

Urban and Suburban Stream Restoration Structures

*Examples, guidance, construction and long-term
performance*



*3 Rivers Wet Weather
Stream Restoration
Symposium
June 22, 2018*

Kelly Lennon, PE



- Vice President
- Water Area Manager for Maryland and Delaware
- 20-years of professional experience in stream & ecosystem restoration
- WSP National Technical Leader for Watershed Management
- Stream and Outfall Implementation lead for MDSHA's TMDL program, currently managing over \$125 million in stream/outfall restoration design and construction projects.





Robin Ernst

- President of Meadville Land Service, Inc.
- Partner of Ernst Seeds
- Installation of native vegetation for 25 years



Steve Fabian

- Estimator and Project Manager at Meadville Land Service, Inc.
- 15 years of experience in stream restoration



Meadville Land Service, Inc.

- A Mobile Restoration Company
- 50 miles of stream constructed and/or restored
- 90 acres of wetland constructed and/or enhanced
- 5,500 acres of specialty seeding
- 33,000 LF of bioengineering structures
- 120,000 live stakes
- 200,000 trees and shrubs
- Celebrating 20 years of success thanks to the great people surrounding us



**COMMITTED TO RESTORING
BALANCE TO THE EARTH**
 **1998-2018**
WWW.MEADVILLELANDSERVICE.COM





Constructed Riffles

- Constructed analog for natural river forms
 - *Riffle - run - pool - glide*
- Hydraulic and grade control
- Void space / subsurface flow
- Habitat for aquatic organisms
- Threshold sizing of riffle armor
- Complexity of design relative to project goals



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Constructed
Riffle with
downstream
sill and
floodplain
bench



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Constructed
Riffles & Live
Stakes at
bridge
replacement
site



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Constructed Riffles - Smaller Channel



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Cross Vanes & J-Hooks

- Imbricated rock structures
- Hardened grade control
- Converging and turning of flows
- Weir flow hydraulics
- Passive bank protection downstream
- Control of bed scour



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Cross Vane



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Cross
Vanes



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J-Hook, Rock Toe & Soil Lift Combination



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Rock Sill

- Role in Design
 - *Provides hardened grade control without vane arm weir influences on channel flows*
 - *Shaped for slight influence on flow directions*
 - *Can provide control of bed scour*
- Post-Construction
 - *More prone to sedimentation*
 - *Fish passage blockage concerns*



Rock Sills



Log Structures

- Log Toes
- Log Vane
- Log Drops
- Toe Wood
- Root Wads



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Log Toes During Construction



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Log Vane

- Single arm
- Double arm



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Log Drops



Imbricated Rock Wall & Rock Toe

- Used in confined channels
- Often used to protect infrastructure
- Can be combined with bank grading and/or soil lifts



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Rock Toe

- Hardened protection of banks in high stress areas
- Protection of utilities
- Hardened construction method for steep slope areas



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Toe Wood

- Construction of steep channel banks in exterior meander bends / pools
- Allows for construction of asymmetric pools
- Great habitat feature within pools
- Use of salvaged native materials from project site
- Cantilevering of logs provides scour resilience
- Bank roughness increases exterior pool scouring / sustainable pools



Root Wads

- Same application as toe wood
- Utilization of felled tree root balls
- Larger diameter of root ball offers increased protection / coverage of stream bank
- Frequently installed with anchors / counterweight stones
- Larger structure than other options



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Floodplain roughness features



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Soil Lifts

- Reconstruction technique commonly used for high erosion / valley wall areas
- Used in conjunction with bioengineering plantings
- Use of wrapped coir materials to provide steeper bank construction
- Use of hardened toe protection in conjunction with soil lifts



Soil Lifts



Soil Lifts with Rock Toe & Live Stakes



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Bioengineering

- Use of native woody plant materials to provide strength and roughness to stream banks
- Common Types:
 - *Brush layering*
 - *Brush mattresses*
 - *Live fascines/wattles*
 - *Post and wattle*
 - *Live stakes*
 - *Brush box palisade and brush dike*
- What not to do
- Keys for success
 - *Dormant live material*
 - *For best survivability the material should be harvested and planted during the dormant season (November 1st - April 30th)*
 - *If material can not be installed when delivered to the site, keep stored in cool, wet and shaded area*
 - *Typical species include Cephalanthus, Cornus, Salix, Sambucus and Viburnum*



Branch
Layering



Brush Mattresses



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Live Fascines



Post and Wattle



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Live Stakes



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At a glance

Floodplain bench plantings

- live stakes
- trees



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Live Stakes -Post Construction



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Brush Box Palisade and Brush Dike



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What Not To Do in Bioengineering?



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Evolution of plantings post- construction

Pre-Construction



1 year
Post-Construction



2006, 5 years
Post-Construction



Step Pools

- Good for steep channels
- Often is headwater and 1st order channels
- Can be designed to encourage infiltration
- Potential to design as RSC or modified RSC to obtain additional water quality treatment credit



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Step Pools



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Rock Tree Pack

- Used to stabilize trees on stream banks



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Nine Mile Run Stream Restoration - Local Case Study

- ~\$3.3 million construction (2004 to 2006) by MLS
- At the time of construction, this was the largest urban stream restoration project in the country
- 10,400 LF of stream channel. Installed over 40 in-stream structures consisting of vanes, cross vanes, j-hook vanes, step pools constructed out of rock.
- Project Goals:
 - *improve in-stream habitat, daylight sections of stream that had been piped underground, stabilize the channel and banks using natural stream channel design, modify the channel dimensions to help control storm water surges, reconnect the channel to the floodplain to accommodate stormwater flows, reforest sections of floodplain, and create additional wetland areas.*
- Salvaged and placed over 135 woody structures such as log vanes, toe wood, rootwads, brush piles, downed logs and standing snags.
- Structures in the stream provide bank protection, help direct stream flow and also create habitat for fish, amphibians and reptiles.
- Constructed approximately 10 acres of wetlands.



Nine Mile Run Fern Hollow Section



Existing condition



Immediately post-construction



3 years post-construction

Nine Mile Run Upper Falls Ravine Step



Existing condition



Post-construction

Nine Mile Run Mainstem - 4 years post construction



Questions?

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