Evaluation of the Performance of Four Catch Basin Inserts in Delaware Urban Applications

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Introduction

Catch basin inserts are becoming more widely used as stormwater best management practices (BMPs). A variety of commercial devices are available. Most are designed to remove trash, sediments and hydrocarbons to varying degrees from stormwater runoff that enters the catch basins. They are a relatively easy and inexpensive retrofit, particularly for older, existing drainage systems where end-of-pipe treatment technologies may be impractical or prohibitively expensive. However, until recently, few catch basin insert filters have had performance data collected under actual field conditions.

The Delaware Department of Transportation (DelDOT) is investigating the performance of four different types of inlet protection devices in urbanized areas of northern Delaware. We are evaluating and comparing the performance of these inserts with respect to their ability to remove sediment and hydrocarbons from stormwater runoff, as well as their maintenance requirements in different applications. Monitoring will continue year-round over a two- to three-year period, in order to incorporate data from varying seasonal and rainfall conditions.

Methods

The catch basin inserts being tested are

1. UltraDrainguard® Oil and Sediment Model (UltraTech International, Inc.) – an X-TEX geotextile sock and skirt that fits the size of the inlet opening.
2. HydroKleen® (Hydro Compliance Management, Inc.) – a two-chambered system consisting of a presettling sediment chamber and a filtration chamber containing one activated carbon and two cellulose filters.
3. DrainPac® (United Stormwater, Inc.) – an HDPE support basket and polypropylene filter liner custom-sized to fit the inlet.
4. Flo-Gard+Plus® (Kristar Enterprises, Inc.) – a support basket and removable polypropylene filter liner, plus a silicate oil-adsorbent filter medium in floatable bags.

The devices were installed in three different locations, with different land use types and varying pollutant loads. These include the service station drainage areas of a rest area on Interstate Rt. 95 near Newark; Drummond North, a residential subdivision in Newark; and a commercial parking area on the Wilmington Riverfront (Table 1). Photographs of each insert are included in Figure 1.

To determine the effectiveness of the catch basin inserts, we are comparing data from wet-weather samples collected at the outfalls of both protected and nearby unprotected (control) runs of inlets. Criteria for a qualifying storm event are a 72-hour dry period preceding and at least 0.1 inch of rainfall during the storm. First flush and flow-weighted composite stormwater samples are analyzed for the following water quality parameters: suspended and dissolved solids, pH, chemical and biological oxygen demand, nutrients, chloride, oil and grease, petroleum hydrocarbons, BTEX, phenolics, PAHs, heavy metals, and indicator bacteria. Only first flush samples are being collected for the Flo-Gard+Plus® inserts. In addition, we inspect all of the inserts on a regular basis; when cleaning or replacement occurs, the sediment and other solids collected in the filters are weighed, characterized as to content, and samples are taken for chemical analysis. This allows us to estimate the total sediment and nutrient load removed by the filters.

The inserts were installed at various times during the past year (Table 1). The drainage pipes and catch basins were cleaned before installation of the inserts.

Results

At the time of this writing, data were available from six wet weather events for the DrainPac® units and one event each for the HydroKleen® and Flo-Gard Plus® units.

HydroKleen®: The HydroKleen® catch basin inserts were selected for the service plaza site because of their multilayer filter design for removing hydrocarbons and other dissolved organics. Baseline monitoring data collected for the past year from the I-95 service plaza show that metals, petroleum hydrocarbons and PAHs are major stormwater contaminants there.

The single set of data from wet weather samples collected from the HydroKleen®-protected run of inlets do not show much protective effect for most of the parameters we measured (Table 2). However, we do not draw any conclusions from this single sampling event, because of the variability of the data. Additional samples collected during the next year or two may clarify this.

The filters were replaced immediately before water quality sampling began, after about nine months of service. The originally white cellulose filters were thoroughly blackened, indicating that the media was saturated with adsorbed hydrocarbons (Figure 2). Little sediment had accumulated in the sedimentation chambers of the inserts; even after nine months most of the chambers had less than an inch of sediment in them. It is not clear whether this is due primarily to a very low sediment and debris load coming from this part of the service plaza or to resuspension and failure to collect the sediment that does enter the units.

DrainPac®: The Drummond North subdivision in which the DrainPac® catch basin inserts were installed lies within the White Clay Creek watershed, an urban area facing TMDL restrictions for nutrients, bacteria, and biology and habitat. This is an older single-family home community, with numerous trees, so the inserts were expected to collect leaves and yard debris, especially during the fall months.

Wet weather data from the DrainPac®-protected catch basins have been highly variable (Table 2). Concentrations of most parameters measured in first flush samples collected from the protected run of inlets were frequently higher than in samples from the untreated control (Table 2). This difference, however, generally was not statistically significant (Wilcoxon signed rank test, $p>0.05$). Contaminant concentrations in composite samples also were not significantly different between treated and control runs. The lack of difference in this case may be explained by the observation that much of the water flowing into the catch basins appears to bypass the DrainPac® filters. The catch basins in this community, like many in Delaware, are grated curb inlets (Figure 3), and, because in our trial the

DrainPac® units do not extend under the curb opening, water that flows into the curb opening does not get treated. For this type of inlet it is clearly desirable to have a BMP that extends under this opening in order that most of the water is not bypassed.

The DrainPac® units, despite the relatively large size of the filter bag, filled up rapidly in this tree-lined community, particularly during the autumn leaf fall (Figure 4). They were cleaned at two-month intervals. However, in this case the units should probably be cleaned more often to prevent resuspension of the collected debris, which may also have contributed to the lack of observed difference in treated and untreated contaminant concentrations. Stenstrom (1999) also demonstrated that DrainPac inserts bypassed much flow once they had accumulated debris.

UltraDrainguard®: UltraDrainguard® inserts were installed in both the I-95 service plaza and the Drummond North subdivision (Table 1). These inserts are appealing because of their relatively low initial cost and ease of installation. However, the smaller bag size compared to other inserts may make their maintenance more burdensome in areas with heavy debris or sediment loads. At the service plaza, these units have collected primarily trash, sand (in winter), grass clippings (in summer), and some leaves. They have been able to go for a number of months between cleanings at this site. The UltraDrainguard® filters were not installed in the Drummond North community until mid-Winter 2004. At the time this paper was written, no wet weather data had yet been collected.

Flo-Gard Plus®: Flo-Gard® inserts also were not installed until late Winter 2004. Initial wet weather data suggest that sediment and oils are removed by the units (Table 2), although more storm events will need to be sampled to determine if this difference is significant.

Discussion and Conclusions

This study was designed to collect stormwater quality data from field installations of catch basin inserts. Thus, the water samples collected represent actual discharge to the stormwater system, including untreated bypass flow. The study will provide information not only on the effectiveness of various inlet protection devices in removing runoff pollutants, but also on their practicality in terms of maintenance issues and cost. Results will help DelDOT in its efforts to select BMPs that are appropriate for particular sites, land uses or stormwater quality problems in the state.

The limited data that we have collected so far on these catch basin inserts point out the variability in wet weather data, as well as in pollutant loads and the effectiveness of the inserts at removing those contaminants. Other studies have also demonstrated considerable variability in field results. DeMaria et al. (2003) have discussed the challenges in acquiring good field data in this type of study. A Navy Environmental Leadership Program study found a 17-95% range of removal efficiencies for DrainPac inserts (NELP, 2002). A study performed by the Interagency Catch Basin Insert Committee found that a variety of catch basin inserts showed little removal of suspended solids, partially due to scouring from relatively small storms (ICBIC, 1995). A recent CalTrans study of highway BMP retrofits included several types of drain inlet inserts. The inserts performed poorly compared to other BMP types, generally providing less than 10% reduction in the concentration of most constitutents. This study concluded that drain inlet inserts are best suited for gross solids removal (Currier et al., 2001; Taylor, 2002).

Lee (2000) and Taylor (2000) claim that storm drain inserts of all kinds generally perform poorly in field tests due to limited contact time between the water and sorptive media, resuspension of material removed by the filters, and requirements for close monitoring and frequent maintenance. They also conclude that inserts do little to remove dissolved contaminants and are bested suited for removing trash and other gross pollutants.

Catch basin inserts are attractive retrofits because of the relative ease and low cost of installation. Ultimately, however, their cost effectiveness is determined by the frequency with which they must be maintained. Our study and others have demonstrated that for many applications a very high frequency of cleaning is necessary to keep the inserts from clogging and bypassing stormwater flows, as well as resuspending captured material. Inserts may not be practical for large drainage areas or for areas with high levels of leaves or debris that can plug them.

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Table 1. Summary of types of catch basin inserts evaluated in this study.

Insert Type	Location	Land Use Drained	Date Installed	No. of Units	Monitoring
HydroKleen®	I-95 Service Plaza	Gas station and vehicle (primarily truck) parking	July 2003	8	Wet weather and sediment
UltraDrainguard®	I-95 Service Plaza	Gas station and vehicle parking	Aug. 2003	19	Sediment only
	Drummond North subdivision	Residential	Dec. 2003	26	Wet weather and sediment
DrainPac®	Drummond North subdivision	Residential	June 2003	21	Wet weather and sediment
FloGard Plus®	Wilmington Riverfront	Commercial parking	Feb. 2004	7	Wet weather

Figure 1. Photographs of installed catch basin inserts. (a) HydroKleen units at the I-95 service plaza; (b) UltraDrainguard filters at the service plaza; (c) DrainPac inserts in Drummond North subdivision; (d) FloGard Plus units at the Wilmington Riverfront.

Table 2. Comparison of first flush (FF) and flow-weighted composite concentrations of selected chemical parameters in stormwater samples from control and insert-protected inlet runs. "ND" indicates a non-detect value.

	TSS, mg/L				Oil & Grease				TPH				COD			
	FF		Composite		FF		Composite		FF		Composite		FF		Composite	
Insert/Storm Event	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*
DrainPac																
9/22/2003	11	17	22	19	ND	ND	ND	ND	ND	ND	ND	ND	86	139	100	80
10/14/2003	161	222	112	51	ND	ND	ND	ND	ND	ND	ND	ND	103	313	60	36
11/19/2003	52	266	149	138	ND	7.4	5.3	8.7	ND	ND	ND	ND	89	189	79	64
11/24/2003	31	85	17	22	ND	ND	7.1	7.0	ND	ND	ND	7.0	117	445	54	59
2/3/2004	2140	476	150	151	ND	ND	ND	ND	ND	ND	ND	ND	64	294	118	97
3/16/2004	59	43	31	51	ND	ND	ND	ND	ND	ND	ND	ND	70	100	42	44
HydroKleen																
3/16/2004	132	188	31	57	ND	14.0	6.1	ND	ND	9.9	6.1	ND	313	674	82	132
Flo-Gard Plus																
3/5/2004	468	136			8.3	ND			ND	ND			287	220		

	TKN				NO2/NO3				Total P				Total Zinc			
	FF		Composite		FF		Composite		FF		Composite		FF		Composite	
Insert/Storm Event	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*
DrainPac																
9/22/2003	1.40	2.00	1.30	1.30	3.15	2.75	1.49	1.69	0.40	0.40	0.59	0.35	0.009	0.010	0.007	0.008
10/14/2003	1.46	3.93	1.29	0.89	2.26	2.29	1.05	0.63	0.37	0.80	0.35	0.23	0.016	0.029	0.008	0.008
11/19/2003	1.50	2.00	0.54	0.57	2.31	0.00	0.00	0.84	0.60	0.56	0.37	0.24	0.018	0.010	0.008	0.009
11/24/2003	1.16	2.40	1.11	1.43	0.25	0.32	0.19	0.21	0.18	0.96	0.27	0.20	0.007	0.071	0.008	0.011
2/3/2004	3.87	3.16	7.65	1.96	2.03	1.75	ND	ND	0.11	0.30	0.52	0.26	0.056	0.201	0.155	0.120
3/16/2004	0.67	1.93	1.09	0.93	2.49	2.24	1.17	1.07	0.18	0.19	0.16	0.11	0.048	0.053	0.047	0.043
HydroKleen																
3/16/2004	9.58	118	5.53	12.50	2.15	1.5	ND	ND	0.35	7.71	0.41	0.98	0.354	0.666	0.168	0.243
Flo-Gard Plus																
3/5/2004													0.262	0.325		

Figure 2. Used cellulose (front) and activated carbon (back) filters removed from HydroKleen inserts after nine months service.

Figure 3. UltraDrainguard-protected inlet showing water flow bypassing the filter and entering the curb opening.

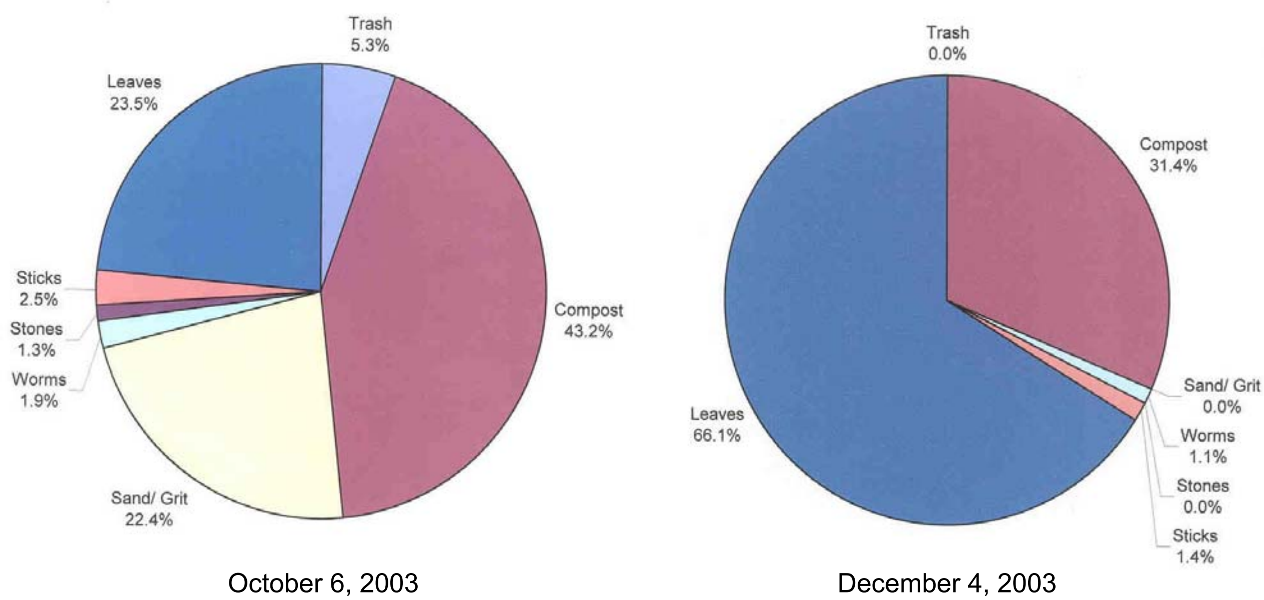

Figure 4. Mean percent volume of contents removed from DrainPac filter bags at two different times, showing the preponderance of leaves and other organic debris.