21st Century Stormwater Management: Designing and Building

Gray and Green

Infrastructure on

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pennsylvania Department of transportation Ederal Highway AECOM



Agenda

- PennDOT Stormwater Strategic Plan
- I-95 Corridor Overview
- Urban Design Challenges
- Green Stormwater Infrastructure
- Research and Maintenance Partnering
- Lessons Learned

New Retaining Wall, I-95 NB **Mainline at Richmond Street**

Prioritizing Stormwater Management

- Multi-Phase Study for Transportation Infrastructure to be Resilient, Sustainable and Effective
- Focus on Current Research and Provide a Roadmap for Future Research
- Stormwater Management
 - Drainage Facilities that Accommodate Increasing development, Including Flooding from Climate Change
 - Reduce Stormwater Runoff Volume and Sediment to Assist with PennDOT's MS4 Permit
 - Reduce Chlorides from Winter Operations

Stormwater Research Strategic Plan



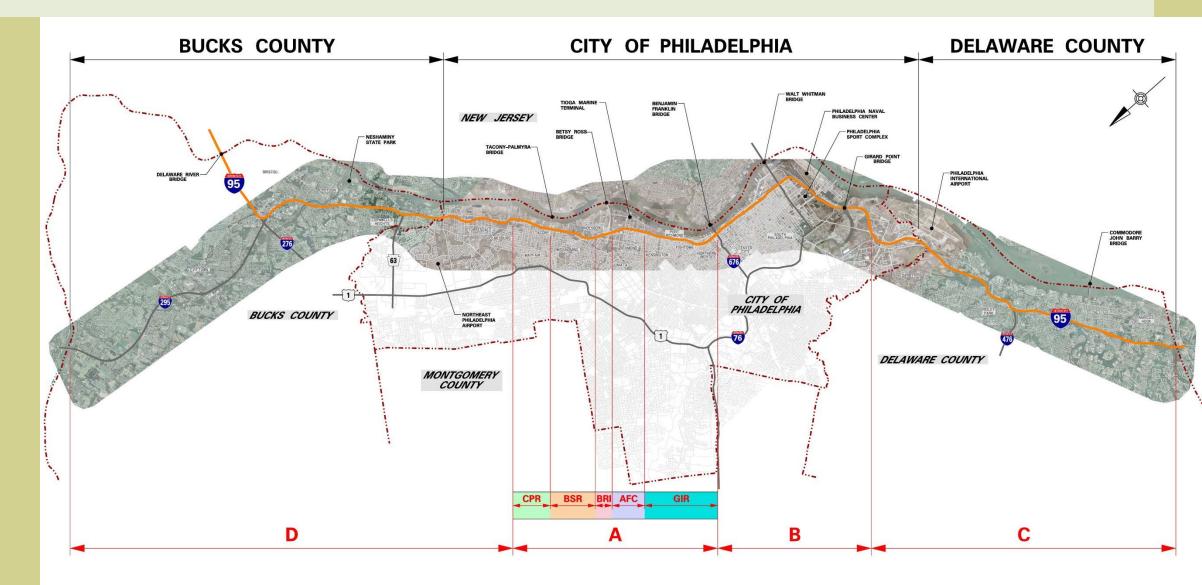
In Partnership with:





I-95 in Pennsylvania

• Divided into 4 Priority Sectors and 3 Counties for a Total of 41 Miles of Reconstruction



Waterfront Planning in 2007 Construction Schedule: 2009-2029 26 Construction Contracts • \$2.7 Billion Estimated Cost BETSY ROSS BRIDGE TACONY-PALMYRA BRIDGE OL MESBURG TACONY BRIDESBURG PORT WISSINOMING FISHTOWN MAYFAIR CPR **BSR** AFC GIR BRI

Sector A

- Design Began in 1999
- Neighborhood Redevelopment in Early 2000's

Mainline and Stormwater Landscape Looking South, Philadelphia

Working in an Urban Environment

- High Density Urban Development
- Commercial, Industrial and Residential Land Uses
- Historic Legacy and New Development
- Active and Rapidly Revitalizing Neighborhoods
- Local Connected and Intersecting Streets
- High Local Vehicular & Pedestrian Traffic
- Highway Forms the Back Wall of Residential, Commercial, and Industrial Areas



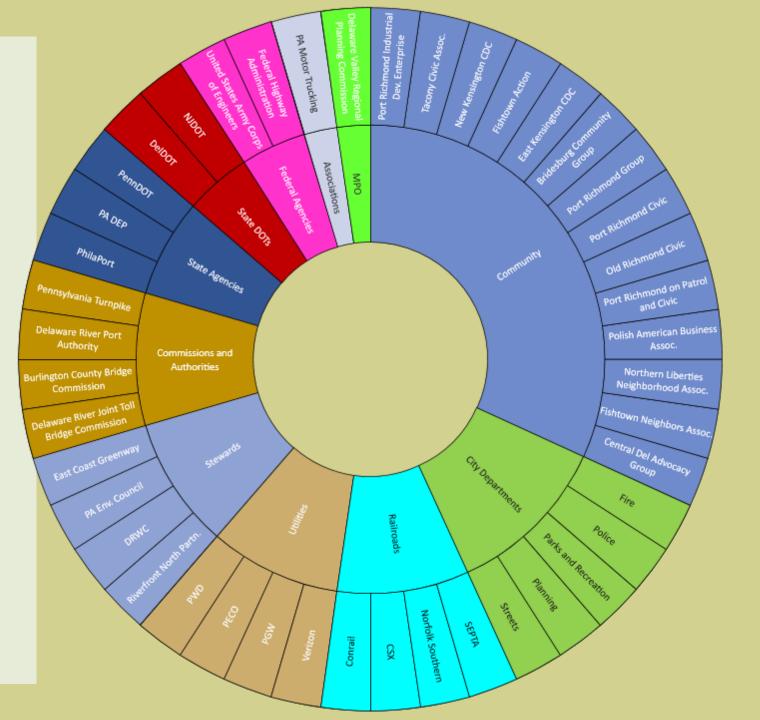
Build More Than a Highway

- Become an Active Participant in Waterfront Change
- Respond Proactively to Changing Environmental Requirements
- Use Green Infrastructure to Create a Human-Scaled Environment
- Build Partnerships for Construction and Maintenance with Agencies and Stakeholders

East Coast Greenway Trail and Aramingo Avenue through Girard Avenue Interchange, Philadelphia

Interested Stakeholders

- Federal Agencies
- State Agencies
- MPO
- City Departments
- Commissions and Authorities
- State DOTs
- Community Associations
- Non-Profit Stewardship Organizations
- Utilities
- Railroads
- Businesses





Sustainable Action Committee

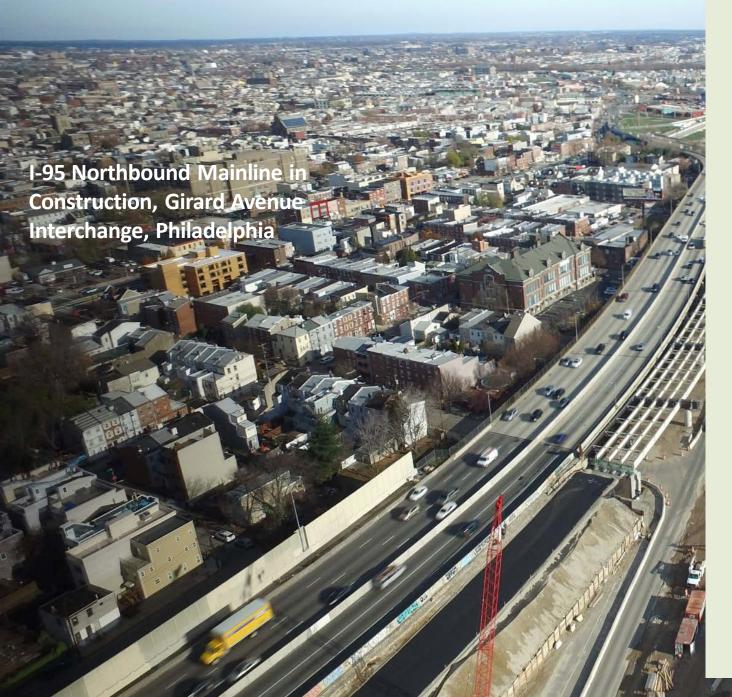
- Multi-Level Communication Process
- Work Collaboratively to Identify Role of I-95 Reconstruction in Implementing Waterfront Projects
- FHWA, PennDOT, City and Regional agencies, Major non-profits
- Consistency in Corridor-wide Policy Decisions
- RESULTS Integrated Stakeholder and Community Needs into the Design and Environmental Clearance Process



Create Living Urban Spaces

- Cities Struggle with Spaces under Urban Highways
- Accommodate Change in an Inflexible Process
- Target Solutions to the Capacity and Interests of the Philadelphia Communities
- Create Solutions that Become a Functional Part of the Neighborhoods
 - Landscaped Stormwater BMPs
 - LED Lighting
 - Waterfront Access under and through Highway
 - Open, Usable and Green Spaces

Existing (above) and Proposed Mainline Viaduct (below), Girard Avenue Interchange, Philadelphia



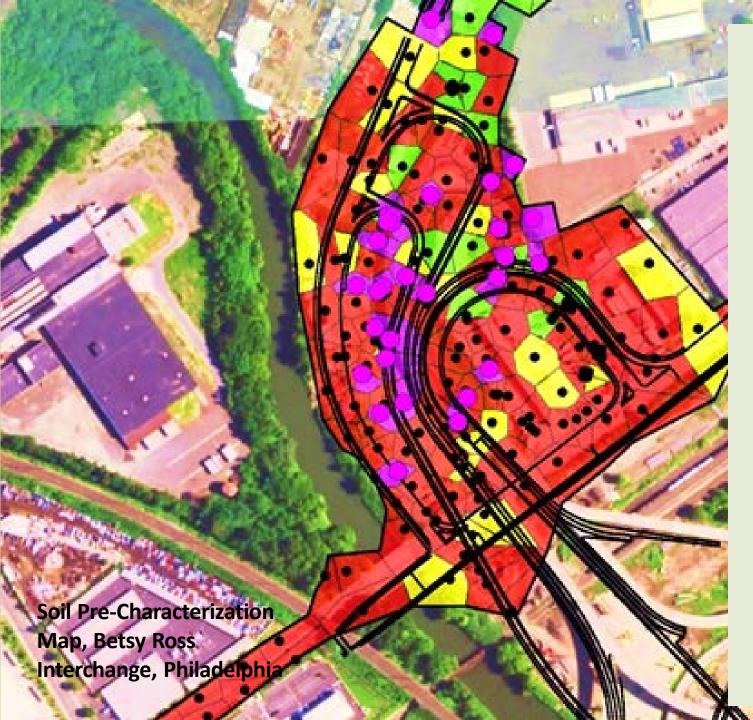
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- Dense Underground Utility Work
- Historic City, Archaeological Findings
- Subsurface Conditions & Contaminated Soils
- 100 Year Floodplain
- Resiliency
- Available Sunlight Under Viaduct
- Water Getting into Green Areas
- Maintenance
- Social Acceptance

Outfall Reconstruction, Girard Avenue Interchange, Philadelphia

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Archaeological Investigation, Girard Avenue Interchange, Philadelphia

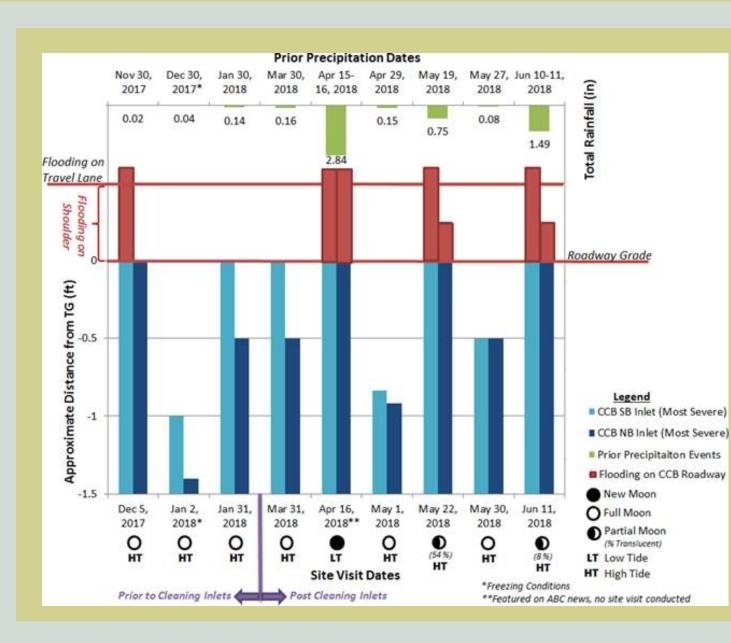
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100 Year Floodplain Map, Frankford Creek, Betsy Ross Interchange, Philadelphia

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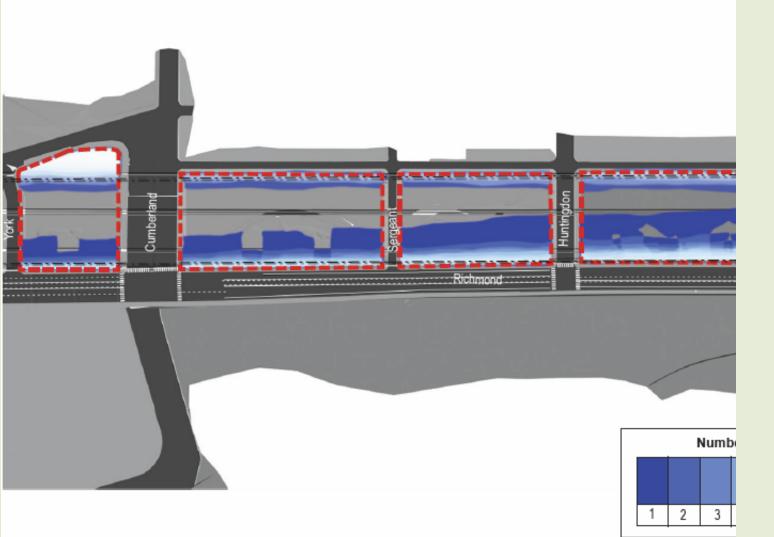


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I-95 GIR Shadow Analysis: York Street to Lehigh Avenue

June 20 (Summer)

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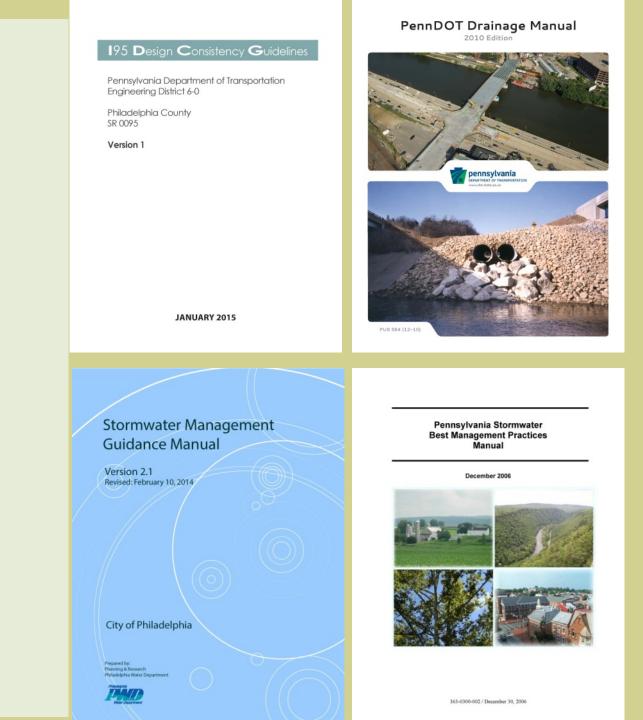
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Mainline Viaduct and Relocated Richmond Street, Girard Avenue Interchange, Philadelphia

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SWM Design Requirements

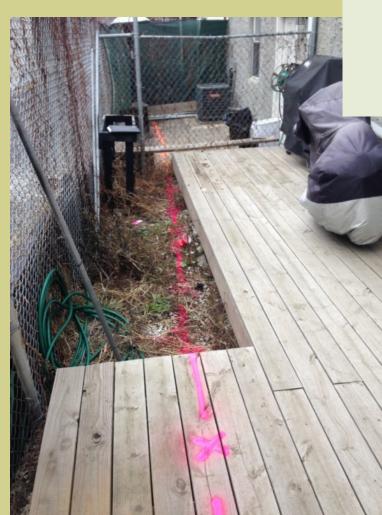
- PennDOT
 - I-95 Design Consistency Guideline
 - PennDOT Design Manual
- Philadelphia Water Dept. (PWD)
 - US EPA Combined Sewer Overflow 2011 Consent Decree
 - ACT 167
 - Water Quality
 - Channel Protection
 - Flood Control
- PA Department of Environmental Protection
 - NPDES Permit
 - JPA Permit



Stormwater Landscape, Girard Avenue Interchange, Philadelphia

"Green Approach"

- Maximize Use of Green Infrastructure
- Extensive Daylight and Water Analysis
- Provide Open Green Spaces with Multiple Uses



Working with Limited Space

- Encroachment and Limited Right-of-Way
- Maximize Spacing
- Create Functional SMP sites
- Aesthetic Designs as an Extension of Neighbors' Backyards



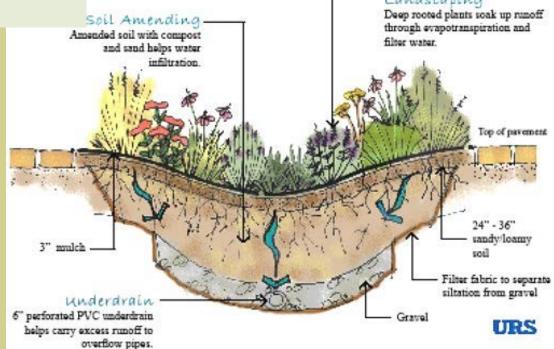


Working with Urban Soils

- Existing Soils with Variable Infiltration Rates
- Infiltration Testing Requirements
- Impervious Liners for Contaminated Soils near Buildings
- Import Amended Soils and Reuse of Existing Soils
- Identify Plant Material to Survive Various Site Conditions

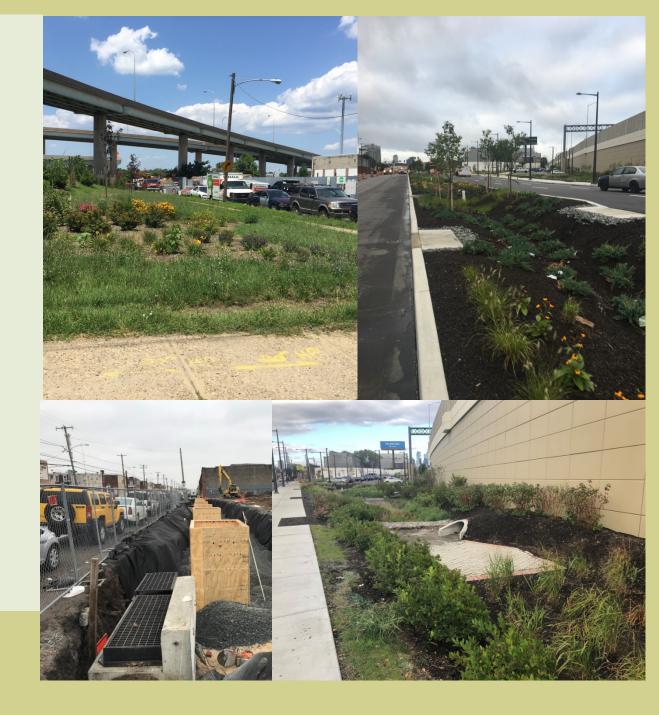






Primary SMP Devices

- Landscape Restoration*
- PWD Tree Vaults & Tree Pits
- PWD Tree Trench*
- Water Quality Structure* (Hydrodynamic)
- Bioswales (Median / Along I-95)
- Bioretention Basins*
- Bioinfiltration Basins*
- Rain Gardens*
- *Contractor Personnel Training, Experienced Designer Inspection Staff, Detailed Construction Specifications



SMP Components

- Pretreatment Devices
 - Stilling Basin
 - Forebay
 - Hydrodynamic Device
 - U-Wall Inlet
- Underdrains with Cleanouts
- Outlet Structures with Trash Rack





SMP Landscaping

- Materials
- Extensive Planting
 - Promote Infiltration and Evapotranspiration with Plant Uptake
 - Plants with Deep Root Systems Maintain Slope and Prevent Erosion
 - Plantings that Screen
 Highway and Sound Walls
 - Heavy Vegetation at Contaminated Sites with Liners

Lawn Edge, Typ.





Landscaping

- New Green Space Created with Garden Variety
 - Girard Avenue
 Interchange (GIR): 27
 Acres



Landscaping

- New Green Space Created with Native Meadow
 - Bridge Street Interchange (BSR): 55.2 Acres
 - Betsy Ross Interchange (BRI): 48 Acres



Few Months After Post-Construction

Sustainable Highway

- Maximize Green
 - Stormwater Management
 - Heat Island Reduction
 - Carbon Dioxide Emission Reduction
- Creative Reuse of Materials
 - Boulders from Phase 1 Excavation
 - Salvaged Building Materials for Art and Function
 - Belgian Blocks Salvaged from City Streets

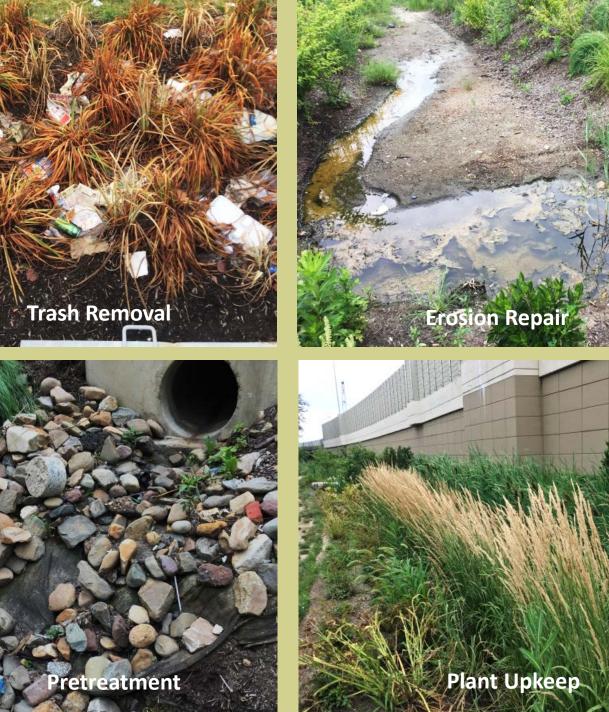






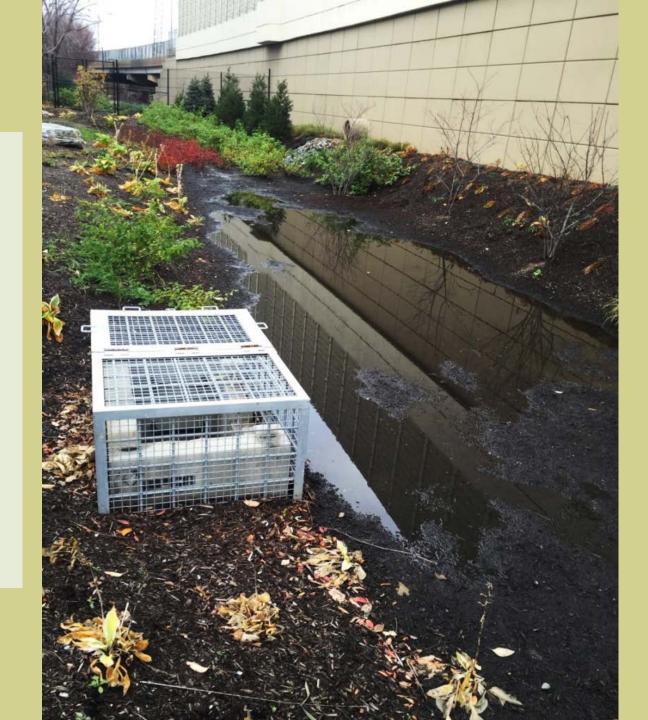
Designing for Maintenance

- Selective Designs to Accommodate Maintenance
- Site Accessibility
- Easy to Clean
- Pretreatment Device Options
- Neighborhood Involvement
- Costs and Concerns
 - Construction: Green* > Gray Maintenance: Green < Gray *5%-7% Total Project Construction Cost



Adapting Designs for the Future

- Pretreatment Devices
- Minimize Compaction during Construction
- Minimize Foot Trafficking
- Landscaping
- Infiltration Testing during Construction
- Long Term Maintenance



I-95 GIR University Partnership

- Established Spring 2016 with PennDOT Innovations Deserving Exploration & Analysis Grant
- PennDOT, AECOM, Temple University, and Villanova University
- Research Focus SMP Performance:
 - Water Quality and Quantity
 - Plant Health and Soil Contamination
 - Maintenance
 - Use of LiDAR, Drone and Infrared
- Research Findings Incorporated into PennDOT Pub 785, Stormwater Research Strategic Plan



Lessons Learned

• Simulated Runoff Test (SRT)

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- Plant Health Differs by Elevation
 - Future Plant Selection
 - Location of Runoff Contamination
 - Type of Contaminants and Metals



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Overall Lessons Learned

- Simulated Runoff Test (SRT)
- Plant Health Differs by Elevation
- Less Labor Intensive Designs
 - Meadow Plantings
- Community Adoption Programs for Long Term Maintenance
- Alternative Plant Species
- Further Research Measuring Metal Uptake in Plants
- Trail Path for More Obvious Foot Paths
- Continued Reporting, Inspection, and Monitoring



What is in our future?

- Maintenance and Inspection Using Drones
- SMP Restoration
- Site Pre-Construction Monitoring
- Continued Research Monitoring
- Resilient Design

http://www.95revive.com/ http://diggingi95.com/