

# VortSentry<sup>®</sup> HS Guide

## Operation Design, Performance and Maintenance



## VortSentry® HS

The VortSentry® HS is a compact, below grade stormwater treatment system that employs helical flow technology to enhance gravitational separation of floating and settling pollutants from stormwater flows. With the ability to accept a wide range of pipe sizes, the VortSentry HS can treat and convey flows from small to large sites. A unique internal bypass design means higher flows can be diverted without the use of external bypass structures. The VortSentry HS is also available in a grate inlet configuration, which is ideal for retrofit installations.

## Operation Overview

The internal flow controls of the VSHS are illustrated in Figure 1. Low, frequently occurring storm flows are directed into the treatment chamber through the primary inlet. The tangentially oriented downward pipe induces a swirling motion in the treatment chamber that increases capture and containment abilities. Moderate storm flows are directed into the treatment chamber through the secondary inlet, which allows for capture of floating trash and debris. The secondary inlet also provides for treatment of higher flows without significantly increasing the velocity or turbulence in the treatment chamber. This allows for a more quiescent separation environment. Settleable solids and floating pollutants are captured and contained in the treatment chamber.

Flow exits the treatment chamber through the outlet flow control, which manages the amount of flow that is treated and helps maintain the helical flow patterns developed within the treatment chamber.

Flows exceeding the system's rated treatment flow are diverted away from the treatment chamber by the flow

partition. Internal diversion of high flows eliminates the need for external bypass structures. During bypass, the head equalising baffle applies head on the outlet flow control to limit the flow through the treatment chamber. This helps prevent re-suspension of previously captured pollutants.

## Design Basics

The primary method of sizing a VortSentry® HS system is the Water Quality Flow Rate Method, which determines which model size provides the desired removal efficiency at a given flow for a defined particle size.

Typically, VortSentry® HS systems are designed to achieve an 80% Total Suspended Solids reduction based on lab generated performance analysis for a particle gradation with an average particle size (d50) of 110-microns (µm).

## Water Quality Flow Rate Method

In many cases, regulations require that a specific flow rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval (i.e. the six-month storm) or a water quality depth (i.e. 20-mm of rainfall).

The VortSentry® HS is designed to treat all flows up to the WQQ. Due to its internal bypass weir configuration, flow rates in the treatment chamber only increase minimally once the WQQ is surpassed. At influent rates higher than the WQQ, the flow partition will allow most flow exceeding the treatment flow rate to bypass the treatment chamber. This allows removal efficiency to remain relatively constant in the treatment chamber and reduces the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the VortSentry® HS will remove a specific gradation of sediment at a specific removal efficiency. Therefore they are variable based on the gradation and removal efficiency specified by the design engineer and the unit size is scaled according to the project goal.

## Treatment Flow Rate

The outlet flow control is sized to allow the WQQ to pass entirely through the treatment chamber at a water surface elevation equal to the crest of the flow partition. The head equalising baffle applies head on the outlet flow control to limit the flow through the treatment chamber when bypass occurs, thus helping to prevent re-suspension or re-entrainment of previously captured particles.

## Hydraulic Capacity

The VortSentry® HS is available in three standard configurations: inline (with inlet and outlet pipes at 180° to each other), grated inlet, and a combination of grate

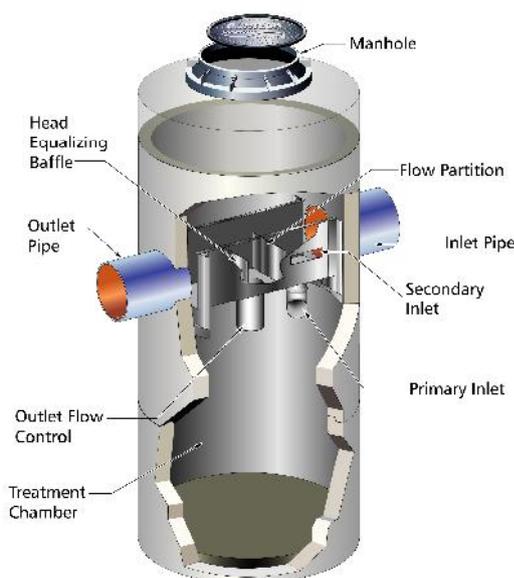


Figure 1: VortSentry® HS components

and pipe inlets. All three configurations are available in 900-mm through 2400-mm diameter manholes.

The configuration of the system is determined by the suffix of the model name:

- A model name without a suffix denotes a standard pipe inlet (Example HS12).
- A “G” at the end of the model designation denotes a grate inlet (Example HS12G).
- A “GP” at the end of the model designation denotes a combination of grate and pipe inlets (Example HS12GP).

## Performance

### Full-Scale Laboratory Test Results

All of the Stormwater360 Hydrodynamic Separator systems have undergone extensive testing at the CONTECH laboratory facility in Scarborough, Maine, USA (Figure 3). This facility allows for comprehensive research and development of new treatment technologies, as well as full-scale performance testing under various flow and loading conditions.

Testing of a 1200-mm diameter VortSentry® HS was conducted using OK-110 Silica, a commercially available sand product with an average particle size of approximately 110- $\mu\text{m}$ . OK-110 is specified by the Maine Department of Environmental Protection (DEP) as the seed pollutant for performance verification under its protocol for laboratory testing of stormwater treatment devices.

During each series of tests, material was metered into a model HS12 at an average concentration of between 220-mg/L and 330-mg/L at a given flow rate, and at least six discrete influent and effluent samples were taken at each flow rate. Flow rates ranged from 5-L/s to 40-L/s, and removal efficiencies at each flow rate were calculated based on the average of discrete influent and effluent concentrations. Results are illustrated in Figure 2, with 80% solids removal measured at flows greater than 10-L/s.

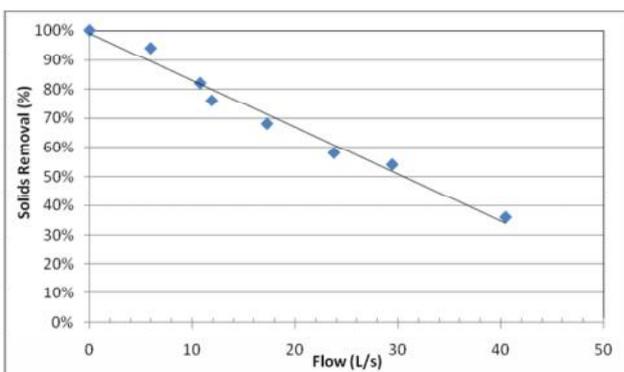


Figure 2: OK-110 removal at varying flow rates



Figure 3: CONTECH laboratory facility

### Computational Fluid Dynamics

Flow modeling using computational fluid dynamics (CFD) software is increasingly used in the development of stormwater treatment systems. CFD is particularly useful in the optimisation of system components, as flow paths and hydraulic velocities can be simulated under varying system configurations and operating conditions. Extensive CFD modeling was used during the development of the VortSentry® HS to achieve a system design that optimises the helical flow path and minimises velocities at the outlet control (Figure 4).

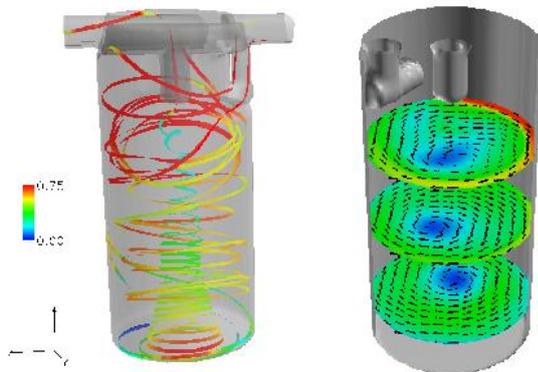


Figure 4: CFD analysis

## Scaling

Assuming that sediment in the inlet chamber is ideally mixed, removal rates through the system will decay according to the percentage of flow bypassed. This effect has been observed in the laboratory where the test system is designed to produce a thoroughly mixed inlet stream. All VortSentry HS models have the same aspect ratio regardless of system diameter (i.e. an increase in diameter results in a corresponding increase in depth). Operating rates are expressed volumetrically.

Removal efficiency at each operating rate is calculated according to the average of volumetric and Froude scaling methods and is described by Equation 1.

$$\text{Equation 1: } \left( \frac{\text{Diameter Prototype}}{\text{Diameter Model}} \right)^{2.75} = \left( \frac{\text{Flow Rate Prototype}}{\text{Flow Rate Model}} \right)$$

Equation 1 and actual laboratory test results were used to determine the flow rate which would be required for the various VortSentry<sup>®</sup> HS models to remove 80% of solids.

## Maintenance

The VortSentry<sup>®</sup> HS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, i.e., unstable soils or heavy winter sanding will cause the treatment chamber to fill more quickly, but regular sweeping will slow accumulation.

## Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and autumn) however more

frequent inspections may be necessary in equipment washdown areas and in climates where winter sanding operations may lead to rapid accumulations of a large volume of sediment. It is useful and often required as part of a permit to keep a record of each inspection. A simple inspection and maintenance log form for doing so is available from Stormwater360.

The VortSentry<sup>®</sup> HS should be cleaned when the sediment has accumulated to a depth of 600-mm in the treatment chamber. This determination can be made by taking two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the base of the treatment chamber. If the difference between these measurements is greater than 600-mm, the unit should be maintained to ensure effective treatment.

## Cleaning

Cleaning of the VortSentry<sup>®</sup> HS should be done during dry weather conditions when no flow is entering the system. Cleanout of the VortSentry<sup>®</sup> HS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole cover and insert the vacuum hose into the sump. All pollutants can be removed from this one access point from the surface with no requirements for Confined Space Entry.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads, which solidify the oils. These are usually much easier to remove from the unit individually, and less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Floating trash can be netted out if you wish to separate it from the other pollutants.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. If anyone physically enters the unit, Confined Space Entry procedures need to be followed.

Disposal of all material removed from the VortSentry<sup>®</sup> HS should be carried out in accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.