

FINAL PROJECT REPORT

FOR

EFFECTIVENESS EVALUATION OF PROMISING STORMWATER TREATMENT TECHNOLOGY

Prepared for

PORT OF HOUSTON AUTHORITY
Houston, Texas

Prepared by

WESTON SOLUTIONS, INC.
5599 San Felipe, Suite 700
Houston, TX 77056

GLO CONTRACT NO. 01-201 R

THIS PAPER IS FUNDED "IN PART" BY A GRANT / COOPERATIVE AGREEMENT FROM THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA). THE VIEWS EXPRESSED HEREIN ARE THOSE OF THE AUTHOR AND DO NOT NECESSARILY REFLECT THE VIEWS OF NOAA OR ANY OF ITS SUB-AGENCIES.



October 2002



W.O. No. 06153.011.001

TABLE OF CONTENTS

Section	Page
EXECUTIVE SUMMARY	ES-1
1. INTRODUCTION.....	1-1
1.1 BACKGROUND	1-1
1.2 PROJECT OVERVIEW	1-1
1.3 OBJECTIVES	1-2
1.3.1 Document Contents.....	1-2
2. DATA COLLECTION, ANALYSIS, AND RESULTS.....	2-1
2.1 DATA ADEQUECY	2-1
2.2 FIELD DATA COLLECTION	2-2
2.2.1 Sample Locations and Field Set Up.....	2-2
2.2.2 Field Efforts	2-2
2.2.3 Rainfall and Flow Measurements	2-3
2.3 REPORTING CALCULATIONS	2-4
2.4 SUMMARY OF RESULTS	2-5
2.5 SUMMARY OF QA/QC ANALYSIS AND DATA VALIDATION	2-5
3. CONCLUSION	3-1
4. REFERENCES.....	4-1

LIST OF APPENDICES

- Appendix A Field Log Book Copies
- Appendix B Laboratory Analysis Raw Data
- Appendix C Autosampler Current Program Elements
- Appendix D Rain Event Water Levels and Hydrographs
- Appendix E Chain of Custodies
- Appendix F Influent Particle Size Analysis Results
- Appendix G Effluent Particle Size Analysis Results

LIST OF FIGURES

Figure	Page
Figure 2-1 Site Plan	2-7
Figure 2-2 Site Photo	2-8
Figure 2-3 Final Set-Up	2-9

LIST OF TABLES

Table 2-1 Influent and Effluent Data for Non-qualified Rain Events	2-10
Table 2-2 Influent and Effluent Data Reporting for Qualified Rain Event	2-12

EXECUTIVE SUMMARY

An effectiveness evaluation of a promising, proprietary, stormwater treatment device was conducted. The device, selected using multiple selection criteria applicable to the site conditions, is known as Stormceptor® and is designed and marketed by Stormceptor Corporation and CSR Hydro. A work plan Weston Solutions, Inc. (WESTON_{SM}) and implemented by the Port of Houston Authority (PHA). The data collection began in August 2002 promptly after the installation of the Stormceptor® at the PHA's Barbours Cut terminal facility. Paired sampling of the stormwater runoff influent and effluent through the device was conducted and samples were analyzed for the most common stormwater pollutants found locally at the site.

Fifteen rain events were proposed for data collection during the project time frame. However, data were collected for three events. Of the three events, only one qualified as a representative event using the criterion set forth in the work plan. Some of the technical difficulties included but were not limited to sampler battery outage due to short life span, inadequate flow measurements due to over sensitivity of the area velocity meter sensor, and lack of rain gauge at the effluent site in the beginning effecting effluent sampler. However, after making some adjustments in the instruments and resolving outstanding technical issues, the field set up was able to collect data from rain events.

Data collected from one rain event were analyzed for the evaluation. Therefore it is difficult to draw a conclusion based on it. The results of this event appear mixed. Some of the constituents have decreased in concentration while some have increased. Since associated flow data is absent, it is hard to observe the effects of mass loadings of these constituents. The particle size distribution analysis, however, seems to indicate that heavier particles are being removed. Additional data is required to make any meaningful conclusion. Now that the system is in place and minor adjustments have been implemented to assure proper data collection, additional data should be collected and evaluated to facilitate appropriate conclusions for this project.

1. INTRODUCTION

1.1 BACKGROUND

The Port of Houston Authority (PHA) was granted funding under the Coastal Zone Management Program administered by the General Land Office (GLO) to conduct an Effectiveness Evaluation of a Promising Stormwater Treatment Technology under GLO Contract Number 01-201. The goal of the evaluation study was to obtain quality assured data documenting the effectiveness of the stormwater treatment device as a strategic planning tool for not only the PHA but other entities in the Gulf Coast region with similar hydrologic characteristics. Additionally, the project would provide data that would assist in implementing the Galveston Bay Plan.

1.2 PROJECT OVERVIEW

The objective of this project was to evaluate the effectiveness (or performance concerns) of a promising, proprietary, stormwater treatment device known as Stormceptor®, designed and marketed by Stormceptor® Corporation and CSR Hydro. Water-quality testing was conducted for several storm events to establish the Event Mean Concentration (EMC) of various pollutants in the influent and effluent streams of the treatment device. Paired flow was measured during the sampling events. Constituents monitored included aluminum, iron, lead, zinc (those constituents currently monitored by the PHA under their National Pollutant Discharge Elimination System [NPDES] Multi-Sector General Permit [MSGP]), and other stormwater constituents of interest. These constituents are presented in Section 2, Data Collection Results. After sampling, data review was performed on the laboratory's analytical report package and is provided in Section 2. The pollutant load reductions were calculated for all qualified storm events for which data were available. Section 2 presents the methodology used for the computations and the results of the analyzed data. Section 3 presents conclusions and recommendations from this effectiveness study.

1.3 OBJECTIVES

The objective of the evaluation was to measure the treatment capabilities of the Stormceptor® over a series of representative storm events. This objective is described in Section 1.3 of the *Work Plan and Quality Assurance Project Plan for Effectiveness Evaluation of Promising Stormwater Treatment Technology – Revision 1*. Monitored constituents and corresponding stormwater flows were measured prior to and after treatment by the Stormceptor®. Influent and effluent constituent loads and concentrations for 15 qualified storm events were to be calculated and analyzed for an assessment of the unit's treatment efficiency at the PHA site for the monitored parameters. However, due to shortage of time and inadequacy of qualified rain events during the project period, complete data from one qualified storm event and two unqualified events were collected and analyzed.

1.3.1 Document Contents

This document is organized into the following sections:

- Executive Summary
- Section 1—Introduction: Provides a brief project overview and background.
- Section 2—Data Collection, Analysis, and Results: Describes the field effort of data collection, equipment, procedures, and project challenges and presents the data results and Stormceptor® evaluation indicators.
- Section 3—Conclusion: Based on the project experience and lessons learned, presents recommendations and/or conclusions.
- Section 4—References: Lists reference material used in writing this report.

2. DATA COLLECTION, ANALYSIS, AND RESULTS

For this Best Management Practice (BMP) effectiveness study, the PHA performed the field data collection and sampling in accordance with the *Work Plan and Quality Assurance Project Plan for Effectiveness Evaluation of Promising Stormwater Treatment Technology – Revision 1*. Using PHA collected sampling data, WESTON prepared this report.

2.1 DATA ADEQUACY

To evaluate the Stormceptor® unit properly and as directed in the work plan, it was necessary to obtain water quality test data for at least 15 qualified storm events. A qualified storm event is defined in the work plan as follows:

- The total rainfall depth for the event, measured at the site, must be 0.1 inches or greater;
- Both influent and effluent flow through the Stormceptor® must be successfully measured and recorded over the duration of the run-off period;
- A minimum of (3) discrete samples including at least one (1) on the rising limb of the run-off hydrograph, at least one near the peak, and at least one on the falling limb of the run-off hydrograph must be collected; and
- A minimum of six hours must exist between consecutive qualified evaluations, i.e., there must be a minimum of six hours between the termination of measured flow during one event and the start of measured flow for the subsequent rainfall event.

This would enable the evaluator to obtain the Event Mean Concentration (EMC) of various pollutants in the influent and effluent of the treatment device. Mass and concentration reductions would then be calculated for a variety of constituents defined in the work plan. However, due to time constraints, Stormceptor® installation delays, technical difficulties (auto-sampler power issues), and various other reasons, adequate data for the 15 planned storm events were not available. Limited data from three storm events was collected and is presented in this report.

2.2 FIELD DATA COLLECTION

Field data collection was a critical part of this project, which consisted of paired sampling of the water quality passing through the Stormceptor® device. The Work Plan and Quality Assurance Plan (QAPP) describe the sampling procedures and methods for the field effort. Site information and the local hydrologic conditions are also documented in Section 4 of this document. Figure 2-1 depicts the site plan and layout. The selected Stormceptor® site is located at the parking lot of PHA's Barbrous Cut terminal maintenance building. Figure 2-2 shows the selected location of the Stormceptor®.

2.2.1 Sample Locations and Field Set Up

Samples were collected and flow was monitored at two locations inside the 12-inch storm drainage pipe serving the Stormceptor® with one location upstream of the inlet of the Stormceptor® – Influent Site and another downstream of the outlet of the Stormceptor® – Effluent Site. Each flow sensor and suction tube inlet was placed as far as feasible (2 to 3 feet) from the inlet and outlet of the Stormceptor® such that there were no interferences from the turbulence or eddy currents generated by the Stormceptor®. The end of each suction tube was installed in the center of the pipe (1.2 inches from the bottom with the open end facing downstream). These locations are depicted in Figure 2-3 along with a cross section of the Stormceptor® and the field set up. Strainers were not used on either suction pipe to avoid excluding coarse solids. A rain gauge was installed on the roof of the maintenance building and connected to the Influent sampler. Later, another rain gauge was also installed and connected to the Effluent sampler.

2.2.2 Field Efforts

Field sampling began in August 2002 promptly after successful installation of the Stormceptor® unit and automatic samplers at the selected location. Samples were collected during three rainfall events in August 2002. The samples from the first and second events, which occurred on 13 and 15 August 2002, are incomplete because they did not meet the qualified number of required sampling criterion and would have distorted the results. The samples from the third

DATA COLLECTION, ANALYSIS, AND RESULTS

event, which occurred on 27 August 2002, were analyzed for reporting calculations (see Section 2.3). Logbook entries of the field effort are presented in Appendix A. The raw laboratory data from field sampling events are included in Appendix B. The log book entry for the August 27th event seems to indicate a power outage that resulted in samples not being promptly picked up; although drawn on the 27th the samples were not picked up until August 29th. Consequently, the lab report indicates August 29th as the sampling date.

The PHA encountered technical difficulties with the ISCO 6700 Autosampler supplied power source and obtaining timely technical assistance from the Autosampler vendor. The small batteries included with the Autosampler maintained a charge for approximately two and half days, resulting in power concerns. To alleviate the concerns, the power sources for the Autosamplers were changed to Deep Cycle Marine batteries. Sample collection was done at fifteen-minute timed intervals rather than flow pacing as suggested in the work plan. Flow pacing was not possible because the influent area velocity sensor used to establish flow became non-operational during the field effort. Current Program Elements for both the Autosamplers – influent and effluent sites are provided in Appendix C. Analysis, Inc., the PHA contracted analytical laboratory, performed the analytical testing for the parameters listed in the Work Plan/QAPP.

2.2.3 Rainfall and Flow Measurements

Rainfall data for the month of August and for individual events on 13, 15 and 27 August, when samples were collected, were plotted using ISCO's Flow Link software. These plots of rainfall data and similar plots for the water level in the pipe over the same time frame are presented in Appendix D. Only Influent site rainfall data is presented as the Effluent site did not have an attached rain gauge (see previous discussion). The hydrographs also show the times when the samples were drawn for the individual sampling events. Hydrographs in this context are the time series plots of the rainfall as the rain event progresses indicating rainfall depth. ISCO 750 A/V flow meters were used to measure the flow rate at the sampling sites. However, due to technical difficulties, the sensor being too sensitive, velocity could not be accurately measured which resulted in unavailability of the flow data. Consequently no mass loadings could not be reported.

2.3 REPORTING CALCULATIONS

Only one event qualified for analysis after applying the definition of a qualified storm event presented in Section 2.1. The other two events did not have a minimum of three samples. The results of the two disqualified rain events are presented in Table 2-1 for informational purposes only. Samples collected from the one qualified event on August 27th were analyzed and presented in Table 2-2.

The Environmental Protection Agency (EPA) provides guidance in their Environmental Technologies Verification (ETV) program regarding the reporting of BMP performance data (EPA, 2001). The following performance indicators need to be calculated to characterize the efficiency of the Stormceptor® stormwater treatment technology:

- **Load Reduction:** The load reduction for each monitored constituent is calculated for each storm event based on the percentage of the total amount of each constituent that was removed from the flow through the device. The load reduction efficiency of the device is based on relating the sum of the total outlet loads to the sum of the total inlet loads as follows:

$$\% \text{ Load Reduction Efficiency} = 100 \times (1 - (A/B))$$

Where:

$$A = \text{Sum of Effluent Load} = (\text{Effluent EMC}_1)(\text{Flow Volume}_1) + (\text{Effluent EMC}_2)(\text{Flow Volume}_2) + \dots + (\text{Effluent EMC}_n)(\text{Flow Volume}_n)$$

$$B = \text{Sum of Influent Load} = (\text{Influent EMC}_1)(\text{Flow Volume}_1) + (\text{Influent EMC}_2)(\text{Flow Volume}_2) + \dots + (\text{Influent EMC}_n)(\text{Flow Volume}_n)$$

n = number of qualified storm events

- **Efficiency Ratio:** The efficiency ratio for each constituent is calculated for each storm event based on the reduction in event mean concentration of each constituent in the flow; and

The efficiency ratio is calculated and reported for each storm event as follows:

$$\text{Efficiency Ratio} = 100 \times (1 - (\text{Effluent EMC})/(\text{Influent EMC}))$$

DATA COLLECTION, ANALYSIS, AND RESULTS

- Annual Load Reduction: The annual load reduction for each constituent is calculated based upon the site specific drainage area and hydrology

$$\text{Annual Load} = (\text{EMC}_{\text{avg}}) \times (\text{Q}_{\text{annual}})$$

2.4 SUMMARY OF RESULTS

Table 2-2 presents the analysis of the one sampling event with efficiency ratios. Due to lack of flow data, mass loadings could not be reported. The minimum analytical level (MAL) was met for all the constituents as set forth in the work plan. QA/QC samples are discussed in Section 2.5. The MAL is the lowest concentration at which a particular substance can be quantitatively measured with a defined accuracy and precision level, using approved analytical methods. The minimum analytical level is not the published method detection limit for an EPA-approved analytical method, which is based on laboratory analysis of the substance in reagent (distilled) water. The minimum analytical level is based on analyses of the analyte in the matrix of concern (i.e., discharges).

Particle size analysis was performed for eight samples collected for the event. Influent and Effluent particle size analysis results are presented in Appendix F and G respectively. The results of this analysis seem to indicate that the Stormceptor[®] is removing the heavier particles.

2.5 SUMMARY OF QA/QC ANALYSIS AND DATA VALIDATION

Due to inadequate sampling events, proposed field QA/QC samples could not be collected. Laboratory QA/QC samples (Matrix Spike and Matrix Spike Duplicates) met all the QA/QC requirements. Data validation was performed by WESTON per Section 6.2.8 of the QAPP and is summarized below.

Required Method Detection Limits (MDL) set forth by the QAPP were met for all analyzed parameters. MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

DATA COLLECTION, ANALYSIS, AND RESULTS

With the limited information provided by the laboratory at the time (QC pages, COCs, and excel spreadsheets) the only validation that could be performed was on the MS/MSD %R, MS/MSD RPD, and PDS %R. These were all within precision and accuracy criteria set forth in the QAPP (Table 6-1). The laboratory reported several constituents that were not discussed in Table 6-1: calcium, magnesium, and kjeldahl-N. Recoveries and RPDs for these analytes fell within the same general ranges required for other constituents. It also appeared by looking at the excel spreadsheet, that method blanks were all non-detect. The laboratory QC information could not be definitely matched with associated samples without the batch information for each sample. It should be noted that because there was a lag of two days between the samples drawn and dispatched for analysis, even though the lab theoretically met the holding time, the Orthophosphorus analysis might not be accurate as reported since it exceeded its 48 hrs. holding time.

Figure 2-1 Site Plan

Figure 2-2 Site Photo



Figure 2-3 Final Set-Up

Table 2-1

Influent and Effluent Data for Non-qualified Rain Events

					Sample 13 August 2002		Sample 15 August 2002	
					Influent	Effluent	Influent	Effluent
Event Data								
Start date and time					8/13/02 8:30	8/13/02 8:30	8/15/02 1:45	8/15/02 1:45
End date and time					8/13/02 9:30	8/13/02 9:30	8/15/02 20:10	8/15/02 20:10
Event Rainfall Depth			(in)		0.02	0.02	4.06	4.06
Maximum Hourly Rainfall Intensity			(in/hr)		0.01	0.01	0.2	0.2
Runoff Volume Through Device			(ft3)		75	75	15225	15225
Analyte Data					Sample 1 of 1		Sample 1 of 1	
Analyte	Method	Filtering	Units	RQL				
Sample Date and Time					8/13/02 8:49	8/13/02 8:45	8/15/02 16:20	8/15/02 16:20
C.O.D.			mg/L	10	38.8	147	77.6	143
Hardness		(filtered)	mg/L CaC	--	41	37	50	27
Hardness			mg/L CaC	--	96	56	150	340
Oil and Grease	1664	1	mg/L	1	<1	<1	4.2	5
Oil and Grease	1664	2	mg/L	1	--	1.7	--	--
Total Dissolved Solids			mg/L	1	129	285	120	257
Total Suspended Solids			mg/L	1	130	157	399	19
Aluminum	ICP	(filtered)	mg/L	0.01	0.114	0.099	0.114	<0.01
Aluminum	ICP		mg/L	0.01	1.27	1.14	2.77	1.14
Cadmium	GFAA	(filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	GFAA		mg/L	0.001	<0.001	0.0011	0.0011	<0.001
Cadmium	ICP	(filtered)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Cadmium	ICP		mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Calcium	ICP	(filtered)	mg/L	0.1	15.5	13.9	19.1	10.3
Calcium	ICP		mg/L	10	35.9	21.7	55	126
Copper	GFAA	(filtered)	mg/L	0.002	0.0034	0.0082	<0.002	<0.002
Copper	GFAA		mg/L	0.002	0.0393	0.0297	0.0339	0.0779
Copper	ICP	(filtered)	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
Copper	ICP		mg/L	0.02	0.0306	0.0291	0.0343	0.074
Iron	ICP	(filtered)	mg/L	0.05	<0.05	0.0624	<0.05	<0.05
Iron	ICP		mg/L	0.05	0.929	0.899	2.36	4.08
Lead	GFAA	(filtered)	mg/L	0.001	0.0018	0.0022	0.0021	<0.001
Lead	GFAA		mg/L	0.001	0.0179	0.0237	0.0197	0.053
Lead	ICP	(filtered)	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
Lead	ICP		mg/L	0.02	<0.02	<0.02	0.0246	0.0663
Magnesium	ICP	(filtered)	mg/L	0.05	0.454	0.531	0.626	0.222
Magnesium	ICP		mg/L	0.05	1.09	1.18	2.05	5.6
Zinc	ICP	(filtered)	mg/L	0.005	0.0651	0.0859	0.0686	0.0263
Zinc	ICP		mg/L	0.005	0.751	0.707	0.855	1.78
Ammonia-N			mg/L	0.01	0.122	0.177	0.129	0.394

Table 2-1 (Continued)

Influent and Effluent Data for Non-qualified Rain Events

					Sample 13 August 2002		Sample 15 August 2002	
					Influent	Effluent	Influent	Effluent
Kjeldahl-N			mg/L	0.5	0.908	1.18	1.16	1.3
Nitrate-N			mg/L	--	0.11	0.067	0.046	0.024
Nitrate-Nitrite-N			mg/L	0.01	0.11	0.0671	0.0458	0.0238
Nitrite-N			mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Ortho phosphorus			mg/L	0.01	<0.01	<0.01	0.0412	0.0532
Total phosphorus			mg/L	0.01	0.0718	0.0615	0.0795	0.308

Table 2-2
Influent and Effluent Data Reporting for Qualified Rain Event

	RQL	Sample 1 of 8		Sample 2 of 8		
		8/29/2002	8/29/2002	8/29/2002	8/29/2002	
		133106	133098	133107	133099	
		Influent	Effluent	Influent	Effluent	
Event Data						
Start date and time			8/27/02 13:30	8/27/02 13:30	8/27/02 13:30	8/27/02 13:30
End date and time			8/27/02 15:00	8/27/02 15:00	8/27/02 15:00	8/27/02 15:00
Event Rainfall Depth	(in)		1.1	1.1	1.1	1.1
Maximum Hourly Rainfall Intensity	(in/hr)		0.34	0.34	0.34	0.34
Runoff Volume Through Device	(ft ³)		4125	4125	4125	4125
Analyte	Units					
Sample ID			I1 29Aug 02 - 1	E1 29Aug 02 - 1	I1 29Aug 02 - 2	E1 29Aug 02 - 2
C.O.D.	mg/L	10	132	25.3	99.6	27
Hardness	mg/L CaCO ₃		250	52	95	54
Hardness*filtered	mg/L CaCO ₃		98	22	64	40
Oil and grease/1664	mg/L	1	4.2	3.3	<1	1.7
Total dissolved solids	mg/L	1	241	92.9	93	92.8
Total suspended solids	mg/L	1	46	179	109	3
Aluminum/ICP	mg/L	0.01	3.46	0.603	1.28	0.482
Aluminum/ICP*filtered	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Cadmium/GFAA	mg/L	0.001	0.003	<0.001	<0.001	<0.001
Cadmium/GFAA*filtered	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium/ICP	mg/L	10	92	19.6	34.7	20.5
Calcium/ICP*filtered	mg/L	0.1	37.1	8.54	24.2	15.8
Copper/GFAA	mg/L	0.005	0.122	0.0162	0.042	0.0124
Copper/GFAA*filtered	mg/L	0.005	0.0099	0.0055	0.006	0.0077
Iron/ICP	mg/L	0.2	3.12	0.525	1.25	0.371
Iron/ICP*filtered	mg/L	0.2	0.295	<0.2	<0.2	<0.2
Lead/GFAA	mg/L	0.005	0.034	0.0122	0.0209	0.0084
Lead/GFAA*filtered	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Magnesium/ICP	mg/L	0.05	4.46	0.807	2.09	0.63
Magnesium/ICP*filtered	mg/L	0.05	1.34	0.167	0.863	0.21
Zinc/ICP	mg/L	0.005	2.51	0.436	0.777	0.374
Zinc/ICP*filtered	mg/L	0.005	1.24	0.048	0.281	0.0499
Ammonia-N	mg/L	1	<1	<1	<1	<1
Kjeldahl-N	mg/L	2	4.55	<2	<2	<2
Nitrate/Nitrite-N	mg/L	0.05	<0.05	0.717	0.0943	0.631
Nitrate-N	mg/L		<0.05	0.717	0.024	0.631
Nitrite-N	mg/L	0.05	<0.05	<0.05	0.0708	<0.05
Ortho phosphorus	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
Total phosphorus	mg/L	0.05	1.35	<0.05	0.192	0.0904

Table 2-2 (Continued)

Influent and Effluent Data Reporting for Qualified Rain Event

	RQL	Sample 3 of 8		Sample 4 of 8		
		8/29/2002	8/29/2002	8/29/2002	8/29/2002	
		133108	133100	133109	133101	
		Influent	Effluent	Influent	Effluent	
Event Data						
Start date and time			8/27/02 13:30	8/27/02 13:30	8/27/02 13:30	8/27/02 13:30
End date and time			8/27/02 15:00	8/27/02 15:00	8/27/02 15:00	8/27/02 15:00
Event Rainfall Depth	(in)		1.1	1.1	1.1	1.1
Maximum Hourly Rainfall Intensity	(in/hr)		0.34	0.34	0.34	0.34
Runoff Volume Through Device	(ft3)		4125	4125	4125	4125
Analyte	Units					
Sample ID			I1 29Aug 02 - 3	E1 29Aug 02 - 3	I1 29Aug 02 - 4	E1 29Aug 02 - 4
C.O.D.	mg/L	10	47.3	16.9	13.5	23.6
Hardness	mg/L CaCO3		61	46	42	44
Hardness*filtered	mg/L CaCO3		37	37	23	34
Oil and grease/1664	mg/L	1	5.8	1.7	<1	<1
Total dissolved solids	mg/L	1	64.5	92.1	46.4	83.2
Total suspended solids	mg/L	1	99	2	30	11
Aluminum/ICP	mg/L	0.01	0.933	0.109	0.146	0.271
Aluminum/ICP*filtered	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Cadmium/GFAA	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium/GFAA*filtered	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium/ICP	mg/L	10	21.6	17.8	15.7	17
Calcium/ICP*filtered	mg/L	0.1	13.9	14.4	8.94	13.3
Copper/GFAA	mg/L	0.005	0.0197	0.0115	0.0103	0.0115
Copper/GFAA*filtered	mg/L	0.005	<0.005	0.0059	<0.005	0.0053
Iron/ICP	mg/L	0.2	1.16	0.236	0.487	0.257
Iron/ICP*filtered	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Lead/GFAA	mg/L	0.005	0.0153	0.0062	0.0068	0.0053
Lead/GFAA*filtered	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Magnesium/ICP	mg/L	0.05	1.66	0.499	0.742	0.49
Magnesium/ICP*filtered	mg/L	0.05	0.596	0.25	0.249	0.263
Zinc/ICP	mg/L	0.005	0.545	0.356	0.255	0.46
Zinc/ICP*filtered	mg/L	0.005	0.107	0.0792	0.0621	0.0934
Ammonia-N	mg/L	1	<1	<1	<1	<1
Kjeldahl-N	mg/L	2	<2	<2	2.03	<2
Nitrate/Nitrite-N	mg/L	0.05	0.6	1.02	0.655	0.654
Nitrate-N	mg/L		0.6	1.02	0.655	0.654
Nitrite-N	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Ortho phosphorus	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
Total phosphorus	mg/L	0.05	0.0986	0.0986	0.0575	0.11

Table 2-2 (Continued)

Influent and Effluent Data Reporting for Qualified Rain Event

	RQL	Sample 5 of 8		Sample 6 of 8		
		8/29/2002	8/29/2002	8/29/2002	8/29/2002	
		133110	133102	133111	133103	
		Influent	Effluent	Influent	Effluent	
Event Data						
Start date and time			8/27/02 13:30	8/27/02 13:30	8/27/02 13:30	8/27/02 13:30
End date and time			8/27/02 15:00	8/27/02 15:00	8/27/02 15:00	8/27/02 15:00
Event Rainfall Depth	(in)		1.1	1.1	1.1	1.1
Maximum Hourly Rainfall Intensity	(in/hr)		0.34	0.34	0.34	0.34
Runoff Volume Through Device	(ft3)		4125	4125	4125	4125
Analyte	Units					
Sample ID			I1 29Aug 02 - 5	E1 29Aug 02 - 5	I1 29Aug 02 - 6	E1 29Aug 02 - 6
C.O.D.	mg/L	10	10.1	20.3	16.9	62.4
Hardness	mg/L CaCO3		36	42	43	170
Hardness*filtered	mg/L CaCO3		24	38	30	84
Oil and grease/1664	mg/L	1	<1	5	<1	<1
Total dissolved solids	mg/L	1	65.3	261	74.3	316
Total suspended solids	mg/L	1	17	10	24	176
Aluminum/ICP	mg/L	0.01	0.133	0.335	0.212	1.32
Aluminum/ICP*filtered	mg/L	0.01	<0.01	<0.01	<0.01	0.0169
Cadmium/GFAA	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium/GFAA*filtered	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium/ICP	mg/L	10	13.4	16.3	16.1	65.6
Calcium/ICP*filtered	mg/L	0.1	9.26	14.7	11.5	33.6
Copper/GFAA	mg/L	0.005	0.0099	0.0107	0.0126	0.0151
Copper/GFAA*filtered	mg/L	0.005	<0.005	0.0057	<0.005	0.0063
Iron/ICP	mg/L	0.2	0.306	<0.2	0.396	0.553
Iron/ICP*filtered	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Lead/GFAA	mg/L	0.005	0.0053	<0.005	0.0064	0.0062
Lead/GFAA*filtered	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Magnesium/ICP	mg/L	0.05	0.548	0.403	0.634	1.72
Magnesium/ICP*filtered	mg/L	0.05	0.251	0.279	0.299	0.0705
Zinc/ICP	mg/L	0.005	0.324	0.372	0.669	0.743
Zinc/ICP*filtered	mg/L	0.005	0.144	0.0969	0.318	0.0052
Ammonia-N	mg/L	1	<1	<1	<1	<1
Kjeldahl-N	mg/L	2	<2	<2	<2	2.01
Nitrate/Nitrite-N	mg/L	0.05	0.651	1	0.769	0.734
Nitrate-N	mg/L		0.651	1	0.717	0.436
Nitrite-N	mg/L	0.05	<0.05	<0.05	0.0516	0.298
Ortho phosphorus	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
Total phosphorus	mg/L	0.05	0.0685	0.112	0.074	0.159

Table 2-2 (Continued)

Influent and Effluent Data Reporting for Qualified Rain Event

	RQL	Sample 7 of 8		Sample 8 of 8		
		8/29/2002	8/29/2002	8/29/2002	8/29/2002	
		133112	133104	133113	133105	
		Influent	Effluent	Influent	Effluent	
Event Data						
Start date and time			8/27/02 13:30	8/27/02 13:30	8/27/02 13:30	8/27/02 13:30
End date and time			8/27/02 15:00	8/27/02 15:00	8/27/02 15:00	8/27/02 15:00
Event Rainfall Depth	(in)		1.1	1.1	1.1	1.1
Maximum Hourly Rainfall Intensity	(in/hr)		0.34	0.34	0.34	0.34
Runoff Volume Through Device	(ft3)		4125	4125	4125	4125
Analyte	Units					
Sample ID			I1 29Aug 02 - 7	E1 29Aug 02 - 7	I1 29Aug 02 - 8	E1 29Aug 02 - 8
C.O.D.	mg/L	10	15.2	94.5	16.9	28.7
Hardness	mg/L CaCO3		38	160	50	51
Hardness*filtered	mg/L CaCO3		31	96	37	32
Oil and grease/1664	mg/L	1	<1	1.7	<1	2.5
Total dissolved solids	mg/L	1	73.7	270	73.7	74.6
Total suspended solids	mg/L	1	16	3	18	49
Aluminum/ICP	mg/L	0.01	<0.01	1.91	0.108	0.64
Aluminum/ICP*filtered	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Cadmium/GFAA	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium/GFAA*filtered	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium/ICP	mg/L	10	14.2	61	18.6	18.8
Calcium/ICP*filtered	mg/L	0.1	11.7	38.2	14.2	12.5
Copper/GFAA	mg/L	0.005	0.0105	0.0436	0.0132	0.0167
Copper/GFAA*filtered	mg/L	0.005	0.0073	0.0306	0.0064	0.0052
Iron/ICP	mg/L	0.2	<0.2	1.4	0.254	0.673
Iron/ICP*filtered	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Lead/GFAA	mg/L	0.005	<0.005	0.0159	<0.005	0.0115
Lead/GFAA*filtered	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Magnesium/ICP	mg/L	0.05	0.566	1.96	0.762	1.01
Magnesium/ICP*filtered	mg/L	0.05	0.351	0.156	0.454	0.241
Zinc/ICP	mg/L	0.005	0.573	1.23	0.539	0.554
Zinc/ICP*filtered	mg/L	0.005	0.374	0.0939	0.342	0.0644
Ammonia-N	mg/L	1	<1	<1	<1	<1
Kjeldahl-N	mg/L	2	<2	2.57	<2	<2
Nitrate/Nitrite-N	mg/L	0.05	0.602	0.95	0.675	0.741
Nitrate-N	mg/L		0.602	0.878	0.675	0.741
Nitrite-N	mg/L	0.05	<0.05	0.0717	<0.05	<0.05
Ortho phosphorus	mg/L	0.1	<0.1	0.128	<0.1	<0.1
Total phosphorus	mg/L	0.05	0.0932	0.582	0.118	0.101

Table 2-2 (Continued)

Influent and Effluent Data Reporting for Qualified Rain Event

		RQL	EMC		Efficiency Ratio
			NA		NA
			NA		NA
			Influent	Effluent	
Event Data					
Start date and time			8/27/02 13:30	8/27/02 13:30	
End date and time			8/27/02 15:00	8/27/02 15:00	
Event Rainfall Depth	(in)		1.1	1.1	
Maximum Hourly Rainfall Intensity	(in/hr)		0.34	0.34	
Runoff Volume Through Device	(ft ³)		4125	4125	
Analyte	Units				
Sample ID			B	A	
C.O.D.	mg/L	10	43.938	37.338	15.021
Hardness	mg/L CaCO ₃		76.875	77.375	-0.65
Hardness*filtered	mg/L CaCO ₃		43	47.875	-11.337
Oil and grease/1664	mg/L	1	1.625	2.113	-30.031
Total dissolved solids	mg/L	1	91.488	160.325	-75.242
Total suspended solids	mg/L	1	44.875	54.125	-20.613
Aluminum/ICP	mg/L	0.01	0.785	0.709	9.682
Aluminum/ICP*filtered	mg/L	0.01	0.005	0.006	-20
Cadmium/GFAA	mg/L	0.001	0.001	0.001	0
Cadmium/GFAA*filtered	mg/L	0.001	0.001	0.001	0
Calcium/ICP	mg/L	10	28.288	29.575	-4.55
Calcium/ICP*filtered	mg/L	0.1	16.35	18.88	-15.474
Copper/GFAA	mg/L	0.005	0.03	0.017	43.333
Copper/GFAA*filtered	mg/L	0.005	0.005	0.009	-80
Iron/ICP	mg/L	0.2	0.884	0.514	41.855
Iron/ICP*filtered	mg/L	0.2	0.124	0.1	19.355
Lead/GFAA	mg/L	0.005	0.012	0.009	25
Lead/GFAA*filtered	mg/L	0.005	0.003	0.003	0
Magnesium/ICP	mg/L	0.05	1.433	0.94	34.403
Magnesium/ICP*filtered	mg/L	0.05	0.55	0.205	62.727
Zinc/ICP	mg/L	0.005	0.774	0.566	26.873
Zinc/ICP*filtered	mg/L	0.005	0.359	0.066	81.616
Ammonia-N	mg/L	1	0.5	0.5	0
Kjeldahl-N	mg/L	2	1.573	1.323	15.893
Nitrate/Nitrite-N	mg/L	0.05	0.509	0.806	-58.35
Nitrate-N	mg/L		0.494	0.76	-53.846
Nitrite-N	mg/L	0.05	0.034	0.065	-91.176
Ortho phosphorus	mg/L	0.1	0.05	0.06	-20
Total phosphorus	mg/L	0.05	0.256	0.16	37.5

3. CONCLUSION

It is difficult to draw a conclusion based on one qualified event. The results of this event appear mixed. Some of the constituents have decreased in concentration while some have increased. Since associated flow data is absent, it is hard to identify the effects of mass loadings of these constituents. The particle size distribution analysis seems to indicate that heavier particles were being removed. Additional data is required to make any meaningful conclusion. Now that the system is in place and minor adjustments have been implemented to assure proper data collection, additional data should be collected and evaluated to facilitate appropriate conclusions for this project.

4. REFERENCES

EPA 2001, ETV Verification Protocol, *Stormwater Source Area Treatment Technologies Draft 4.0 for US EPA Environmental Technology Verification Program and EPA/NSF Wet-Weather Flow Technologies Pilot*.

The Stormceptor® System: Stormwater Pollution Control Technical Manual. June 1997, Rockville, MD 20852.

Work Plan and Quality Assurance Project Plan for Effectiveness Evaluation of Promising Stormwater Treatment Technology. August 2001. GLO CONTRACT NO. 01-201 R.

APPENDIX A

FIELD LOG BOOK COPIES

APPENDIX B

LABORATORY ANALYSIS RAW DATA

APPENDIX C

AUTOSAMPLER CURRENT PROGRAM ELEMENTS

APPENDIX D

RAIN EVENT WATER LEVELS AND HYDROGRAPHS

APPENDIX E

CHAIN OF CUSTODIES

APPENDIX F

INFLUENT PARTICLE SIZE ANALYSIS RESULTS

APPENDIX G

EFFLUENT PARTICLE SIZE ANALYSIS RESULTS
