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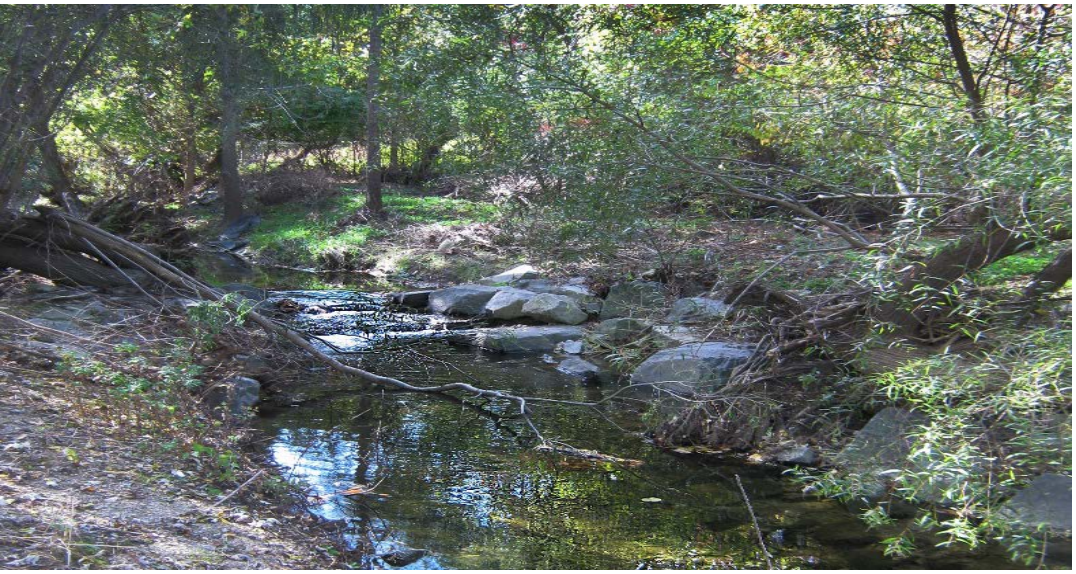


MS4 Municipal Stormwater Compliance and Vulnerable Infrastructure:

Stormwater Pollutant Removal and Extreme Event Adaptation

Transportation Engineering and Safety Conference

December 6, 2018

MS4 Compliance & Vulnerability

- Environmental Regulations: CWA
- Integrated Watershed Planning
- MS4 Stormwater Runoff Pollution TMDL Reductions

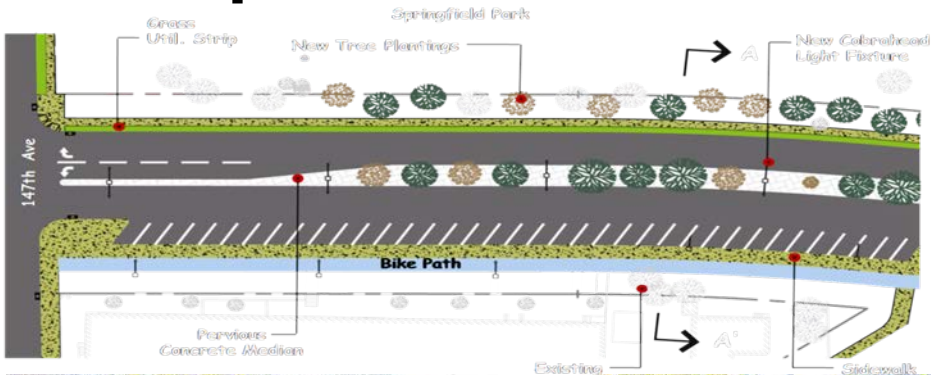
Extreme Weather Events

- Asset Inventory, Vulnerability Assessment, Risk Management and Adaptation
- Transportation Safety

Integrated Watershed Based Planning for Joint Gray/Green Infrastructure Implementation

Transportation / Land Use / Water

- Green/Natural-Nature Based Infrastructure: GI/NNBI (GSI: MS4/CSO/SSO)
- Highways and Transportation
- Sustainability/walk-ability/ livability/Community Health
- PennDOT Connects(MPO/RPO)
- Capital Improvements w/Green
- Multiple Benefits:
  - Increased Resiliency
  - Multiple Benefits/Users-Triple Bottom Line: (Social/Ecologic/Economic)
  - Improved Sustainability
  - Cost Effective (B:C>1)



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Philadelphia: Gray to Green Streets with GSI

Source: Green City Clean Waters, Philadelphia Water Department, 9/2009

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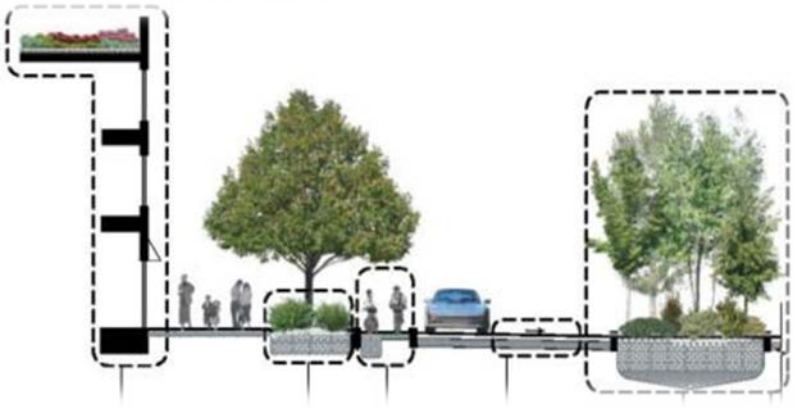
Gray Infrastructure

- Land Development (Agricultural/Residential/Commercial/Industrial/ Active Public Recreational Spaces)
- Transportation (Roads/Bridges/Transit/Airports/Ports)
- Utilities (Power/Sewer/Water/Gas/Electric/Communications)
- Stormwater and Flood Control (Basins/Impoundments/Dams/ Levees/Dikes)

Green/Nature Based Infrastructure GI/NNBI)

- Open Space Parks and Recreation Areas
- Passive Recreation (Trails/Walkways/Boardwalks/Foot-bridges)
- Pedestrian/ Bicycle Friendly Transportation
- Green Stormwater Infrastructure/PCSMs
  - Best Management Practices (BMPs) / Stormwater Control Measures (SCMs)
    - Floodplain Reconnection
    - NSCD Restoration/Stabilization
    - Floodplain Wetlands
    - Stormwater Wetlands
    - Basin Retrofits/Naturalization



Source: NYC''s High Performance Infrastructure Guidelines

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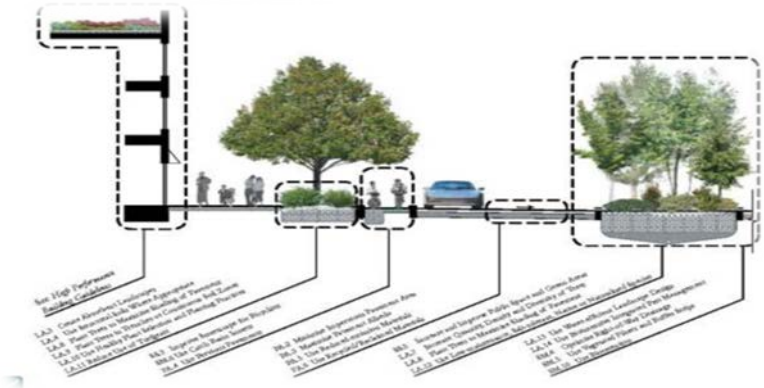
Joint Planning & Implementation Benefits

- Integrated Watershed/Infrastructure Planning: IWM Partnerships (York County)
  - Private/Non Profit Groups
  - Watershed Groups
  - Municipalities, MPOs/RPOs/DOTs
  - More Comprehensive WQ Results
  - Increased Investment Flexibility
  - Greater Cost Effectiveness



Source: NYC's High Performance Infrastructure Guidelines

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NPDES Permits MS4 Stormwater

- Regulated Small/Non-traditional MS4s – design stormwater management plan that:
  - Reduces discharge of pollutants to the maximum extent practicable (MEP)
  - Protects water quality
  - Satisfies appropriate water quality requirements of CWA
- 6 MCMs
- Additional Watershed Specific TMDL/PRP Requirements

Source: June 2011 Stormwater, www.storm.h20.com

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MCM #3 IDDE

- What is and illicit discharge (ID)?
  - Improper dumping (discharge) from a property owner
  - Improper physical connection

- PennDOT tracks potential illicit discharges (PIDs) to verify compliance with the MS4 permit requirements.

- Implements standard inspection/verification and monitoring documentation for use by all PennDOT Districts, activity tracking has been standardized and monitored across the state.

MCM #3 IDDE

- Illicit discharge detection and elimination as a means of providing TMDL waste load allocation compliance under MS4 permits

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MCM #5- Green Stormwater Infrastructure- Flow/Volume Stormwater Control Measures

- Green Roof
- Stormwater Wetland
- Pervious Paving
- Rain Garden
- Rain Barrel
- Flow-through Planter
- Stormwater Tree Trench
- Curb Bump-out
- Stormwater Planter
- Storage/Infiltration Basin

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MCM#5 PCSM/SCM Design/Construction/Long-term O&M Considerations

- Inventory SCMs
- Inspect (Frequency)
- Assess Conditions
- Screening Reports
- ID Maintenance Requirements:
  - Routine
  - Retrofit
  - Reconstruct
- Required Permits
- Access
- Maintenance Forces/ Contractor

MS4- TMDL/PRP Requirements

- Reduce pollutants (MS4 waste load allocation) from stormwater discharges w/in UAs
- Required by many watershed implementation plans (WIPs) including the Chesapeake Bay watershed
- Integrated Watershed Management (IWM)

Source: US Department of Agriculture

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TMDL / Pollution Reduction Requirements

Sediment / Nutrients / Toxicants---- Impaired Waters (303d Listed)

CSO-SSO-MS4-TMDL Pollution/Volume Reduction

- Streetside GSI/Bio-Retention
- Basin Retrofits
- Stream Restoration
- Floodplain Reconnection
- Stormwater Wetlands
- Enhanced Riparian Buffers

(Cobbs: PWD-PAI Market Street Rain Garden)

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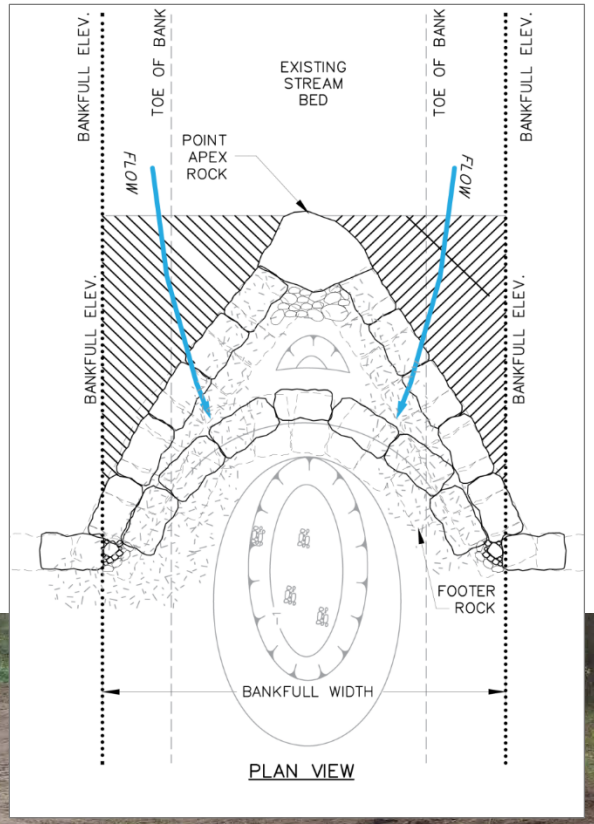
Stream Restoration for Pollutant Reduction

- Floodplain Reconnection
- Streambank stabilization
- Channel Stability-lowered shear stress
- Bankfull bench grading-floodprone area
- Increased Floodplain Capacity
- Improved Resiliency for Extreme Events



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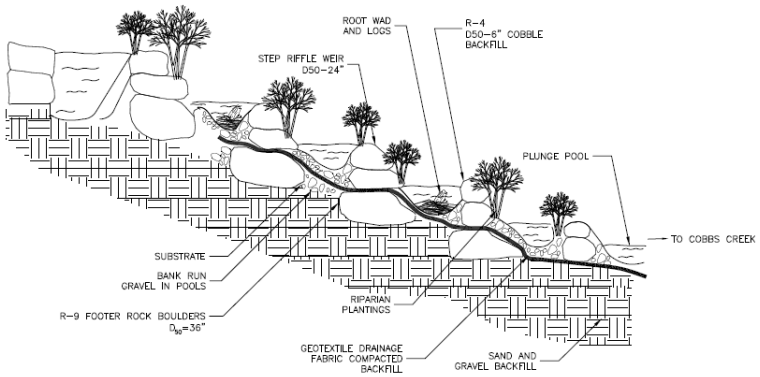
Pollutant Reduction & Natural Stream Channel Design Restoration (TMDL credits/Resiliency)

- Stream restoration documented for future pollutant load reduction credit: **44.88 #/LF/YR Sediment Reduction**
- Floodplain reconnection: sediment & nutrient pollutant load reduction credit: scour reduction-improved stability

Step-Pool Stormwater Conveyance at Outfalls



IS-13 STEP-POOL STORMWATER CONVEYANCE
N.T.S.

Source: My Green Montgomery, Montgomery County (MD) DEP

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Stream Restoration- Floodplain Reconnection

Culvert/Outfall Step-Pool Conveyance Systems *Storm-Flood Hazard Mitigation*

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Integrated Gray Infrastructure with Nature Based /Ecosystem Restoration

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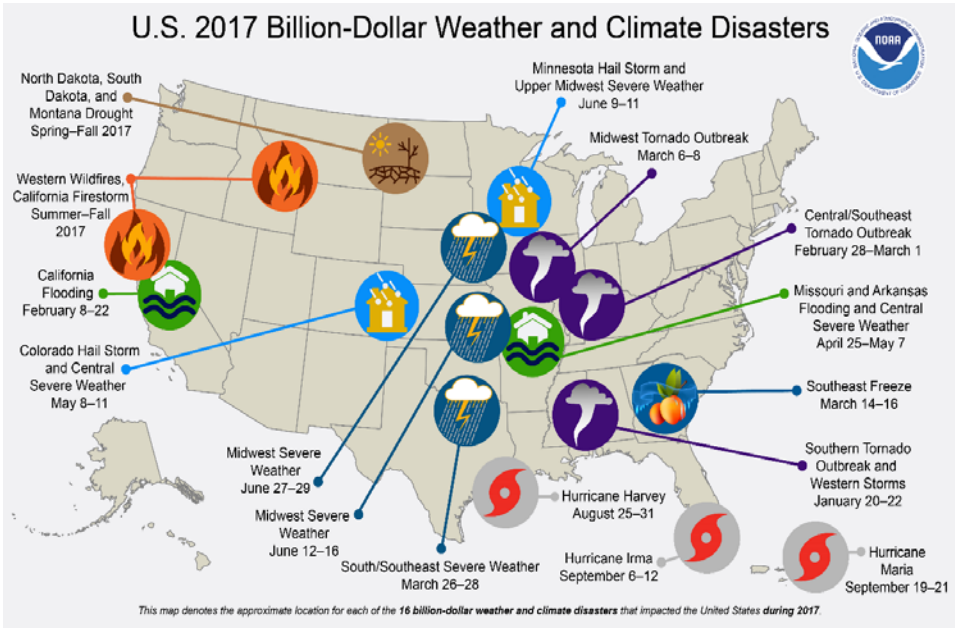
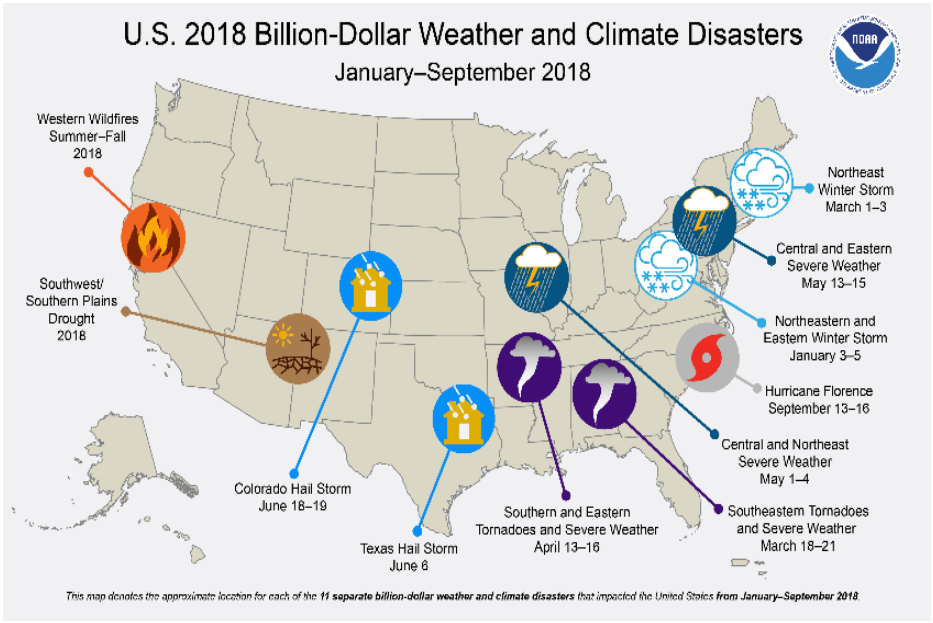
Plan & Design for Extreme Event Risks to Improve Resiliency

- Adaptation, Preparedness and Resilience for Extreme Weather Events
  - More numerous and more intense extremes= increased vulnerability/risk





Source: NYC's High Performance Infrastructure Guidelines

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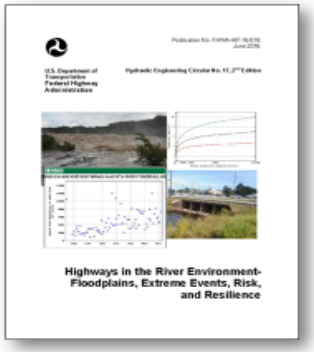
FHWA- Extreme Event Transportation System Preparedness, Risk & Resilience

- FHWA: Integrated Planning: NCHRP 840 Watershed Approach to Stormwater 08-93
- System-wide Risk Management 25-25(94)
- Integrating Extreme Weather Risk- Asset Management Resiliency Planning for Transit
- HEC-20: Scour Analysis
- HEC- 17: Highways-Riverine
- HEC-25: Highways-Coastal
- EDC 4, 5 CHANGE- 2D Models
- Special Federal Aid Funding (23 CFR 667-Repeat Loss Evaluate)



For more information on HEC 17:
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec17_announcement.cfm

To download the new HEC 17:
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif16018.pdf

HEC 17 Webinar Series

Highways in the River Environment – Floodplains, Extreme Events, Risk and Resilience

FHWA is hosting three webinars to provide an overview of HEC 17 and allow you to ask questions of FHWA staff:

Webinar 1: Introduction, Floodplains, Riverine Flood Events, Non-Stationarity (Chapters 1-4)

Webinar 2: Climate Modeling and Risk and Resilience (Chapters 5 and 6)

Webinar 3: Analysis Framework and Case Studies (Chapters 7 and 8)

For more information, please contact Brian Beucler at Brian.Beucler@dot.gov

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Bridge Scour Assessment for Sediment Load and Risk Reduction

- Natural stream channel design (NSCD) restoration improves water quality and resiliency during bridge replacement and highway reconstruction

Scour undermines bridges and may cause bridge failures due to structural instability. **In the last 30 years, more than 1,000 bridges collapsed in the U.S. and about 60% of the failures are related to the scour of bridge foundations.**

Reference: FHWA/LA.10/535

Bridge Scour Effects

- 13,000 bridges in PA crossing streams and waterways. Many are rated scour critical
- Scour is the most common cause of bridge losses nationally
- Types and effects of scour

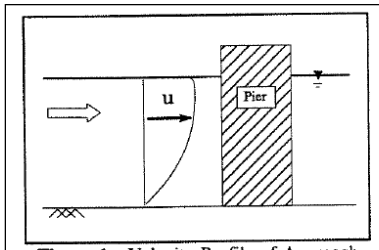


Figure 1 - Velocity Profile of Approach Flow

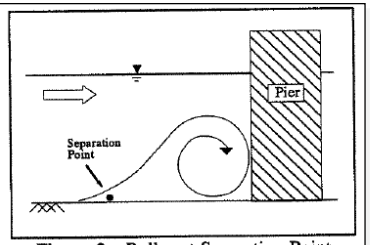


Figure 2 - Roller at Separation Point

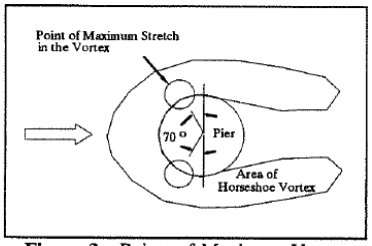


Figure 3 - Points of Maximum Vortex Stretch

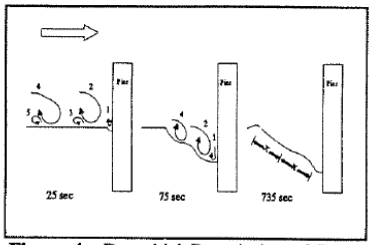


Figure 4 - Dargahis' Description of Scour Vortices

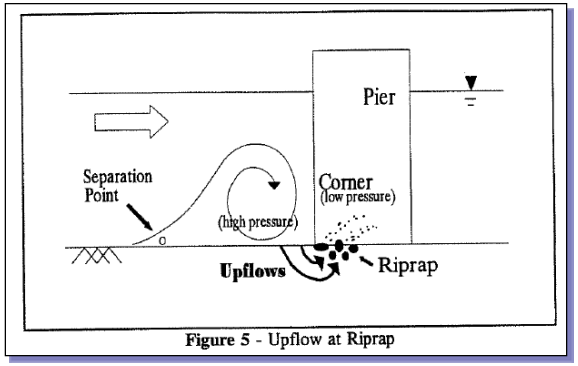
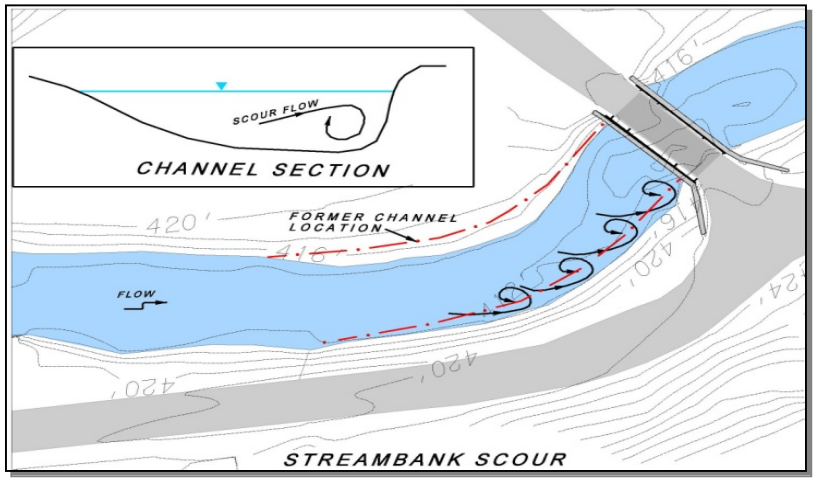


Figure 5 - Upflow at Riprap



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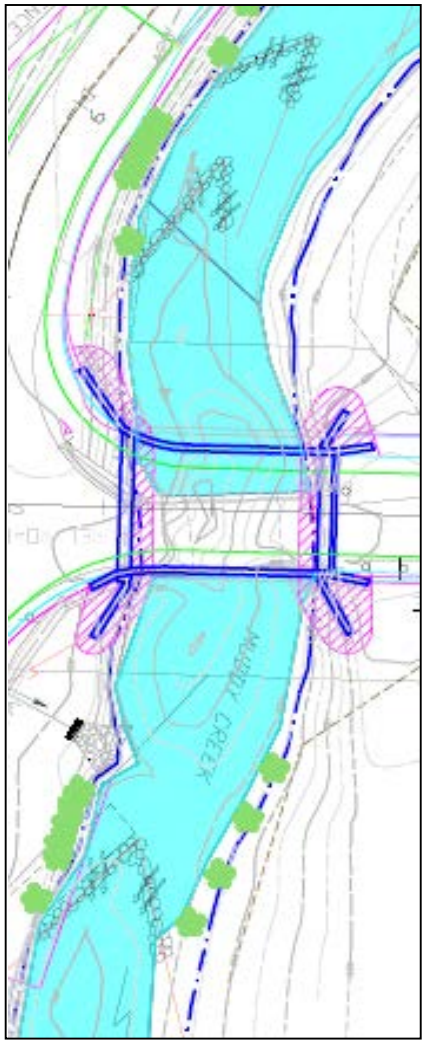
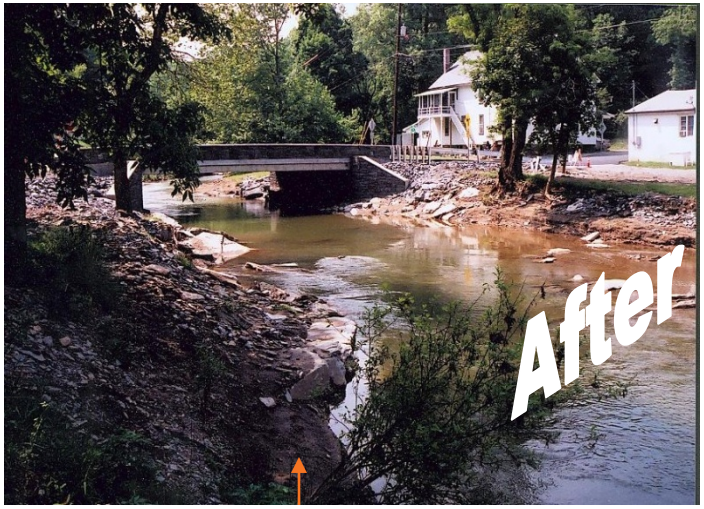
SR 2075 Bridge Replacement Over Muddy Creek, Tributary to the Susquehanna River

Isolated 7.5” rainfall event over 4 hours September 2001 & again on August 31, 2018- 8” event in 3 hours





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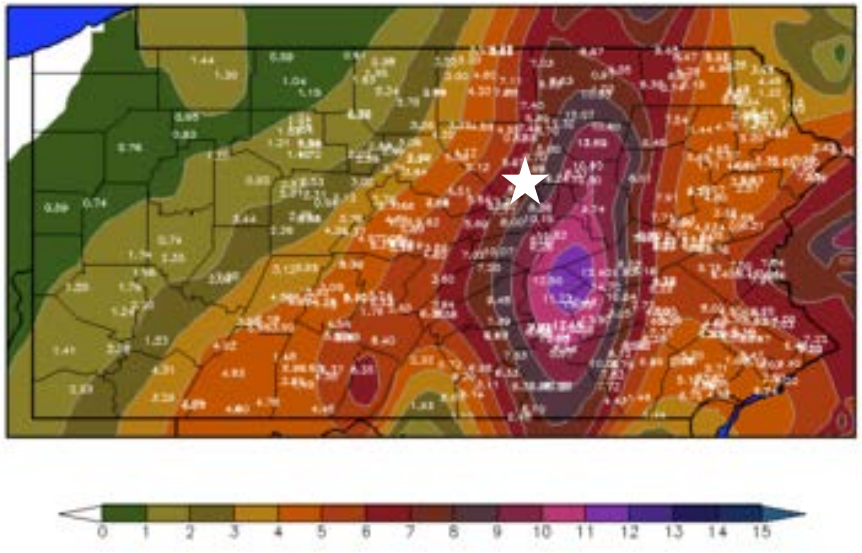
SR 1003, Bridge Replacement, Stream and Embankment Restoration, Wallis Run, Tributary to Loyalsock Creek

- Valley Ridge-Middle Section, Alleghany front, glacial outwash and terminal deposition,
- Confined hemlock forested valley, confluence grade flattening-deposition
- Gas pipeline infrastructure
- Prior damage, debris accumulation Tropical Storm Lee 8-9” September 8, 2011, (10 days post Irene)
- Severe Weather Event: October 21, 2016 : 8+” rainfall over 4.5 hours



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October 21, 2016 Extreme Weather Event

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Before and after Extreme Event

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Stream Channel, Embankment and Bridge Storm Damage-Loyalsock Creek

Channel Restoration and Rock J-Vane Construction

- 3-5 ton rock vanes
- Constructed to bankfull elevation

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Stream Restoration Completion

Bridge Replacement & Cross Vane Completion

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SR 1003 Bridge, Embankment & Wallis Run Restoration

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Post Sandy Concept Design- Floodplain Restoration, Stormwater Wetlands & GI/NNBI

Oakwood Beach, Staten Island

- Stormwater- 100YR, Revetment 500YR+ SLR **(FEMA to Revise)**
- Stormwater wetlands: 80+ acres (Freshwater and Tidal Wetlands)
- Riparian buffer enhancements documented for future pollutant load reduction credit
- NSCD Restoration 1200+ LF- Living Shoreline option
- 2.0 miles- Trails, Boardwalks, Viewing Areas

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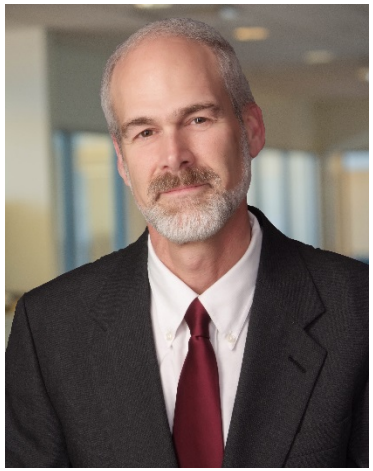
Questions ?



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Examples of Integrated Gray Infrastructure Planning and Natural / Ecosystem Restoration

I-76/DLA – New Cumberland, York County

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Floodplain Reconnection and Stormwater Wetlands

Springfield Gardens Park – Queens, New York City

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Floodplain Restoration / Reconnection

Ecology Park, Valley Creek – East Whiteland Township, Chester County

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Riparian Buffer Restoration

Ecology Park - Valley Creek

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Floodplain Wetland / Stream Restoration

SR 202 Mitigation Wetland – Little Valley Creek, Tredyffrin Township

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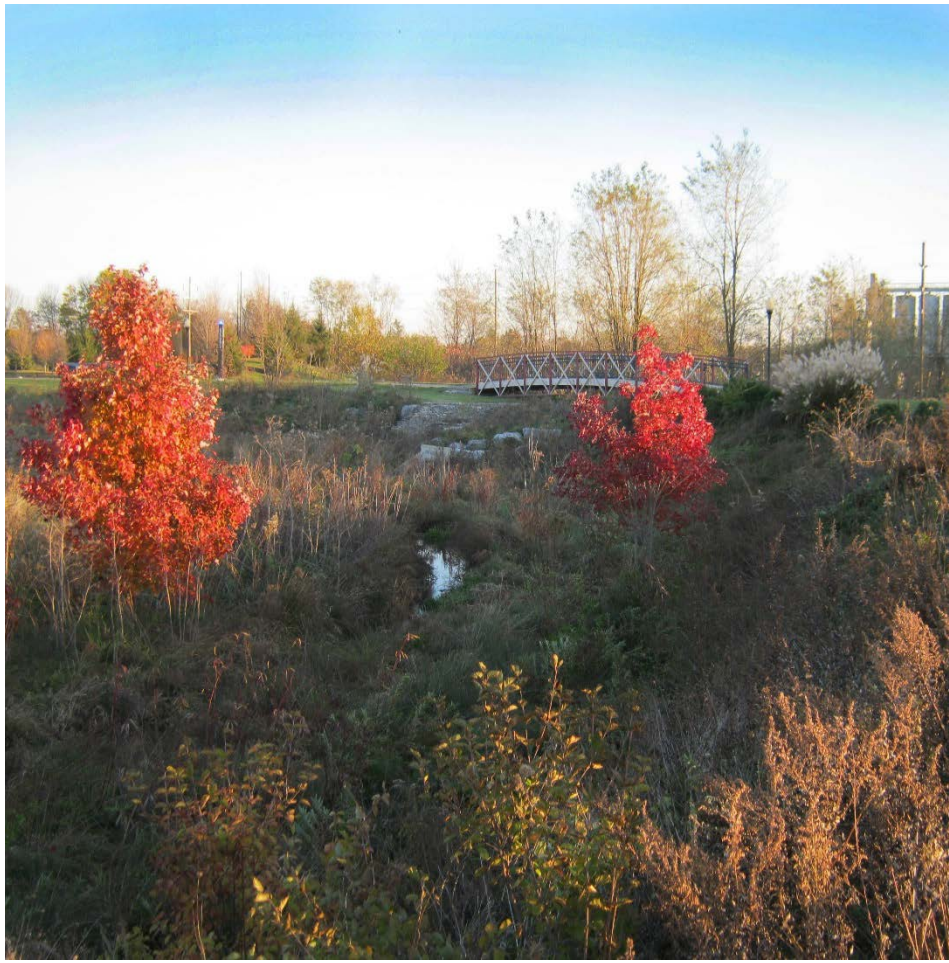
Stormwater Basin Retrofit – Stream/Wetlands Reconstruction

Tributary to Quittapahilla Creek – LVC, Lebanon County



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Stream Daylighting – Floodplain Restoration

Mill Run Headwaters – Derry Township, Dauphin County

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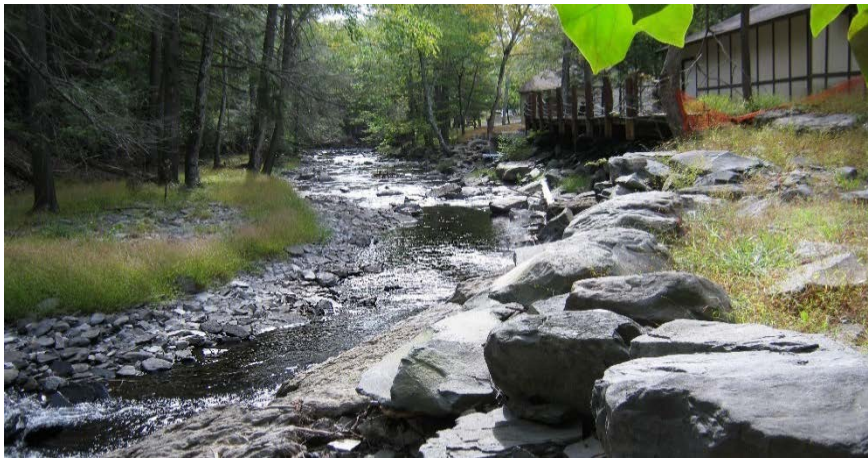
Lehman Township Park- Step-Pool Conveyance / Stabilization

Winona Five Falls – Monroe County



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SR 441 Bridge Replacement and BMP

Spring Creek – Swatara Township. Dauphin County Park

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Wildwood Lake Park and Regional Basin

I-81 – Dauphin County Parks

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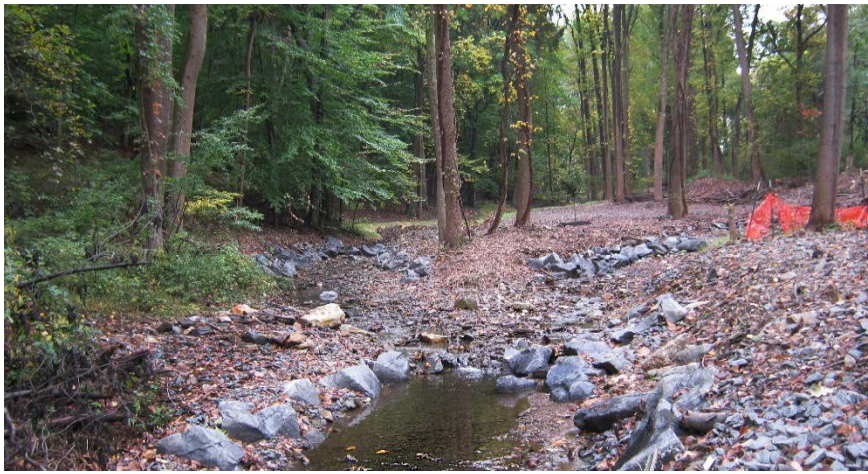
Bells Mill Run Reconnection - NSCD

Wissahickon Creek – Montgomery County



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Cobbs Creek Park

Market Street – Philadelphia and Delaware County

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Avenal Farm Golf Course

Potomac – Montgomery County

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Center Street / Agricultural Wetland

Conodoguinet Creek – Cumberland County

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Floodplain/Stormwater Wetland

East Penn Drive (Center Street) – Cumberland County

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Simple Low-No Cost Examples: Retentive Grading Storage/Infiltration

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Disconnected Floodplain - Storage / Recharge

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Disconnected Floodplain Storage

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Offset Pipe / Retention Storage / Infiltration

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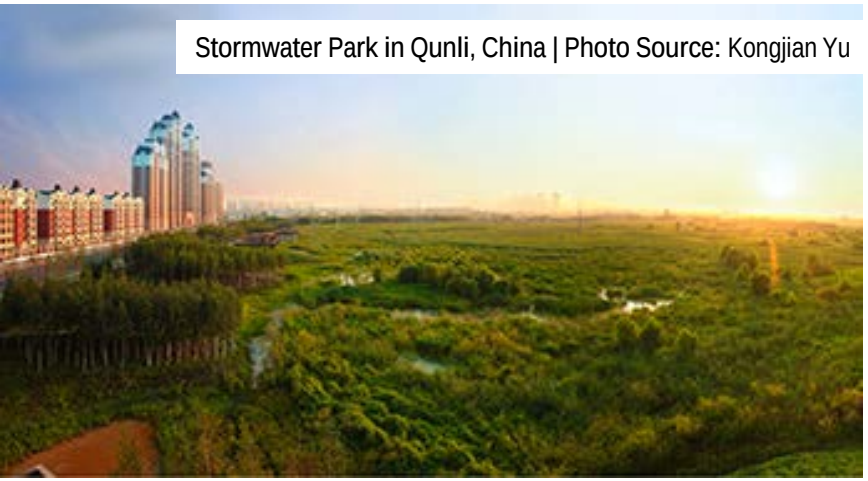
International Examples of Integrated Planning and Floodplain Management



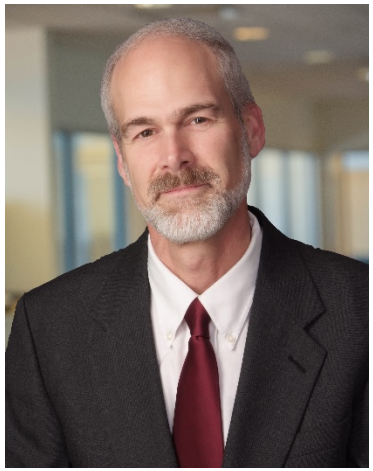
Stormwater Park in Qunli, China | Photo Source: Kongjian Yu

River Waal, Netherlands | Photo Source: Room for the River Waal

Buffalo Bayou Promenade | Photo Source: Tom Fox/SWA

Reference: Gies, Erica. (2015, September 1). *Cities are Finally Treating Water as a Resources, not a Nuisance* Retrieved from: http://ensia.com

Contact Info



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