VortCapture™

Technical Design Manual

VortCapture™ Contents

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Design and Operation

Basic Operation

VortCapture™ is an engineered stormwater management solution for the removal of trash and organic debris from stormwater runoff. Based on proven hydrodynamic separator technology, VortCapture is a uniquely designed full capture device. It removes all particles 5 mm and greater from treated flows, including neutrally buoyant material. It also effectively removes settleable solids and free-floating oil and grease. The design has been optimized through rigorous CFD (computational fluid dynamics) modeling and full-scale laboratory testing.

The internal treatment components are made of marine grade aluminum and include a perforated screen with 4.8 mm diameter apertures. These components are housed in a round, concrete manhole. Due to its lightweight, compact design VortCapture is well suited for tight sites and can be used as a standalone treatment system or as a pre-treatment device in conjunction with other stormwater BMPs (best management practices).

VortCapture employs a unique screen design that maximizes hydraulic capacity and minimizes blinding. During operation, a tangential inlet causes stormwater to swirl in the circular treatment chamber. Buoyant materials migrate to the center of the treatment chamber and rise above the screen while non-floating pollutants are trapped in the sump below. The vortex action creates high tangential velocities across the face of the screen relative to the normal velocities through the screen. This indirect screening feature scours the screen, preventing the “stapling” of debris into apertures, which can clog screens and restrict flow.

VortCapture is typically sized to treat a design storm or water quality flow rate, where all runoff is directed into the treatment chamber. At higher flow rates, a portion of the runoff spills over the flow partition and is diverted around the treatment chamber and screen, filling the head equalization chamber. This collapses the head differential between the treatment chamber and the outlet, resulting in a relatively constant flow rate in the treatment chamber even with a substantial increase in total flow through the system. The configuration reduces the potential for pulverization or washout of previously captured debris and sediment.

Design Process

Water Quality Flow Rate Method

VortCapture is sized to capture 100% of the trash and debris greater than 5 mm from all treated flow rates. In many cases, a specific water quality design flow rate (WQQ) serves as a benchmark performance objective to size a system that will meet a long-term performance objective. This WQQ is usually the peak flow rate from an event with a specific recurrence interval (e.g., the 3-month storm) or it may represent the peak flow rate associated with a water quality depth (e.g., ½-inch).

VortCapture is designed to treat all flows up to the WQQ, increasing treatment chamber flow rates only minimally once the WQQ is surpassed. At influent rates higher than the WQQ, the flow partition will direct most flow exceeding the treatment flow rate around the treatment chamber. This keeps previously captured debris and sediment in the treatment chamber and reduces the risk of washout regardless of influent flow rates.

Treatment Flow Rate

The treatment flow rate is the rate at which VortCapture will remove 100% of all particles greater than 5 mm. The treatment chamber outlet is sized to allow the entire WQQ to pass through the treatment chamber at a water surface elevation equal to the crest of the flow partition. The head equalization baffle is set with a crest elevation equal to the crest of the flow partition.

The lower edge is set at the water surface elevation occurring in the outlet chamber at the WQQ, so that it will restrict flow once the WQQ is exceeded. At that point, water spilling over the flow partition

will combine with the flow leaving the treatment chamber to submerge the opening under the head equalizing baffle. As the head equalizing chamber fills, it offers resistance to flow leaving the treatment chamber. Therefore, even at influent rates several times higher than the treatment flow rate, the flow rate through the treatment chamber remains constant.

Hydraulic Capacity

VortCapture hydraulic capacity is determined by the length and height of the flow partition and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities far exceeding the treatment flow rate. VortCapture models can be customized as necessary to ensure that the system will pass the peak conveyance flow with an acceptable impact on the hydraulic grade line.

VortCapture Sizing

To determine the appropriate VortCapture for a particular project, first select the smallest model from table below that has a treatment capacity equal to or greater than the water quality design flow. Then check that the model can accommodate the expected pipe diameter selected for the project. If the pipe size on-site exceeds the maximum listed for the model in table below, select the next larger system that can accommodate it.

VortCapture Model	Treatment Capacity (L/s)	Max. Pipe Diameter (mm)*
VC40	39	450(900)
VC50	69	450(1050)
VC60	109	600(1200)
VC70	185	750(1500)
VC80	283	750(1500)
VC100	411	1050(2100)
VC120	574	1200(2100)

* denotes the “HF” or High Flow model which incorporates a high flow diversion chamber on the side of the unit.

VortCapture can be sized to meet specific sediment removal requirements. Please contact Stormwater360 for more information.

Maintenance

Inspection

Inspection is the key to effective maintenance and is easily performed. Stormwater360recommends ongoing quarterly inspections to determine the amount of accumulated trash or organic debris in the system. Pollutant deposition and transport may vary from year to year, and quarterly inspections will help insure the system is cleaned out at the appropriate time. It is very useful to keep a record of each inspection. A simple form for doing so is provided in **VortCapture Inspection & Maintenance Log**.

Table 2. **VortCapture Inspection & Maintenance Log**

Model:			Location:			
Date	**Distance from Water Surface to Sediment[1]**	**Floatable Layer Thickness**	**Debris Accumulation (% of chamber filled)**	**Maintenance Performed**	**Maintenance Personnel**	**Comments**
Notes:						

1 The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface.

Table 3. **VortCapture Sample Maintenance Sheet**

Model : VC60				**Location : Anytown, New Zealand**		
Date	**Distance from Water Surface to Sediment**	**Floatable Layer Thickness**	**Debris Accumulation (% of chamber filled)**	**Maintenance Performed**	**Maintenance Personnel**	**Comments**
12/1/03	2.2m	0	0%	N/A	B.Jones	Installed
3/1/03	2.1m	50mm	5%	None	B.Jones	Swept
9/1/03	1.9m	100mm	10%	None	S.Riley	Water surface covered
12/1/03	1.8m	Sheen	25%	None	S.Riley	
4/1/04	1.7m	380mm	30%	Cleaned out schedule	S.Riley	Heavy Floating debris
15/04/04	2.2m	0	0%	Debris & sediment removed	ACE enviro Services	Cleanout completed
Notes :						

Cleaning

VortCapture should be cleaned out when necessary to ensure optimum performance. The rate at which the system collects pollutants depends more on site activities than the size of the unit (e.g., excessive amounts of trash or organic debris will cause the treatment chamber to fill more quickly, but regular street cleaning will slow accumulation).

VortCapture should be cleaned when inspection reveals that the accumulated debris is approximately one-third of the treatment chamber volume. This equates to an 450 mm thick floating mat of debris, or a sediment depth of 450 mm in the treatment sump (Maintenance Indicators). At a minimum, VortCapture should be cleaned out annually.

VortCapture maintenance is easiest when there is no flow entering the system, so it is a good idea to schedule the cleanout during dry weather. The most effective method for removing pollutants from

VortCapture is to use a vacuum truck. Simply remove the manhole cover and insert the vacuum hose into the treatment chamber. All pollutants can be removed from this one access point. Once the treatment chamber is empty, the debris screen should be power washed and visually inspected for wear and to ensure that it remains properly fastened. While not essential, this step will ensure optimal long-term performance. Only those properly trained and equipped for confined space entry should enter the VortCapture or any other below grade, enclosed structure. Upon completion, manhole covers should be securely seated to ensure that surface runoff does not leak into the unit from above.

Table 4. Maintenance Indicators

VortCapture Model Designation	**Diameter**	**Distance Between Water Surface and Top of Sediment**	**Debris Storage**	**Sediment Storage**
	mm	**m**	**m^3**	**m^3**
VC40	1200	1.5	0.9	0.5
VC50	1500	1.8	1.5	0.8
VC60	1800	2.1	2.3	1.2
VC70	2100	2.3	3.4	1.6
VC80	2400	2.6	4.7	2.1
VC100	3000	3.1	8.5	3.3
VC120	3600	3.6	10.5	4.8

On sites where the risk of large petroleum spills is small, floating liquid contaminants may not accumulate as quickly as trash. However, any 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 since they are usually cheaper to dispose of than the oil water emulsion that may be created by vacuuming the oily layer.

Laboratory Testing Data

Objective

Performance of VortCapture has been verified through a comprehensive, full-scale, laboratory-testing program. The primary goals of this program included documentation of debris removal and retention, hydraulic characteristics, blinding potential, and sediment removal capabilities.

Test Configuration

A VortCapture VC40, which is 1.2 m in diameter, was tested in the CONTECH Stormwater Solutions laboratory. The system was equipped with a 1.6 m^2 perforated aluminum screen with 4.8 mm apertures. The percent open area of the screen was 51%.

The laboratory test unit was configured for a peak conveyance flow rate of 57 l/s and a treatment flow of 16 l/s. Flow was conveyed from an upstream, 21,000L supply tank to the system in a 300 mm diameter PVC pipe. Flow rates were regulated by a butterfly valve located upstream of the unit, and continuously measured with an ISCO 4250 area-velocity meter. Flow discharged from the VortCapture test unit into a 1.8 m x 3.6 m catch tank. Two debris fences covered in landscape fabric spanned the width of the tank, and filtered all water before two 10-horsepower pumps returned it to the supply tank.

Testing used a mixture of organic material and trash typically found in stormwater runoff. Organic debris consisted primarily of leaf litter, grass clippings, and small twigs. Roadside litter was composed of fast food and candy wrappers, paper scraps, plastics bags, straws, cigarette butts, and other miscellaneous items. The material was mixed together in a 60/40 ratio of organic material to trash.

Debris Retention

VortCapture debris retention was documented at flow rates of 16 l/s, 28 l/s, and 45 l/s. Before each trial, 0.21 m^3 of debris was added to the treatment chamber of the unit and allowed to saturate for a minimum of 1-hour. Trials ran in 2-hour intervals and the water surface elevation (WSE) in the unit was recorded every 15 minutes.

Visual observations of flow characteristics in the unit were recorded during each test. At the conclusion of each trial the unit was pumped down to allow a thorough inspection of the screen. At the flow rates tested, VortCapture retained 100% of previously captured debris (Debris Retention Test Results).

Table 5.Debris Retention Test Results

Flow Rate	**Change in Water Surface Elevation**	**Debris Retention**	**Stapling**	**Hydraulic Observations**
l/s				
15	0	100%	None	Preferential swirling with good tangential velocities at screen face
28	0	100%	None	
45	0	100%	None	

During the tests, debris was observed contacting the screen, but material did not come to rest on the face of the screen. This confirmed what the CONTECH Stormwater Solutions CFD (computational

fluid dynamics) modeling predicted. It also supported the hypothesis that debris would be deflected because the velocity of water passing parallel to the screen face would be sufficiently greater than the velocity of flow through the screen. After prolonged testing, several pieces of debris remained in contact with the screen in the vicinity of the treatment chamber outlet pipe, but these materials fell from the screen during simulated dry weather conditions. The screen was thoroughly inspected after each test and no stapling of debris to the screen was observed.

Debris Capture

A typically sized VortCapture will remove 100% of the debris load greater than 5 mm in size from a regulated design flow or design storm, and divert higher flow rates around the treatment chamber. The laboratory model VC40 was designed to treat up to 16 l/s. To determine the debris trapping efficiency of VortCapture, tests were conducted at 16 l/s, 28 l/s, and 44 l/s, each lasting 1-hour. Debris was introduced through a 150 mm diameter standpipe located upstream of the unit. A debris fence lined with landscaping fabric was positioned downstream of the test unit to capture any debris potentially lost from the unit. VortCapture trapped 100% of the debris load at 16 l/s, the design flow rate.

Mass Loading

To establish the effective storage capacity of the VortCapture system, the unit was loaded to a condition of overcapacity (i.e., failure). Debris was added to the laboratory VortCapture unit at the beginning of each of the five, 4-hour loading tests conducted at a constant flow rate of 42 l/s. Prior to the first test, 0.21 m^3 of debris was added to the treatment chamber of the system and allowed to saturate for 1-hour. An additional 0.21 m^3 of debris was added to the unit before each subsequent test until 125% of the 1.1 m^3 storage volume was consumed.

Flow patterns in the VortCapture were monitored throughout each test. A debris fence was located downstream of the unit so that the point at which debris began to be released from the test unit (i.e., maximum storage capacity) could be precisely determined. At the conclusion of the final test, the system was pumped down to allow for a thorough inspection of the debris screen.

No material was lost from the VortCapture during tests 1 through 3 (VortCapture VC40 Mass Loading Test Results). During test 4 a significant floating mat of debris had developed but there was still evidence of water circulation below the mat of debris. The water surface elevation in the treatment chamber remained static but it was during this test that a small amount of debris was released (less than 0.03 m^3).

Table 6.VortCapture VC40 Mass Loading Test Results

Test	Water Surface Elevation	Change in Head	Debris Retention	Total Debris in System	Debris Storage Capacity Consumed
				m^3	
1	500	0	100%	0.21	25%
2	500	0	100%	0.43	50%
3	500	0	100%	0.64	75%
4	500	0	99%	0.86	100%
5	500	0	95%	1.07	125%

Flow was held constant at 42 l/s throughout testing.

Based on these tests, a maximum debris storage volume of 0.8 m^3 was identified for the VC40. This debris storage volume is extrapolated for all models based on filling one-third of the treatment chamber's volume adjacent to the screen and 0.4 m of the 0.9 m sediment storage sump with debris (VortCapture Debris Storage Volumes). However, as with any stormwater treatment system, regular inspection and maintenance will insure that the system functions optimally.

Table 7.VortCapture Debris Storage Volumes

VortCapture Model	**Diameter**	**Debris Storage**
	mm	**m^3**
VC40	1200	0.8
VC50	1500	1.5
VC60	1800	2.3
VC70	2100	3.4
VC80	2400	4.8
VC100	3000	8.5
VC120	3600	10.5

VortCapture Sediment Removal

In addition to trapping trash and organic debris, the VortCapture can be sized to meet specific sediment removal targets. It utilizes the same treatment features as VortSentry®, a manhole based hydrodynamic separator, designed by Stormwater360to provide superior removal of floating and settling pollutants. VortCapture and VortSentry sediment removal and retention rates have been shown to be similar in laboratory tests and by CFD modeling.

To verify VortCapture sediment removal capabilities, full-scale laboratory tests were conducted on a VortCapture VC40. To enable a direct comparison between systems, the same sediment removal testing protocol used to document VortSentry performance was used to test the VortCapture. Using OK-110 silica sand (particle d_{50} of 106um) as a sediment source, the system was tested over a similar range of flow rates. These tests confirmed that similarly sized VortCapture and VortSentry models remove equivalent percentages of the influent sediment. Therefore when sizing the VortCapture to meet a specific sediment removal goal, the sizing methodology used for the VortSentry applies. For a detailed description of the testing process, please refer to VortSentry Technical Bulletin 1, available at www.stormwater360.co.nz.

Figure 1 VortCapture VortSentry OK 110 Testing