

INTERSTATE SERVICE PLAZA RETROFITS AS A BMP DEMONSTRATION PROJECT

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INTRODUCTION

The Delaware Department of Transportation's (DelDOT's) MS4 permits require the agency to monitor performance of stormwater best management practices (BMPs). In 2002, a long-term BMP performance monitoring and research program was begun and has expanded considerably since that time. Long-term objectives of DelDOT's BMP monitoring program include the following:

- Quantify pollution removal abilities of BMPs.
- Identify types and amounts of pollutants present in DelDOT-controlled stormwater discharges.
- Determine potential impact of DelDOT discharges on water quality.
- Assure compliance with regulatory standards.
- Provide design engineers with additional treatment options for difficult, site-specific situations.
- Evaluate and select emerging stormwater treatment technologies to provide best benefit: cost performance.

Retrofits provide an excellent opportunity for controlled studies of BMP effectiveness. Therefore, much of our monitoring effort is devoted to studies of retrofit structural BMPs. DelDOT owns and operates a multi-service rest area on Interstate 95 in Newark, Delaware. Because the service plaza is controlled by DelDOT and is a runoff pollution hot spot, DelDOT's Stormwater Quality Program has chosen to use the site as a demonstration and evaluation area for BMP technologies.

STUDY SITE AND RETROFITS

The 33-acre I-95 service plaza lies in the median of the eight-lane expressway. It includes two gas stations, a large food and rest area, pet exercise areas, and parking for trucks, cars and buses. Over the past two years, a number of stormwater quality retrofit BMPs were installed at the site. Figure 1 shows photographs of these BMPs, and Figure 2 provides a site map showing the location of each. These retrofit projects are described in more detail below.

Catch Basin Inserts:

We installed two types of storm drain inlet protectors at the service plaza in order to test their effectiveness at removing pollutants from runoff from the service station and parking lot drainage areas. In 2003, eight HydroKleen[®] catch basin inserts were installed in an area that collects drainage from the northwest side of one of the two gas stations (Figure 1(e), Figure 2). The remaining 56 catch basins have been protected with UltraDrainguard[®] insert filters. We regularly inspect and maintain all of the catch basin inserts. In addition, for the past two years we have monitored and analyzed sediments collected in them and performed wet weather monitoring on the HydroKleen-protected catch basins.

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. The UltraDrainguard inserts are appealing because of their relatively low initial cost and ease of installation. However, the smaller basket 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.

Other BMPs:

Four other types of structural BMPs were installed at the service plaza in 2004 and 2005. These BMPs were selected because they are designed to remove what we have found to be the problem pollutants at the site, as demonstrated in the baseline monitoring. Also, we tried to select some of the newer technologies for testing and compare the monitoring results for these to those obtained from more conventional technologies such as sand filters and retention ponds.

Figure 2 shows the location of each of these BMPs. They include:

- A bioretention cell to replace concrete swales located between the southbound highway lanes and the plaza (Figure 1(a)).
- A StormFilter[®] unit installed south of the Exxon service station (Figure 1(b)).
- A sand filter installed north of the Exxon service station at the east end of the service plaza (Figure 1(c)).
- A BaySaver[®] device installed in the drainage area of the food service area of the plaza (Figure 1(d)).

In addition, we installed nine pet waste bag dispenser units with educational signs in the areas of the service plaza that receive heaviest use for dog walking.

BASELINE MONITORING

We began this project by conducting baseline monitoring at the I-95 Service Plaza for more than a year prior to installation of the water quality retrofits. Five sampling points were selected on the site to provide baseline runoff quality information and to assess the impact of service plaza discharges on Leatherman's Run (see map, Figure 2). First flush and flow-weighted composite samples were analyzed for 50 different chemical parameters, including heavy metals, suspended and dissolved solids, oxygen demand, chloride, bacteria, petroleum hydrocarbons, BTEX, phenolics and PAHs.

Baseline monitoring began in April 2003. Eleven wet weather events were sampled. The baseline data are summarized in Table 1. The event mean concentrations of nearly all parameters were highly variable. In general, the central manhole site (which collects the bulk of the drainage from the parking lots and both gas stations) and the southbound side swale (along which many trucks park) had the highest concentrations of most contaminants. Samples from the Leatherman's Run site downstream of the service plaza discharge consistently had higher levels of pollutants than those from the upstream site, indicating that runoff from the plaza does indeed impact the stream.

These data have provided information on total pollutant loads coming from different parts of the service plaza, as well as total loads being discharged to the stream. They will be compared to data collected from these same points after installation of the retrofits in order to determine the impact of the retrofit BMPs on stormwater discharges from the service plaza.

BMP MONITORING

The eight HydroKleen catch basin inserts were installed in a run of catch basins that collect drainage from one side of a gas station (Figure 2). A similar run of inlets on the other side of the gas station was left unprotected so that water quality from the two runs could be compared. Wet weather monitoring showed that these inserts remove some hydrocarbons from the runoff, but they were not as

successful in capturing sediment. Only marginal differences in water quality were noted between the drainage from protected and control inlets, and we concluded that the drainage into the two runs of inlets was not sufficiently similar to make them comparable. This year we re-evaluated the monitoring protocol for the HydroKleen test in order to conduct a more carefully controlled follow-up study of these units.

For the follow-up study, a single HydroKleen insert unit was modified so that samples of both influent runoff and treated effluent could be sampled directly in that catch basin. This modification involved configuring the unit with a stainless steel tray (made from a modified kitchen sink) to capture effluent, including bypassed water, during a storm (Figure 1(f)). Sampling tubes were added to draw water from this tray. Plans for 2006 include similar controlled study of other catch basin insert types, including the UltraDrainguard and the Abtech UltraUrban[®] at this same location.

Following installation of the bioretention cell, sand filter, StormFilter, and BaySaver BMPs at the service plaza, we began wet weather monitoring of each device to assess and compare their effectiveness at removing runoff pollutants. Our goal is to monitor three to six storm events per year for each BMP. Sites previously sampled during baseline monitoring at the service plaza also are being sampled during this follow-up study in order to assess the effect that the BMP installations have upon total discharges from the site.

Each BMP was designed and instrumented so that both influent and effluent samples can be collected. Both first flush and composite samples are collected, and these are analyzed for 49 different parameters. After each storm event, the influent and effluent data are used to calculate a percent mass removal for each parameter for each of the different BMPs. Insufficient data have been collected to date to provide any conclusions or comparisons with respect to BMP performance. All of the BMPs will continue to be monitored for at least another two to three years.

STREAM ASSESSMENT

DelDOT contracted with KCI Technologies to conduct a long-term stream condition assessment and biomonitoring study on Leatherman's Run, the stream to which all of the stormwater from the I-95 service plaza is discharged. The objectives of this stream assessment project are: (1) to determine the impact on Leatherman's Run of stormwater discharges from DelDOT-owned facilities and drainage systems, particularly the I-95 service plaza; (2) to determine locations for future retrofit projects that will have maximum impact in improving the condition of the stream; (3) to determine strategies for addressing the Christina Basin TMDL; and (4) to track improvements in stream quality associated with BMP retrofits implemented by DelDOT.

Analysis of the Leatherman's Run watershed began with a stream assessment conducted in December 2003. The stream assessment included walking all of the streams in the watershed to update the current stream channel mapping and attribute each channel as perennial, intermittent or ephemeral; identify breaks in geomorphic channel type and conduct preliminary cross-sections to develop geomorphic classifications for all natural channels; identify changes in physical habitat condition and conduct habitat assessments for each separate reach; and to record and assess infrastructure and environmental features such as utilities and erosion points.

Twice per year, in spring and fall, water quality analyses and biological monitoring (including fish studies and macroinvertebrate sampling) are conducted in the stream. Figure 3 shows the sampling sites selected. For the purposes of stream monitoring, the 1741.5-acre Leatherman's Run watershed was subdivided into four catchments, labeled LR1 through LR4 in Figure 3.

Leatherman's Run shows signs of both stormwater quantity and quality stress. The I-95 corridor occupies a significant portion of the center of the stream basin. Monitoring over the past few years has

indicated detectable increases in temperature and dissolved solids near DeIDOT's Chapman Road Maintenance Yard and I-95. We have used the results of the three years of study to identify opportunities for improvements in the Leatherman's Run watershed and I-95 area, including retrofit BMPs, that may help to improve water quality. DeIDOT will be partnering with the Delaware Department of Natural Resources and Environmental Control to implement some of these improvements in the coming years.

CONCLUSION

The I-95 service plaza site has provided DeIDOT with an ideal demonstration and testing site for a variety of structural BMPs. Because the property is owned by DeIDOT, we fully control the site and do not need to seek additional permissions for construction or monitoring. The site is a pollutant "hot-spot," with inputs from vehicle traffic and parking, trucks and buses, gas stations, pet walking and food service. Thus, it provides a real test for the BMPs. Furthermore, because all of the stormwater discharge from the plaza dumps directly into Leatherman's Run, which is piped beneath the site, the probability is high that we can demonstrate actual water quality benefits in the stream resulting from implementation of these BMPs. Complete results of the study eventually will be published and presented at future conferences.

ACKNOWLEDGEMENTS

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Table 1. Summary of event mean concentration data from baseline wet weather monitoring at the I-95 service plaza. Data represent means from eleven wet weather events. Non-detects were assumed to be one half of the limit of detection for calculating means.

Parameter		Sampling Location									
		Leathermans Run Upstream		Leathermans Run Downstream		Central Manhole		Northbound Swale Inlet		Southbound Swale Inlet	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
TSS	mg/L	116.	197.8	86.	79.3	6.4	63.5	24.	17.7	36.	34.4
TDS	mg/L	399.	482.3	644.	1130.8	1020.	1292.8	1047.	1313.6	491.	847.3
COD	mg/L	67.	80.4	165.	161.6	140.	114.2	145.	120.3	149.	124.0
BOD	mg/L	8.0	7.4	18.6	15.7	21.6	18.4	19.5	15.2	21.5	16.8
Chloride	mg/L	213.	363.2	113.	182.8	147.	261.7	380.	734.3	122.	302.2
pH	-	6.96	1.17	6.87	0.31	6.76	0.30	7.31	0.46	6.88	0.34
TKN	mg/L	1.02	0.563	3.16	2.84	5.10	4.52	2.76	1.88	2.55	1.98
Nitrate	mg/L	7.51	9.41	5.72	5.74	5.17	5.57	5.44	10.40	11.6	19.8
Nitrite	mg/L	0.011	0.005	0.110	0.122	0.158	0.122	0.138	0.115	0.214	0.083
Ammonia	mg/L	0.18	0.176	0.58	0.324	0.94	0.635	0.32	0.343	0.70	0.464
Total P	mg/L	0.12	0.081	0.53	0.404	0.55	0.611	0.20	0.189	0.28	0.278
Dissolved P	mg/L	0.06	0.019	0.26	0.313	0.25	0.351	0.12	0.099	0.18	0.147
Orthophosphate	mg/L	0.15	0.194	0.20	0.203	0.32	0.341	0.10	0.119	0.16	0.120
Total Cd	mg/L	ND	-	ND	-	ND	-	ND	-	ND	-
Total Cr	mg/L	0.006	0.0059	0.007	0.0060	0.008	0.0058	0.007	0.0055	0.011	0.0080
Total Cu	mg/L	0.020	0.0140	0.047	0.0547	0.102	0.1635	0.057	0.0556	0.081	0.0694
Total Pb	mg/L	0.017	0.0178	0.013	0.0137	0.012	0.0139	0.010	0.0055	0.014	0.0162
Total Ni	mg/L	0.016	0.0205	0.018	0.0308	0.011	0.0051	0.020	0.0431	0.025	0.0549
Total Zn	mg/L	0.082	0.0515	0.150	0.1310	0.174	0.1363	0.115	0.1198	0.183	0.1889
Oil & Grease	mg/L	4.64	4.12	4.88	2.58	5.36	3.21	3.78	2.65	4.71	3.79
TPH	mg/L	4.42	3068	3.71	1.76	3.32	1.76	3.50	1.96	3.59	2.36
GRO	mg/L	ND	-	ND	-	ND	-	ND	-	ND	-
BTEX	µg/L	ND	-	5.42	8.39	3.90	2.33	ND	-	ND	-
PAHs	µg/L	3.64	8.14	ND	-	ND	-	ND	-	ND	-
Phenolics	mg/L	0.070	0.108	0.124	0.157	0.127	0.211	0.074	0.068	0.091	0.092

ND = non-detect

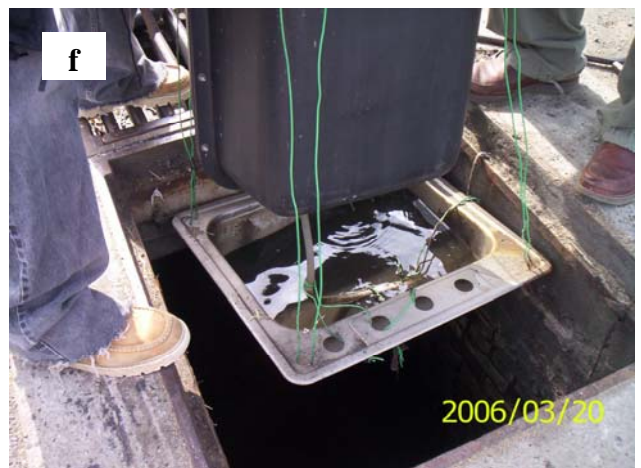
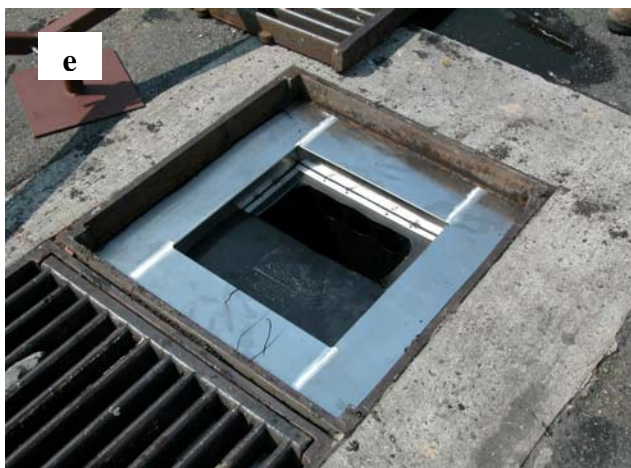
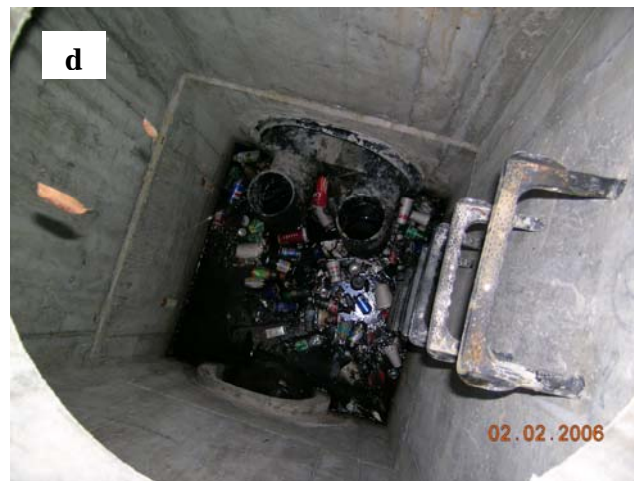
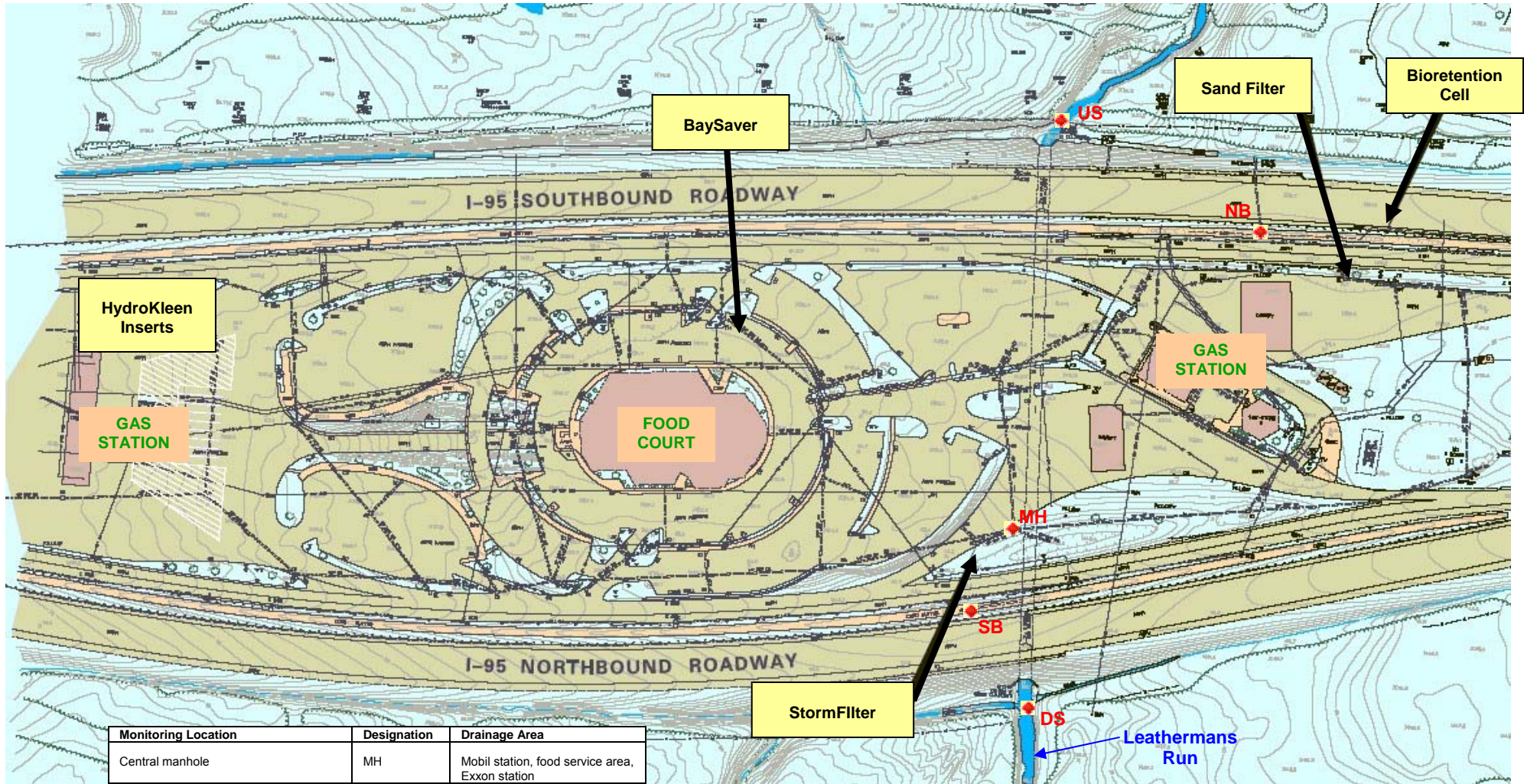


Figure 1. Photographs of BMP retrofits installed for evaluation at the I-95 service plaza in Newark, DE: (a) bioretention cell in swale that drains southbound highway and service lanes; (b) view into vault of StormFilter unit; (c) Delaware sand filter installed in drainage of service station; (d) view into BaySaver manhole; (e) HydroKleen unit mounted in storm drain inlet; (f) HydroKleen unit modified to collect effluent samples.



Monitoring Location	Designation	Drainage Area
Central manhole	MH	Mobil station, food service area, Exxon station
Inlet in southbound side concrete swale	SB	I-95 southbound lanes, service plaza access road
Inlet in northbound side concrete swale	NB	I-95 northbound lanes, service plaza access road
Leatherman's Run, just upstream of service plaza	US	N/A
Leatherman's Run, just downstream of service plaza discharge	DS	N/A

Figure 2. Map of the Delaware I-95 service plaza with locations of retrofits and water quality sampling points.

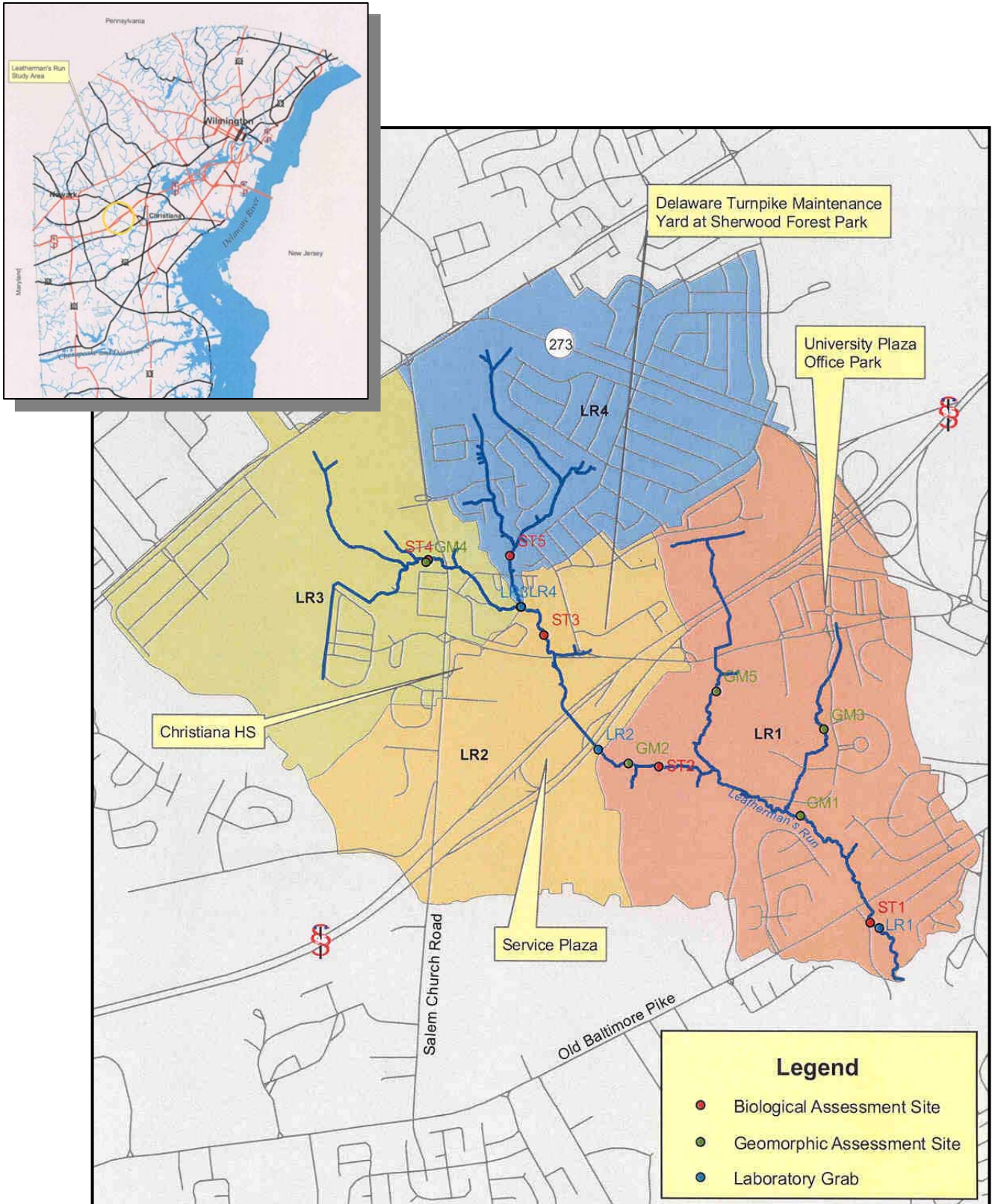


Figure 3. Map showing locations of stream monitoring stations in Leatherman's Run. Inset shows the location of the stream in New Castle County.