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CENTER FOR RESILIENT WATER SYSTEMS

An Overview of the PennDOT I-95 Research Sites

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OVERVIEW

The Pennsylvania Department of Transportation (PennDOT) is incorporating extensive green stormwater infrastructure into the redesign of the I-95 corridor that runs through Philadelphia, PA. The installed stormwater management practices (SMPs) are designed to capture at least the first inch of stormwater that falls on the I-95 highway deck via infiltration and evapotranspiration mechanisms. The use of SMPs to manage stormwater runoff helps the city to achieve compliance with the Philadelphia Green City, Clean Waters program regulations which were designed to reduce the occurrence of combined sewer overflow events.

Villanova University and Temple University are collaborating on a research initiative which aims to inform a resilient PennDOT stormwater strategy that reduces overall costs through reduction of risk, enhanced performance, extended lifecycle, and optimized maintenance of SMPs. To achieve this goal, the Villanova research team is actively monitoring and researching a collection of bioinfiltration systems in the Fishtown region of Philadelphia to understand:

- Hydrologic performance of SMPs
- Subsurface hydrologic processes of SMPs
- Hydraulic function of inlets and curb cuts
- Relationships between geomorphology and SMP function
- Ideal SMP maintenance and inspection protocols

SITE MAP

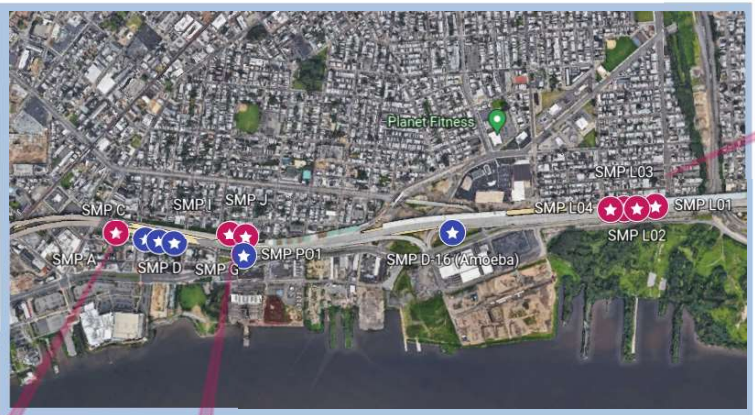

Figure 3. Overview of PennDOT I-95 research sites in Philadelphia, PA. Pink icons represent active research sites, and purple icons indicate past/retired research sites. (Map imagery courtesy of Google Earth)

SMP A

SMP A is a single linear bioswale located between Frankford Ave. and Shackamaxon St. in Philadelphia. The site has three inlets connected to the I-95 highway deck that convey runoff into the site. SMP A is fitted with its own weather station and various sensors are installed through the basin. 72+ variables are measured on site every 5 minutes and the data is logged remotely.

Figure 2. SMP A weather station.

Figure 1. SMP A outlet structure, looking upstream.

Parameters recorded on-site at SMP A include runoff inflows and outflows, ponding depths, rainfall depths, other weather parameters, soil composition, and hydraulic conductivity. Analysis of SMP A has provided insight into various aspects of rain garden design and maintenance, including:

- Uncertainty of inflow capture rates and sources
- Calming turbulent inflow for sensor measurements
- Geomorphologic behavior of a vegetated swale
- Utilizing soil moisture sensors to monitor subsurface hydrology

SMP I&J

Figure 4. SMP I under reconstruction in 2022.

SMPs I&J are two adjacent linear bioswales on the corner of Salmon St. and E Columbia Ave. in Philadelphia. They receive runoff from a southbound portion of the I-95 highway deck. These rain gardens were initially constructed in 2016 but were classified as underperforming systems due to extended ponding times. It was deduced that steep slopes in the basin, sediment deposition, mulch accumulation, and compacted native soils led to infiltration underperformance (1). SMPs I&J are currently under reconstruction and present an opportunity to study the performance of a rehabilitated bioinfiltration system while testing new energy dissipation methods for rain gardens.

Upon construction completion, SMPs I&J will be instrumented with sensors that record weather parameters and site conditions. All parameters measured at SMP A will also be recorded at SMP I&J. The redesign of SMP I includes a series of vegetated steps separated by weirs and gabion baskets to promote infiltration and reduce erosion in the basin. The performance of this design will be examined using bubblers on each step to measure ponding depth.

Figure 5. SMP J in 2016. (Photograph via AECOM)

SMP L01 - L04

Figure 6. SMP L-01, looking downstream.

L-01, L-02, L-03, and L-04 are a series of four rain gardens adjacent to Richmond St, between E Lehigh Ave and E Huntington St. Recently constructed underneath I-95, all four rain gardens include a combination rain garden design with rock over sand in the non-sunlight exposed areas and vegetation over soil media in the adjacent sunny areas. Monitoring performance of these rain gardens will include comparison between varying soil media depth and soil media types between each basin. The different basin designs include combinations of loamy sand, sandy loam, and sand in different orders and depths. The research questions of studying the L-01 – L-04 rain garden system are:

- Do the four rain gardens perform similarly?
- How can this series of SMPs work together as a system?
- How does varying soil media depth and type influence rain garden performance?
- What are the benefits and challenges of constructing an SMP in a shaded area?

Figure 7. SMP L-03, looking downstream.

REFERENCES

1. Reis, V. E. (2019). "Techniques for Investigating Causes of Green Stormwater Infrastructure Underperformance and Recommendations for Rehabilitation." thesis.

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AECOM

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