



Multi-Strategy Whole Watershed Restoration for Ecological and Human Resiliency

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Watershed Restoration

Aim to re-establish normal rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems

Resiliency to stochastic events, climate and land use stress

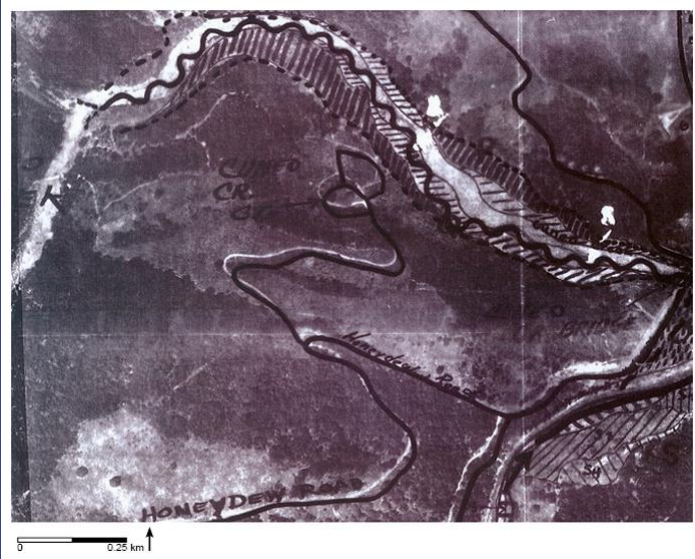
- *Ecological: biodiversity, ecosystem processes*
- *Human: water quality, flow regime*

Watershed Restoration:

Not producing the desired recovery of ecosystem functions and biodiversity (e.g. Bernhardt et al. 2005; Palmer 2009)



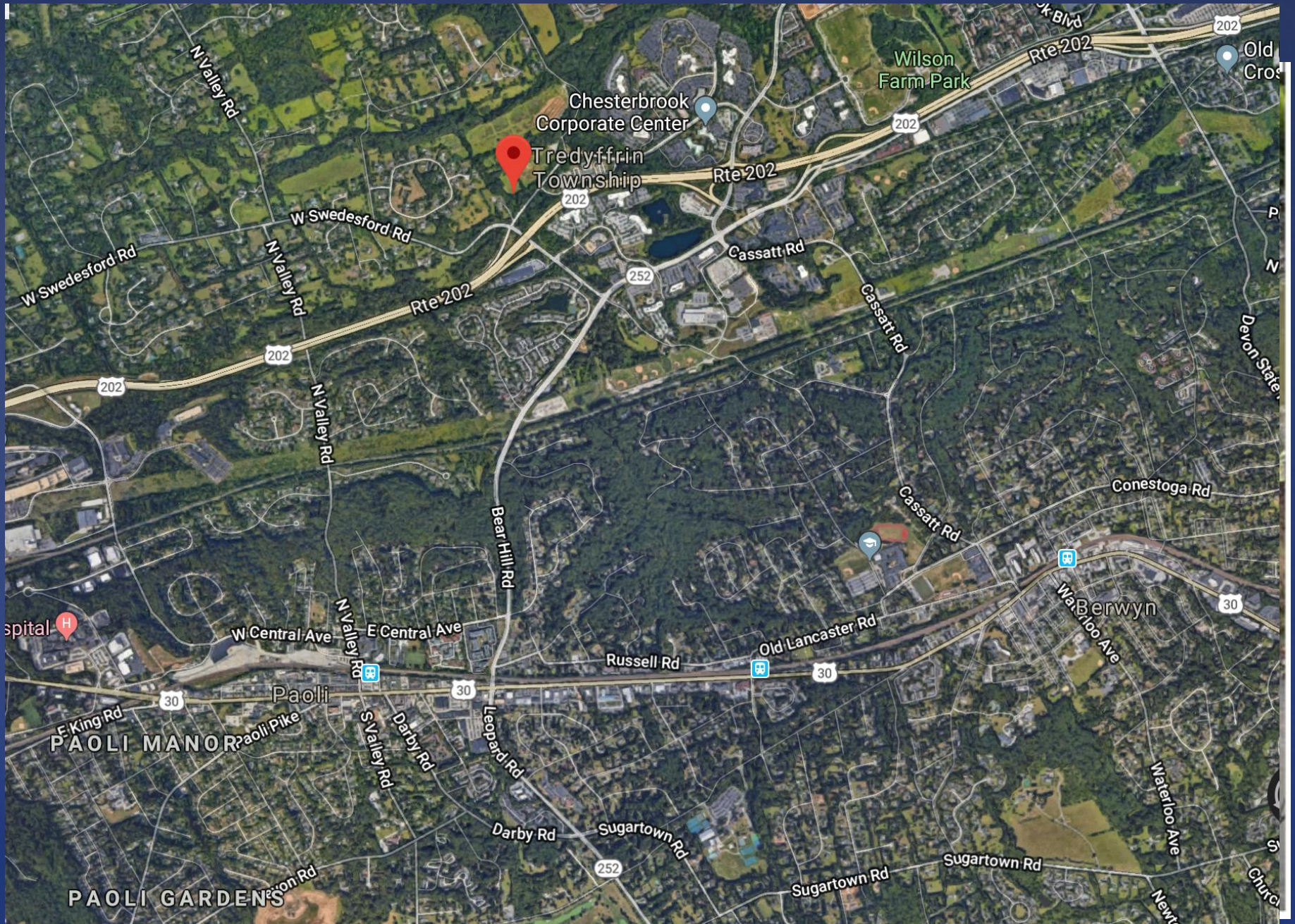
Fundamental disconnect between watershed science and restoration practice



Design for Cuneo Creek reconstruction project (from Rosgen 1991). (photography courtesy of the California Department of Parks and Recreation).



Kondolf, G. M. 2006. River restoration and meanders. *Ecology and Society* 11(2): 42. [online] URL: <http://www.ecologyandsociety.org/vol11/iss2/art42/>

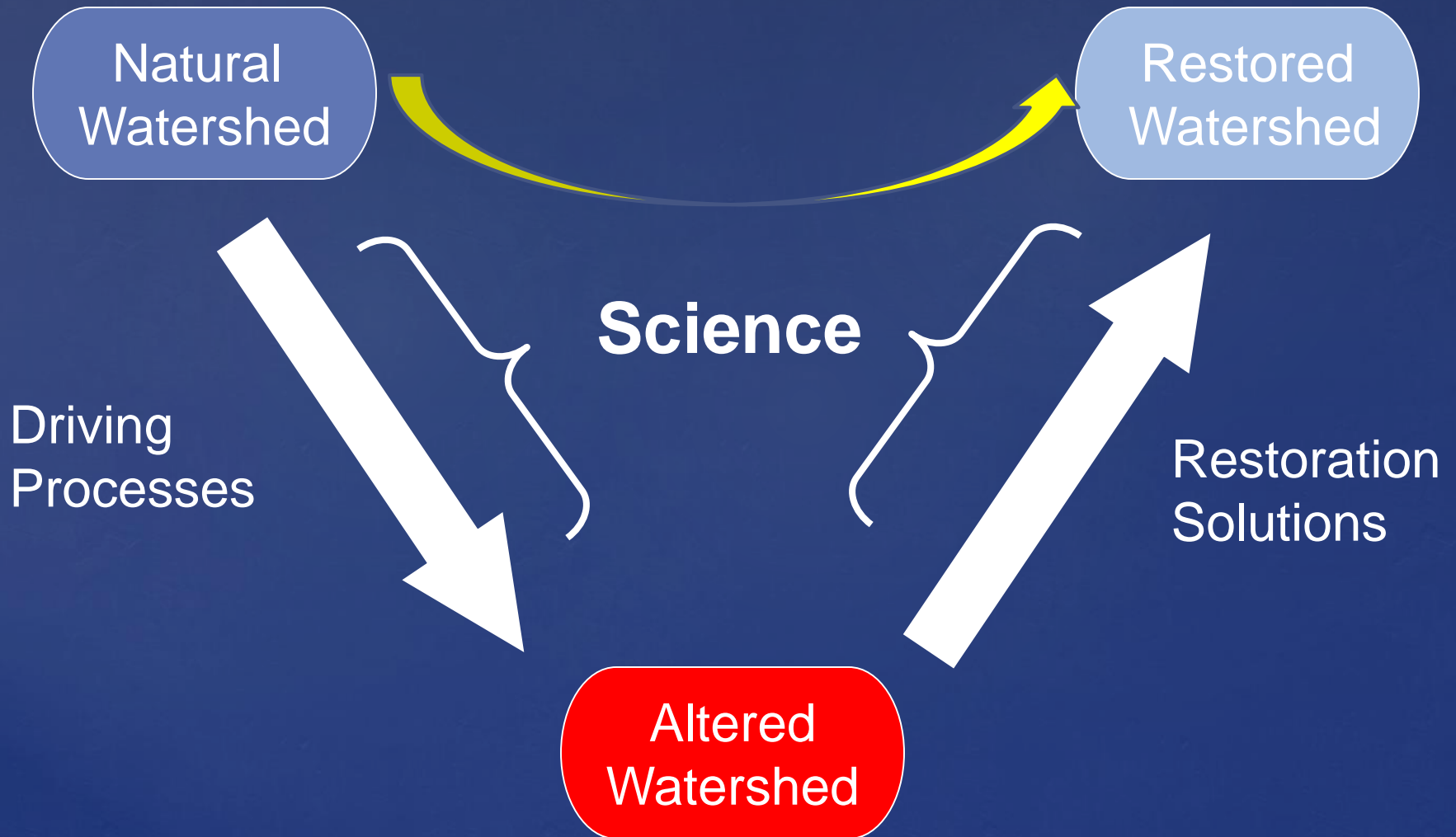


Legacy Sediment Removal





Watershed Restoration



Climate Change

Hillslope Processes

Riparian Ecology

Critical Zone Processes

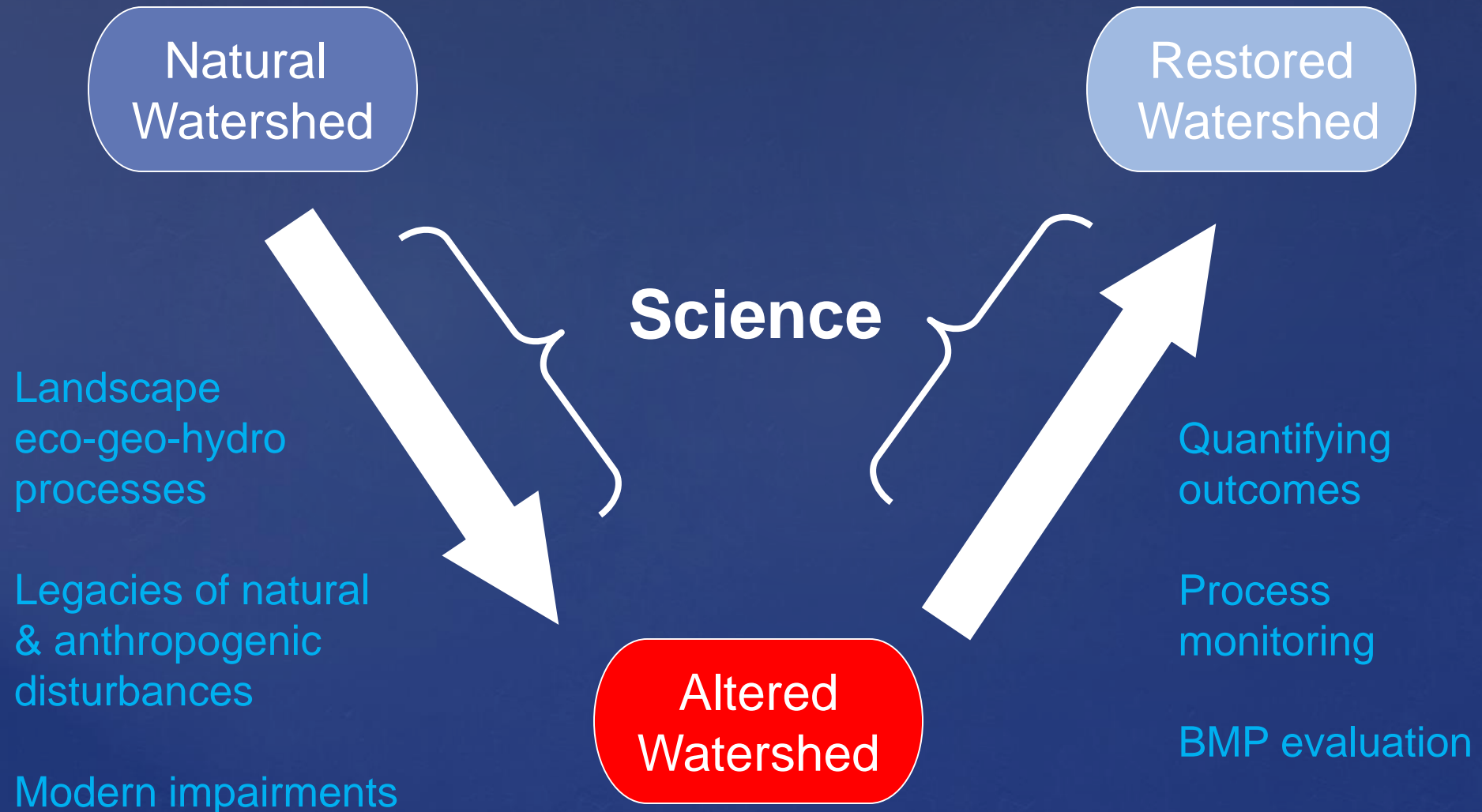
Floodplain and Channel
Geomorphology

Stream Ecology

Watershed Fluxes



Challenge: Identifying The Real Problems And Applying The Right Tools From The Restoration Toolbox

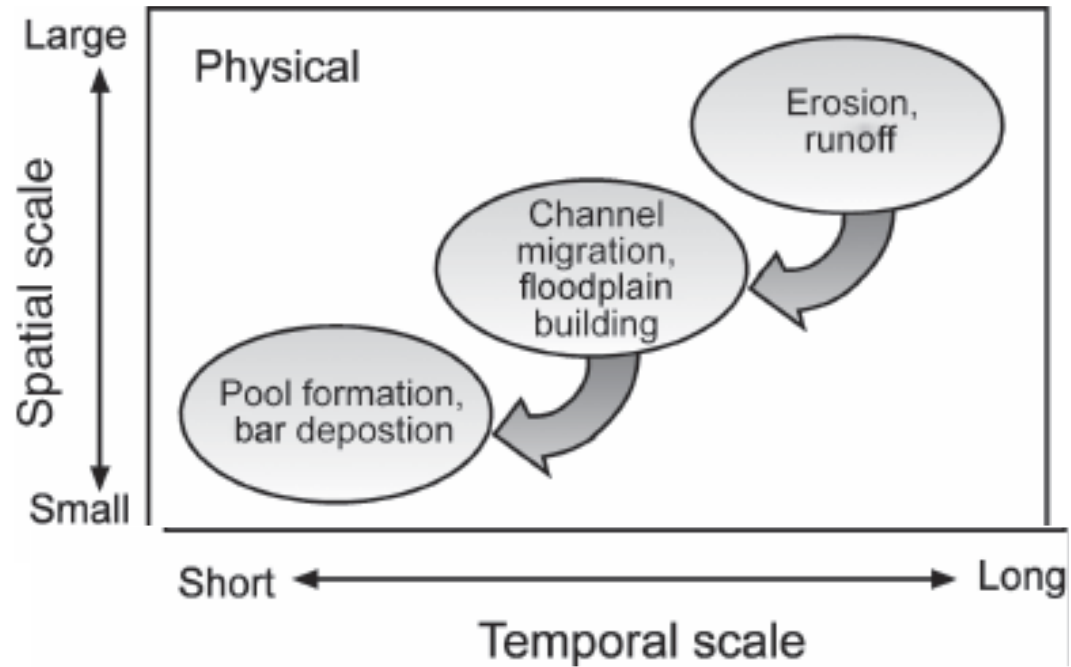


Important to evaluate landscape to local scales

Natural Watershed

Driving Disturbance Agents

Altered Watershed



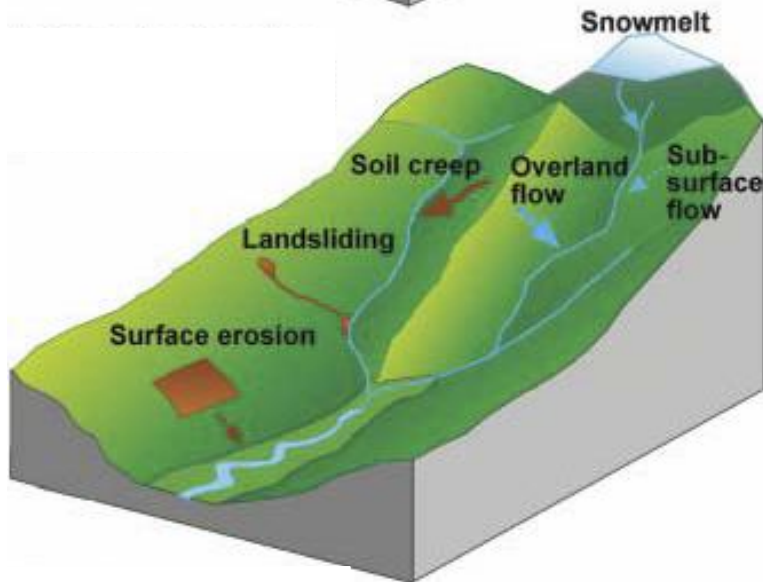
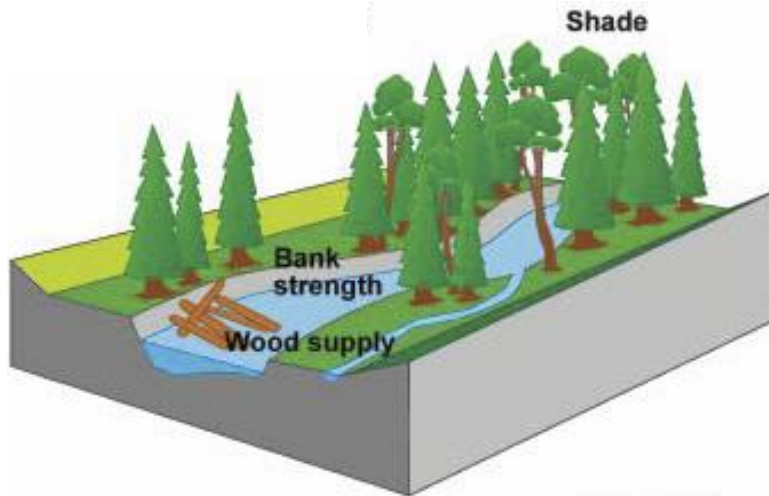
Beechie et al. 2010

Reach Scale

Damming
Channelization
Riparian Clearing
Grazing Access
Wood Removal

Landscape Scale

Deforestation
Agriculture
Urbanization/Roads



Beechie et al. 2010

Hurricane Sandy Coastal Resiliency Competitive Grant Program

The Hurricane Sandy Coastal Resiliency Competitive Grant Program supports projects that reduce communities' vulnerability to the growing risks from coastal storms, sea level rise, flooding,



PROGRAM INFORMATION
New Grantee Information



Restored
Watershed

Restoration
Solutions

Altered
Watershed

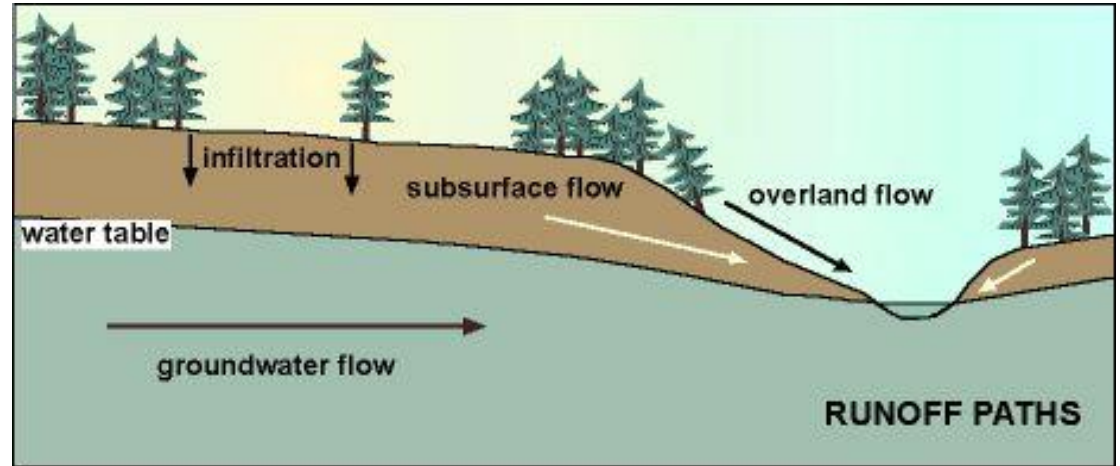
STROUD
WATER RESEARCH CENTER

Improving Human and Ecological Resiliency

- Decrease flooding
- Improve water quality

- Decrease summer stream temperatures
- Increase organic matter storage in stream channels
- Decrease suspended sediment concentrations
- Increase nutrient uptake and lower nitrogen and phosphorous concentrations
- Improve physical habitat via large woody debris additions

Hydrologic Watershed Restoration for Flood Control

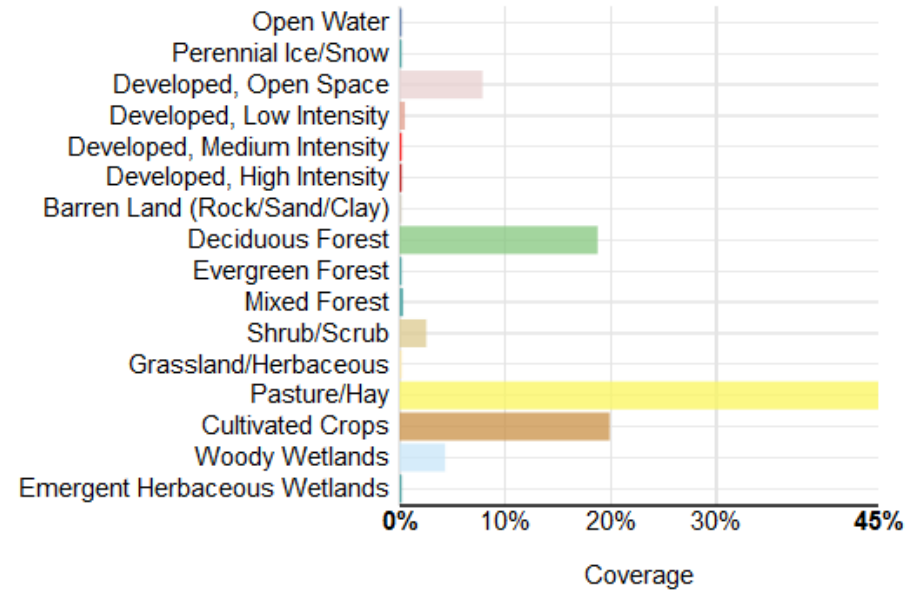


- *Increase infiltration*
- *Increase concentration time*
- *Increase baseflow (cools in summer, warms in winter)*

White Clay Creek Watershed Chester County, PA

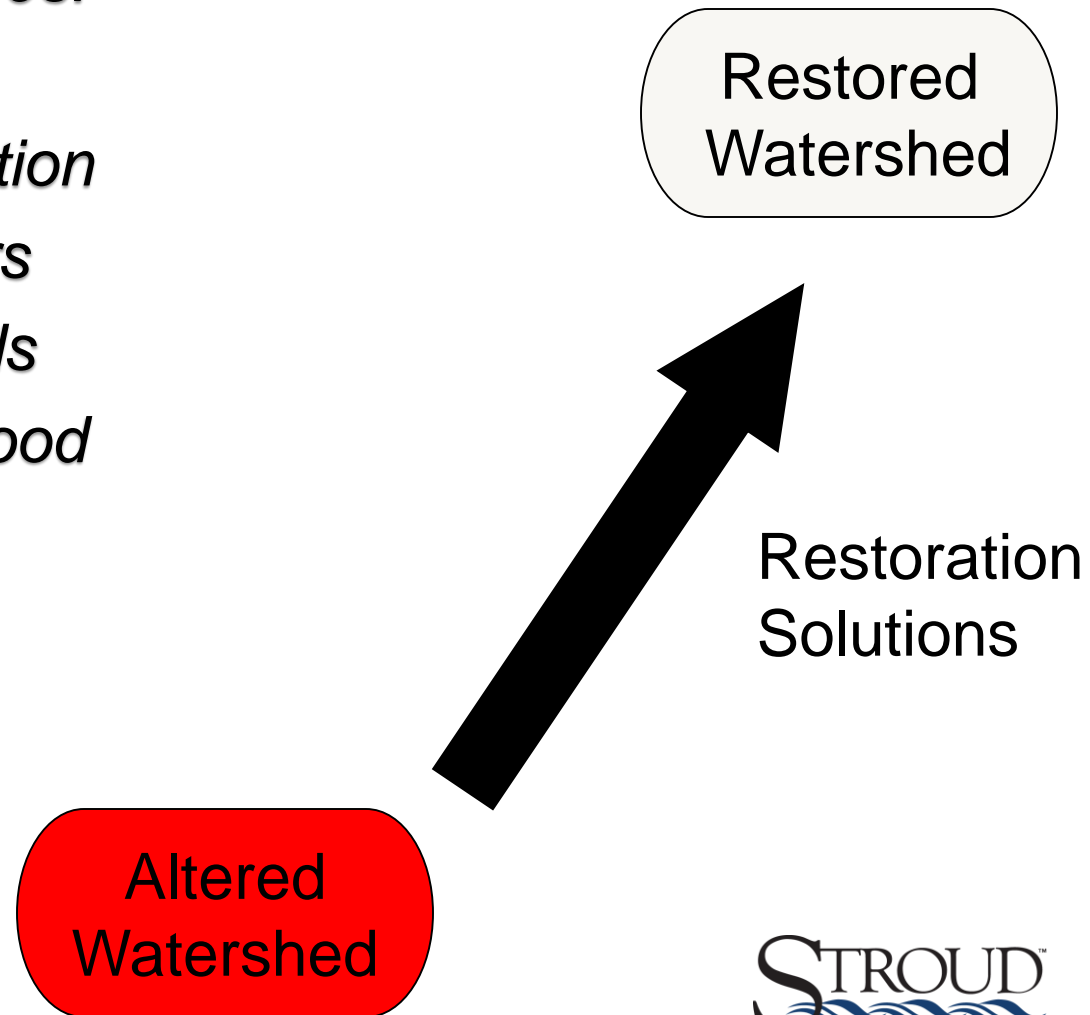
Total Area 8 km²

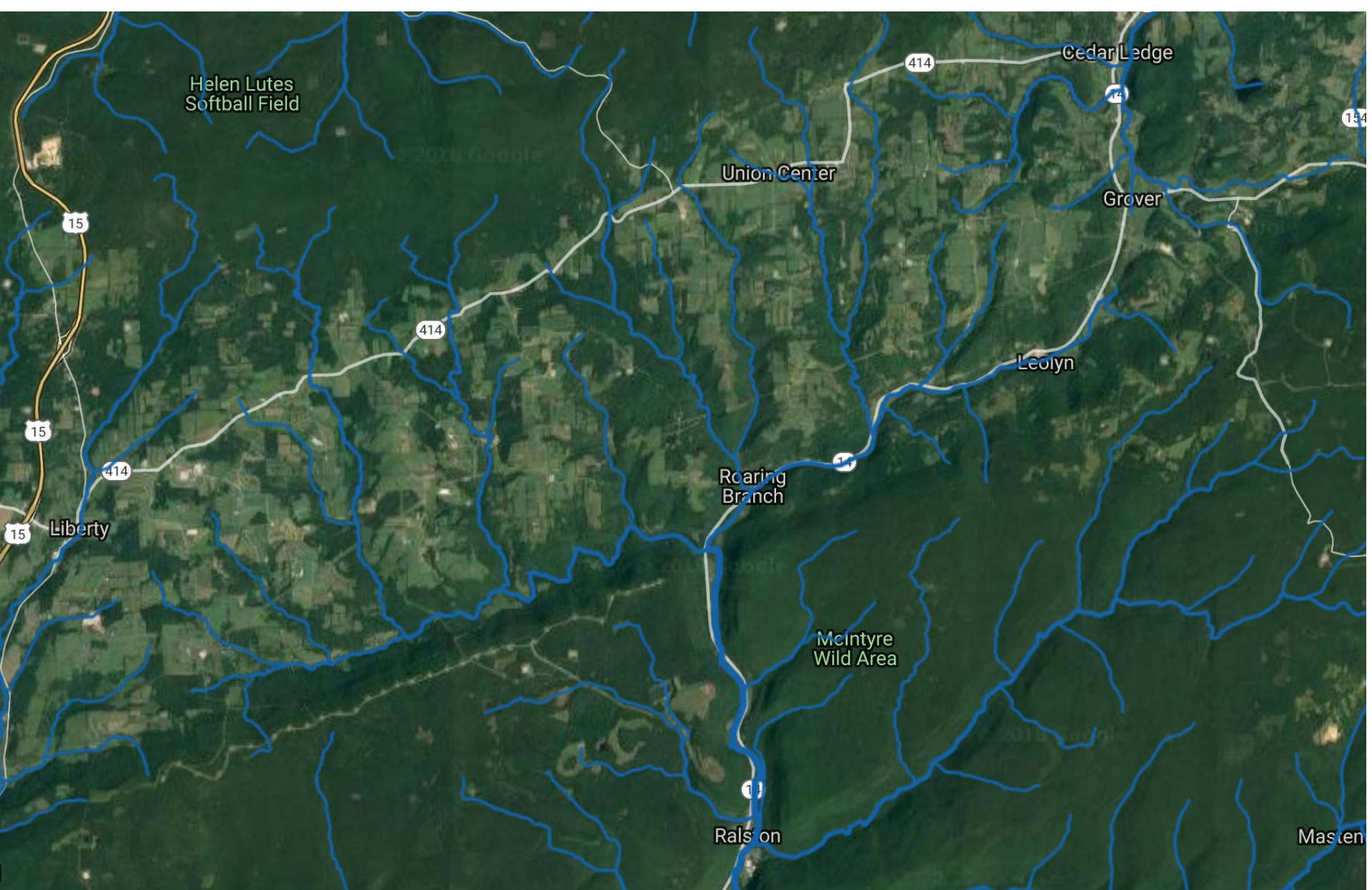
Land cover distribution from National Land Cover Database
(NLCD 2011)



Restoration Approaches:

- *Riparian Reforestation*
- *Level-Lip Spreaders*
- *Floodplain Wetlands*
- *In-channel large wood*
- *Agricultural BMPs*



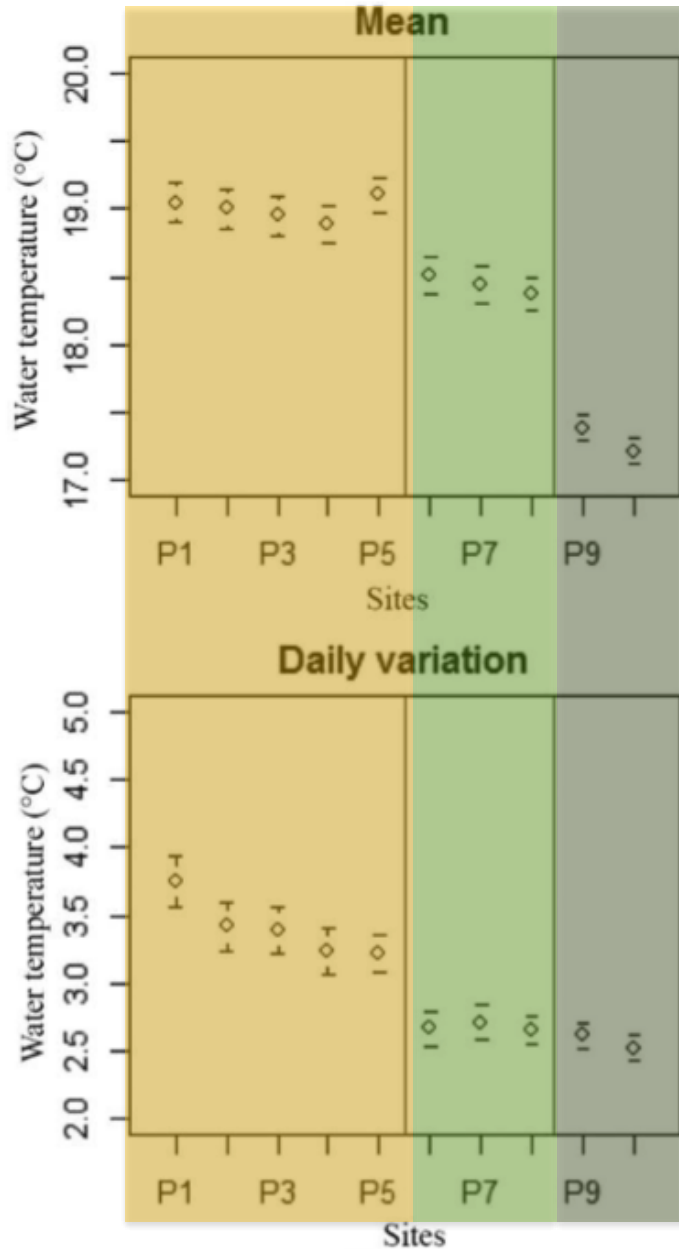
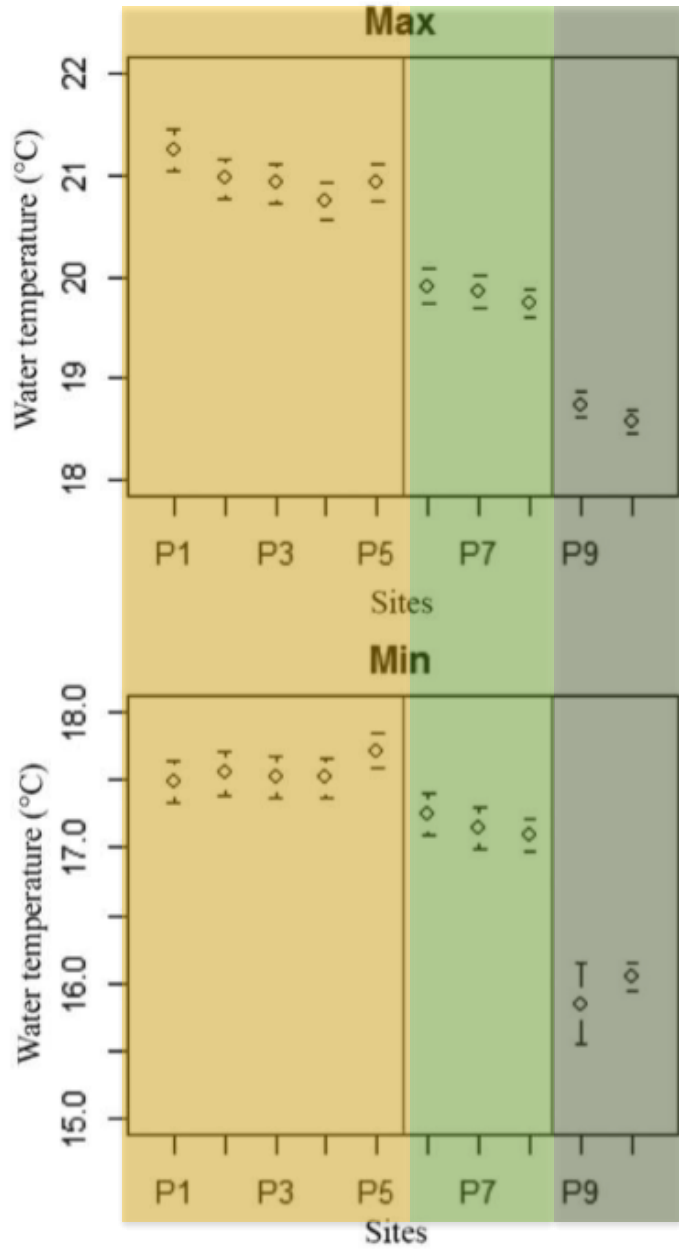


Planted Apr 2007
Photo Aug 2008



Spring 2014





“Level-lip spreader” located behind Stroud Water Research Center before construction



Level-lip spreader during construction



Level-lip spreader during construction



Level lip spreader after construction

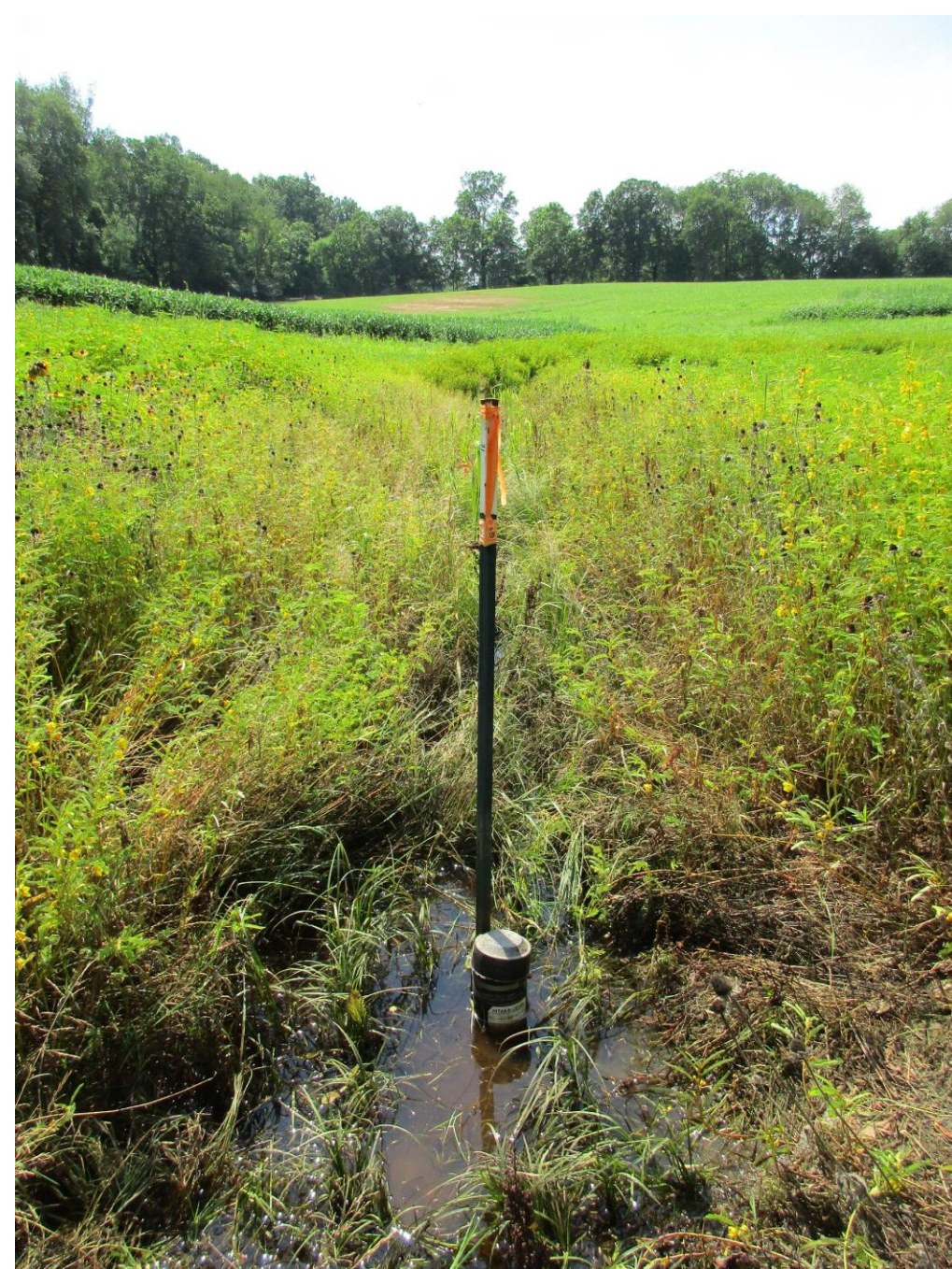


“Level-lip spreaders” are shallow conservation swales built along the contour of the slope that collect surface runoff during rainstorms. With most storms the water that is collected will infiltrate into the ground, sediments settle out, and the water flows as groundwater to the stream. In big storms the water will flow over the level-lip evenly into the streamside forest before reaching the stream. Level-lip spreaders help reduce flooding and prevent nutrients and sediments from reaching the stream. These swales are being designed by Chester County Conservation District in partnership with the Stroud Center.



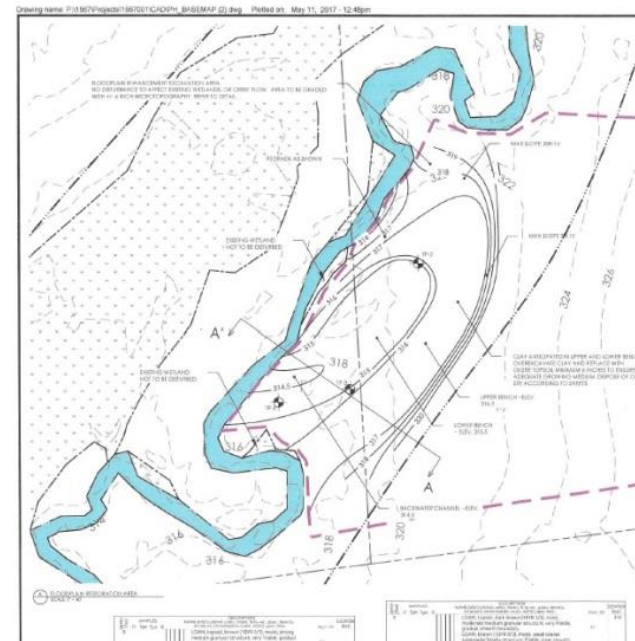






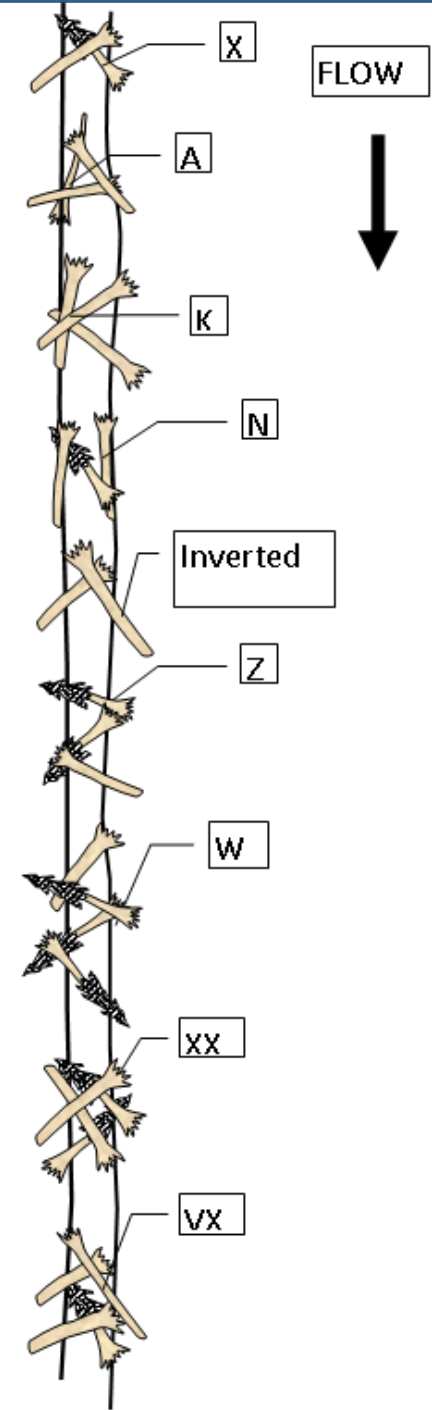
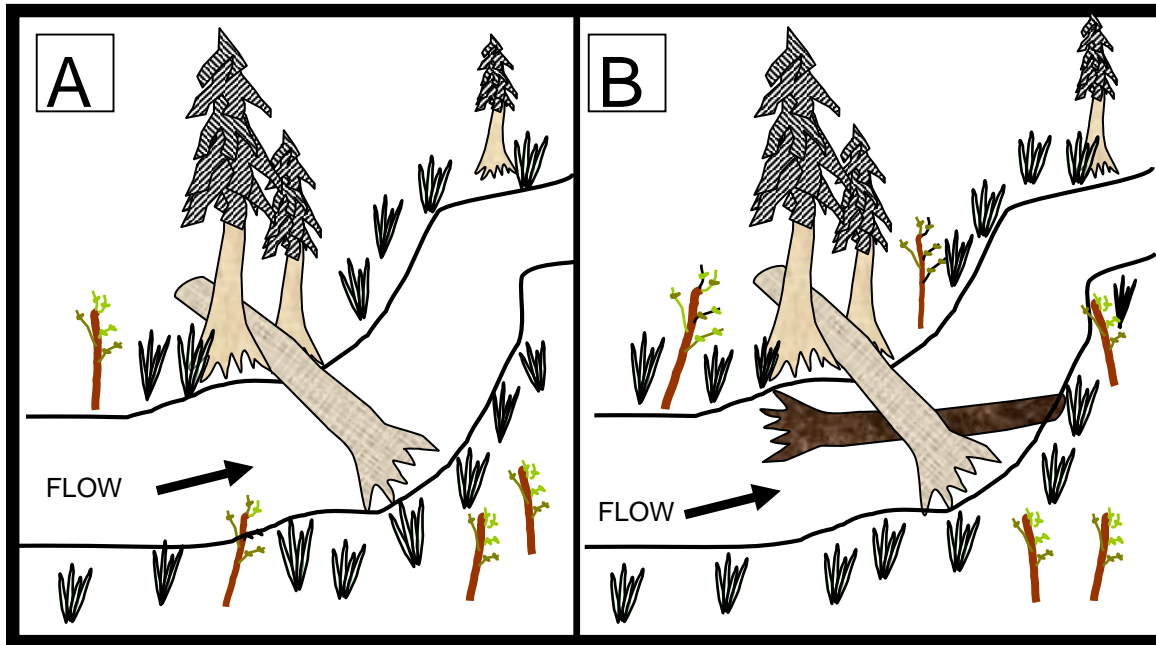


Level Lip Spreaders and Wetland storage > 10,000 m³
(~25% of a 2 inch, 24 hour storm event)

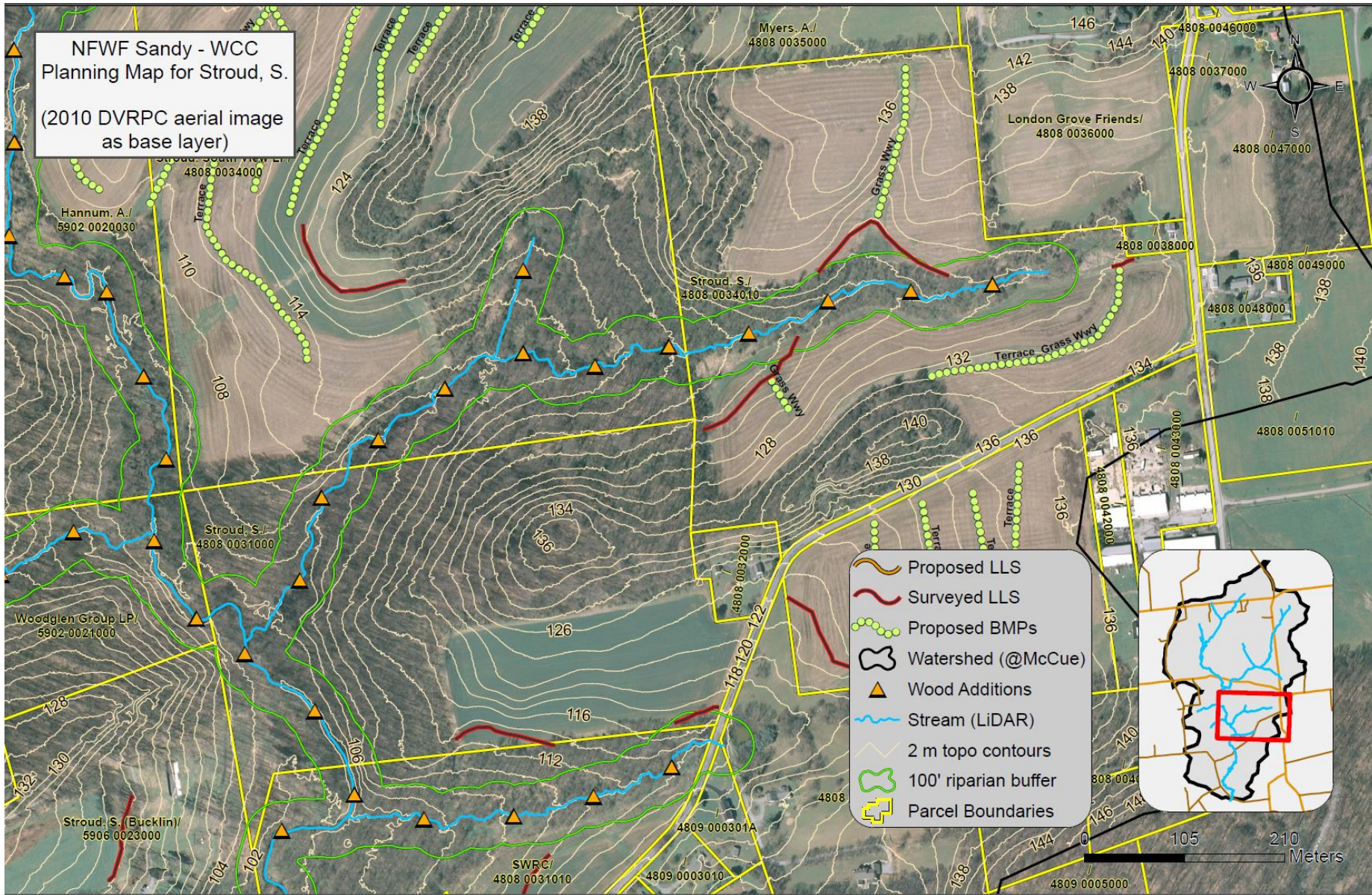











Princeton Hydro

Wood Additions



NFWF Sandy - WCC
 Planning Map for Stroud, S.
 (2010 DVRPC aerial image
 as base layer)



-  Proposed LLS
-  Surveyed LLS
-  Proposed BMPs
-  Watershed (@McCue)
-  Wood Additions
-  Stream (LiDAR)
-  2 m topo contours
-  100' riparian buffer
-  Parcel Boundaries







Forest Buffers combined with Level-Spreaders can remove 10-50% of nutrients and sediment in field runoff

Riparian
Forest Buffer

Ag Fields

50-90% of pollutants still
reaching the stream

Level-Spreader

Forest Buffer – critical for in-stream ecosystem services, intercepts some of field runoff of nutrients and sediment

Level-Spreader – intercepts and infiltrates field runoff, removing sediment and increasing nutrient filtration by forest buffer





SPEED
LIMIT
25

NO
TRUCKS



No cover crop

Cover crop



Acknowledgements:

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