Sustainable UD water

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

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Water Quality Monitoring at the Star Campus: Silver Brook Comes to Light

Introduction

Silver Brook is a tributary of the Christina River, one of 4 drinking water intake streams in Delaware. The headwaters of the Silver Brook are piped through storm drains upstream of STAR campus, where it drains residential neighborhoods. The tributary was relocated underground in a 7' diameter culvert when the old Chrysler plant was built. Storm water from ~200 acres of industrial impervious surface drains to Silver Brook via catchments located throughout the former plant site. As it flows from the site, the Silver Brook discharges to Christina Creek and then to the Christina River.

Many segments of the Christina River do not meet water quality standards for dissolved oxygen, nutrients and bacteria. In 2007, a multi-state pollution control strategy was developed to achieve "total maximum daily load" (TMDL) criteria set under the EPA's Clean Water Act. TMDLs have been set for the segment of Christina Creek directly below Silver Brook.

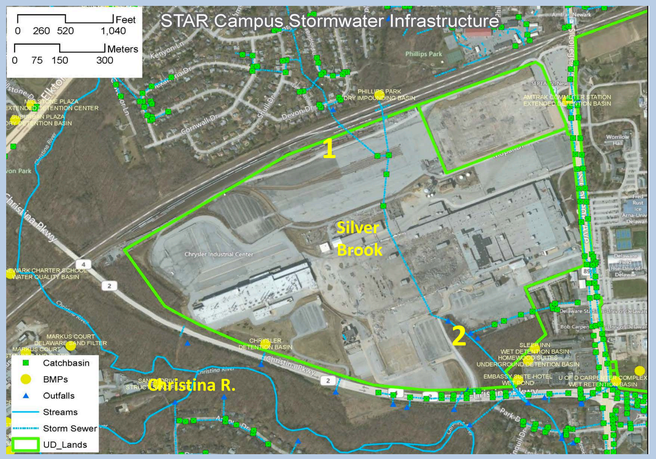

Fig. 1. Silver Brook as it flows through STAR campus and joins Christina Creek and then the Christina River. 1. In-flow sample site 2. Out-flow sample site.

Objectives

In 2009, the University of DE purchased the former Chrysler Site and began redeveloping the site as the UD Science and Technology Campus (STAR). Redevelopment of this site provides opportunities to improve water quality and to mitigate periodic downstream flooding problems in Silver Brook's residential communities by installing a range of innovative stormwater control and treatment systems.

The objective of this work was to monitor the changes in water quality of Silver Brook as it moves through STAR and to monitor the effect of the new construction on stream health.

Fig.2. Inflow Testing Site

Fig. 3. Outflow Testing Site

Methods

To monitor the site, the UD Water interns took monthly water samples at 2 locations of the Silver Brook creek. One was taken before the Brook entered STAR through the culvert under the railroad tracks (Fig. 2). The 2nd location was at the south end of the culvert where Silver Brook daylights to the wooded stream bed (Fig. 3). Within the week before sampling, the students calibrated the field probe. They sampled monthly, waiting at least 3 days after significant rainfall. With the field probe, they recorded Dissolved Oxygen (DO), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, conductivity (COND), temperature (T), and Oxidation Reduction Potential (ORP). They also collected samples from each site for future tests on nutrients and solids. They took stream flow measurements. We completed a field spike and a QC check to maintain precision. Analysis followed "Standard Methods for the Examination of Water and Wastewater" by the American Water Works Association, American Public Health Association, and Water Pollution Control Federation.

Results

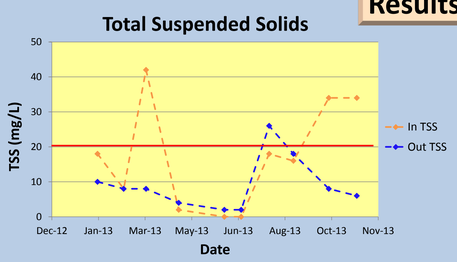

Fig. 4. Change in TSS over time for In-Flow and Out-Flow. Red line indicates the 20 mg/L EPA standard for general stream health.

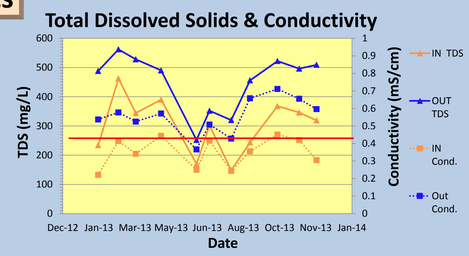

Fig. 5. Change in TDS & Cond. over time for In-Flow and Out-Flow. Red line indicates the 250 mg/L EPA TDS standard for general stream health. Optimum range for Cond. is 0.05-1.5 mS/cm for US rivers (EPA).

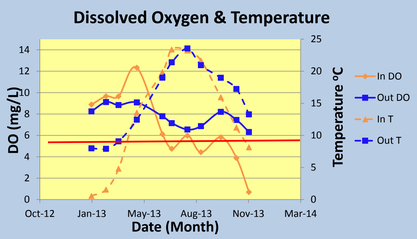

Fig. 6. Change in DO & T over time for In-Flow and Out-Flow. Red line indicates the >5.5 mg/L EPA DO Daily Ave. standard for general stream health. Temp. standard is no > 27.7-30°C.

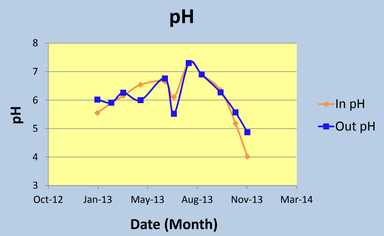

Fig. 7. Change in pH over time for In-Flow and Out-Flow. The optimum range for pH is 6.5- 8.5 for the DE standard for general stream health.

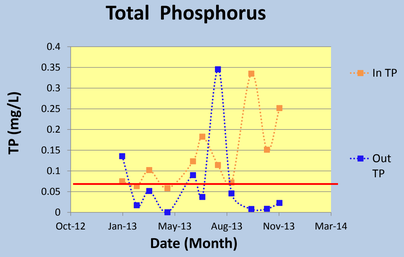

Fig. 8. Change in TP over time for In-Flow and Out-Flow. Red line indicates the 0.0528 mg/L EPA TP standard for general stream health.

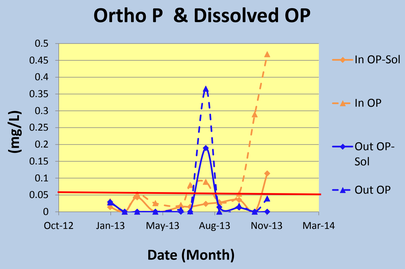

Fig. 9. Change in OP & SRP over time for In-Flow and Out-Flow. Red line indicates the 0.0528 mg/L TP Std for general stream health.

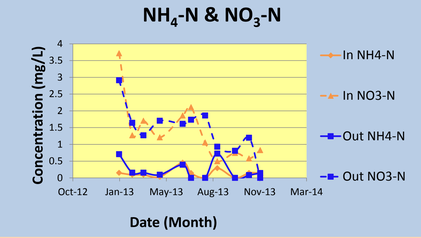

Fig. 10. Change in ammonia nitrogen (NH_3-N) & nitrate nitrogen (NO_3-N) over time for In-Flow and Out-Flow. 24.10 mg/L NH_3-N is the acute EPA standard for aquatic life health. 10 mg/L is the drinking water standard for NO_3-N.

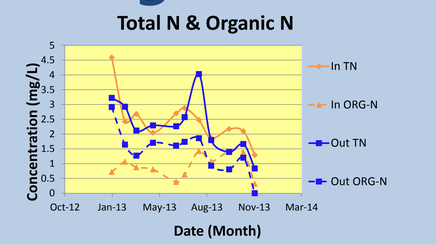

Fig. 11. Change in Total Nitrogen (TN) & Organic Nitrogen over time for In-Flow and Out-Flow. 0.71 mg/L is the EPA TN standard for aquatic life health.

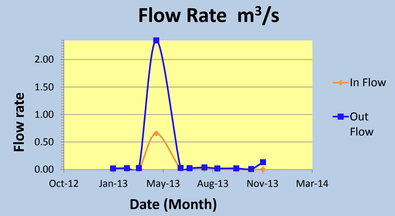

Fig. 12. Change in Flow Rate over time for In-Flow and Out-Flow.

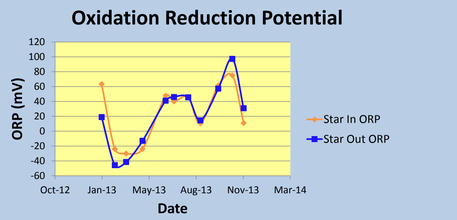

Fig. 13. Change in Oxidation Reduction Potential (ORP) over time for In-Flow and Out-Flow.

Discussion

Most of the parameters we tested for were below the water quality standards for general stream health. Nitrogen values were well below the acute NH_3-N limit (24.10 mg/L) and the NO_3-N drinking water standard (10 mg/L) for both samples. There was little difference in the inorganic N between the In-Flow and Out-Flow samples.

The parameters that did not meet the water quality limits were TSS, TDS, TP, OP, Dissolved OP and DO. Total Suspended Solids in the In-Flow increased above the limit in March but decreased below by the next sampling. Another increase above the limit occurred in October and November. The Out-Flow TSS concentration was below the limit for dates except July. TDS in the Out-Flow was above the 250 mg/L limit for all samples. In-Flow TDS was lower than the Out-Flow but remained above the limit except for May and July. In-Flow DO fell below the limit in June, August, October and November. Out-Flow DO remained above the limit all year.

In-Flow TP was above the limit for all samples. Out-Flow TP was above the limit in January, June, and July. In-Flow OP was below the limit except for November. Out-Flow OP and dissolved OP peaked above the limit in July. In-Flow soluble OP also peaked in July and again in October and November.

Flow rate was higher in the out-flow by a factor of 10. There was a large increase in flow for both samples in April.

In 2013, the Bloom Energy facility and property was under construction. During this part of the project, they made a direct connection into the Silver Brook culvert. The area had little vegetation and often large dust clouds moved across the site (personal observations). There is also a southern stormwater discharge point that flows directly into Silver Brook.

Construction activities caused an increase in dissolved solids and phosphorus in Silver Brook as it flowed through STAR. These increases will negatively affect the TMDL loads for the Christina Creek. Implementation of Best Management Practices to improve and enhance storm water quality as it moves through STAR campus is needed to protect the Christina River basin. The concentration of TP was also high in the Silver Brook as it entered STAR. Programs to increase awareness of proper fertilizer use in the residential neighborhoods should help reduce TP in the Silver Brook.

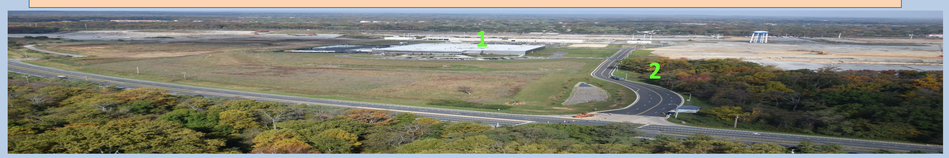

Fig 14: Picture taken 11-3-14 after the Bloom Energy building opened. 1. Sample area north of the railroad tracks where Silver Brook enters STAR. 2. Sample area near trees where Silver Brook exits STAR.