THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**STORMWATER TREATMENT TECHNOLOGY**	
APPLICATION:	**SUSPENDED SOLIDS AND ROADWAY POLLUTANT TREATMENT**	
TECHNOLOGY NAME:	**CRYSTALSTREAM™ WATER QUALITY VAULT MODEL 1056**	
TEST LOCATION:	**GRIFFIN, GEORGIA**	
COMPANY:	**PRACTICAL BEST MANAGEMENT OF GEORGIA, INC.**	
ADDRESS:	**1960-C Parker Court** **Stone Mountain, Georgia 30087**	PHONE: **(800) 748-6945** FAX: **(770) 979-6954**
WEB SITE:	**http://www.crystalstream.com**	
EMAIL:	**johnmoll@crystalstream.com**	

NSF International (NSF), in cooperation with the U.S. Environmental Protection Agency (EPA), operates the Water Quality Protection Center (WQPC), one of six centers under Environmental Technology Verification (ETV) Program. The WQPC recently evaluated the performance of the CrystalStream™ Water Quality Vault, Model 1056 (CrystalStream) distributed by Practical Best Management of Georgia, Inc. (PBM). The system was installed in a city-owned right-of-way near downtown Griffin, Georgia. The testing organization (TO) was Paragon Consulting Group (PCG) of Griffin, Georgia.

EPA created ETV to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

TECHNOLOGY DESCRIPTION

The following description of the CrystalStream was provided by the vendor and does not represent verified information.

The CrystalStream is a device that removes trash, debris, and larger particulates from stormwater. The device consists of a reservoir, trash basket, oil collection buckets, baffles, and adsorbents, enclosed in a pre-cast concrete vault.

The CrystalStream works on the principle that things less dense than water float and things more dense than water sink. The device remains full of water at all times. A reservoir spans the device from side to side and nearly to the bottom, blocking flow from going directly to the outlet. Incoming storm water flows through a fine mesh in the trash basket, capturing floating debris and vegetative matter. The bottom of the trash basket lies above the standing water elevation in the CrystalStream, preventing the debris from becoming waterlogged, decomposing, and sinking to the bottom of the tank. The water passes around baffles, slowing and spreading the flow, allowing sediments to settle and hydrocarbons to float on the water surface and into a hydrocarbon reservoir. As the water rises out of the unit in the outlet chamber it passes through a 3/4-inch thick coconut fiber filter, designed to remove smaller floating or suspended materials.

The vendor claims that the CrystalStream installed at the Griffin, Georgia site was designed to receive runoff from the drainage area up to a flow rate of 17.5 cfs (7,850 gpm), and can collect as much as 800 lb of material per acre of drainage basin every year.

VERIFICATION TESTING DESCRIPTION

Methods and Procedures

The test methods and procedures used during the study are described in the *Environmental Technology Verification Test Plan For Practical Best Management CrystalStream™ Water Quality Vault, TEA-21 Project Area, City of Griffin, Spalding County, Georgia,* (NSF, June 2003). The CrystalStream treats runoff collected from a drainage basin slightly larger than four acres.

Verification testing consisted of collecting data during a minimum of 15 qualified events that met the following criteria:

- The total rainfall depth for the event, measured at the site, was 0.2 in. (5 mm) or greater;
- Flow through the treatment device was successfully measured and recorded over the duration of the runoff period;
- A flow-proportional composite sample was successfully collected for both the influent and effluent over the duration of the runoff event;
- Each composite sample was comprised of a minimum of five aliquots, including at least two aliquots on the rising limb of the runoff hydrograph, at least one aliquot near the peak, and at least two aliquots on the falling limb of the runoff hydrograph; and
- There was a minimum of six hours between qualified sampling events.

Automated sample monitoring and collection devices were installed and programmed to collect composite samples from the influent, the treated effluent, and the untreated bypass during qualified flow events. In addition to the flow and analytical data, operation and maintenance (O&M) data were recorded. Samples were analyzed for sediments (total suspended solids [TSS] and suspended solids concentration [SSC]) and nutrients (total nitrate, total nitrite, total Kjeldahl nitrogen [TKN], and total phosphorus). The SSC analysis included a "sand-silt" split which quantified the percentage of the sample's sediment particles greater than and less than 62.5 μm.

VERIFICATION OF PERFORMANCE

A total of 15 qualified storm events were sampled over a 17-month time period.

Test Results

The precipitation data for the qualified storm events are summarized in Table 1.

Table 1. Rainfall Data Summary

Event Number	Start Date	Start Time	Rainfall Amount (inches)	Rainfall Duration (hr:min)	Runoff Volume (gal)[1]
1	3/26/03	19:55	0.36	2:40	13,800
2	5/5/03	0:45	0.49	1:15	32,900
3	1/25/04	1:25	0.25	4:15	2,890
4	4/13/04	19:25	0.89	9:25	20,240
5	4/26/04	11:15	0.21	3:50	10,600
6	4/30/04	21:05	0.78	8:15	16,600
7	6/25/04	13:25	0.27	6:20	4,265
8	6/28/04	22:40	0.45	2:25	9,730
9	6/30/04	19:25	1.12	3:05	44,800
10	7/12/04	14:45	0.34	0:30	9,040
11	7/17/04	15:00	0.27	0:20	9,700
12	7/25/04	21:40	0.77	4:25	22,400
13	8/5/04	18:55	0.63	0:50	15,400
14	8/12/04	1:20	0.49	2:50	17,100
15	8/21/04	15:40	0.23	1:15	5,870

[1] Runoff volume was measured at the outlet monitoring point. Refer to the verification report for an explanation of the rationale for utilizing the volume data from the outlet monitoring point

The monitoring results were evaluated using event mean concentration (EMC) and sum of loads (SOL) comparisons. The EMC or efficiency ratio comparison evaluates treatment efficiency on a percentage basis by dividing the effluent concentration by the influent concentration and multiplying the quotient by 100. The efficiency ratio was calculated for each analytical parameter and each individual storm event. The SOL comparison evaluates the treatment efficiency on a percentage basis by comparing the sum of the influent and effluent loads (the product of multiplying the parameter concentration by the precipitation volume) for all 15 storm events. The calculation is made by subtracting the quotient of the total effluent load divided by the total influent load from one, and multiplying by 100. SOL results can be summarized on an overall basis since the loading calculation takes into account both the concentration and volume of runoff from each event. The analytical data ranges, EMC range, and SOL reduction values are shown in Table 2.

Table 2. Analytical Data, EMC Range, and SOL Reduction Results

Parameter	Units	Inlet Range	Outlet Range	EMC Range (%)	SOL Reduction (%)[1]
TSS	mg/L	12 – 190	12 – 140	-120 – 68	21
SSC	mg/L	38 – 4,400	33 – 200	-41 – 98	89
Total nitrite[2]	mg/L as N	<0.01 – 0.03	<0.01 – 0.02	-100 – 83	50
Total nitrate	mg/L as N	0.09 – 0.66	0.07 – 0.7	-90 – 50	25
TKN	mg/L as N	0.6 – 2.4	0.5 – 2.0	-14 – 44	13
Total phosphorus	mg/L as P	0.02 – 0.58	0.08 – 0.3	-600 – 76	40

1. SOL reductions were calculated using outlet flow volumes for inlet and outlet flow data.
2. Total nitrite inlet and outlet concentrations were close to or below method detection limits, so the EMC and SOL reduction may not be indicative of the actual CrystalStream nitrite treatment capabilities.

A "sand-silt split" analysis on samples submitted for SSC analysis when adequate sample volume was collected. The analysis identified that the runoff entering the CrystalStream contained a proportion of coarse sediment ranging from 17.8 to 93.9%, while the outlet contained a proportion of coarse sediment ranging from 6.20 to 33.1%. The sand-silt split and SSC concentration data were used to recalculate the SOL, which showed that the CrystalStream achieved a 98% SOL reduction of sand and a 34% SOL reduction of silt.

System Operation

The device was delivered and placed by PBM into an excavation prepared by a site contractor. A PBM employee was on site to supervise the installation. According to the vendor, it is PBM policy to provide delivery and crane services, and to provide a PBM representative on site to assure proper installation. The device was shipped fully assembled and operational. The site contractor attached the pipes and back-filled the installation site.

Debris accumulated in the CrystalStream's trash basket to the point where it caused water to back up to a level of 16 to 20 in. in the 24-in. inlet pipe during ten of the eleven qualified events in which it was installed. The basket was removed by the TO during events 3 through 6, and during these events, the backup did not occur. The debris accumulating in the trash basket restricted flow into the vault. Inspections conducted by the TO and vendor identified items such as roofing shingles, leaves, twigs, trash, rocks, concrete, and sediment in the trash basket. The CrystalStream can operate without the trash basket in place, but the vendor notes this could decrease removal efficiencies.

PBM recommends that the CrystalStream be inspected every 90 days, and maintained every 180 days or as site conditions warrant. PBM offers inspection and maintenance as part of its service. PBM conducted the inspection and maintenance of the CrystalStream installed at Griffin, and computed the mass of material retained in the vault per acre of drainage basin per year. Their findings are summarized in the vendor comments section of the verification report.

A sample of the retained solids was collected and analyzed for toxicity characteristic leachate procedure (TCLP) metals and was determined to be non-hazardous.

Quality Assurance/Quality Control

NSF personnel completed a technical systems audit during testing to ensure that the testing was in compliance with the test plan. NSF also completed a data quality audit of at least 10% of the test data to ensure that the reported data represented the data generated during testing. In addition to QA/QC audits performed by NSF, EPA personnel conducted an audit of NSF's QA Management Program.

Original signed by	*Original signed by*
Sally Gutierrez *September 2, 2005*	*Thomas Stevens* *September 7, 2005*
Sally Gutierrez Date	Thomas G. Stevens, P.E. Date
Acting Director	Project Manager
National Risk Management Laboratory	Water Quality Protection Center
Office of Research and Development	NSF International
United States Environmental Protection Agency	

Availability of Supporting Documents

Copies of the *ETV Verification Protocol, Stormwater Source Area Treatment Technologies Draft 4.1, March 2002,* the verification statement, and the verification report (NSF Report Number 05/25/WQPC-WWF) are available from:

ETV Water Quality Protection Center Program Manager (hard copy)
NSF International
P.O. Box 130140
Ann Arbor, Michigan 48113-0140

NSF website: http://www.nsf.org/etv (electronic copy)
EPA website: http://www.epa.gov/etv (electronic copy)
Appendices are not included in the verification report, but are available from NSF upon request.