to Use It

Manufactured HDS devices are widely used throughout the United States, and there are many options on the market. Their small footprint makes them particularly suitable for urban areas, or as retrofits to existing stormdrain networks. They are relatively simple to maintain, making them ideal for use as pretreatment components in treatment trains that also include filtration or infiltration systems.

Implementation

The approved use of HDS devices varies from state to state. This variability is due, in part, to the discrepancies that exist between laboratory-based and field-based performance data.

Many states approve the use of HDS devices for primary stormwater treatment, however, there is a trend toward limiting their use to pretreatment. Currently, some states require field-performance certification before HDS systems can be used for primary treatment. Other states restrict their use to pretreatment, or require that they are used in combination with other stormwater systems as part of a treatment train. This trend, combined with the widespread adoption of HDS devices, reflects the need for programs that provide independent, certified field-testing of system performance.

The installation cost of HDS devices ranges between $18,000 to $20,000 per acre of runoff treated, and this does not include system maintenance.

Designs for HDS devices are available from the manufacturers.

Many states allow hydrodynamic separators for primary stormwater treatment; however, there has been a trend toward limiting their use to pretreatment. The systems evaluated at UNHSC all demonstrated water quality treatment performances appropriate for pretreatment usage.

Fast Facts

CATEGORY TYPE
Manhole Retrofit, Swirl Separation

BMP TYPE
Manufactured Device

DESIGN SOURCE
Various

BASIC DIMENSIONS
Varies

SPECIFICATIONS
According to Manufacturer

TREATMENT FUNCTION
Physical: Hydrodynamic Separation & Sedimentation

INSTALLATION COST PER ACRE TREATED
$18,000 – $20,000

MAINTENANCE
Maintenance Sensitivity: High
Inspections: High
Sediment Removal: High

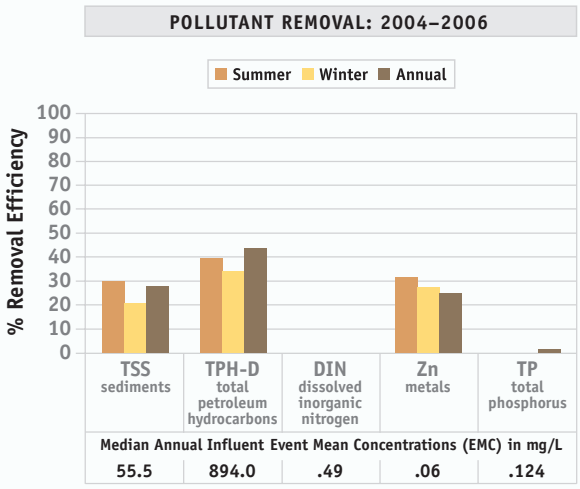
How the System Works

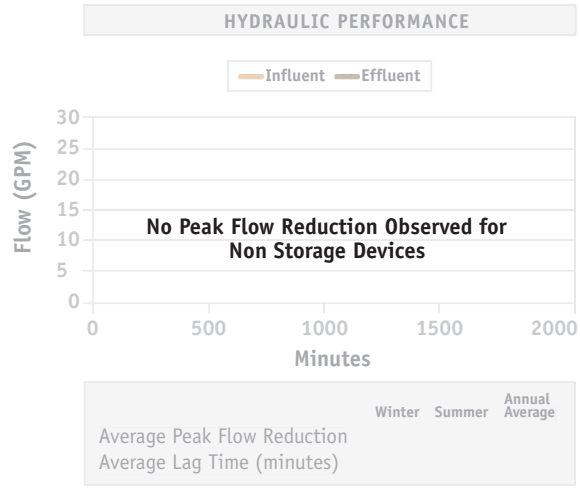
Design

The design of HDS devices varies, and is completed by the manufacturer in accordance with local watershed conditions and target water quality treatment objectives. Often, these systems are designed to replace or retrofit existing catchbasins.

Typically, HDS devices consist of a chamber that is configured for tangential flow, meaning that stormwater enters the device through an angled inlet that creates a swirl action to enhance particle settling. Many also contain a flow partition to minimize sediment re-suspension during times when flow rates exceed the design target.

Typically, HDS devices are equipped with a baffled outlet to remove floating debris, oil, and grease in stormwater runoff. To prevent the re-suspension of captured solids during times of high flow volume, some manufacturers have adapted HDS designs to include internal, online bypasses. When appropriate, these systems also can be outfitted with external, offline bypasses so that high flows can bypass the system completely.





Water Quality Treatment

Water quality performance was moderate to poor across the range of pollutants commonly associated with stormwater treatment performance assessment. The following observations are based on median values that reflect the performance of the four systems evaluated at UNHSC: the VortSentry, the CDS, the V2B1, and the Aqua-Swirl.

The median annual average for removal of total suspended solids in these systems was well below the EPA's recommended level for removal—they performed in the 30 percent range during the warmer months and 20 percent range in the winter. Likewise, they did not meet regional ambient water quality criteria for removal of petroleum hydrocarbons and zinc. No removal was recorded for nutrients, dissolved inorganic nitrogen, or total phosphorus.

The chart at top left is based on median values for the class of HDS systems evaluated; it reflects their performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over 18 storms, with the data further divided into summer and winter components.

Water Quantity Control

Typically, HDS devices are flow-through systems. Therefore, they exhibit no peak flow reduction, volume detention, or lag time, as demonstrated by the chart at bottom left.

Maintenance

Maintenance of HDS devices includes the periodic inspection for floating debris, oil, and grease and the removal of solids by a vacuum truck. Systems in which the catchbasin is designed to be open and accessible allow for more thorough removal of sediment and are less costly to maintain. These devices did not requiure cleaning during their evaluation at the field site.

Cold Climate

As a class, the ability of HDS devices to remove sediments was significantly impacted during cold winter months. This is due to the increased viscosity of stormwater runoff and high concentrations of chloride, both of which combine to reduce particle settling velocity. Calculations of particle settling velocities at temperatures and chloride concentrations typically found in winter runoff demonstrated that HDS devices need about twice the time necessary to settle the same size particles in cold weather. When designed for installation in prolonged cold climate conditions, HDS devices that rely on particle settling for sediment removal need to be oversized to account for these changes in system performance.

Water Quality Treatment Process

1. Runoff flows into the HDS device.
2. Typically, water quality treatment is achieved through a variety of sedimentation processes that involve the physical settling of particles.
3. Water typically leaves the system by flowing under a baffle in front of the outlet. Trash and other floatables remain in the chamber, a process referred to as "indirect filtration."
4. If the HDS is part of a treatment train, the water is routed to the next component of the system. Otherwise it is channeled to a stormdrain system or discharged to the surface.