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DRAFT

Project Update
A Tail of Two Streams

Big Spring Run – Effects of Floodplain Restoration and Legacy Sediment Removal

Reasons for Study

- Large amounts of sediment stored behind historic mill dams (legacy sediment), upon breach or removal, downcutting, mobilize sediment and associated nutrients
- Viewed as a major contributing source of sediment and nutrients, <u>however,</u> lack of before and after stream restoration monitoring information
- Determine potential BMP efficiency for “legacy sediment removal and aquatic restoration”
- Report and data analysis for two-time periods -- WY2009-2011 (pre) WY2012-2015 (post) restoration
- Data from previous 8 year (1994-01) study available for climatic comparisons

Project Cooperators

USGS

- Pennsylvania and Maryland Water Science Centers

Partners

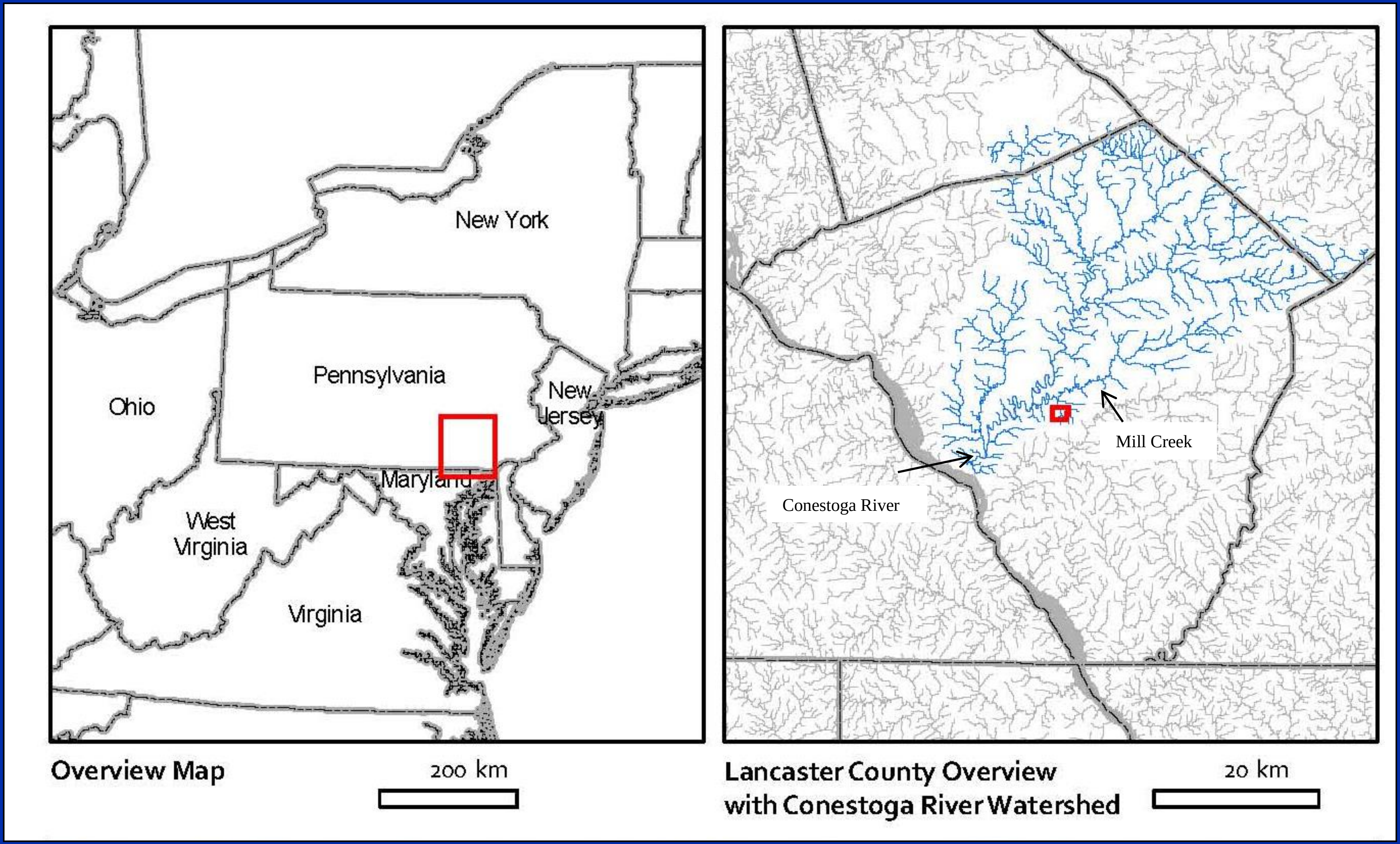
- Pa Department of Environmental Resources (PaDEP)
- Franklin and Marshall Collage (F&M)
- USEPA

Approach/Monitoring Design

Surface Water

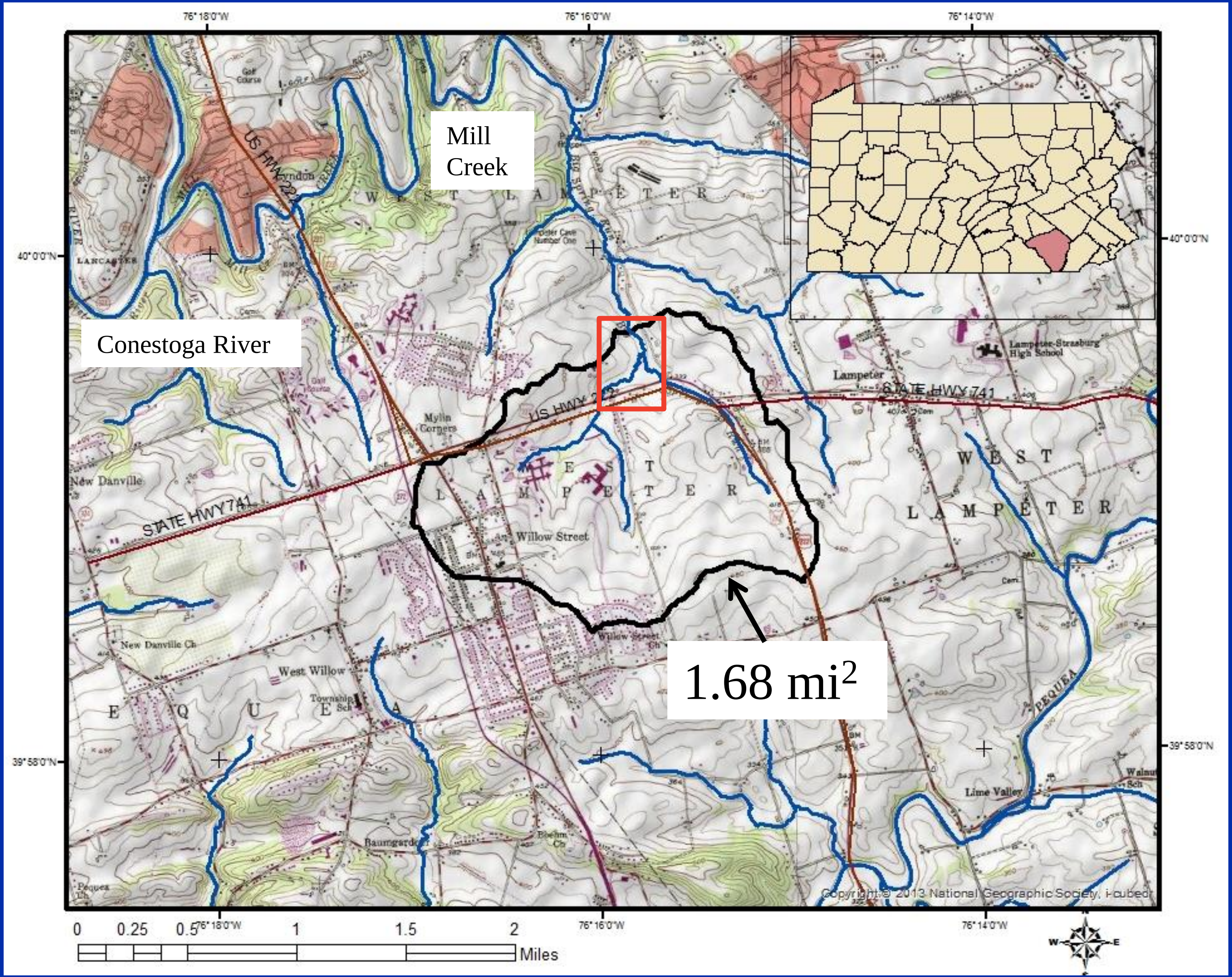
- 3 locations, continuous steamflow, temp, and turbidity
- discrete monthly base flow sampling, 8 targeted storms
- T+D nutrients, sediment, and sand/silt splits base flow and selected storms
- automatic samplers for sediment/turbidity relations

Regional Location Map



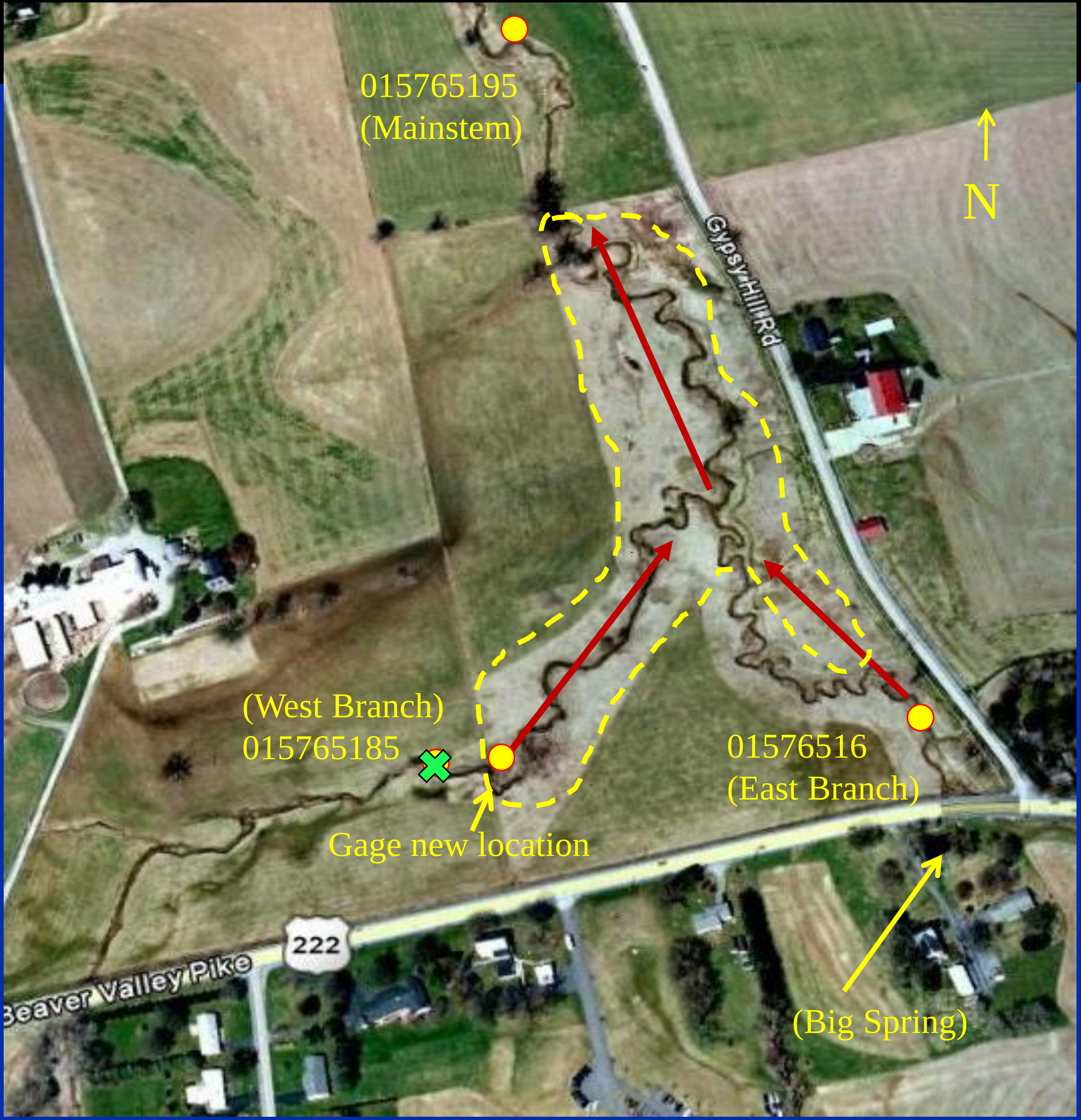
Map courtesy Franklin and Marshall Collage

Local Location Map

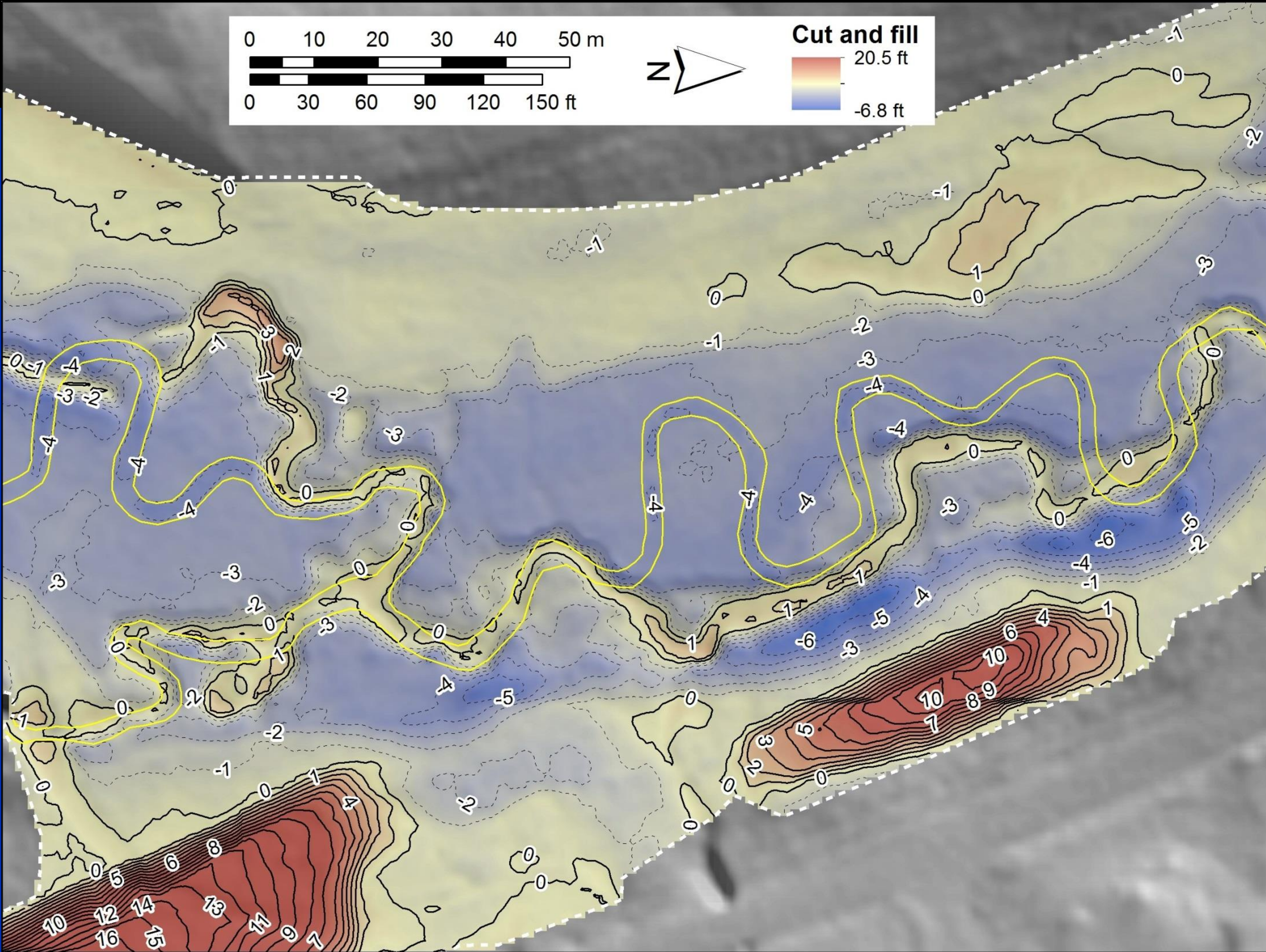


Study Area

- -- Legacy sediment removal area (4.6 acres)
- → Flow direction
- ● Water-quality and -quantity gages



Sediment Removal Before and After


0 10 20 30 40 50 m
0 30 60 90 120 150 ft
N
Cut and fill
20.5 ft
-6.8 ft

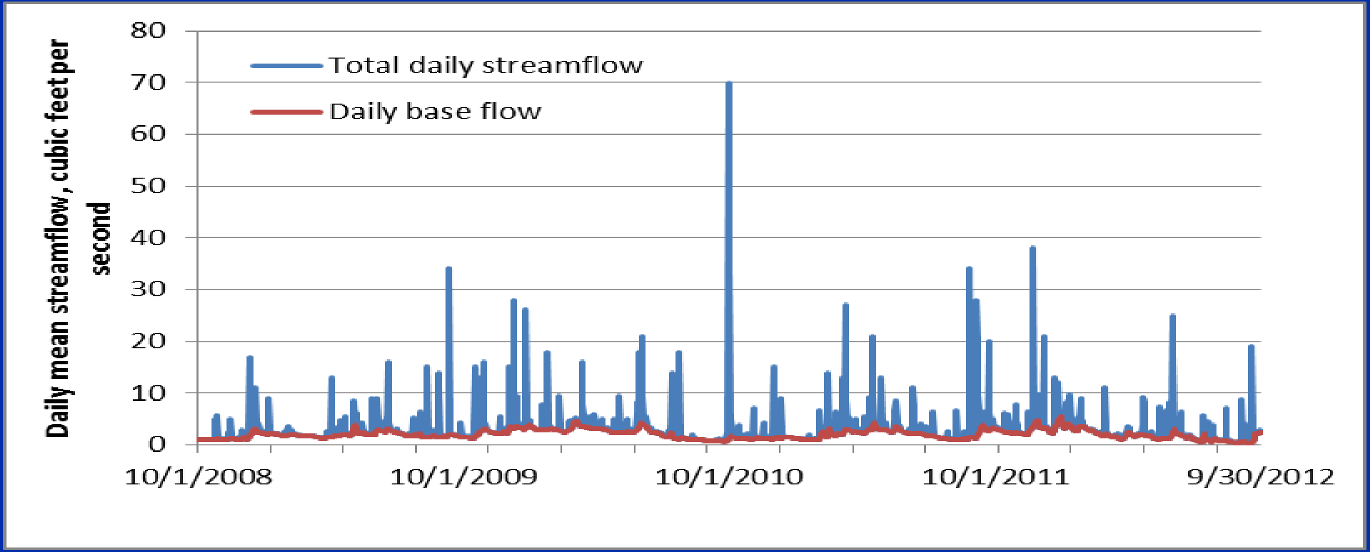
Streamflow - findings

Daily Hydrograph Separation - "source"

- East Branch (01576516) dominated by base flow 79% and 80% pre- and post-monitoring

- West Branch (015765185) less dominated by base flow 46% and 49% pre- and post-monitoring

- Downstream gage a resulting mixture 69% and 68% base flow in pre- and post-monitoring



Streamflow – Quantity

Daily Hydrograph Separation Reveals –

Monitoring period	Mean stream flow (percent)	Mean base flow (percent)	Mean base flow (downstream site) minus (East and West branch upstream sites) (million gallons)	Annual average mean base flow (million gallons)
Pre restoration (2009-2011)	88	82	261	87
Post restoration (2012-2015)	72	69	588	147
Difference	16	13	326	60

- Upstream to downstream streamflow post-restoration period
  - 16% increase in streamflow
  - 13% attributed to increased GW contribution
  - Average increase of 60 million gallons in base flow / year

Streamflow – major findings

Pre- to Post-Monitoring Period

- Removal of ~22,000 tons of sediment (4.6 acres)
- Removal of 63,700 pounds TN, 32,900 pounds of TP

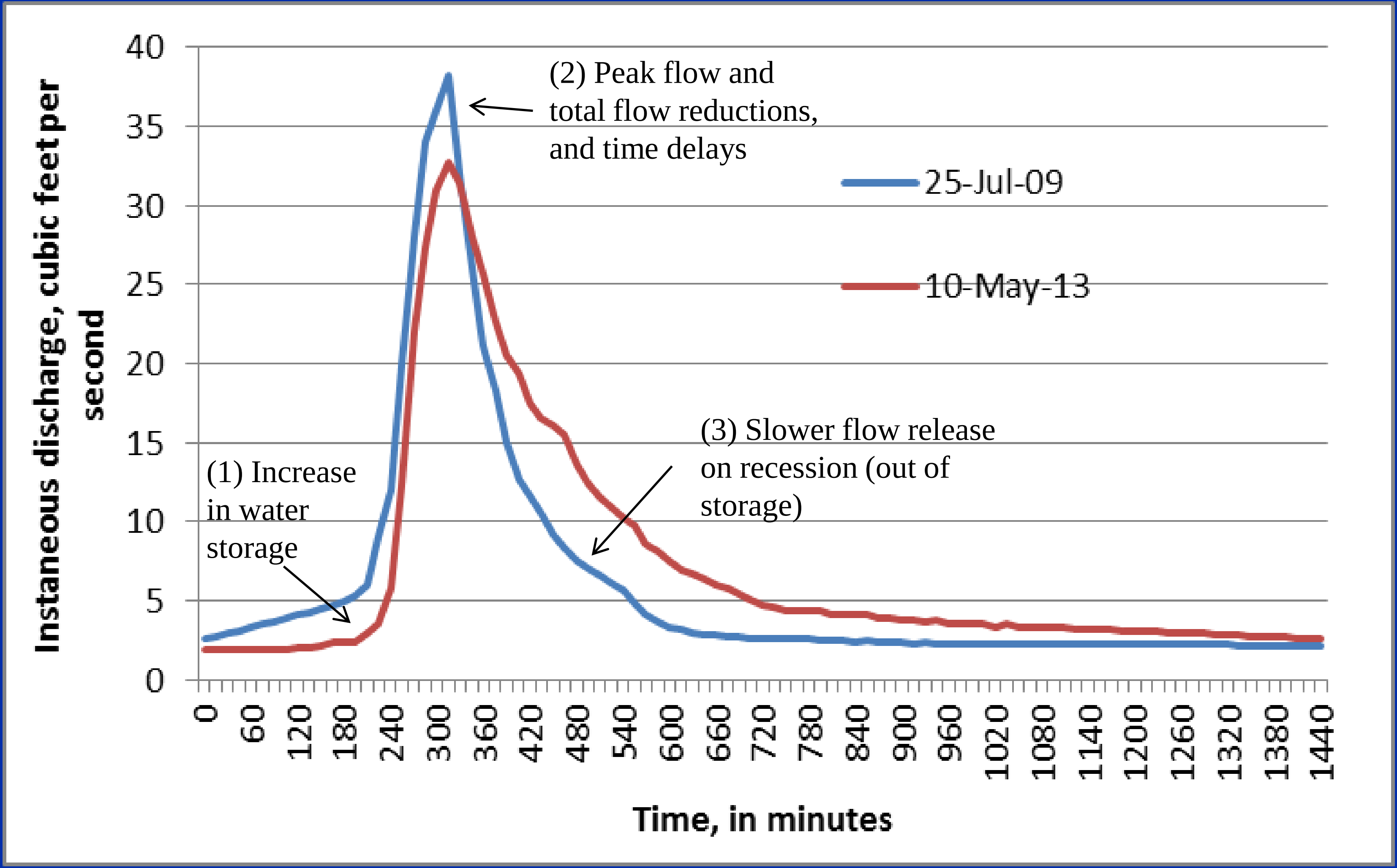
Pre- to Post-Monitoring – 4 major findings

- Increased water storage (2.7 million gallons)
- Reduced peak flows
- Decreased average volume of streamflow to peak at the downstream site
- Increased time between upstream and downstream peaks

Streamflow – draft findings

Time vs flow - pre to post changes (based on 10 storm comparisons)

Storms selected bases on similar streamflow and rainfall characteristics



9/18/2012

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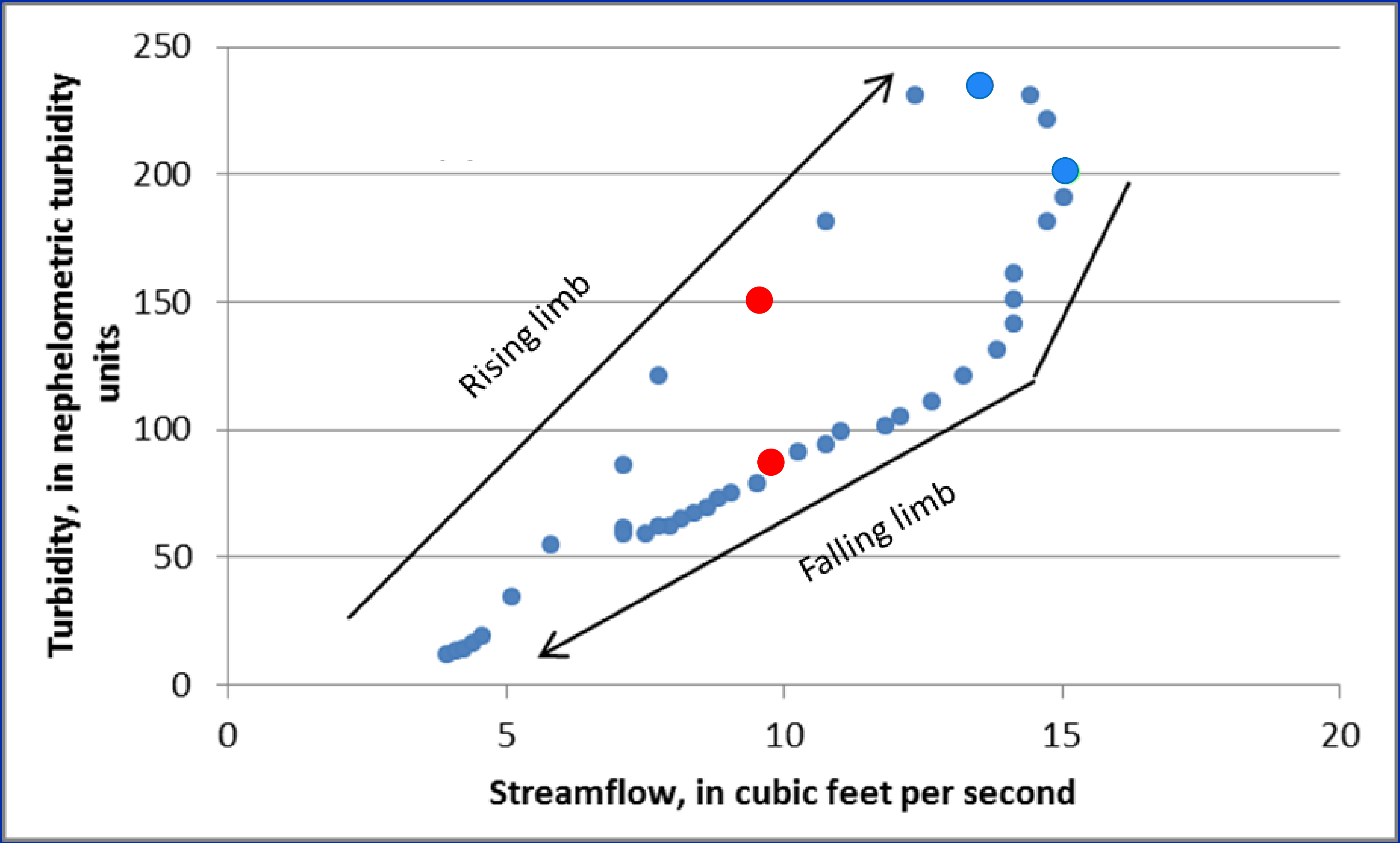
Turbidity - draft findings

Results

- Clockwise hysteresis present in all storms, pre and post
- Indicative of nearby source (stream banks/channel)
- Four-fold increase in number (2 to 8) of turbidity (Turb) peaks after stormflow (STF) peak, however, majority Turb peaks (70%) in post period occurred before STF peaks
- Significant reductions in turbidity peaks pre to post restoration (~45%)
- Distributions in the 1 to 10 FNU range increased 30% at the DS site and 6% and 4% at the upstream sites in the post-monitoring (less sediment and possible sediment trapping in restoration area)

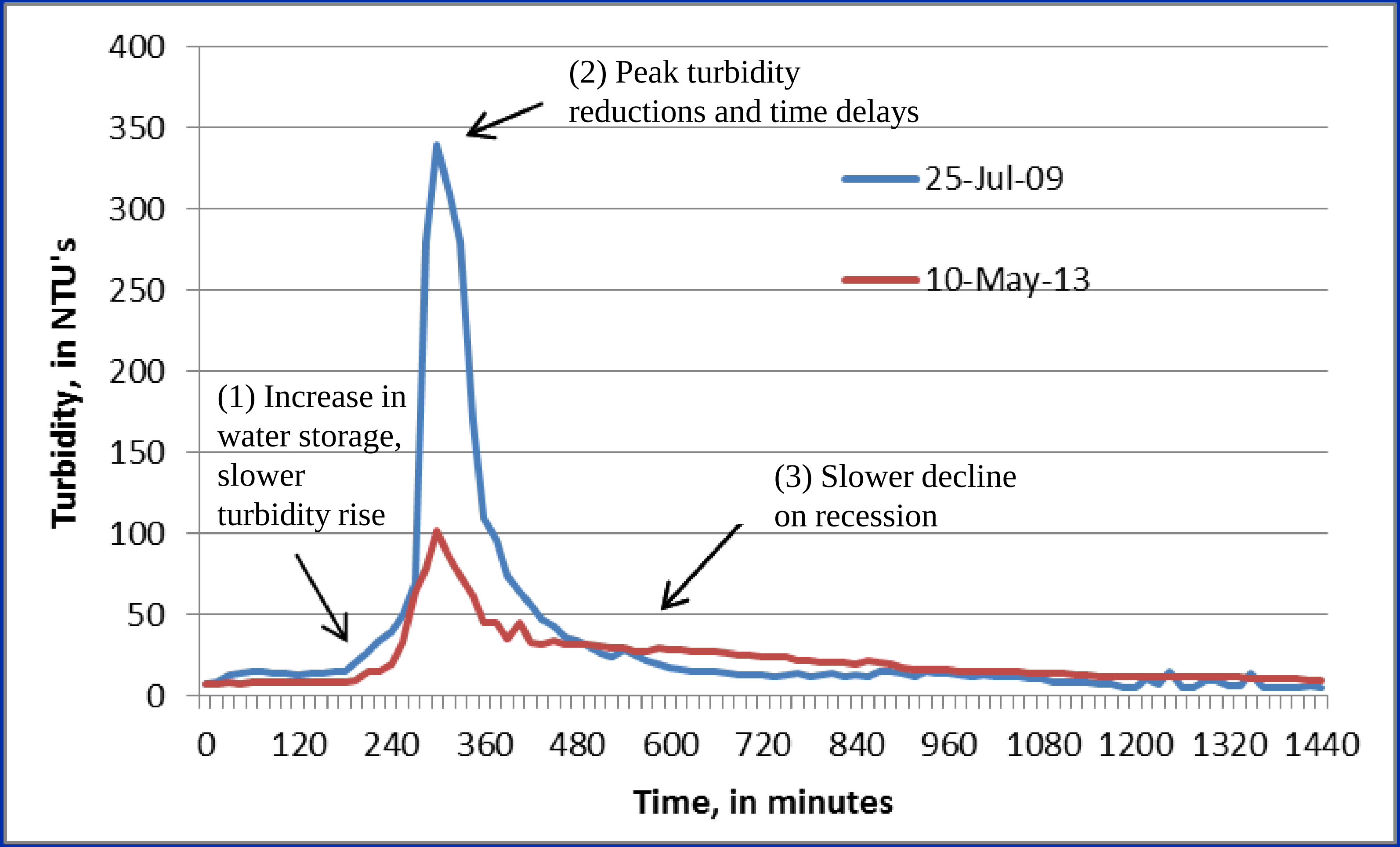
Hysteresis - draft findings

Clockwise hysteresis – two different turbidity values for same streamflow values (150 and 80 both at 9.9 ft^3/s)



Turbidity - draft findings

Turbidity for same storms as shown for streamflow changes



Sediment - Draft Findings

Turbidity / Sediment relations

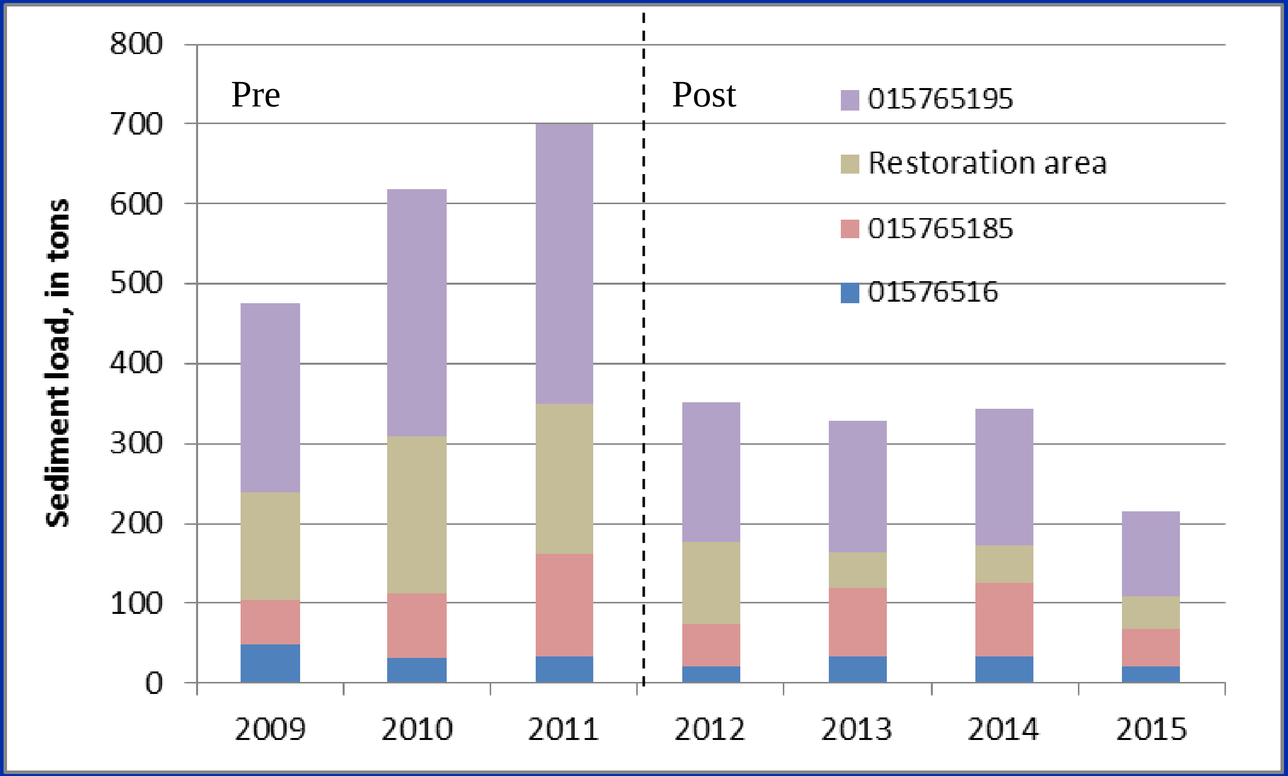
- Total of 87 of 180 storm events had sediment concentration analysis
- Turbidity underestimated sediment concentration by an average of 20% in the pre- and 18% in the post-monitoring period.
- Turbidity, sediment, and streamflow used as surrogates to predict 30-minute sediment concentration record for the 7-yr period
- Estimates for daily, monthly, and annual sediment loads

Sediment Loads - *Draft Findings

Sediment Loads (tons)	Average 2009-2011	Average 2012-2015	Difference (tons)	Difference (pounds)
01576516 (IN)	38	28	-10	
015765185 (IN)	88	70	-18	
subtotal upstream (IN)	126	98	-28	-56,000
015765195 (OUT)	299	155	-144	-288,000
Load between upstream and downstream sites (tons)	173	58	-115	-230,000

- Export of 1,710 tons from study site, 897 tons 3-yr pre- and 813 tons 4-yr post-monitoring period
- Average reduction of 144 tons (~50%) in the post-monitoring period, 80% from restoration area and 20% from upstream of restoration area
- A disproportionate reduction (80%) in terms of percent of watershed (<5%)

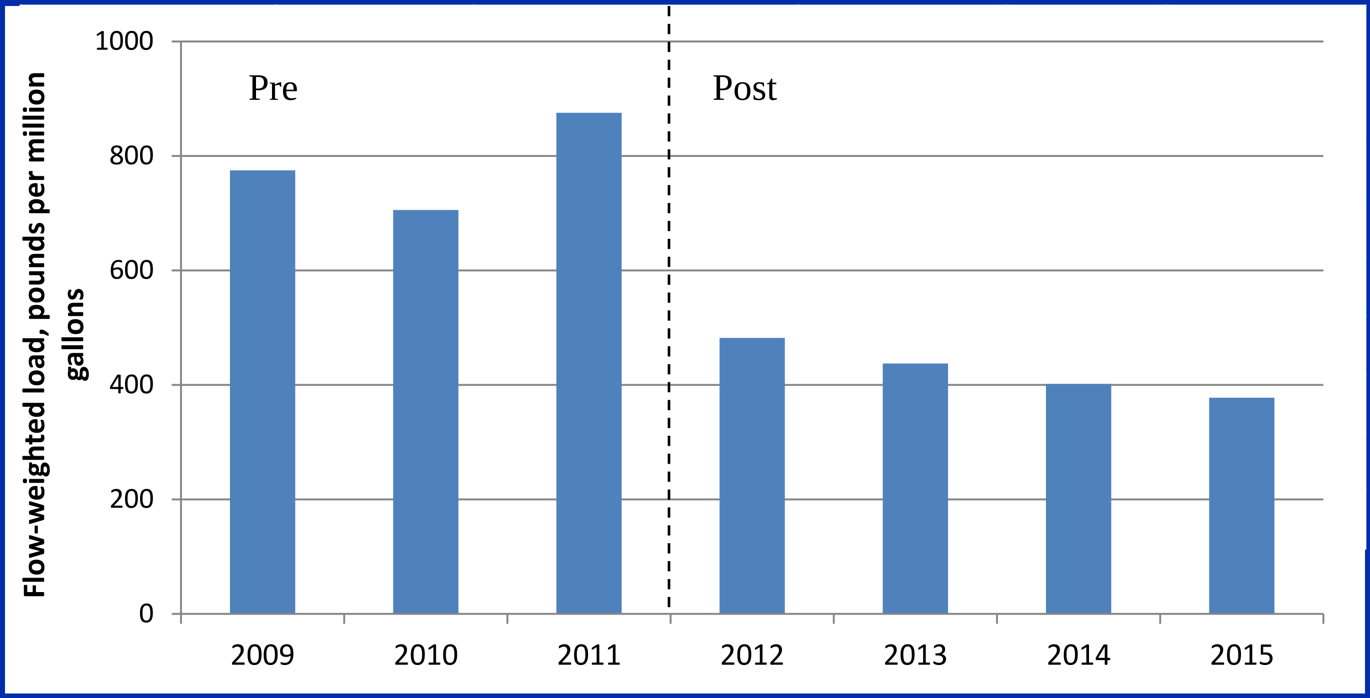
Sediment – Annual loads



- Barcharts showing annual change in loads pre-post restoration
- 2012 indication biological community not completely established
- Franklin and Marshall College researchers indicate one-quarter to one-half of the current sediment from the “restoration” area, is from the non-restored reaches.

Normalize sediment load and flow

Flow-Weighted Load (FWL)



- FW loads - total sediment load / total annual flow (gallons)
- Reduction of 360 pounds/Mgal (-46%), in the post-monitoring period

Summary - draft

- Demonstrated with various techniques changes to streamflow sources, and fundamental changes to the streamflow and turbidity hydrographs (storage, timing, and reduction of peaks)
- Annual loads indicated an average reduction of ~50 percent in the post-monitoring period
- Similar reduction (47 percent) in flow-weighted load (360 pounds/Mgal) in the post-monitoring period
- About 80 percent of the reduction is attributed to the removal of sediment in the restoration area

Thank You