VILLANOVA UNIVERSITY
COLLEGE OF ENGINEERING

CENTER FOR RESILIENT WATER SYSTEMS

An Overview of the Villanova Research Sites for the Delaware River Watershed Initiative

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OVERVIEW

- By combining the efforts of over 50 organizations, the William Penn Foundation formed the Delaware River Watershed Initiative (DRWI) in 2014.
- The goal of the DRWI is to ensure clean, abundant water within the watershed.
- As part of this work, Villanova University is monitoring and modeling selected stormwater control measures (SCMs) and receiving water bodies at three sites within the Upstream Suburban Philadelphia Cluster (Fig. 1).

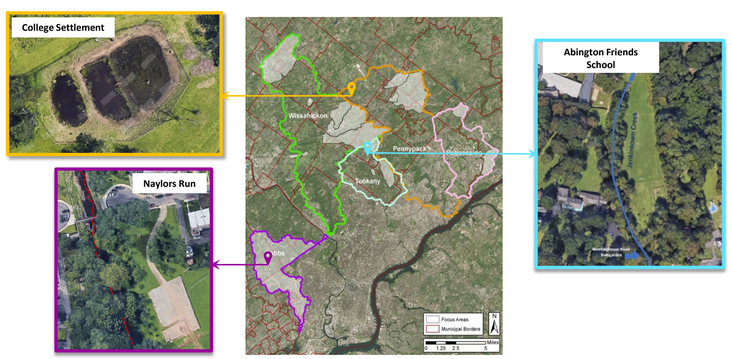

Figure 1: Upstream Suburban Philadelphia Cluster with the Villanova focused area

KEY FINDING

College Settlement:

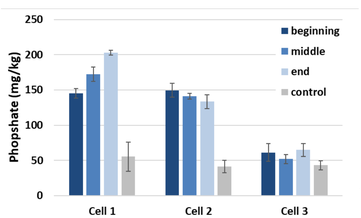

Figure 5. Phosphate Accumulation in Sediment.

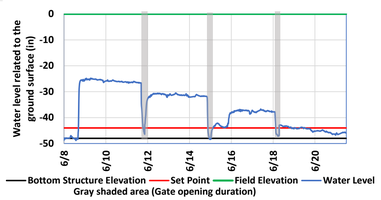

Figure 6. Real-Time Control; Slow-release performance (June 2022).

- The first two cells contained about three times higher phosphate volume than untreated samples (Fig. 5).
- After each storm, RTC gradually releases the captured runoff to prepare the detention cell for the next event (Fig. 6).

Abington Friends School:

2017 Evapotranspiration [mm/day]						
	Min	Max	Quartile 1	Quartile 3	Median	Mean
Hargreaves	0.402	2.506	1.425	2.074	1.712	1.692
Penman-Monteith	0.038	5.441	1.971	3.401	2.620	2.662
Change in Soil Moisture	0.002	6.230	0.146	2.257	0.680	1.454
2018 Evapotranspiration [mm/day]						
	Min	Max	Quartile 1	Quartile 3	Median	Mean
Hargreaves	0.336	3.186	1.548	2.197	1.995	1.830
Penman-Monteith	0.133	9.931	3.145	5.100	3.946	4.015
Change in Soil Moisture	0.007	5.540	0.055	0.483	0.159	0.457

- Evapotranspiration quantification techniques for the Abington Friends School sites showed discrepancies between methods.
- Penman-Monteith and Hargreaves approaches were more susceptible to weather changes whereas the Change in Soil Moisture approach depended on water availability.

FUTURE WORK

- ***College Settlement :***

Implementing Machine Learning prediction approaches, and assessment of the possible impact of sediment accumulation on SCM capacity.

- ***Abington Friends School:***

Investigating methodologies to expand the internal water storage of the bioretention rain garden to enhance water quality and water quantity management.

- ***Naylors Run:***

Analyzing the stream water quality data collected since 2018. Investigating applications of SWMM modeling to improve SCM decisions

SITE DESCRIPTIONS

College Settlement:

- Located at College Settlement in Horsham, PA, which is at the headwaters of the Pennypack Creek, about 24 km north of Philadelphia.
- A multi-stage basin with three cells, two retention basins followed by one detention basin.
- Agri-drain which controls the water level inside the last cell of the basin in order to mitigate the runoff and erosion downstream.
- Real-Time Control manages the slow-release performance while utilizing the maximum capacity of the SCM during the storm.

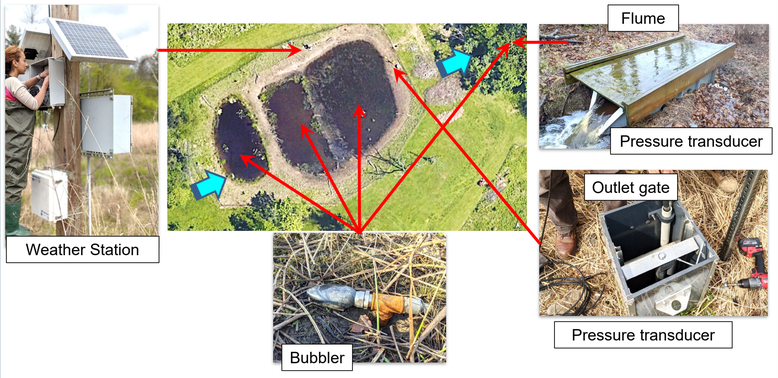

Figure 2. Plan view of the three cells with instrumentation locations designated

Abington Friends School:

- Located at the headwaters of the Jenkintown Creek, a 5.81-km-long tributary to the Tookany Creek.
- The SCMs includes two rain gardens, which discharge into the Jenkintown Creek, and riparian buffer improvements along the creek.
- Both rain gardens contribute to managing stormwater runoff through infiltration and evapotranspiration processes.

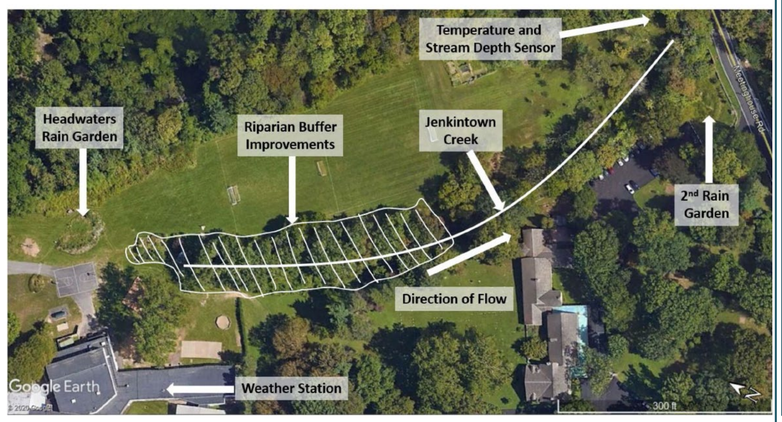

Figure 3. Location of SCMs and instrumentation along the Jenkintown Creek

Naylors Run:

- Located at the Cobbs Watershed, drains approximately 2900-acres of suburban area including portions of Upper Darby and Haverford Townships.
- Three bioswales were installed in Drexel Gardens Park, nearby Naylors Run.
- The SWMM modeling will be utilized to evaluate the performance of the bioswales in controlling runoff.

Figure 4. The proposed GSI at the Drexel Garden Park

PUBLICATIONS

- Martin, R.A., S. Carvajal Sanchez, A. L. Welker, and J. Komlos. "Thermal effects of stormwater control measures on a receiving headwater stream." Journal of Sustainable Water in the Built Environment 7, no. 1 (2021): 06020002.
- Burns, M. J. “Evaluation of three techniques to quantify evapotranspiration in A rain garden.” M.S. Thesis, Villanova University, Villanova, PA., (2021).
- Martin, R. A. “Biological health of streams in relation to flashiness, temperature, and chlorides.” M.S. Thesis, Villanova University, Villanova, PA., (2020).
- Mohammed, W. K. “Influence of Geotechnical Design Characteristics on the Performance of Stormwater Control Measures: Individual and Watershed Investigations.” Ph.D. Dissertation, Villanova University, Villanova, PA, (2020).

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