Hydrologic and Hydraulic Processes and Connectivity In Altered Mid-Atlantic Riverine Systems

Presented to:

Mid-Atlantic Stream Restoration Conference @ Rocky Gap

by
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November 2011

Natural Piedmont Stream Valley

Floodplain elevation has no link to coarse grain bed load transport or design storm. Based on the thickness of post-settlement alluvium and present degree of incision into the recent or older deposits.

Connectivity between Rooting Zone, Groundwater, and Stream Flow

Roots extend to groundwater

Floodplain Soils – Shallow, Peaty, Organic

Cobble/Gravel Bed (Groundwater)

Bedrock

Hydrologic Functions: Maximizing Sediment, Nutrient, and Carbon Retention in Natural Systems

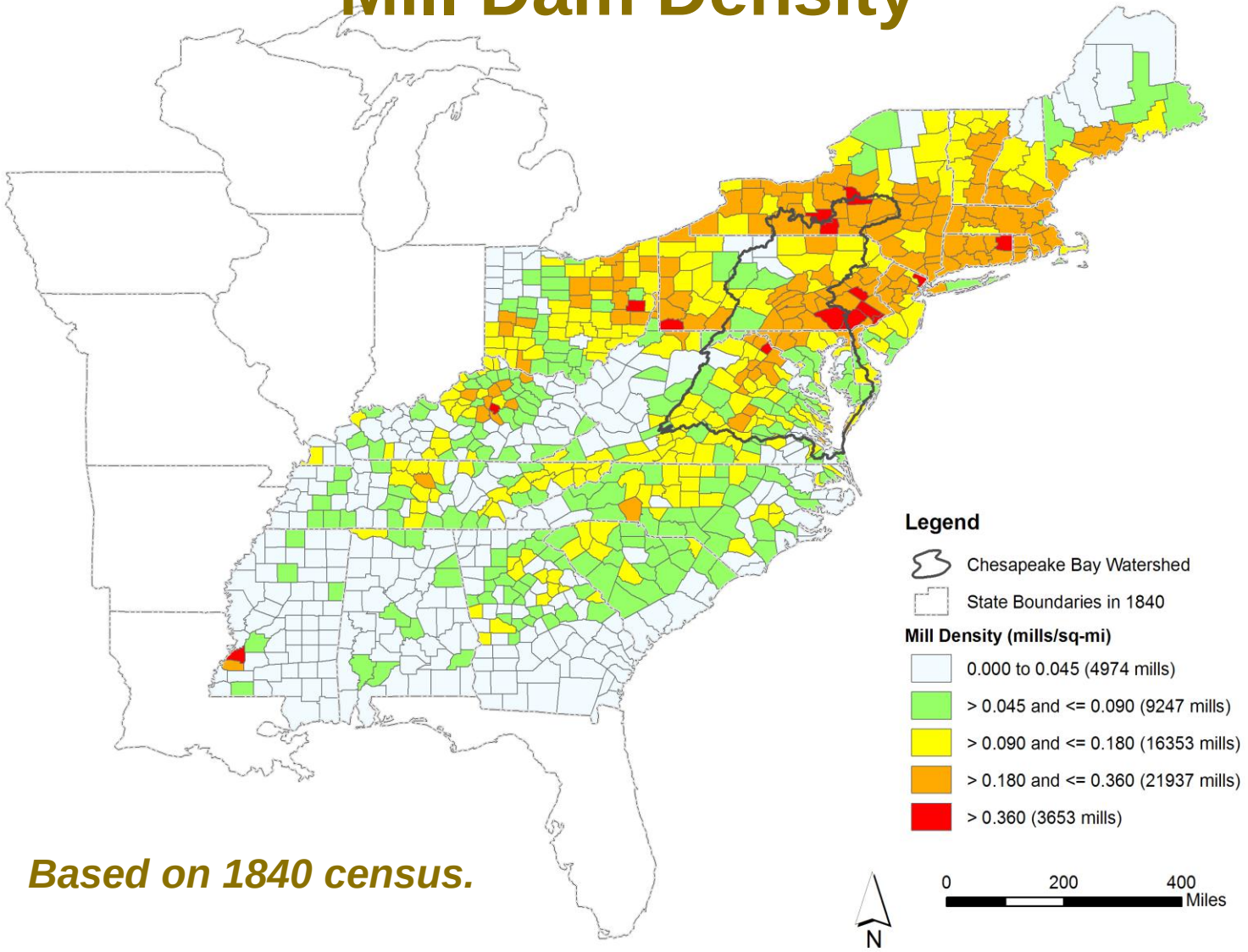
Beaver Dam Controlled Stream

Marshland

Hydrologic Functions of Natural Streams

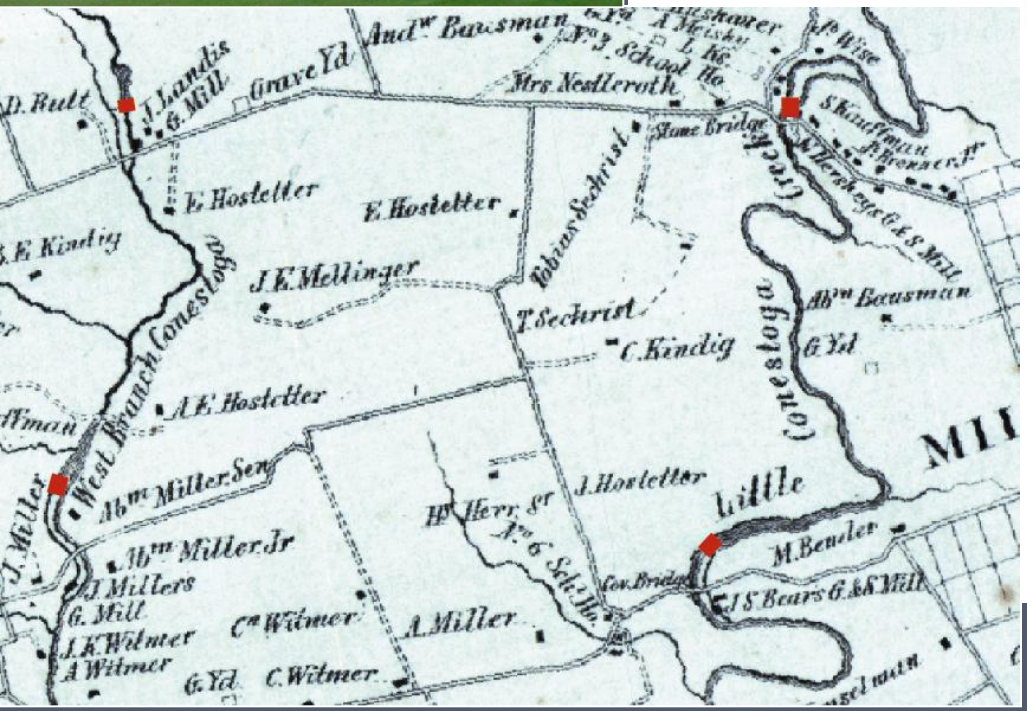
- Minimizes Bank Erosion from Flows and Freeze Thaw (first spring flush of sediment)
- Minimizes Downstream Transport of Sediment and Nutrients – Extremely Frequent Floodplain Access (first flush floodplain access)
- Minimizes Bed Degradation - Maintains Riffle Material and Spawning Gravels
- Increases Denitrification and Plant Uptake
- Increases Biomass Exchange
- Minimizes or Regulates Thermal Changes
- Increases Carbon, Nutrient and Sediment Retention

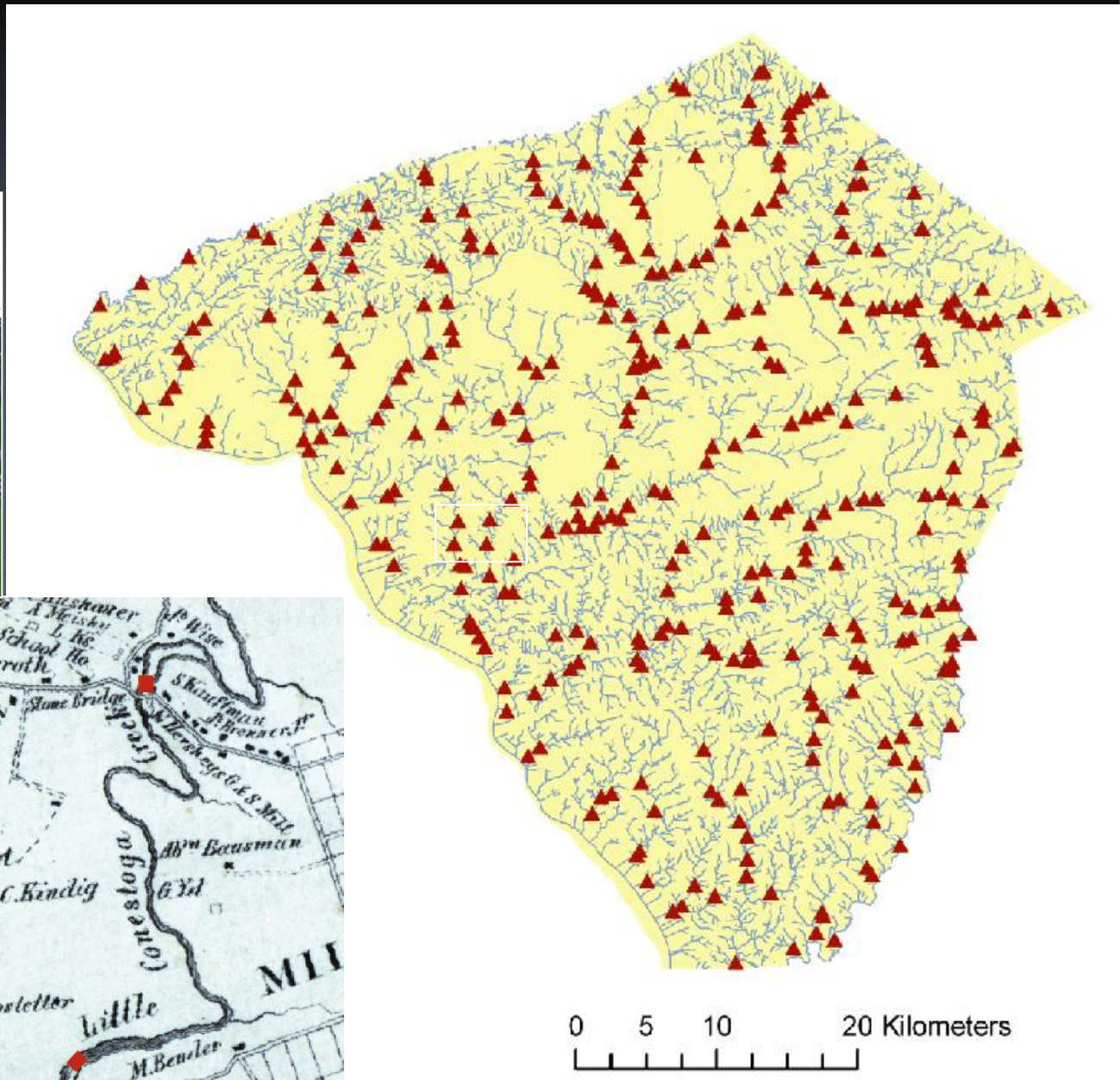
Mill Dam Density



Based on 1840 census.

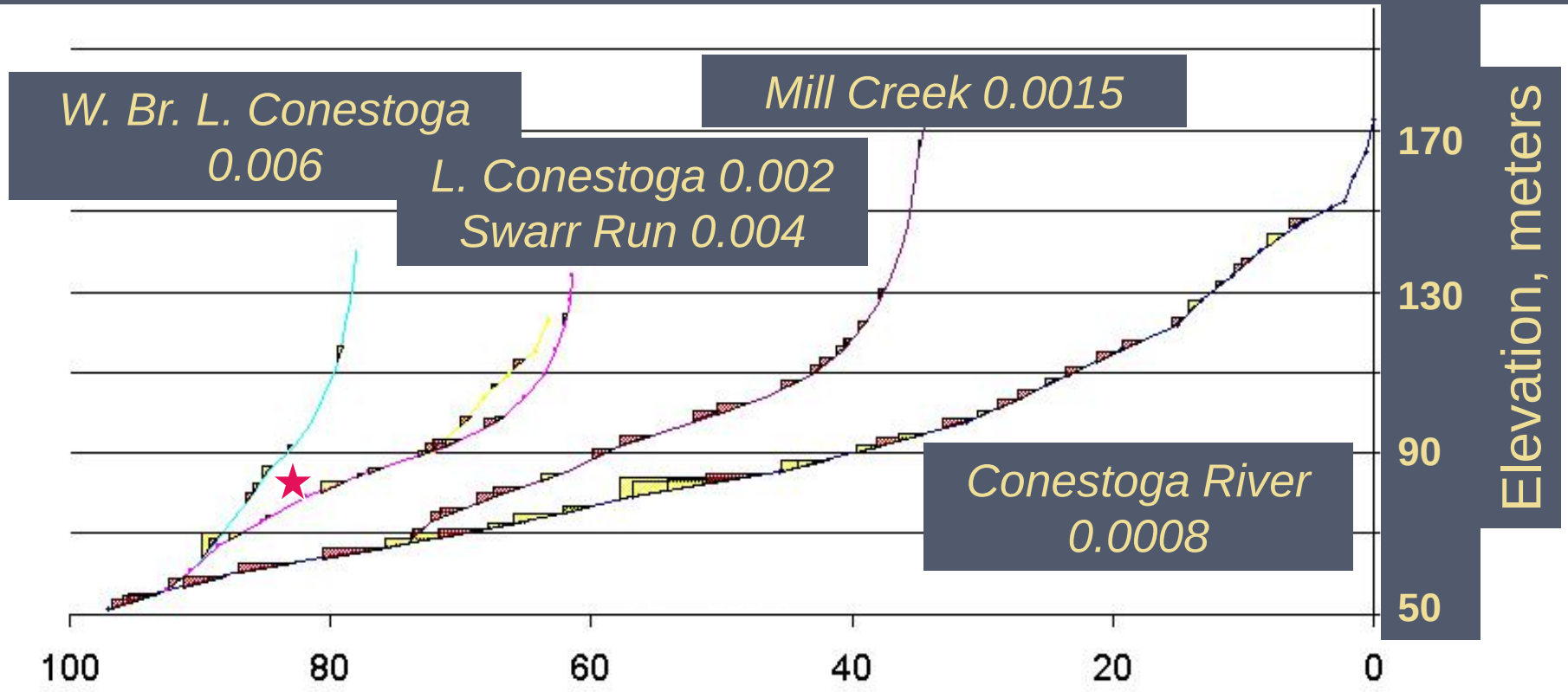
Location of 383 Historical Mill Dams Lancaster County, Pa.





Bridgen's 1864 Atlas

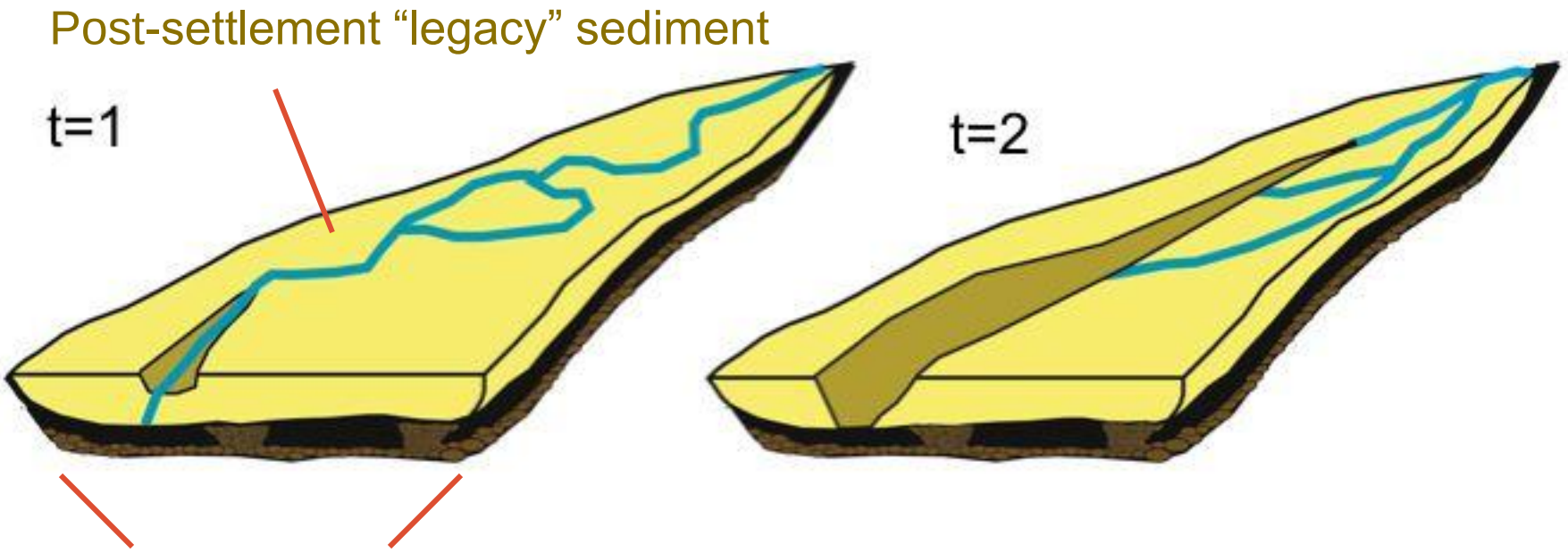
Longitudinal Stream Profiles, Lancaster Piedmont, Pa., with Average Downstream Gradients

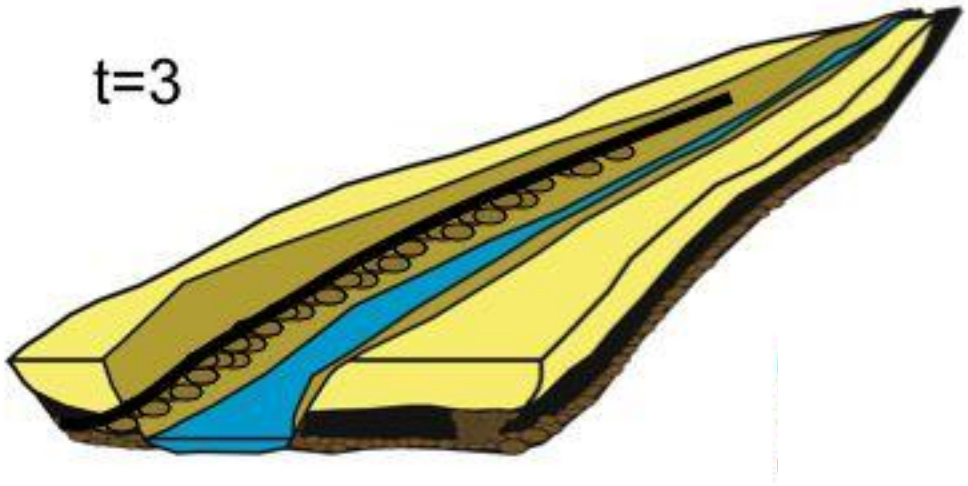


Average Dam Height 2.4 m (actual height unknown)

Actual Dam Height

Ponds identified from field/air photos, but no historical information





Time 1: Perched stream (disconnected from floodplain); dam breached

Time 2: Channel incision and bank widening after dam breaches

Time 3: Channel incises to depth of original gravel-bed/bedrock stream and erodes pre-Colonial gravel

Little Swatara Watershed
Berks County, Pa.

UPSTREAM
Perched

Low Energy System with Poor Habitat

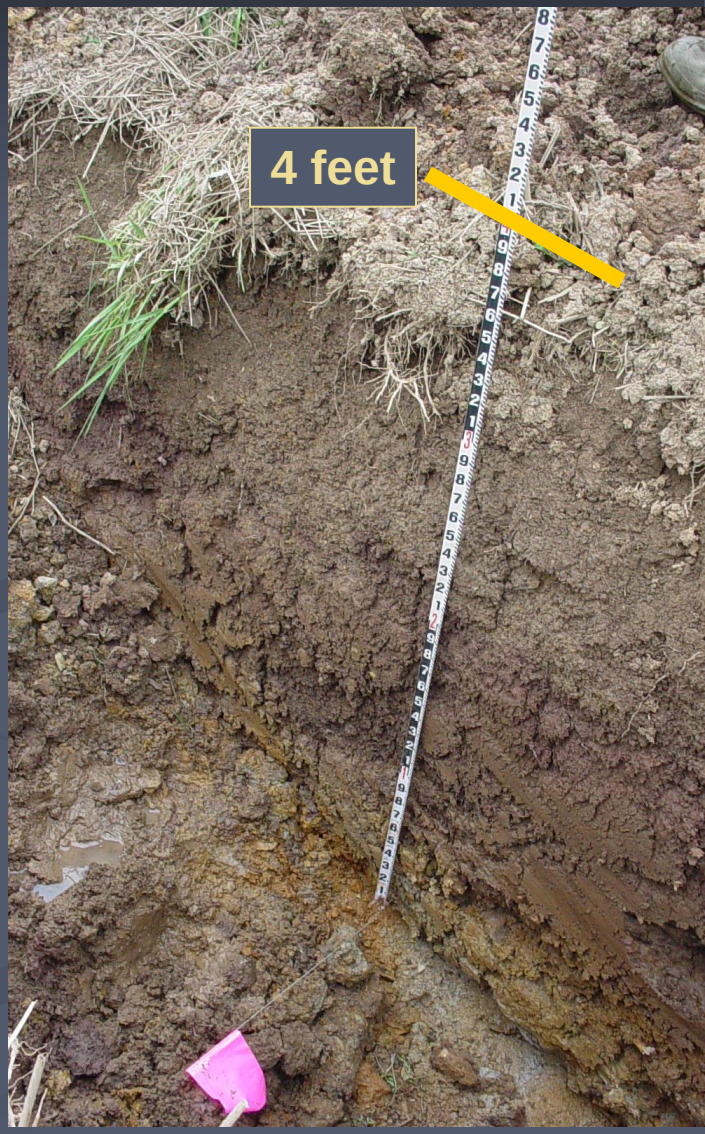
200 feet apart

DOWNSTREAM
Incised

Higher Energy System Exhibiting Lateral Migration and Poor Habitat

Little Swatara Watershed

Berks County, Pa.



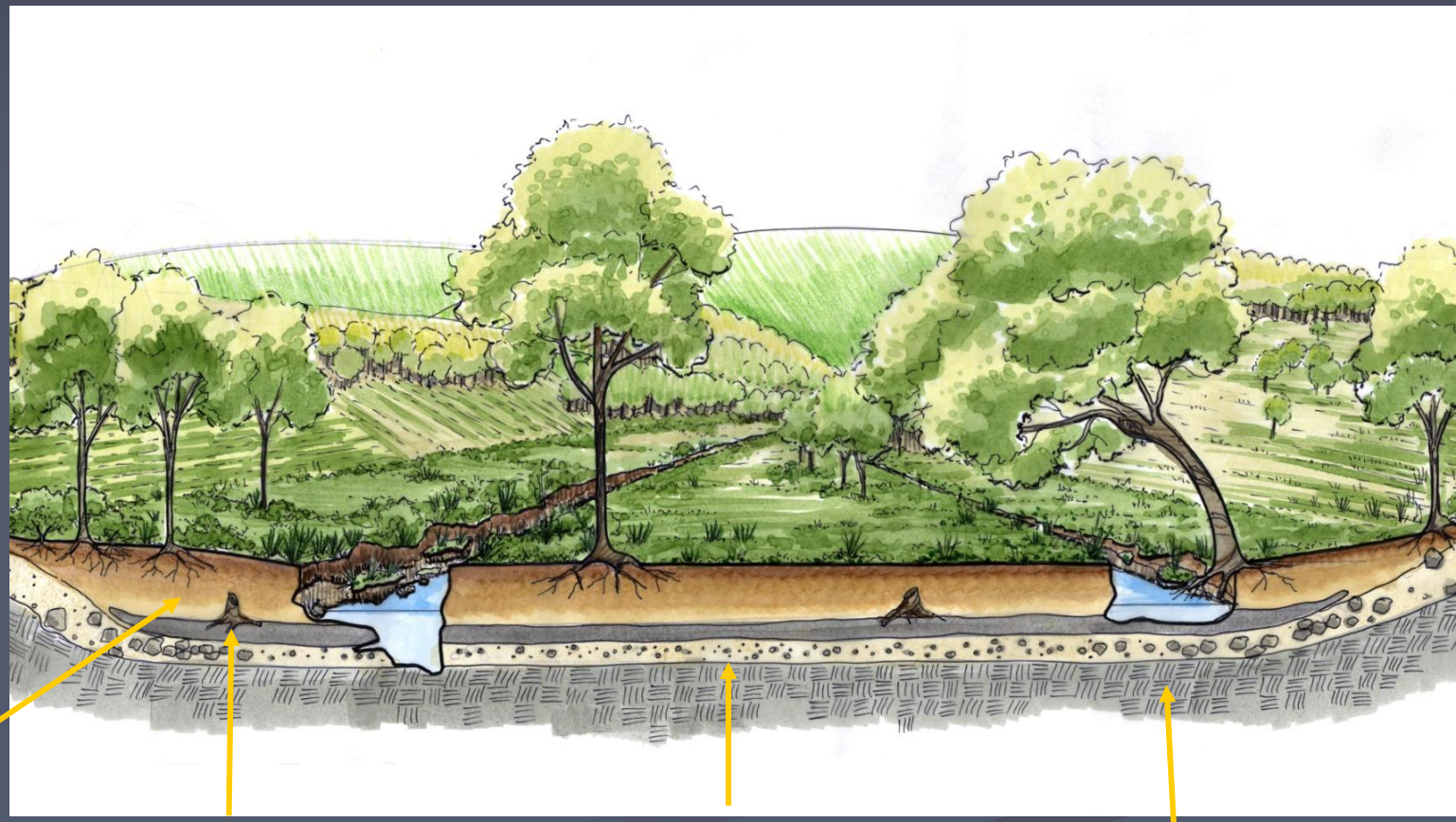
Perched Stream Channel

Groundwater Impacts

Existing Conditions

Floodplain elevation has no link to coarse grain bed load transport or design storm. Based upon the thickness of post-settlement alluvium and present degree of incision into the recent or older deposits.

Lacking Connectivity Between the Rooting Zone, Groundwater, and Stream Flow



Post-Settlement Alluvium

Historical Floodplain Soils

Cobble/Gravel Bed (Base level control)

Bedrock

Hydrologic Functions of Impaired Streams

- Significant Bank Erosion from Flows and Freeze Thaw (first spring flush of sediment)
- Provides Downstream Transport of Sediment and Nutrients – Infrequent Floodplain Access (typically requiring the 1 to 5 year storm event)
- Bed Degradation Occurring - Transporting Riffle Material (base level controls) and Spawning Gravels
- Minimal Denitrification and Plant Uptake
- Minimal Biomass Exchange from Floodplain
- Extreme Thermal Changes
- Minimal Carbon, Nutrient and Sediment Retention

Post-Settlement Sedimentation

Five Meter-High Cutbank of Laminated Silts and Clays

Colonial-Era Dam Remnants

West Branch Little Conestoga Creek

Five Meter-High Cutbank

West Branch
Little Conestoga

Post-settlement
Laminated Silts and Clays

Leaf Mat:
Chestnut, White Oak, Red Oak, & Sycamore
1660-1810 Cal AD

Peaty Clay:
1510-1660 Cal AD

Big Spring Run

Big Spring Run

Design Features of Restoring Hydrologic Function and Frequent Connectivity

- Entire channel bed located in pre-settlement gravel/groundwater.
- Floodplain Elevation – Reduce Energy/Boundary Stress
  Root zone accesses aquifer in pre-settlement gravels.
- Planform is sinuous, single and multi-thread channels.
- Maximize width of floodplain at or below bank elevation.
- Condition soils for root penetration.
- Include woody debris throughout channel & floodplain.

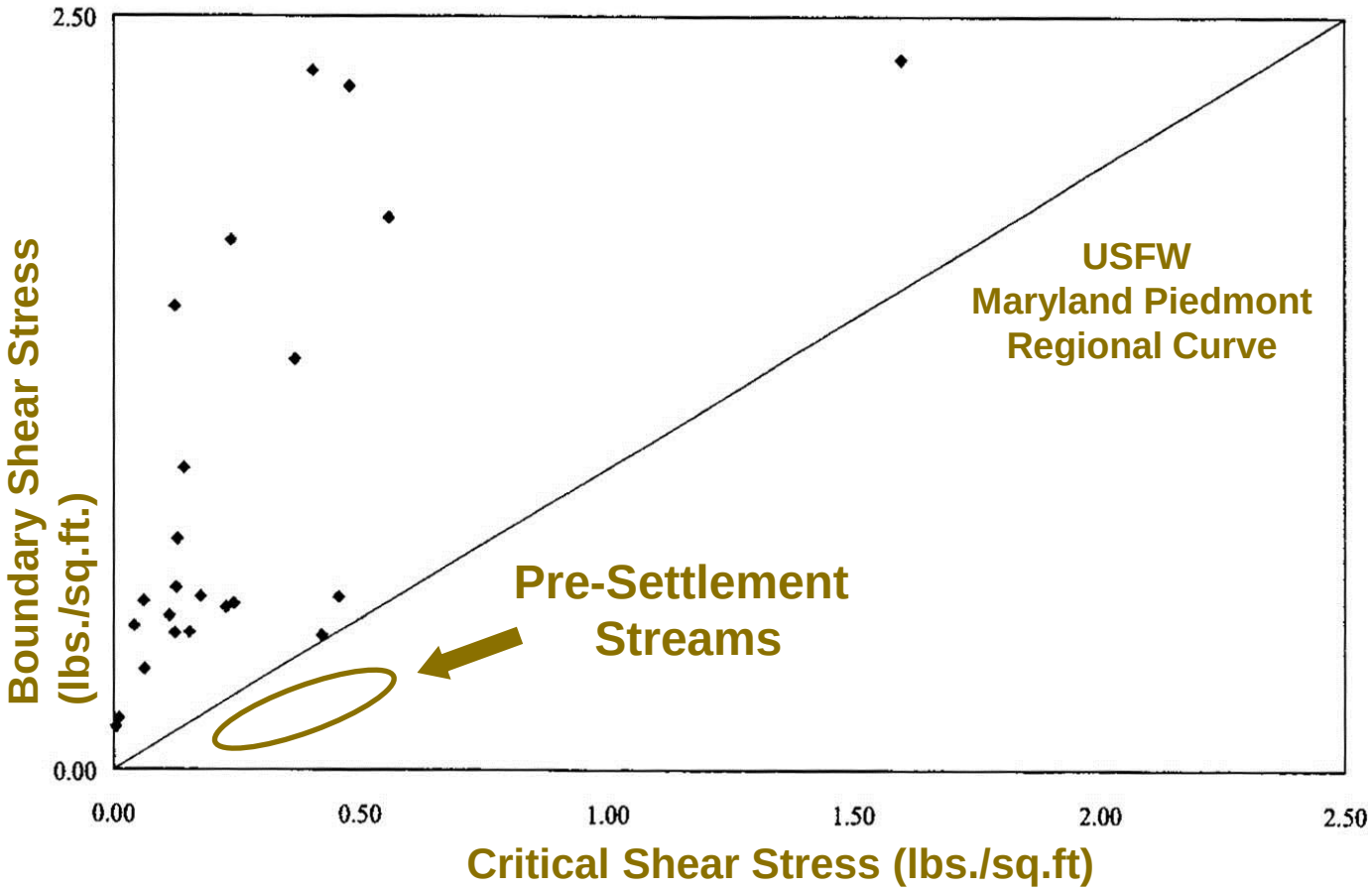
Other Benefits of Restoring Hydrologic Function and Frequent Connectivity

- Design based more upon Habitat
- Minimize Downstream Transport of Sediment and Nutrients – Extremely Frequent Floodplain Access
- Maintains Riffle Material and Spawning Gravels
- Wetland Creation
- Regional Flood Reduction
- Wildlife Habitat Improvement – Deep Pools
- Minimizes Invasive Vegetation
- Thermal Improvements – Base Flow

Discharge Summary Table of Restoration Projects

Stream Name & Location	Drainage Area	Design Q	Design Boundary Stress	USFW Piedmont Bankfull Q	USGS PA Carbonate Region Bankfull Q	Urban Area Bankfull Q
	Sq. Mi.	CFS	lbs/sq. ft.	CFS	CFS	CFS
Lititz Run Lancaster County, Pa.	12.0	55	0.2	559	214	1,382
Shober's Run Bedford County, Pa.	14.1	30	0.2	632		
Hammer Creek Lancaster County, Pa.	30.0	240	0.32	1,121		
Santa Domingo Lancaster County, Pa.	3.7	3.3	0.06	229	102	545

Comparison of estimated average boundary shear and calculated critical shear stress



New Street Ecological Park

This section of the stream bank in New Street Park shows clear evidence of heavy erosion.

Channel capable of transporting nutrients and fine sediment downstream for most precipitation events throughout the year.

Before Restoration

New Street Ecological Park

Relatively straight with little floodplain and channel interaction.

Channel is temporary storage for both fine sediment and nutrients before the next storm event transports downstream.

Before Restoration

New Street Ecological Park

The small proposed channel is designed to meander across the valley and maximize floodplain and channel interaction.

First flush from precipitation will access floodplain and remove nutrients and sediment loadings from upstream flows reducing in-channel nutrient and fine sediment storage and transport.

During Restoration

New Street Ecological Park

The newly constructed channel flows in gentle, wide meanders through New Street Park. The new floodplain is now attached to the channel, so that high flows will move easily out of the channel, helping to maintain channel stability over the long term, thus reducing erosion and sedimentation.

After Restoration

New Street Ecological Park
Floodplain Restoration Project

First year after restoration

D.A. = 3.7 sq. mi.
Design Discharge = 3.3 cfs
Design Bounding Stress = 0.06 lbs/sq. ft.

Lititz Run Watershed
Lititz, Pennsylvania

New Street Ecological Park

Fourth year after restoration

New Street Ecological Park

Differences in energy levels and floodplain storage functions during flood flows are apparent.

Restoration Site

FLOOD FLOW

Immediately Downstream of Restoration Site

New Street Ecological Park

Flood Flow September 2011

Post Flood Event

Shober's Run at Bedford Springs Resort

Slumping Banks

Before Restoration

Shober's Run at Bedford Springs Resort

Before Restoration

Shober's Run at Bedford Springs Resort

D.A. = 14 sq. mi.
Design Discharge = 30 cfs
Design Bounding Stress = 0.2 lbs/sq. ft.

First year after restoration

Lititz Run - Banta Site

Before Restoration

Lititz Run – Banta Site

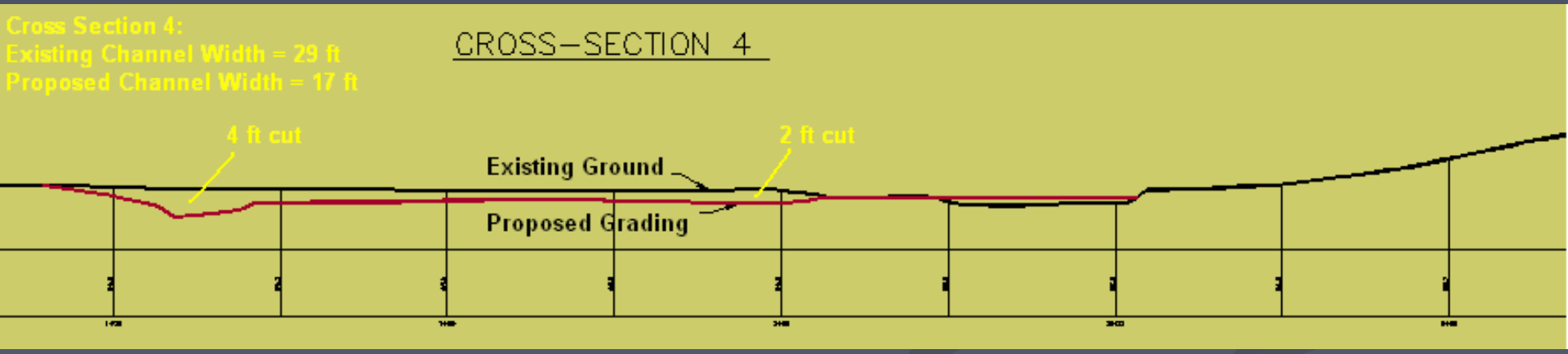
Leaning tree is evidence of bank instability. Once it falls into the channel and creates a debris jam, further channel and bank erosion will ensue.

Before Restoration

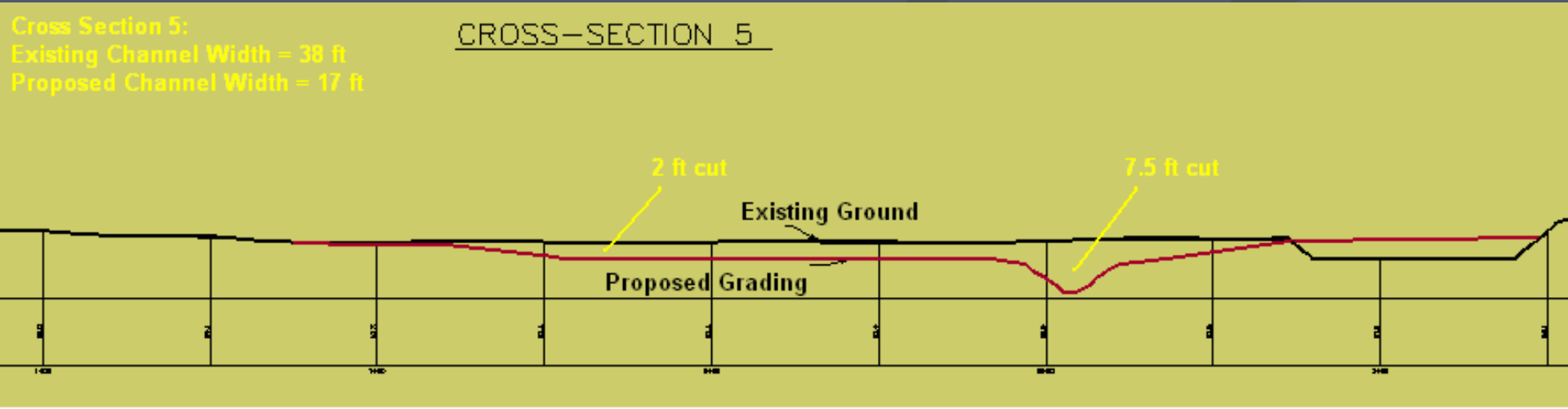
Existing and Proposed Cross Sections

Lititz Run:

Cross Section 4:
Existing Channel Width = 29 ft
Proposed Channel Width = 17 ft



Cross Section 5:
Existing Channel Width = 38 ft
Proposed Channel Width = 17 ft



Lititz Run - Banta Site
Floodplain Restoration Project

D.A. = 12 sq. mi.
Design Discharge = 55 cfs
Design Bounding Stress = 0.2 lbs/sq. ft.

Third year after restoration

Lititz Run Watershed
Lititz, Pennsylvania

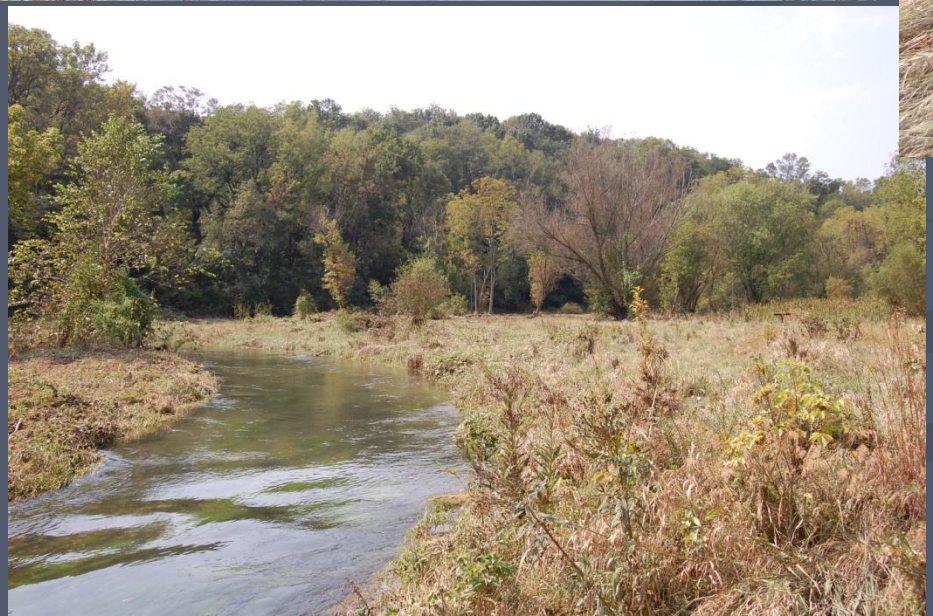
Lititz Run – Banta Site

The channel was relocated to the center of the stream valley, at the lowest, and natural, elevation for the channel. The new channel is shallow and narrow, with banks rising only 12 to 18 inches above the water surface.

After Restoration

Lititz Run – Banta Site

Post flood event September 2011



With Grateful Acknowledgement
to Our Colleagues at

Dr. Dorothy Merritts

Dr. Robert Walter

Mr. Michael Rahnis

Dr. Arthur Parola