UP-FLO™ FILTER: *CPZ MIX*™ PERFORMANCE REPORT FOR REMOVAL OF SIL-CO-SIL 106

April 2006

Hydro International ▪ 94 Hutchins Drive ▪ Portland, ME 04102
Tel: (207) 756-6200 ▪ Fax: (207) 756-6212 ▪ E-mail: hiltech@hil-tech.com

TABLE OF CONTENTS

HYDRO INTERNATIONAL
UP-FLO™ FILTER *CPZ MIX*™ PERFORMANCE REPORT FOR REMOVAL OF SIL-CO-SIL 106

1.0 INTRODUCTION

The Up-Flo™ Filter is a high rate, modular filtration system designed to meet the most stringent stormwater treatment regulations. It incorporates multiple elements of a treatment train design into a single, small-footprint device. The Up-Flo™ Filter is engineered to remove over 80% of fine TSS and associated pollutants. Filter Media can be customized to target site-specific pollutants. This test evaluated the TSS removal performance of Hydro International's custom *CPZ Mix*™. The *CPZ Mix*™ is a blend of activated Carbon, Peat, and manganese-coated Zeolite.

2.0 THE UP-FLO™ FILTER TEST FACILITY DESCRIPTION

2.1 LABORATORY SET UP

The Hydro International test facility contains a 23,000-gallon clean water storage reservoir equipped with a Flygt submersible pump to distribute feed water. The 3" Flygt pump delivers water to the Up-Flo™ Filter through an 8-inch PVC pipe network that freely discharges into the open top of the test tank. The 8-inch PVC delivery line is equipped with clear standpipes and a Hershey VP-820 butterfly valve that redirects flows in excess of the desired influent flow rate back into the feed reservoir. A Watson Marlow 704 S/R peristaltic pump conveys slurry from a slurry tank into the delivery line via a standpipe about 3-feet upstream from the Up-Flo™ Filter.

2.2 UP-FLO™ FILTER CONFIGURATION

The 4-ft x 4-ft polypropylene test tank stands 7-ft high and houses from one (1) to six (6) Up-Flo™ Filter Modules. The test tank has a 12-inch outlet pipe that discharges into a large underflow basin on the floor of the lab. Two, 2-inch Flygt pumps send water from the underflow basin back into the feed reservoir.

A Catch Basin configuration Up-Flo™ Filter equipped with 1 Filter Module was used for testing. The Filter Module housed two (2) media bags filled with Hydro International's custom *CPZ Mix*™ then latched shut. A more detailed description of the laboratory set-up can be seen Appendix A.

2.3 FLOW RATE

The flow rate to the Up-Flo™ Filter can be adjusted from 0-450 gpm (0.0 - 1.0 cfs) using the notched Hershey VP-820 butterfly valve fixed to the delivery pipework.

The filtration capacity of a Filter Module depends on the filter media housed with the module and the height of driving head acting on the filter media. This test evaluated the performance of a one-module set up with a flow capacity of 25 gpm at 20 inches of driving head. To test the Filter Module at steady state conditions, the influent flow rate was set to 25 gpm.

2.4 INFLUENT FEED SAND GRADATION

The Up-Flo™ Filter targets the removal of fine sediment. Commercially available feed sands of different grades are selected to best represent the sediment likely to be encountered at a project location. For this Up-Flo™ Filter test, Sil-Co-Sil 106 was used as the feed sand.

2.5 SEDIMENT LOADING

This test targeted a sediment loading concentration in the 200 – 300 mg/L range. For flow rates suitable for the one-Filter Module set-up, 1.25 lbs Sil-Co-Sil 106 was adequate for attaining the desired influent sediment load.

3.0 TESTING PROCEDURE

3.1 PARTICLE SIZE DISTRIBUTION

Particle size analysis was performed on each blend to ensure that it conforms to the target gradation. Because Sil-Co-Sil 106 is composed of very fine particles, the particle size distribution was tested according to ASTM D422 (AASHTO T88).

3.2 FLOW RATE CALIBRATION

A 3-inch, non-variable Flygt pump delivered flows at a constant rate of 448 gpm (1.0 cfs). A series of butterfly valves, a Hersey VP-820 valve and a notched Hershey VP-812 valve, were used to step the flow down to the desired influent flow rate of 25 gpm. Excess flows were redirected to the storage reservoir. The flow rate was calibrated using the Volumetric Time-To-Fill Method. After the valves had been set to their desired notches, time to fill the tank to the 8-cubic feet mark was recorded. The flow rate equals the volume divided by the time-to-fill the volume.

3.3 TSS PERFORMANCE TESTING

3.3.1 INFLUENT AND EFFLUENT SAMPLING

The following sampling procedure was used:

1. Accurately weigh out a bulk sample of the influent feed sand. Ideally, 1.25 lbs should be used for a Sil-Co-Sil 106 slurry mixture being filtered by a 1-Filter Module Up-Flo™ Filter.
2. Start the 3" submersible pump and allow it to pump water into the Up-Flo™ Filter test tank until there is enough driving head to start pushing water up through the filter. Continue to pump flows into the tank until the desired operating head of 20 inches is reached. When the water is at 20 inches of operating head, use the butterfly valves to reduce the influent flows until they are equal to the effluent flows, stabilizing the water level within the Up-Flo™ Filter test tank.
3. Start the stopwatch as switch on the Watson Marlow peristaltic pump to begin feeding the influent feed slurry into the 6-inch diameter standpipe in the Up-Flo™ Filter line at a constant rate.
4. While the sand is being fed, watch the water level in the test chamber at regular intervals. Be sure that the water level in the chamber is not rising or falling below 20 inches of operating head. If the water level *is* rising or falling, adjust the flow rate accordingly and steady it at 20 inches of operating head.
5. When the stopwatch reads 12:00 minutes and steady-state conditions have been reached, take grab samples of the influent and effluent. Two lab technicians may be required to take the samples simultaneously.
6. Take five (4) more samples at 1 minute intervals. This yields a total of 10 samples.
7. Stop the sampling and test. Stop the pumps, stirring motor and automatic sampler.
8. Drain the test unit. Flush the test unit out twice. Clean the test unit and prepare for the next round of testing.

4.0 ANALYSIS

4.1 SAMPLE ANALYSIS

A total 15 pairs of influent and effluent samples were collected during three different laboratory trials. The samples were analyzed using an equivalent standard to the TSS Test Method 2 Filtration in ASTM, 1999, D 3977-97. Specifically, the Standard Methods 19th Ed 1995 for the Examination of Water and Wastewater prepared and published by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF) chapter 2-2540 D Total Suspended Solids Dried at 103-105 deg C is used.

4.2 DATA ANALYSIS

The % of Sil-Co-Sil 106 removed for each sample pair was determined using Equation 1:

Eq. 1 $$\% \text{ Removal} = 100 \times ([TSS]_{inflow} - [TSS]_{outflow}) / [TSS]_{inflow}$$

The average % Removal for each laboratory trial was calculated using Equation 2:

Eq. 2 Avg. % Removal = 100 x ($[TSS]_{Mean\ inflow} - [TSS]_{Mean\ outflow}$) / $[TSS]_{Mean\ inflow}$

Test data and calculations can be seen in Appendix B.

5.0 Conclusions

Based on laboratory testing, the Up-Flo™ Filter *CPZ Mix*™ will remove over 87% of Sil-Co-Sil 106 at 25 gpm per Filter Module.

Appendix A - Test Unit and Facility Details

Description of the Up-Flo™ Filter

A full description of the system components and functionality of the Up-Flo™ Filter is presented in a Flash Animation File found on Hydro International's web page http://www.hydro-international.biz/.

Test unit description

The test unit is fabricated from polypropylene and takes the form of a 4-ft x 4-ft square chamber cylinder approximately 7 ft (2.1m) high. The internal polypropylene components and Type 304 stainless steel support frame are the same as found in actual units. There is no inlet. The set-up simulates a catch-basin insert technology which treats stormwater runoff pouring into a chamber from an overhead grate. The outlet is flanged with a 12 in. (300mm) NP16 flange. The relevant levels are as shown in the drawings and flash animation.

In order to clean out the unit and view the sediment storage area, an 18 in. (460mm) access hatch with a clear viewing port is located at sump level.

The 4-ft square Up-Flo™ Filter test unit has an effective treatment volume equal to:

$V = l \cdot w \cdot h$ = ft = 40.0 ft^3 (1.13 m^3); where h=2.5 ft, l=w=2 ft

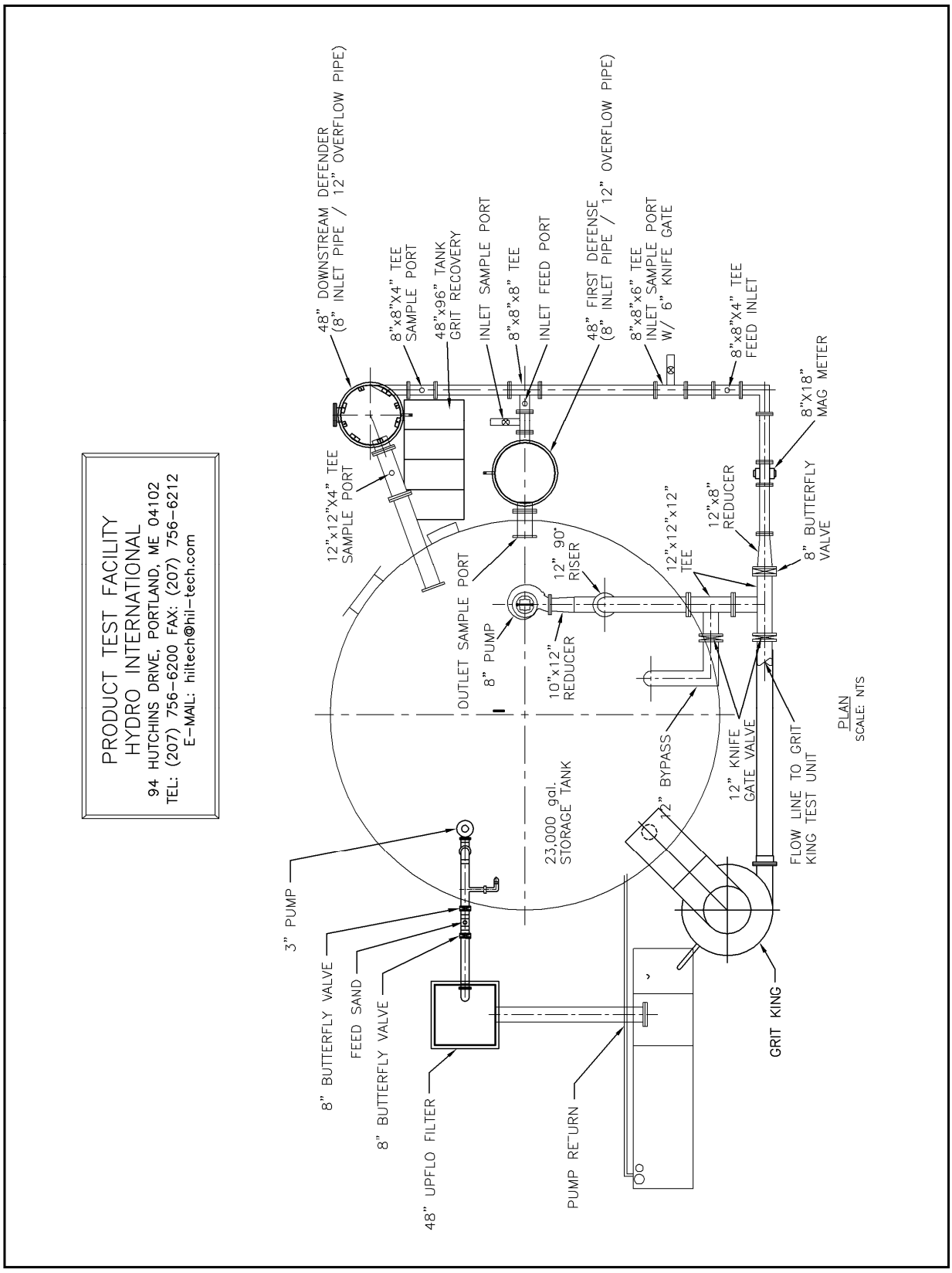
- where l = length of treatment unit
  w= width of treatment unit
  h = distance between top of sump volume and invert of internal bypass weir (which excludes the sediment storage area in the sump).

The theoretical residence time is equal to the amount of time it takes one (1) unit volume to pass through the system at a given flow rate assuming plug flow conditions (no underflow).

The residence time for the Up-Flo™ Filter depends on the peak treatment flow rate. The peak treatment flow rate depends on the number of Filter Modules included in the system as well as the media housed within the Filter Modules. The following residence time calculation is for one (1) Filter Module housing the CPZ Mix™:

t_r = treatment volume/flow rate = (300 gal)/(25 gal/min) = 12 minutes

Test Facility General Arrangement



Test unit photographs

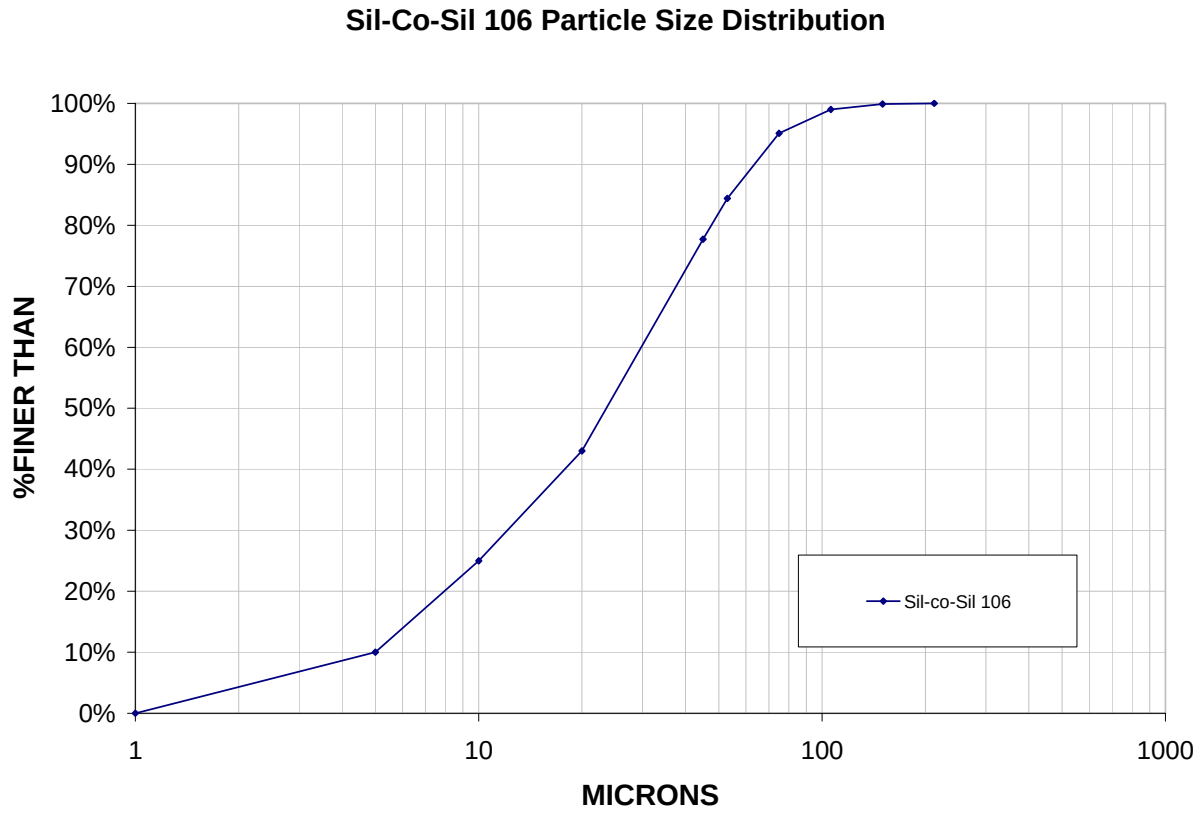
View Showing Up-Flo™ Filter Overhead Inlet Pipe, Outlet Pipe and Collection Basin

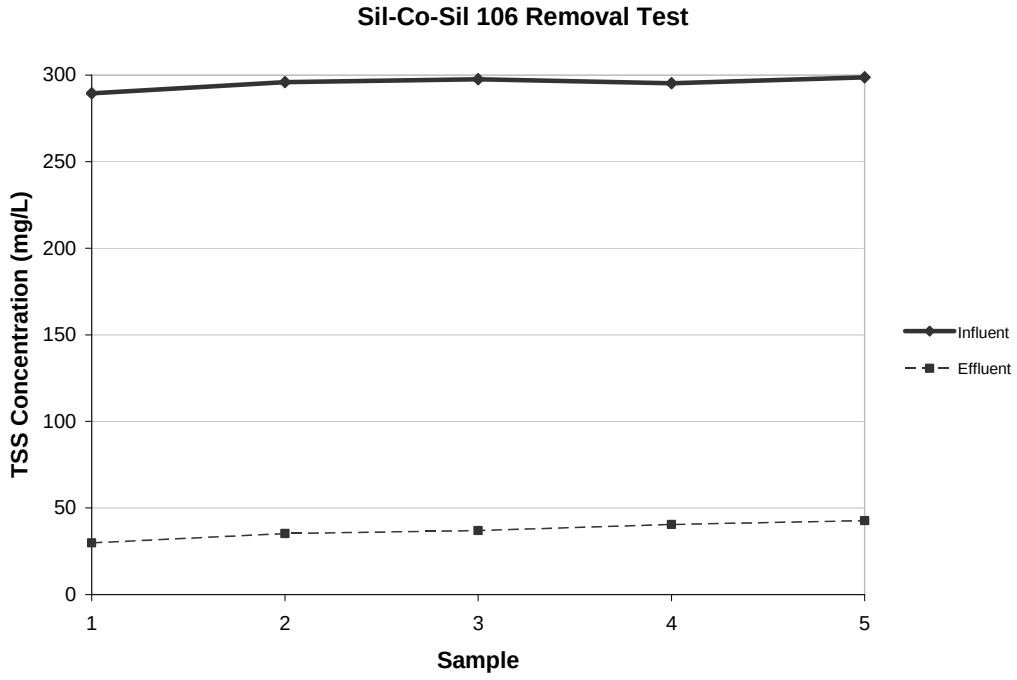
View Showing a One-Module Set-Up

View Showing closed and opened Filter Modules

A close-up view of Hydro International's *CPZ Mix*™

Appendix B – Test Data and Calculations





Sil-Co-Sil 106 Testing

Media	CPZ Mix	**Media Bag Material**	200 NMO
# of Filter Modules Used =	1	**Test #:**	**1**
Peristaltic Pump Speed =	80 rpm	**Done By:**	LG
Weight of Sand =	1.25 lb	**Date:**	3/30/2006
Volume of Water =	40 gallons	**Driving Head:**	20" head
Influent Flow Rate =	25 gpm		

INFLUENT

Sample	Volume (mL)	Volume (L)	Combined Empty Mass (g)	Combined Dried Mass (g)	Mass (mg)	mg/L
1	715	0.715	2.734	2.941	207	289.510
2	730	0.730	2.763	2.979	216	295.890
3	820	0.820	2.695	2.939	244	297.561
4	735	0.735	2.819	3.036	217	295.238
5	790	0.790	2.871	3.107	236	298.734
6						
AVG	758.0	0.7580			224.00	295.3868

EFFLUENT

Sample	Volume (mL)	Volume (L)	Combined Empty Mass (g)	Combined Dried Mass (g)	Mass (mg)	mg/L
1	870	0.870	2.845	2.871	26	29.885
2	880	0.880	2.858	2.889	31	35.227
3	865	0.865	2.76	2.792	32	36.994
4	840	0.840	2.865	2.899	34	40.476
5	915	0.915	2.873	2.912	39	42.623
6						
AVG	874.00	0.8740			32.40	37.0411

Notes: *Weep holes were **opened** during testing.

Total Efficiency =	**87.460** %
Efficiency Sample 1 =	89.677 %
Efficiency Sample 2 =	88.094 %
Efficiency Sample 3 =	87.568 %
Efficiency Sample 4 =	86.290 %
Efficiency Sample 5 =	85.732 %