Applying Principles for the Ecological Restoration of Aquatic Resources to Legacy Sediment Problems in Pennsylvania

Pennsylvania

Department of Environmental Protection

Pennsylvania Legacy Sediment Workgroup

Jeffrey Hartranft

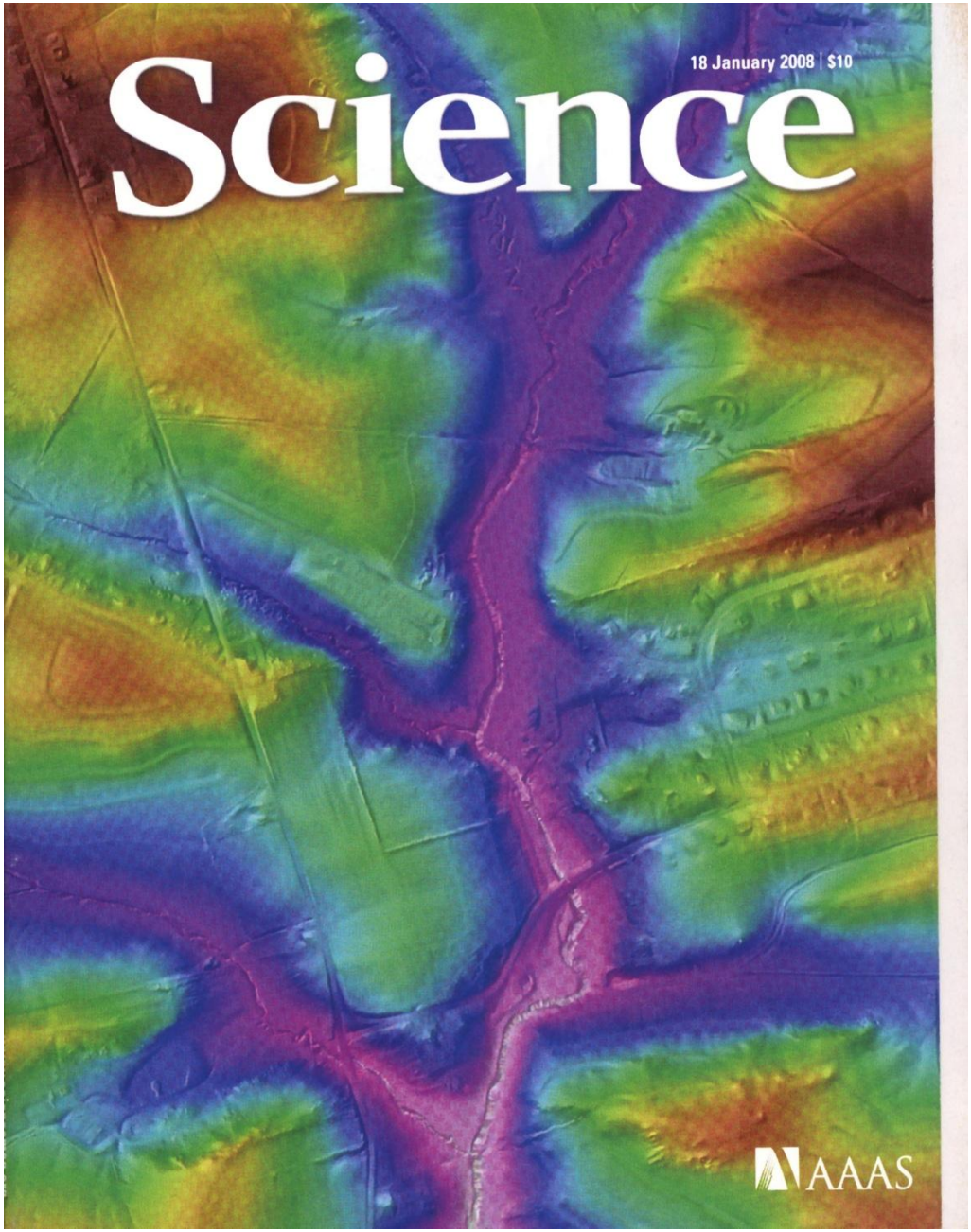
Bureau of Waterways Engineering and Wetlands

jhartranft@pa.gov

717-772-5320

Big Spring Run, Lancaster County – Legacy Sediment Type Section

Photo Courtesy Franklin & Marshall College



Natural Streams and the Legacy of Water-Powered Mills

January 18, 2008 pp. 299-304

Robert C. Walter and Dorothy J. Merritts

Franklin & Marshall College

Lancaster, PA


Mountain Creek - Cumberland County, PA

Photo Courtesy Franklin & Marshall College

White Clay Creek at Stroud Water Research Center in Avondale, PA

Photo Courtesy Franklin & Marshall College

Legacy Sediment Definition

Legacy Sediment (n.) Sediment that (1) was eroded from uplands during several centuries of land clearing, agriculture, and other intensive land uses; (2) accumulated behind ubiquitous dams in slackwater environments, resulting in thick accumulations of cohesive clay, silt and sand, which distinguishes "legacy sediment" from fluvial deposits associated with meandering streams; (3) collected along stream corridors and within valley bottoms, burying natural floodplains, streams, wetlands, and other aquatic resources; (4) altered and continues to impair the morphologic, hydrologic, biologic, riparian, and other ecological services and functions of natural aquatic resources; (5) can also accumulate as coarser grained, more poorly sorted colluvial (not associated with stream transport) deposits, usually at valley margins; (6) can contain varying amounts of nutrients which contribute to watershed loads from bank erosion processes. Widespread indicators of impaired watercourses and watersheds due to legacy sediment include a history of damming, high banks and degree of channel incision, rapid rates of bank erosion, high sediment loads, watercourses relocated from their natural position in a valley, low channel pattern development, infrequent flooding in the riparian zone, diminished sediment storage capabilities, riparian zones lacking groundwater at or near the surface, natural habitat degradation, and other diminished natural aquatic ecosystem functions and services.

Principles for the Ecological Restoration of Aquatic Resources (EPA841-F-00-003)

US Environmental Protection Agency, Washington, DC. 2000.

What is ecological "restoration" ?

The National Research Council – 1992:

Restoration of Aquatic Resources

"Return of an ecosystem to a close approximation of its condition prior to disturbance."

"The term restoration means the reestablishment of pre-disturbance aquatic functions and related physical, chemical and biological characteristics."

Federal Agency Definitions for Wetland Tracking

"the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded wetland."

http://www.epa.gov/owow/wetlands/restore/defs.html#Fed

Principles for the Ecological Restoration of Aquatic Resources (EPA841-F-00-003)

US Environmental Protection Agency
Washington, DC. 2000.

- The list of principles are based upon lessons learned from on-going and completed projects.
- The list of principles have been determined to be critical to the success of a wide range of aquatic resource restoration projects.
- The principles are intended for use by a wide variety of people and organizations ranging from Federal, State, Tribal and local agencies to outdoor recreation or conservation groups.

http://www.epa.gov/owow/wetlands/restore/

Ecological Restoration Guiding Principles

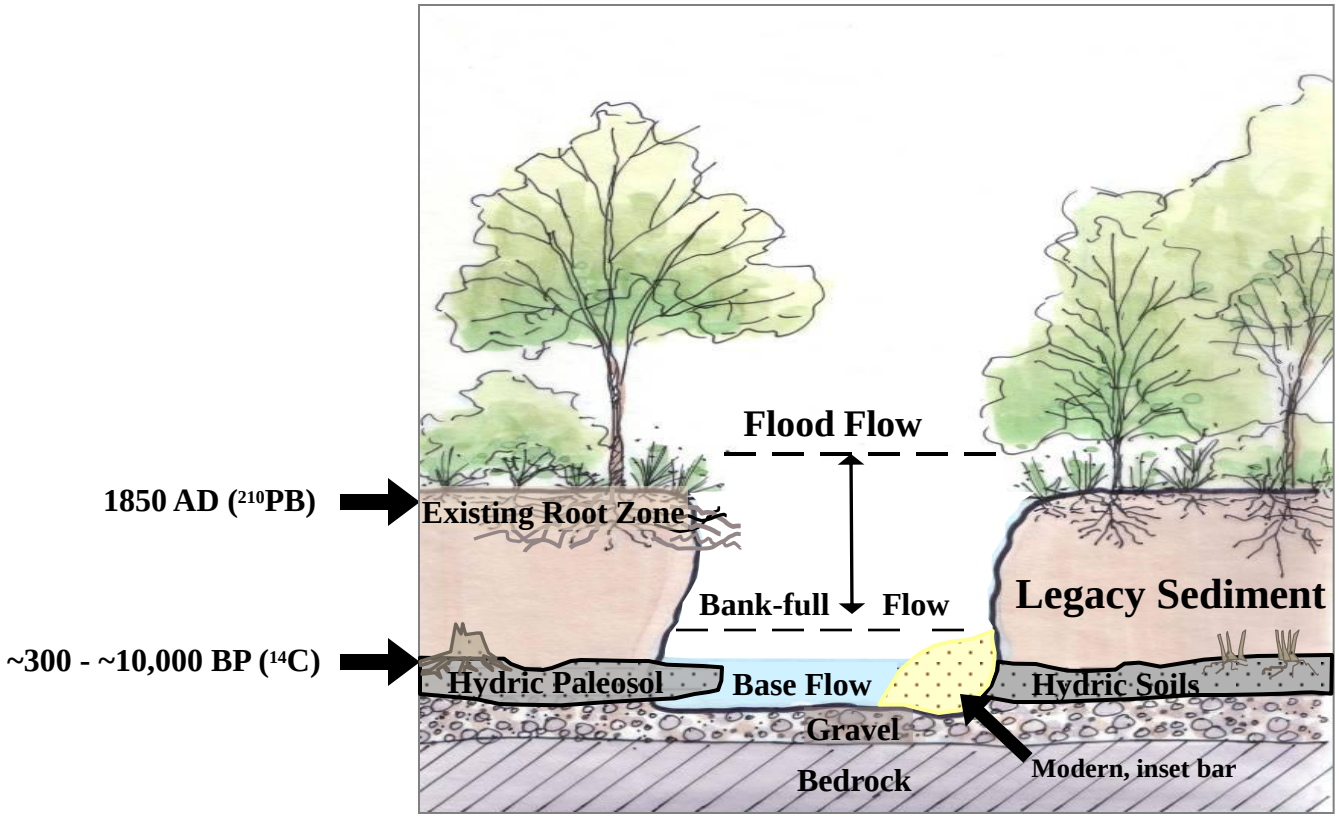
Address ongoing causes of degradation.

- Restoration efforts are likely to fail if the sources of degradation persist.
- It is essential to correctly identify the causes of degradation and eliminate or remediate them.
- Understanding a stream's evolutionary trajectory is relevant to correctly diagnosing the problem, as well as to developing restoration approaches that are likely to be sustainable.

"… understanding the legacy sediment problem is the first step in proposing a fix."

Bay Journal, March, 2007. Alliance for the Chesapeake Bay.

Typical Existing Condition



- **Legacy sediment stored in valley bottoms predominantly was established by the combined effect of increased sediment supply from uplands and sediment trapping behind ubiquitous dams in many watersheds of the mid-Atlantic Region. (Walter and Merritts, 2008)**
- **Conceptual models linking channel condition and sediment yield exclusively with modern upland landuses are incomplete for valleys impacted by mill dams (Merritts, et al. 2011)**
- **Streambanks represent a significant sediment and nutrient source in watersheds where channels have incised through legacy sediment. (Walter, Merritts, et al., 2007; 2010)**

Ecological Restoration Guiding Principles

Work within the watershed and broader landscape context

- Legacy sediment is a catchment scale impairment in many PA watersheds
- Recognizing this catchment scale impairment is the first step in targeting restoration efforts
- Site selection may target specific locations within valley corridors where dams existed
- Addressing legacy sediment may help mitigate problems generated from other catchment scale impairments, (ie. stormwater, agricultural runoff)

Ecological Restoration Guiding Principles

Restore Natural Structure

Physical Characteristics

- **Natural valley morphology**
- Channel alterations – relocation, incision, etc.
- Essential to the success of other aspects like hydrology, soils, bio-geochemical processes, plant communities, and other natural functions and services

Restore Natural Function.

Natural function and natural structure of aquatic resources are closely linked.

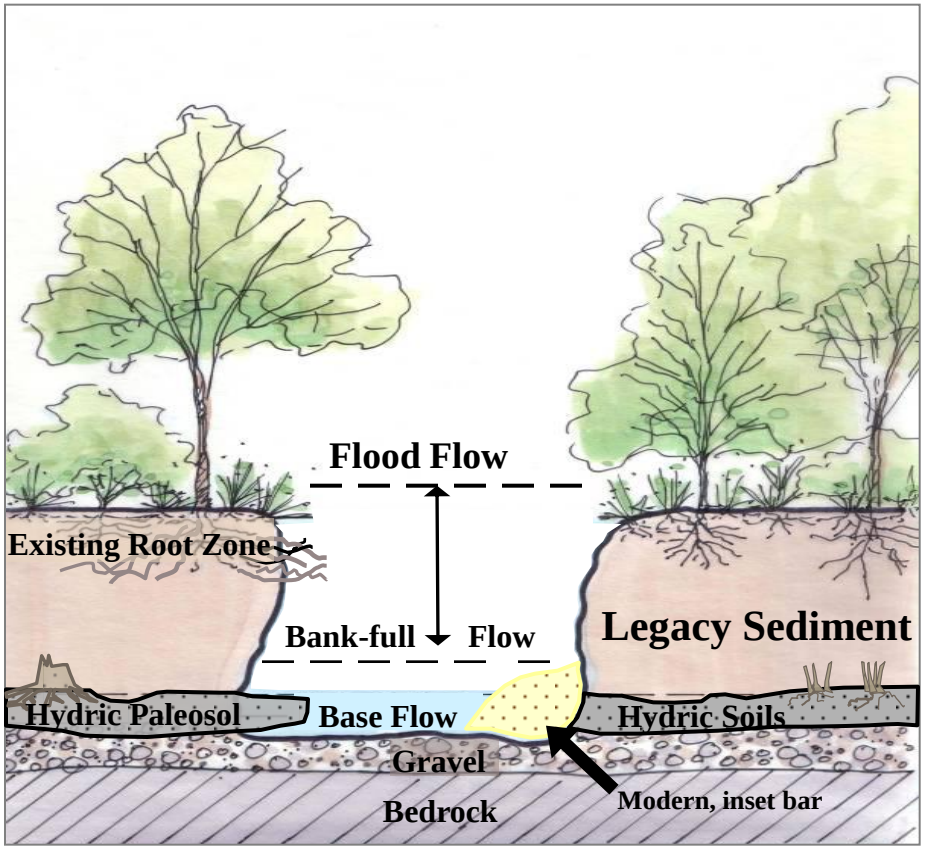
- For instance, re-establishing natural foodplain elevations to restore the natural structure that drives beneficial functions and services.

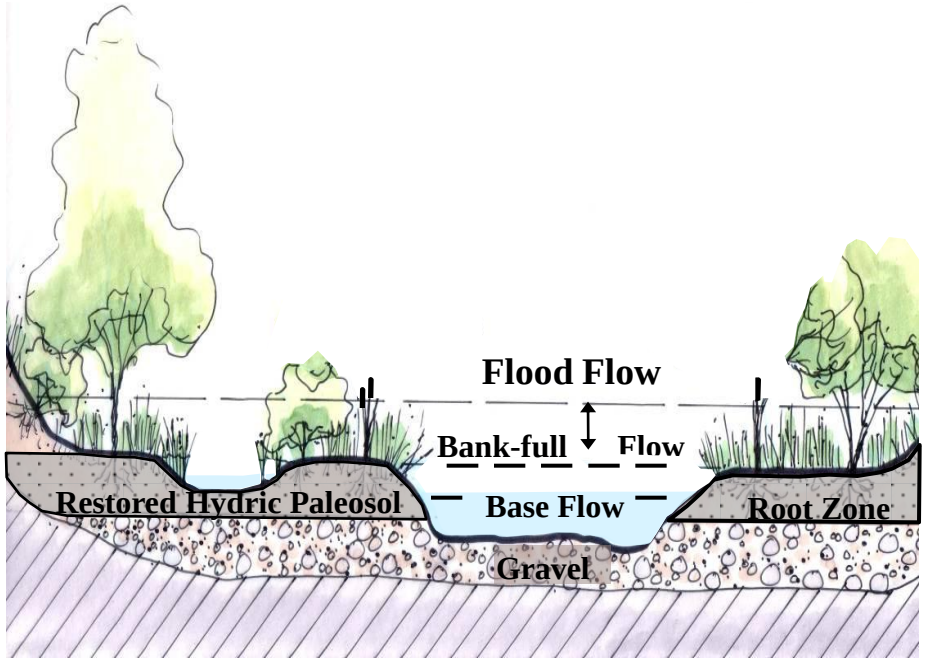
Legacy Sediment Removal

Natural Floodplain, Stream and Riparian Wetland Restoration Best Management Practice – AKA Legacy Sediment Removal

Conceptual Design

Typical Existing Conditions ⇨ Proposed Restoration





⇨ Natural Valley Morphology

Legacy Sediment Removal

Natural Floodplain, Stream and Riparian Wetland Restoration Best Management Practice

Typical Existing Conditions ⇨ **Restoration**

9/13/2011

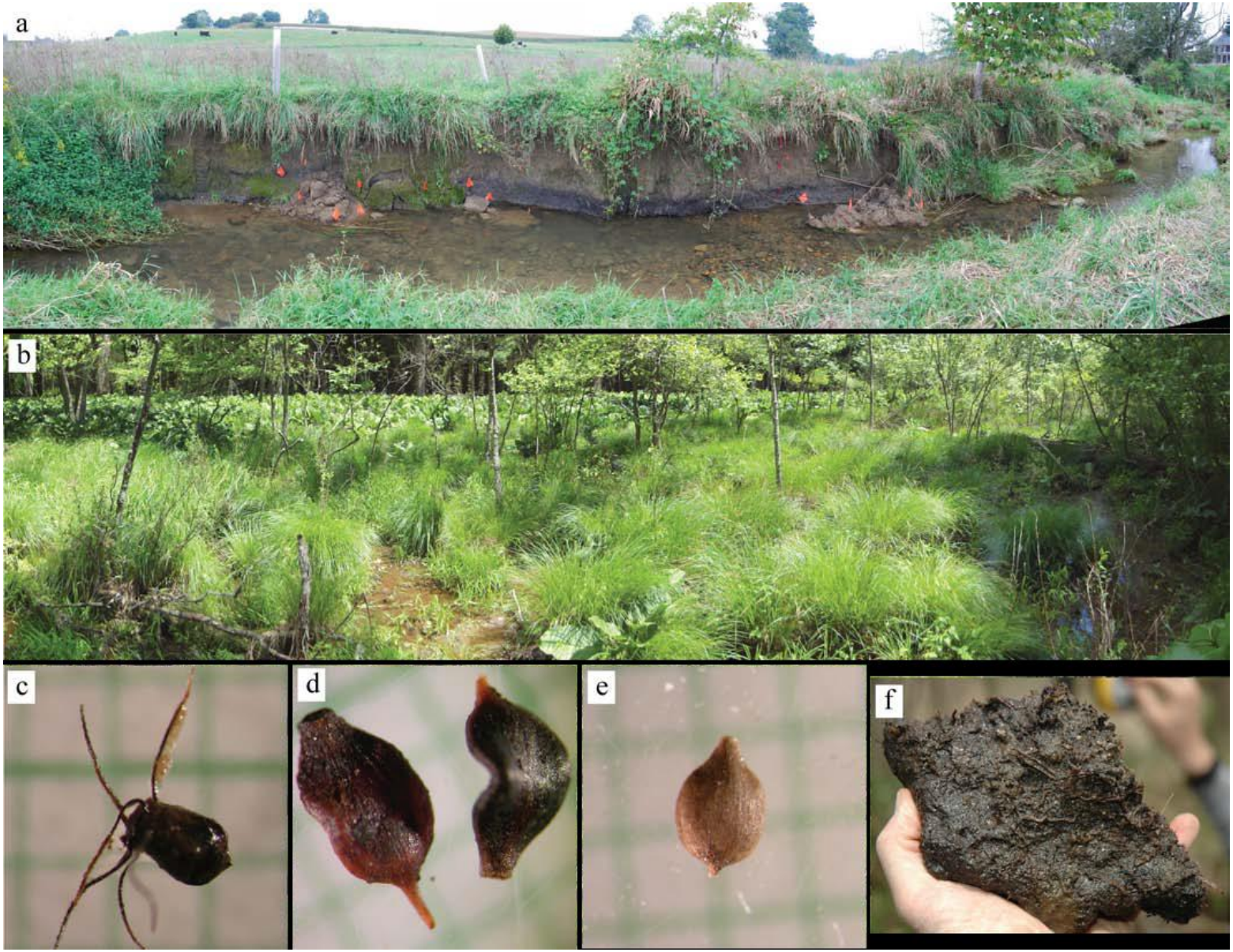
08/17/2012

⇨ **Natural Valley Morphology**

Ecological Restoration Guiding Principles

Utilize a reference condition

- **Identifying natural reference conditions are essential to ensure project success**
- Channels incised through legacy sediment, with low entrenchment ratios, disconnected floodplains/terraces, etc. are not natural analogs in the non-glaciated mid-Atlantic Region (Merritts, et al. 2011; Voli, et. al 2009)
- **Use historic information on altered sites**



from Merritts, et. al. 2012

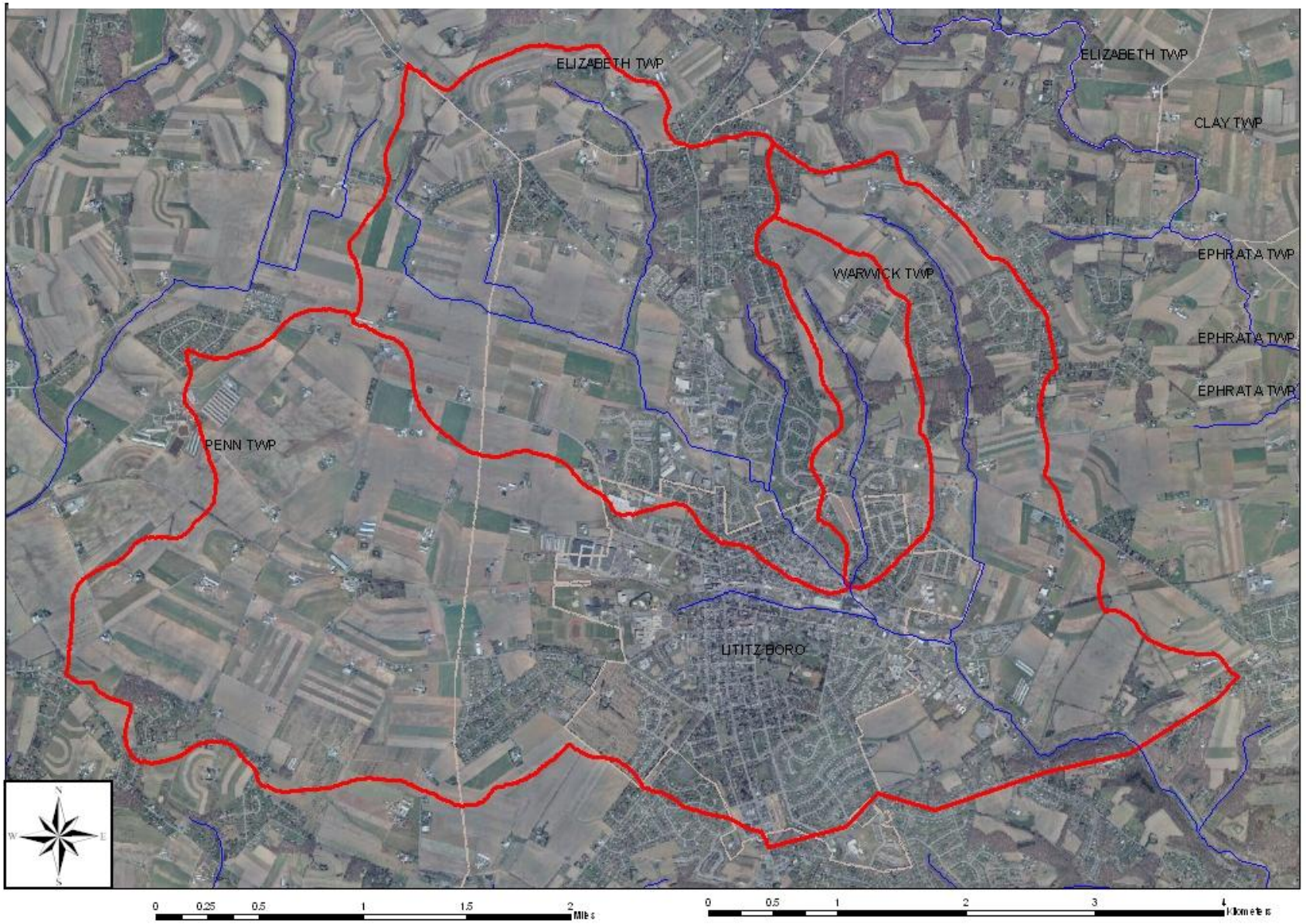
Ecological Restoration Guiding Principles

Recognize the ***natural potential***

- Guides the restoration goals
- Dependant upon climate, geology, hydrology, anthropogenic influences (stormwater, sediment supply, etc.) and biological characteristics
- May be constrained by the extent and magnitude of watershed changes and restoration planning should take this into account

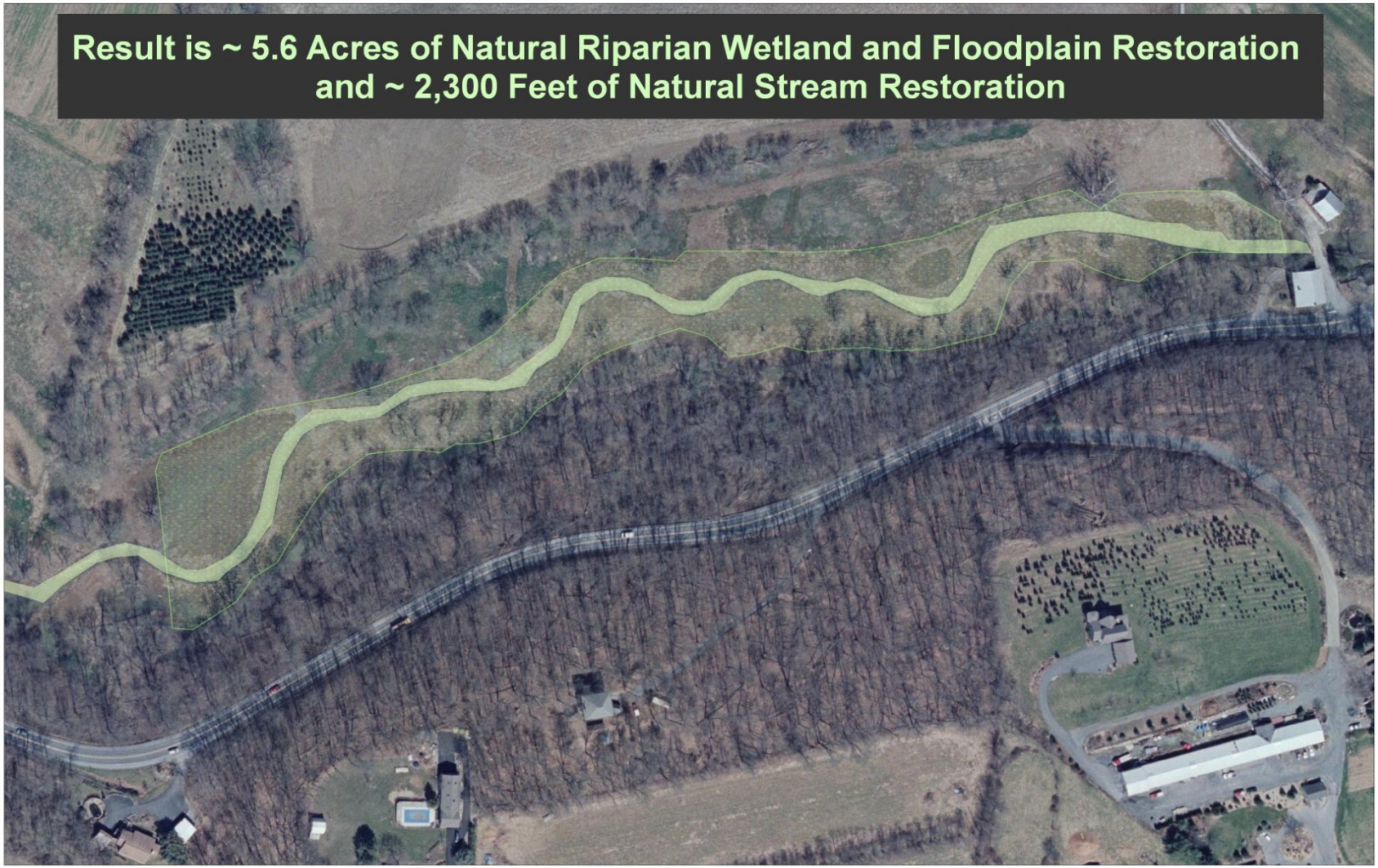
Lititz Run Natural Floodplain, Stream, and Riparian Wetland Restoration Project
"Banta Restoration Project" construction 2004 – Lancaster County, PA

Watershed Area ~ 33.5 square km (13 square miles)



Lititz Run Natural Floodplain, Stream and Riparian Wetland Restoration Project
"Banta Restoration Project" - Lancaster County, PA

Lititz Run Natural Floodplain, Stream and Riparian Wetland Restoration Project "Banta Restoration Project" - Lancaster County, PA

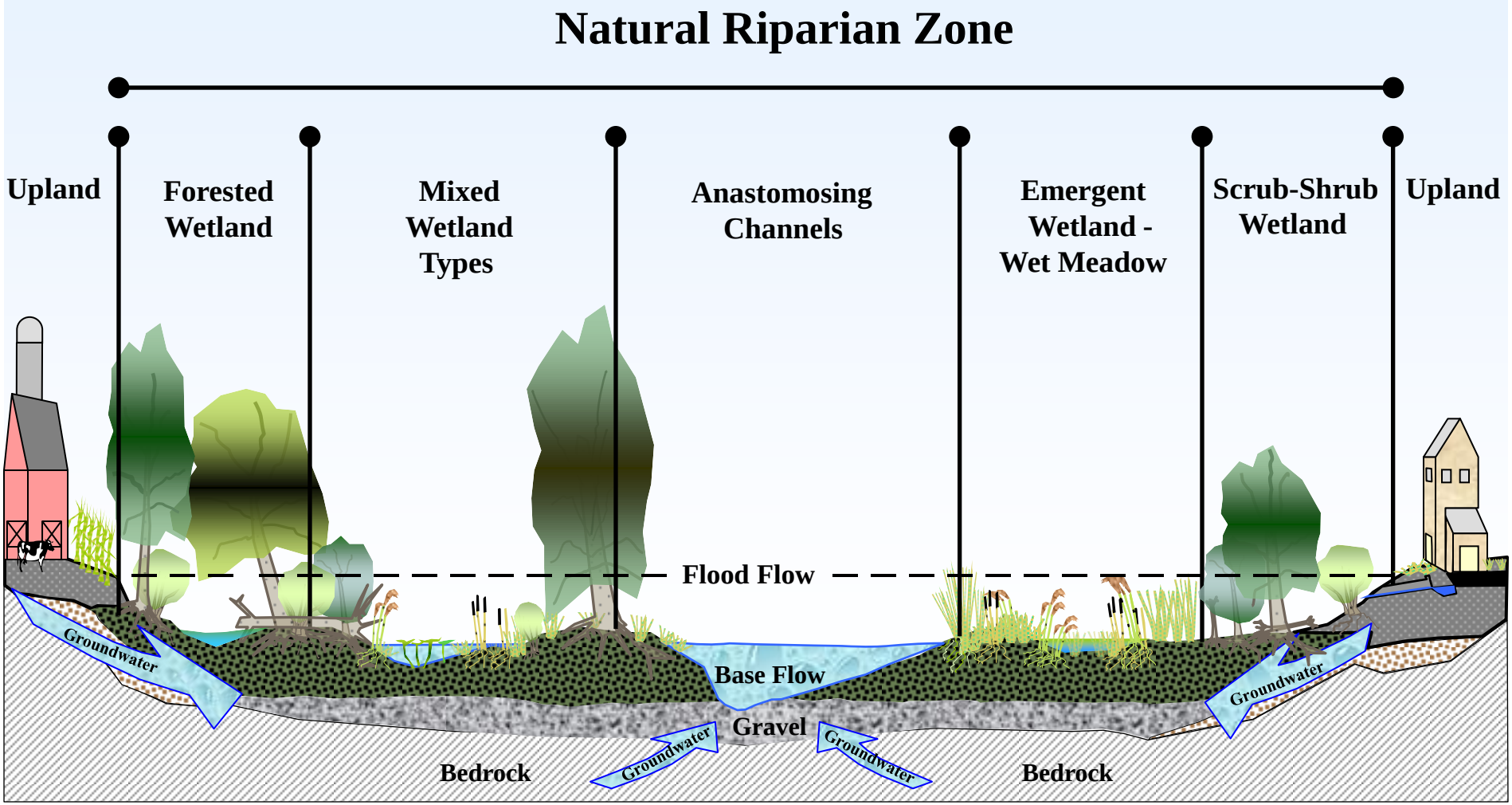


2007 Banta Restoration Site, Lititz Run – Lancaster Co.

Photo Courtesy Franklin & Marshall College

2011 Banta Restoration Site, Lititz Run – Lancaster Co.

Natural Floodplain, Stream and Riparian Wetland Restoration Best Management Practice Goal



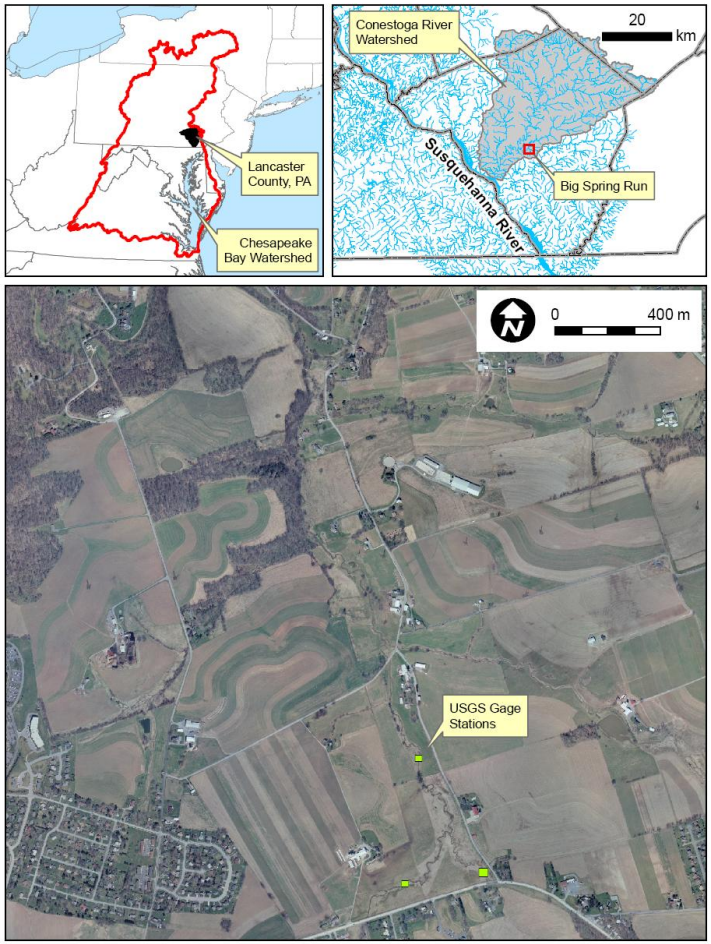
Natural Potential of Aquatic Resources

Ecological Restoration Guiding Principles

Involve the skills and insights of a multi-disciplinary team.

- Restoration can be a complex undertaking that integrates a wide range of disciplines
- Universities, government agencies, and private organizations may be able to provide useful information and expertise
- Complex projects require effective leadership to bring viewpoints, disciplines and styles together as a functional team

Big Spring Run Natural Floodplain, Stream and Riparian Wetland Restoration Project



We have assembled a multidisciplinary team of biologists, ecologists, engineers, geomorphologists, geochemists, landowners, restoration practitioners, and construction experts (Hartranft et al, 2011).

October 2011

October 2011

Monitor and adapt where changes are necessary

- Monitoring **before, during, and after** the project is crucial for evaluating whether goals are achieved
- Post implementation monitoring can provide useful information for future restoration efforts
- Data gathered may be useful for model development and predicting results when scaling up in size

USGS
science for a changing world

In cooperation with the
Pennsylvania Department of Environmental Protection

Effects of Streambank Fencing of Pasture Land on Benthic Macroinvertebrates and the Quality of Surface Water and Shallow Ground Water in the Big Spring Run Basin of Mill Creek Watershed, Lancaster County, Pennsylvania, 1993-2001

Scientific Investigations Report 2006-5141

By Daniel G. Galeone, Robin A. Brightbill, Dennis J. Low, and David L. O'Brien

Ground Water monitoring – monthly samples for water-level, temp, pH, DO, specific conductance, dissolved - ammonia plus organic nitrogen, ammonia, nitrite, nitrate, phosphorous, orthophosphate

Surface Water monitoring – collected during low flow and storm flow conditions – discharge by stage, temp, pH, DO, specific conductance, dissolved- ammonia, nitrite, amonia plus organic nitrogen, nitrite plus nitrate, phosphorous, orthophosphate, total – nitrogen phosphorous and suspended sediment

Biological monitoring – benthic macroinvertebrates, habitat(USEPA-RBPIII), chlorophyll a

Big Spring Run, Lancaster County PA

Post-Restoration 2012

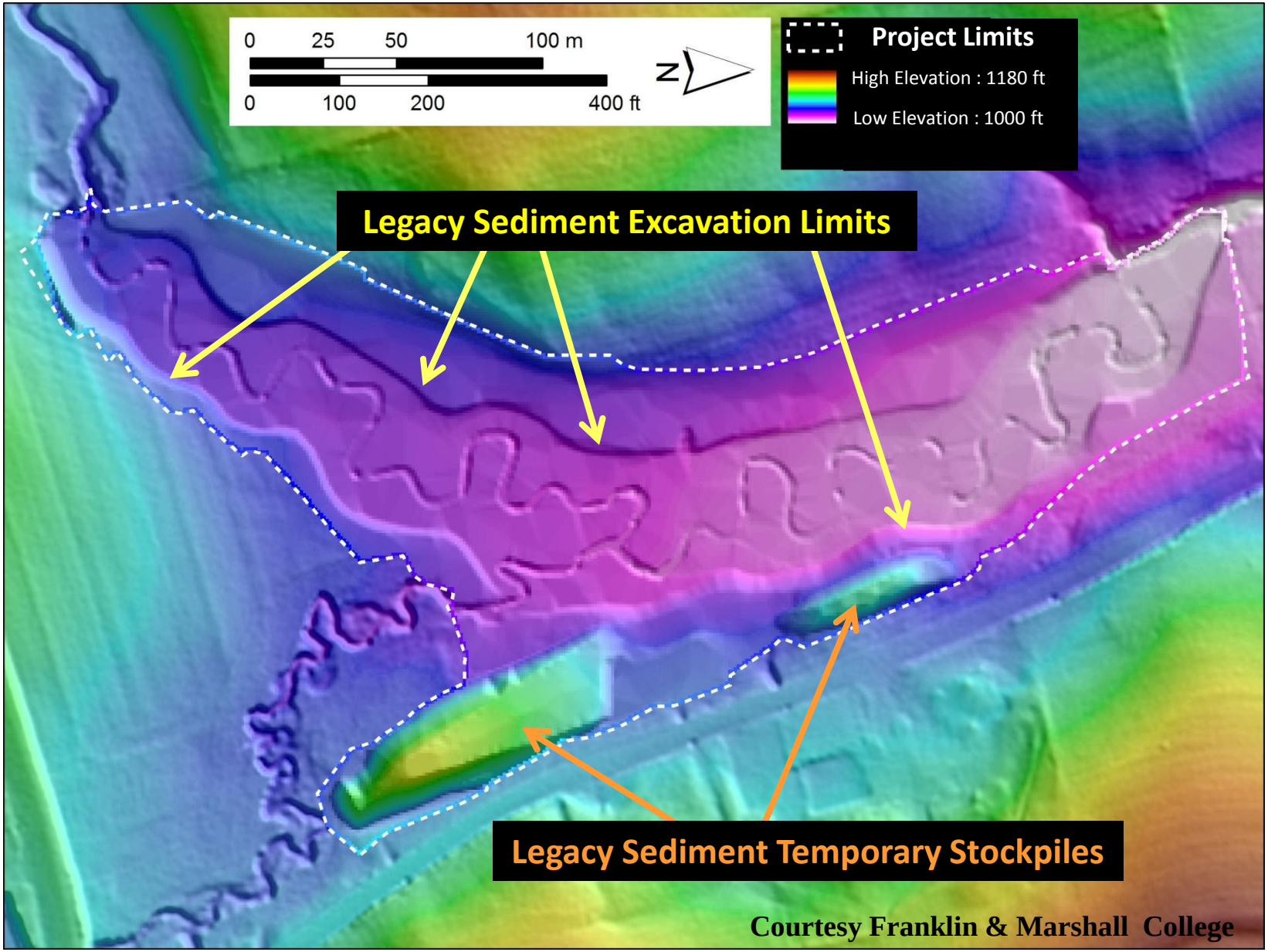
Big Spring Run, Lancaster County PA

Post-Restoration 2012

Regulatory Interpretations Related to Ecological Restoration and Legacy Sediment

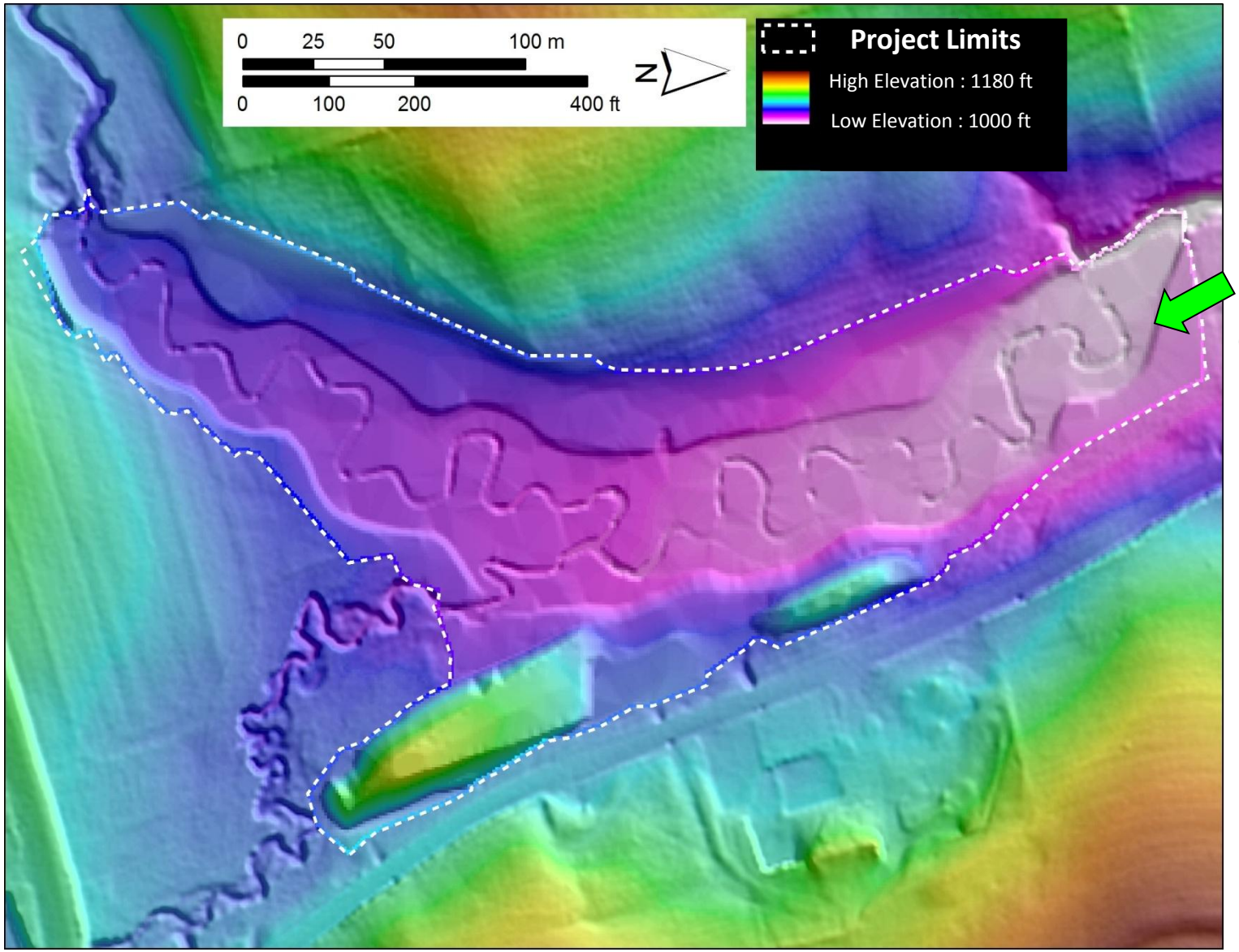
- PADEP regulatory interpretation documents provide program clarification of 25 PA Code § 105.12(a)(16) Restoration activities that address legacy sediment and restore natural floodplains, streams, riparian wetlands and other aquatic resources(May 1, 2012). This "restoration waiver" was used to authorize the Big Spring Run project.
- Section 401 – Chapter 105.15 Environmental Assessment was used to authorize the Big Spring Run project.
- Section 404 – Nationwide Permit Number 27 (NWP-27) – Aquatic Habitat Restoration, Establishment and Enhancement was used to authorize the Big Spring Run project (2011).
- February 21, 2012 NWP 27 Decision Document and Reissuance cites Walter and Merritts (2008) publication in Science.

November 2011 Post-Excavation – Hillshade Elevation Drawing



August 2012 – *Cyperus bipartitus, Polygonum spp., etc.*

Big Spring Run, Lancaster County PA



Courtesy Franklin & Marshall College

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 3:30 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 4:00 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 4:30 PM

Post-Restoration

Big Spring Run, Lancaster County PA

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September 18, 2012 @ 4:35 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 4:45 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 5:00 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 7:15 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 18, 2012 @ 8:30 PM

Post-Restoration

Big Spring Run, Lancaster County PA

Courtesy Telemonitor, Inc.

September 20, 2012 @ 10:00 AM

Post-Restoration