  

Post-Storm Infrastructure Improvements and Stream Restoration: Three Case Studies

NEWEA Stormwater Conference May 7, 2018

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Today’s Session: Three Case Study Examples

- Hurricanes, Tropical Storms, Extreme and Severe Weather/ Precipitation Events and Responses
- Flood Hazard Mitigation/Restoration for Improved : Resiliency (R) & Sustainability (S)
- Pollutant Reduction Plans / Total Maximum Daily Load (TDML) Reductions
- Joint Infrastructure Rehabilitation and Natural Stream Channel Design (NSCD)
- Green/Nature Based Infrastructure Opportunities
- Infrastructure Vulnerability - Risk Assessment and Mitigation

Integrated Watershed Management/ Planning: Gray and Green

Transportation / Land Use / Water

- Green infrastructure (MS4/ CSO/SSO)
- Highways and transportation
- Sustainability/walk-ability/ live-ability
- Capital infrastructure in concert with above
- Multiple Benefits:
  - Increased Resiliency
  - Multiple Benefits/Users-Triple Bottom Line: Social/Ecologic/ Economic)
  - Improved Sustainability
  - Cost Effective (B:C>1)

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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

- Greenways, Open Space Parks and Recreation Areas
- Passive Recreation (Trails/Walkways/Boardwalks/ Foot-bridges)
- Pedestrian/ Bicycle Friendly Transportation
- Green Stormwater Infrastructure **(Cobbs: PWD-PAI Rain Garden)**

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MS4 - TMDL / Pollution Reduction Plan

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

- Integrated Watershed Management:
  - Streetside GSI/Retention Berms
  - Stream Restoration
  - Floodplain Reconnection
  - Stormwater Wetlands
  - Riparian Buffer Enhancements
  - Reforestation
  - Basin Retrofits

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Geomorphic Assessment- Vulnerability/Risk

- Natural channel design stream restoration as a means of improving 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 US and about 60% of the failures were related to the scour of bridge foundations.**

Reference: FHWA/LA.10/535

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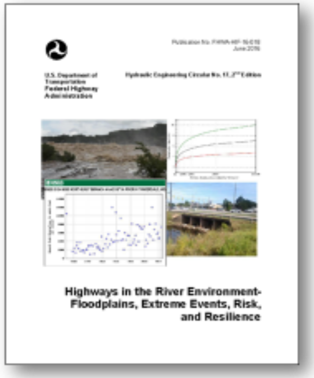
Transportation- Vulnerability, Risk Assessment & Adaptive Mitigation

- 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



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)

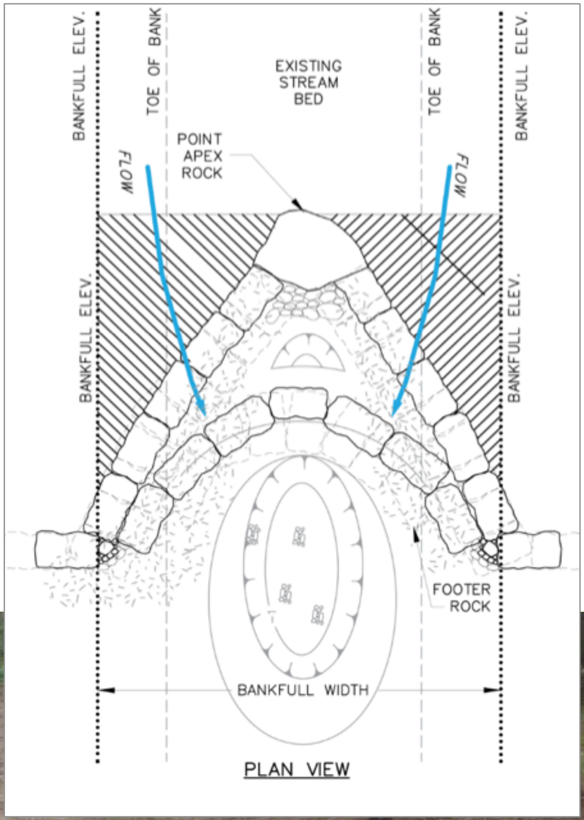
Webinar 2: Climate Modeling and Risk and Resilience (Chapters 5 and 6)

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

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

Natural Stream Channel Design for Scour & Flood Hazard Mitigation

- Floodplain Reconnection
- Streambank stabilization
- Channel stability- lowered shear stress
- Bankfull bench flood prone area
- Improved Floodplain Resiliency
- Increased Capacity for Extreme Events



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Pollutant Reduction through Natural Stream Channel Design Restoration (TMDLs)

- Stream restoration documented for future pollutant load reduction credit: **248 #/LF/YR Sediment Reduction**
- Floodplain reconstruction documented for sediment/ nutrient pollutant load reduction credit


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Stream Restoration- Floodplain Reconnection

Headwater Step-Pool Conveyance System *Flood Hazard Mitigation*

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Integrated Gray Infrastructure with Nature Based /Ecosystem Restoration

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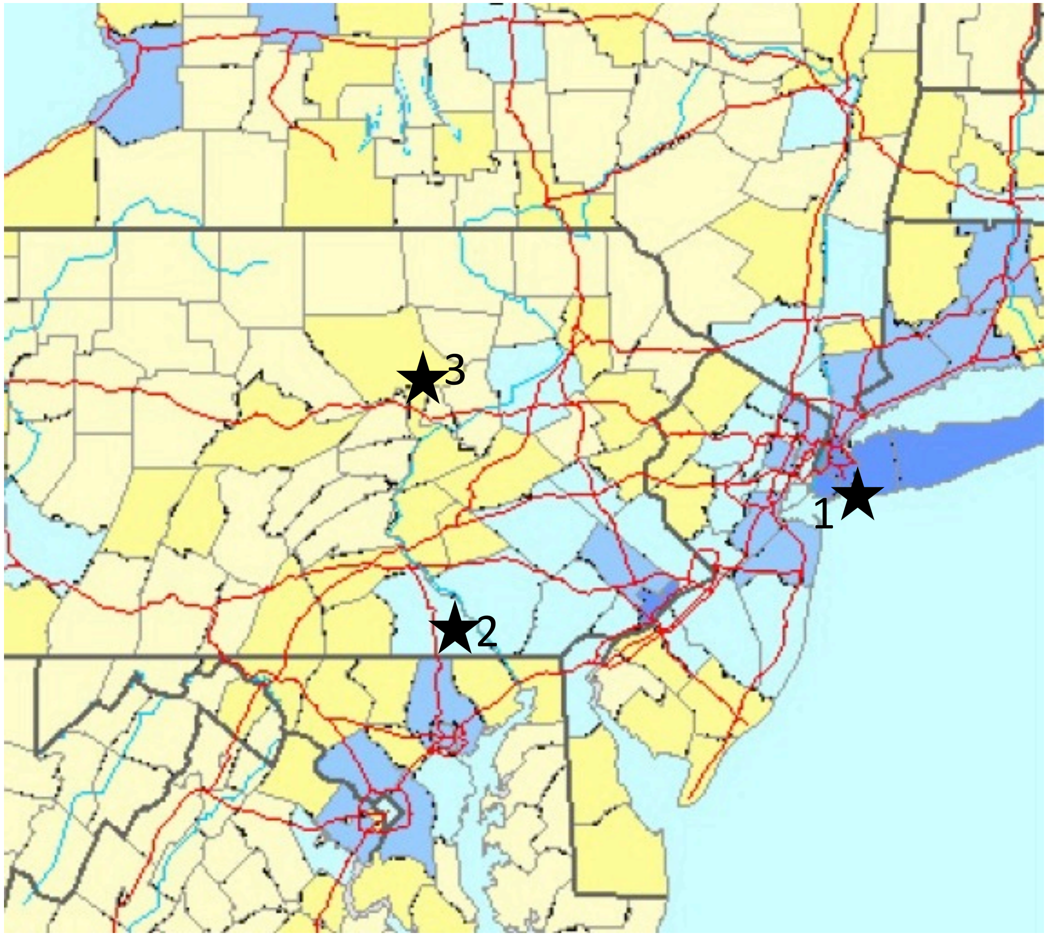
Case Study Location Map



1. Oakwood Beach Flood Attenuation, Staten Island, NY
2. State Route 2075, Muddy Creek Tributary to the Susquehanna River, York County, PA
3. State Route 1003, Wallis Run, Tributary to Loyalsock Creek, Lycoming County, PA

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Oakwood Beach Project Area

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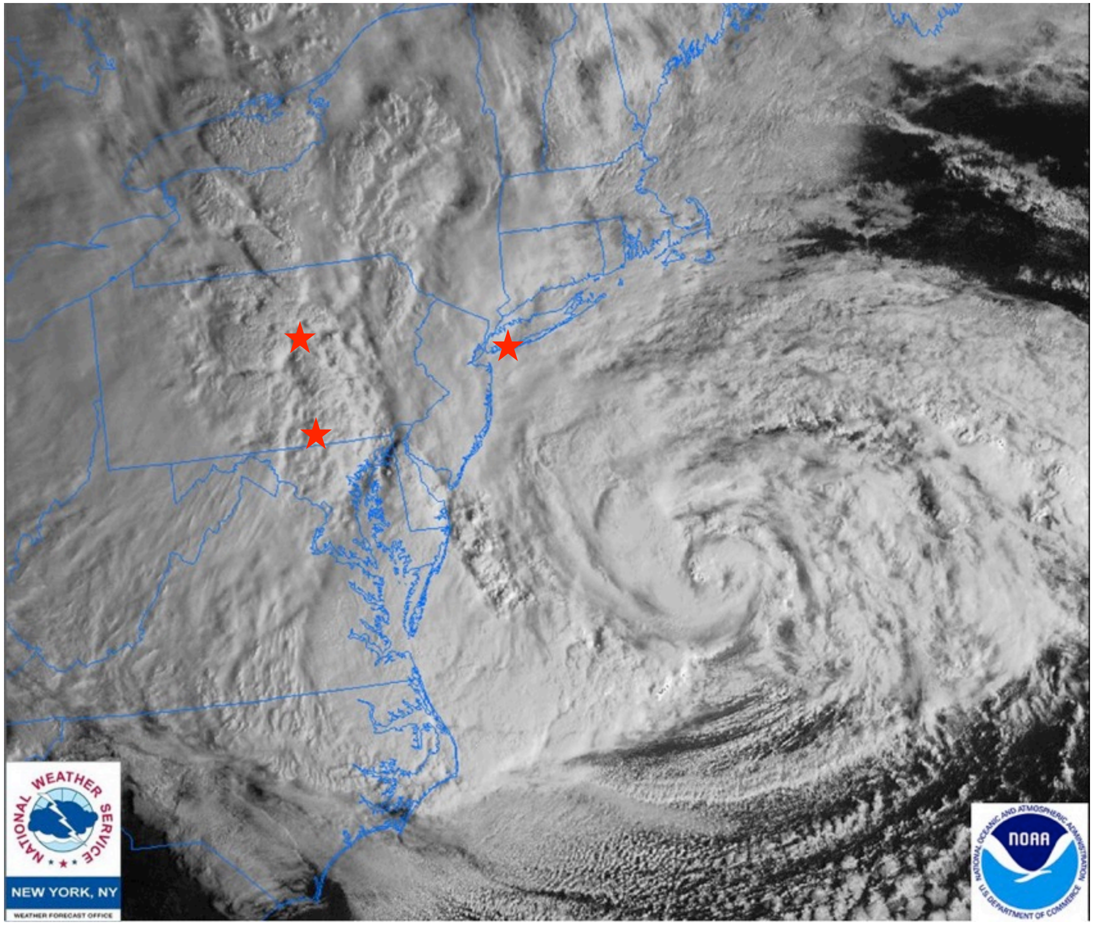
Oakwood Beach Flood Attenuation, Mill Run Tributaries to Lower Bay, Staten Island, NY

- Lower Coastal Plain, glacial outwash and coastal sand deposition,
- Stormwater outfalls and sanitary sewer lines
- Tidal influences/SLR
- Hurricane Sandy – combined high and neap tide-lowest low: 14’surge, October 29, 2012



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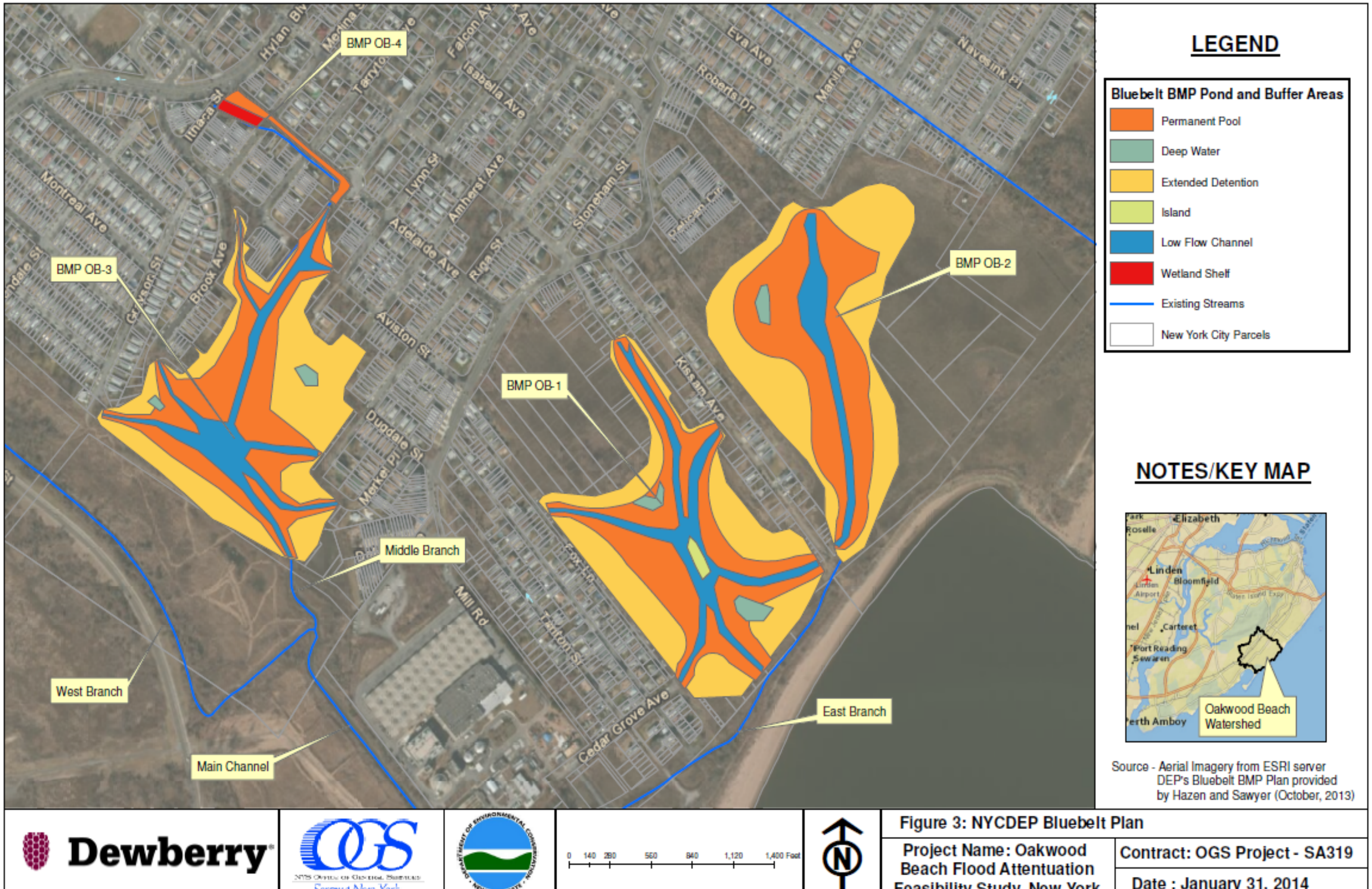
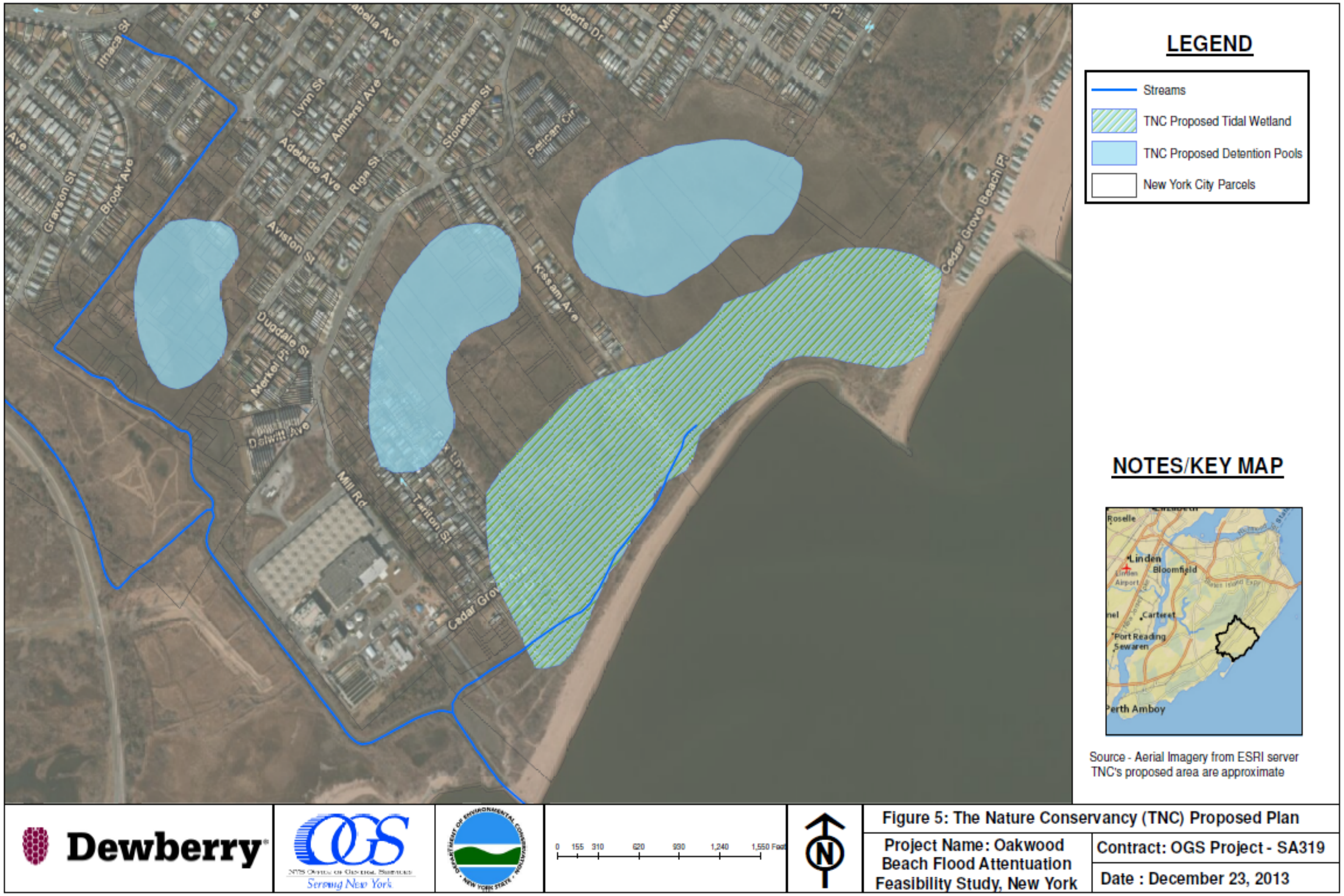
Hurricane Sandy Impacts

USACE Storm Risk Reduction

NYCDEP Bluebelt Plan



TNC Plan



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Objectives

- Project Objectives
  - Evaluate natural infrastructure solutions in addition to NYC DEP's proposed Best Management Practices (BMPs), the USACE rock revetment structure, and The Nature Conservancy Plan
  - Develop Alternatives based on 3 footprints

– Environmental, Coastal modeling, H&H modeling

Project Methodology → Conceptual Design in 6 months

Data Collection	Hydromorphic Assessment & Tidal Datum	Evaluate TNC and USACE Plans	Develop Conceptual Alternatives	Develop Final Conceptual Plan

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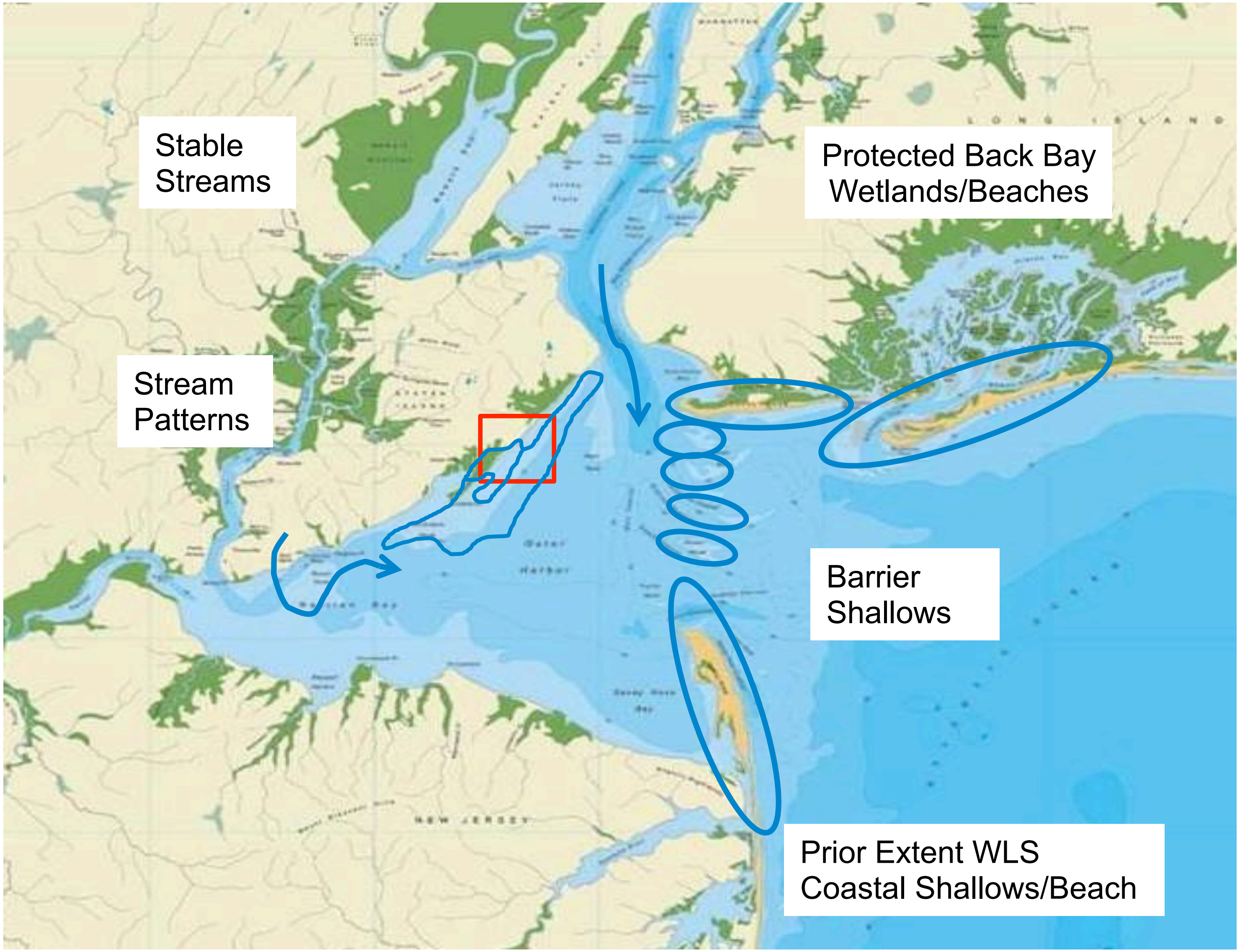
Coastal Morphology



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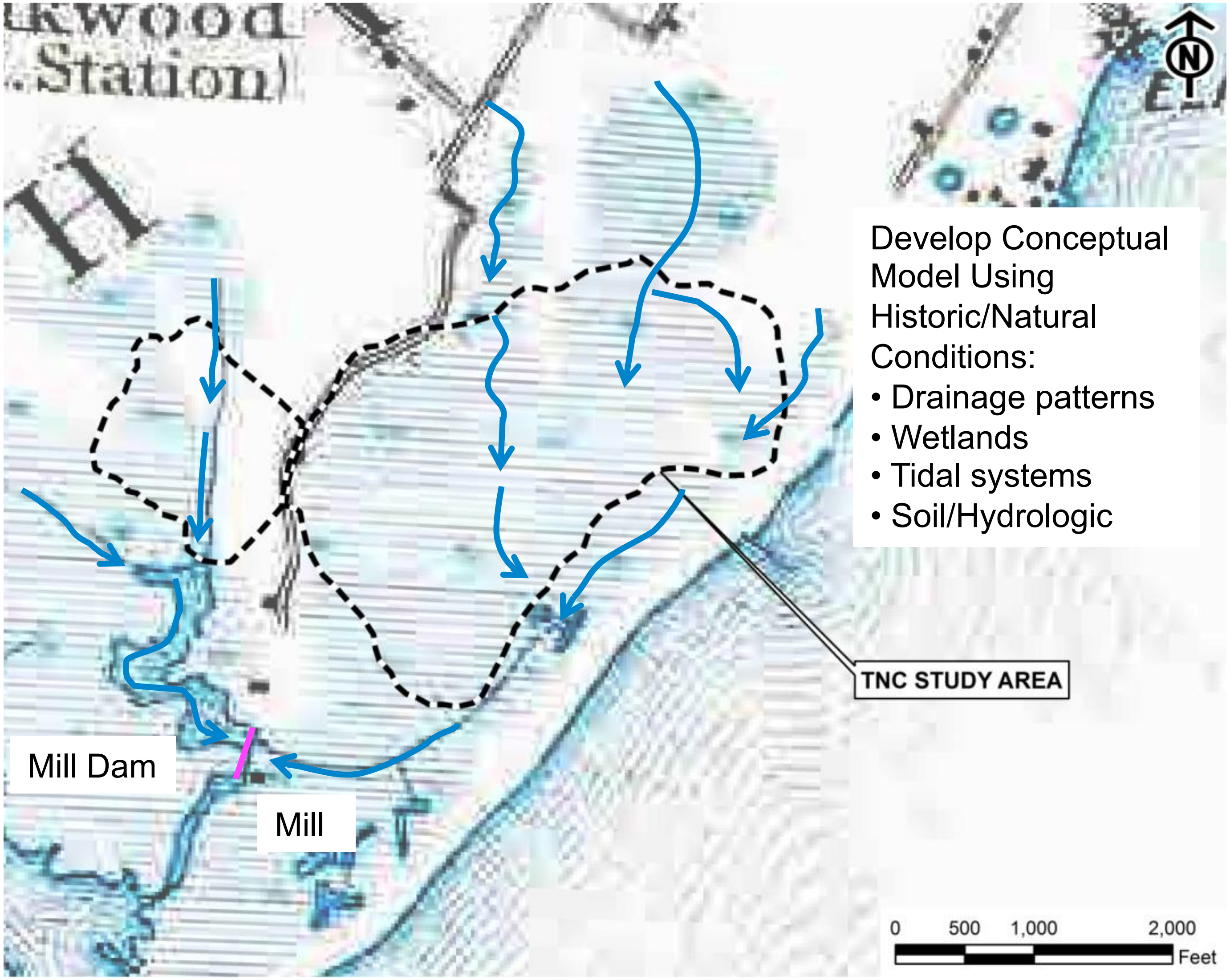
1891 USGS Topographic Survey



Develop Conceptual Model Using Historic/Natural Conditions:

- Drainage patterns
- Wetlands
- Tidal systems
- Soil/Hydrologic

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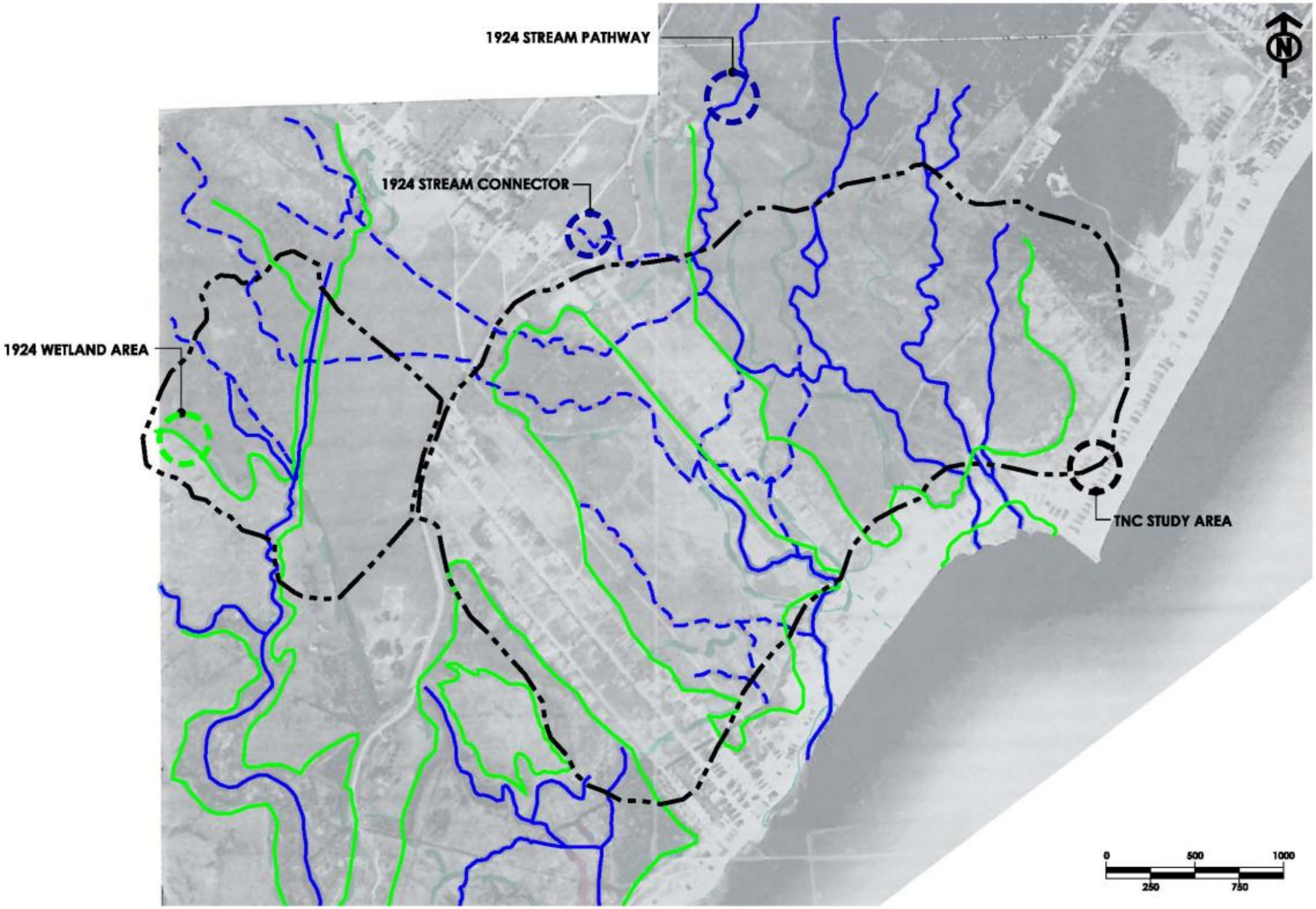
1924 – Channel Patterns



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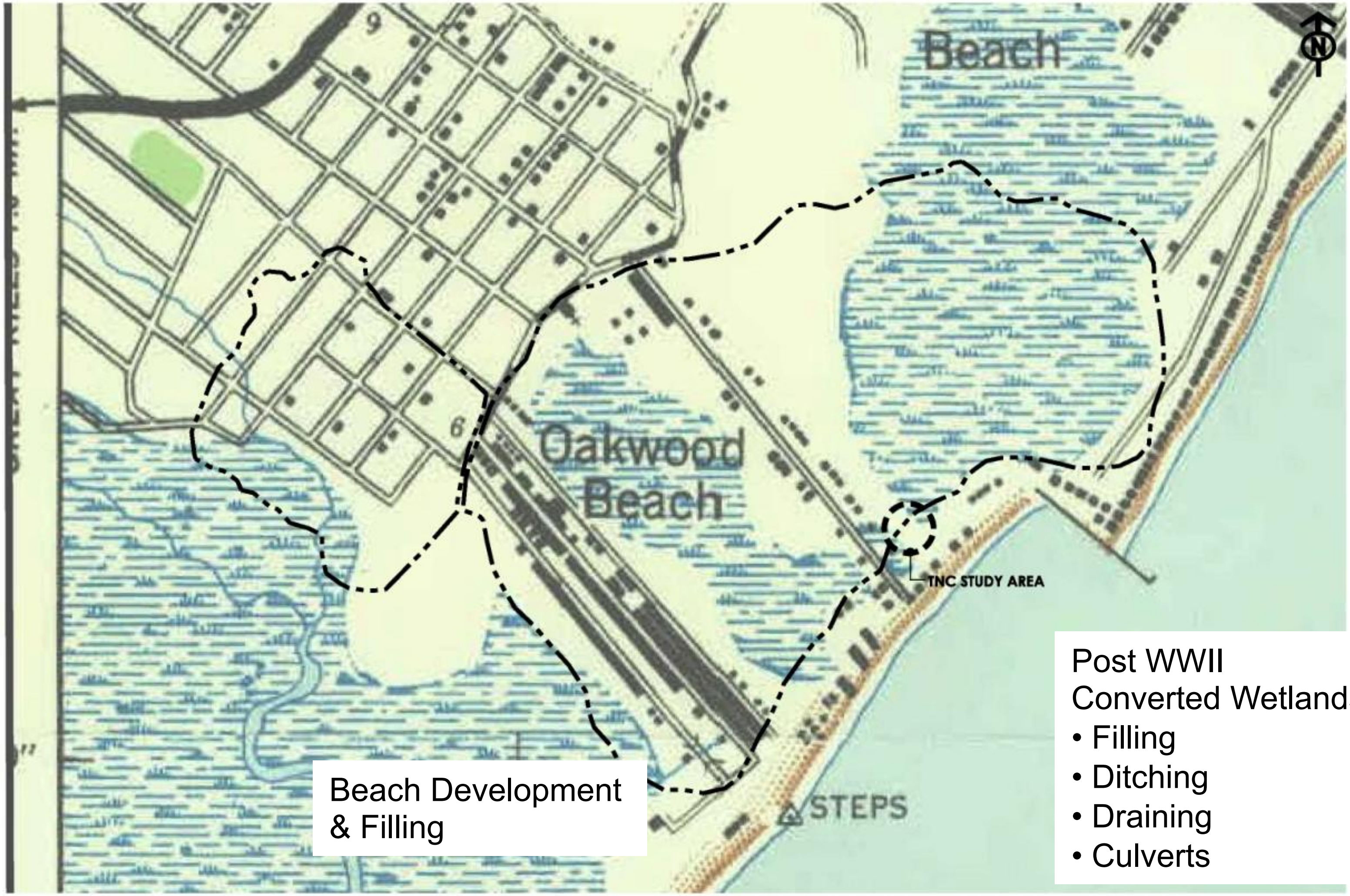
1947 – Coastal Changes



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1966 – Coastal Sediment Accretion Area

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Field Data Collection Locations

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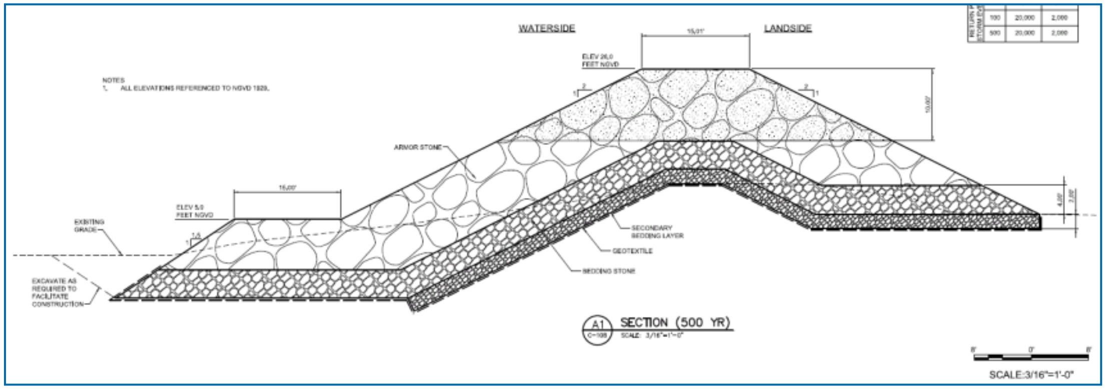
Wave Overtopping

- Empirical formulations from Eurotop Manual (Pullen et al., 2007)
- 2-stone layers
- Seaward slope: 2:1 (H:V)
- Permeable 15-foot crest
- Overtopping threshold:
    - 50 l/m/s (USACE)
- Added SLR Resiliency



Wave Overtopping Results for Alternative 1 and 3 Proposed Revetment/Levee

Annual Return Freq.	Stage (ft)	Tp (sec)	H_{toe} (ft)	Mean Wave Overtopping (l/m/s) for varying crest heights			
				17.5 ft	18.5 ft	20 ft	21 ft
0.2%	16.1	16	6.4	65.9	36.4	14.7	8.1

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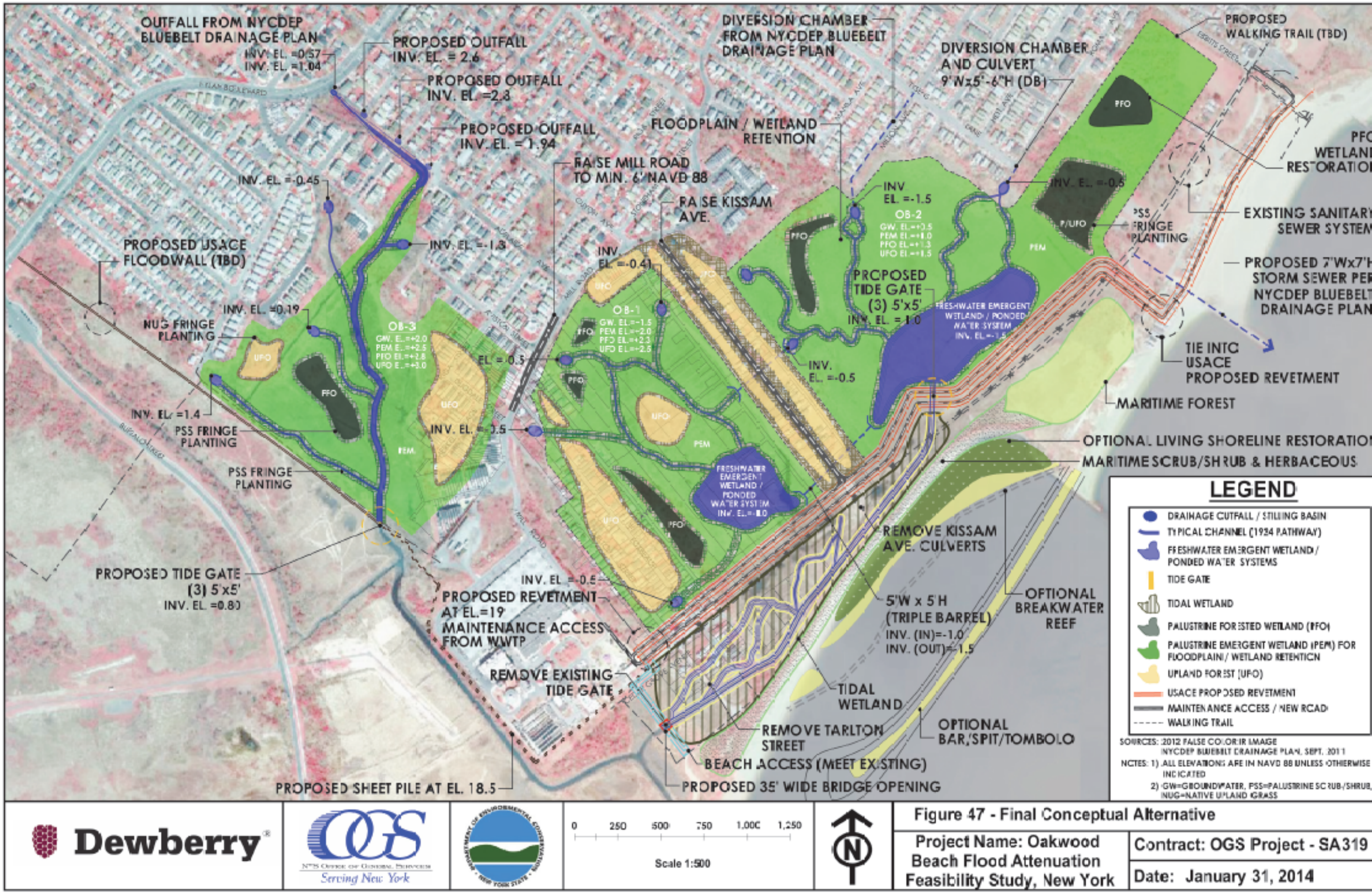
Final Conceptual Alternative



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Summary of Final Alternative

Benefits of Final Conceptual Alternative	
Items	**Final Conceptual Alternative**
Number of Houses Protected from Coastal Storm Surge	1,843
Nature Based/Natural Areas Restoration	Approx. 193 Acres
Level of Protection	0.2%-annual-chance (500-yr) for Coastal Storm Surge Storage capacity for 1%-annual-chance (100-yr)
Public Access and Trail Components	Public open space - 193 acres 2 miles of trails around restored natural areas 1 mile trail on revetment maintenance access
Stormwater detention storage areas (acres)	OB-1: 45.6 OB-2: 42.4 OB-2 Extended: 10.7 OB-3: 42.2
Volume of Stormwater contained in Restored Storage Areas	OB-1: 35.3 million gallons (108.4 acre-ft) OB-2: 61.5 million gallons (188.8 acre-ft) OB-2 Extended: 8.8 million gallons (27.2 acre-ft) OB-3: 61.8 million gallons (189.9 acre-ft)
Approximate Preliminary Cost	$173 million

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Oakwood Beach Flood Attenuation Project Concept Summary

Floodplain Restoration – Stormwater, Wetland

- Stormwater Conveyance/Retention for 100Year Rainfall
- Tidal/Freshwater wetlands: 80+ acres for Water Quality
- NSCD Restoration 1200+ LF/Riparian Buffer Enhancements
- Coastal Revetment Restoration-Living Shoreline Options
- Green/Nature Based infrastructure Improvements

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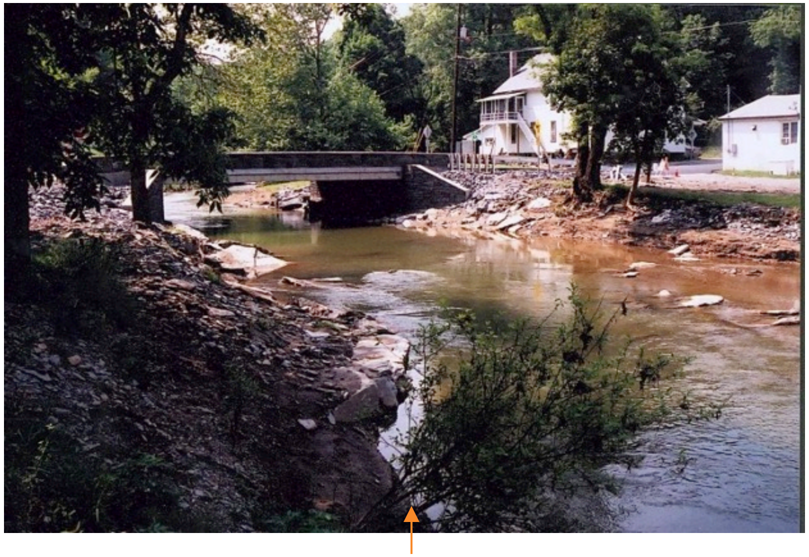
SR 2075 Bridge Replacement Over Muddy Creek, Tributary to the Susquehanna River

- Lower Piedmont, confined valley/deep alluvium,
- Historic alterations constrained by former railroad and roads
- Upper Chesapeake Bay, isolated 7.5” rainfall event over 4 hours September 2001



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Bridges in Pennsylvania

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

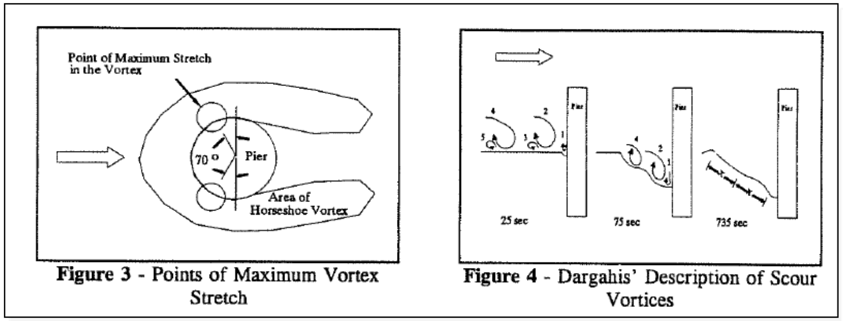


Figure 3 - Points of Maximum Vortex Stretch

Figure 4 - Dargahis' Description of Scour Vortices

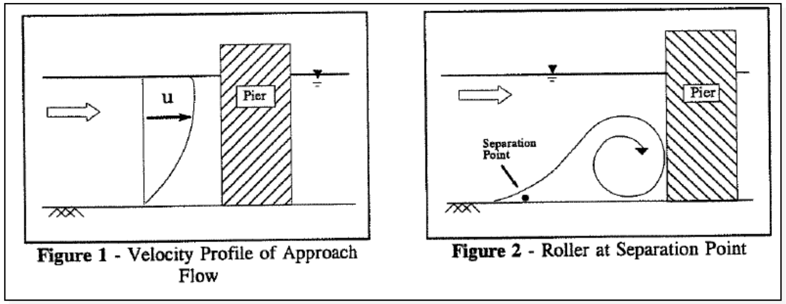


Figure 1 - Velocity Profile of Approach Flow

Figure 2 - Roller at Separation Point

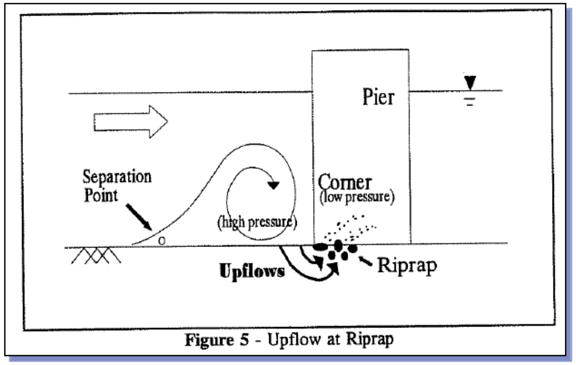
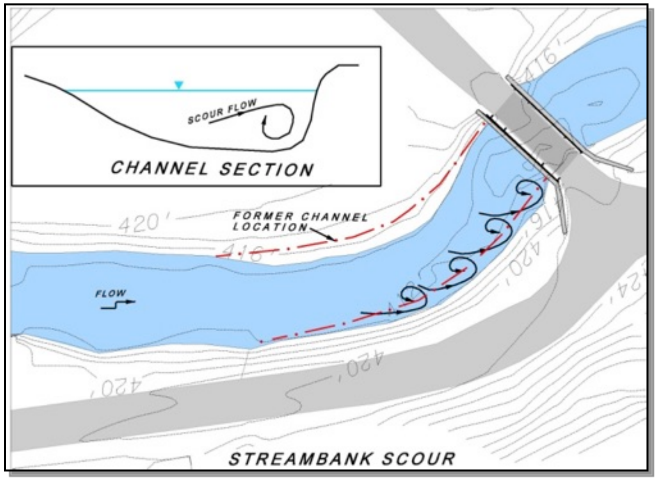


Figure 5 - Upflow at Riprap



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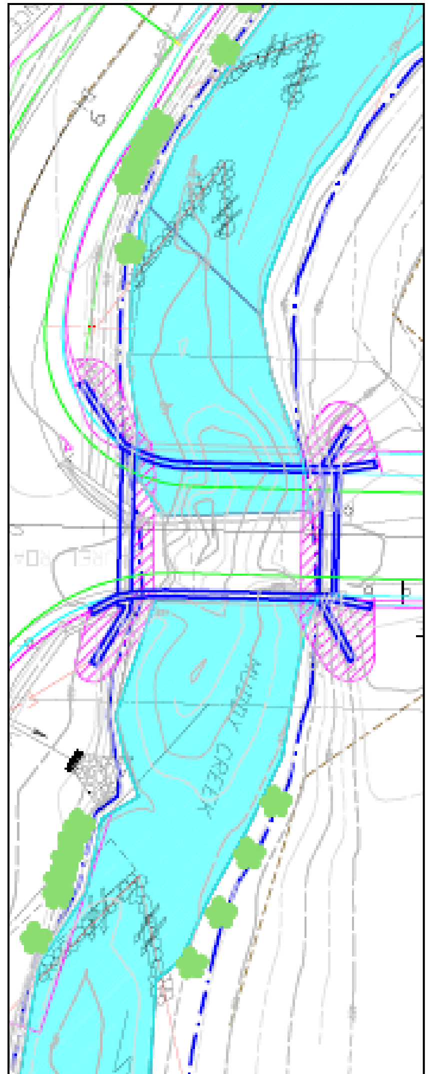
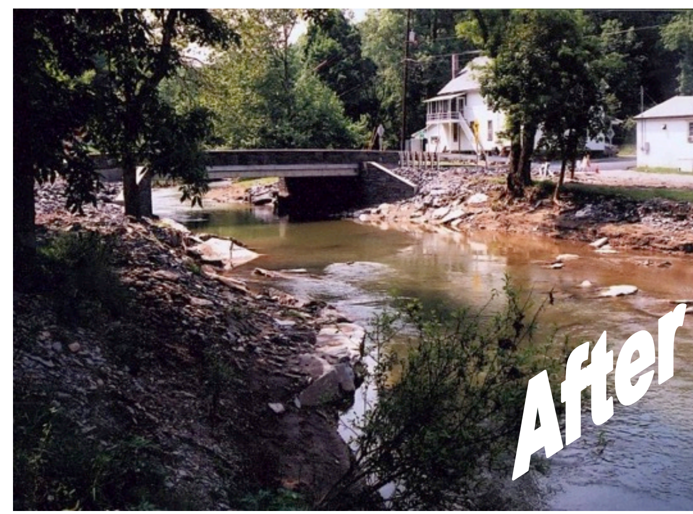
Muddy Creek, S.R. 2075, York County





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Natural Stream Stabilization at Structure Crossings

- Creates a win-win for all by providing:
  - Reduced sediment discharge
  - Stable channels and streams
  - Scour protected bridge structures & streambanks
  - Stream habitat and fisheries improvements
  - Improved Resiliency

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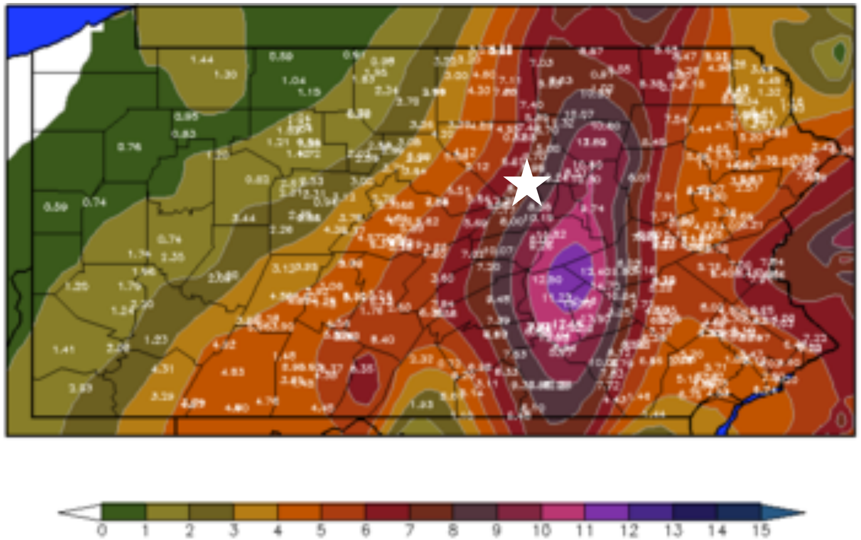
SR 1003, Bridge Replacement, Stream and Embankment Restoration, Wallis Run, Tributary to Loyalsock Creek

- 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

Stream Channel, Embankment and Bridge Storm Damage

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Stream Channel, Embankment and Bridge Storm Damage

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Stream Channel, Embankment and Bridge Storm Damage

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Stream Channel, Embankment and Bridge Storm Damage

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Stream Channel, Embankment and Bridge Storm Damage

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Stream Channel, Embankment and Bridge Storm Damage-Loyalsock Creek

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Channel Restoration, Rock J-Vane Construction and Embankment Reconstruction

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Channel Restoration and Rock J-Vane Construction

Channel Restoration and Rock J-Vane Construction

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Rootwad Construction Channel and Embankment Completion

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Rootwad Construction Channel and Embankment Completion

Channel/Embankment Construction and Bridge Replacement

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Bridge Cross Vane & Embankment Completion

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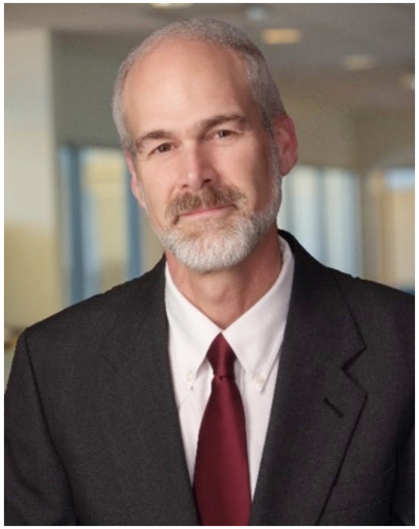
Questions?

Special recognition and thanks to NYSOGS, NYSDEC, NYCDEP, USACE, GOH and PennDOT



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