MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

Stream Restoration Planning and Design

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Personal Background

- Graduated from Purdue in 2016 with degrees in Environmental Science and Environmental Engineering

- Worked in Nashville, TN for seven years in stream consulting
  - Stream Design
  - Functional Assessment & Monitoring
  - Dam Removals
  - Bank Stabilizations

- Recently started at EGLE in April 2023

Outline

- Stream and Wetland Interaction Overview
- Stream Functional Pyramid
- Site Selection
- Stream Types and Bankfull Identification
- Channel Sizing
- Stream Geomorphology
- In-Channel Structures
- Riparian Vegetation

Stream and Wetland Interaction

- Why are Streams and Wetlands often viewed separately?
- Frequently exist together
- Healthy streams create healthy wetlands, and healthy wetlands create healthy streams!
- What are the keys to this?
  - Good floodplain access
  - Stable channel
  - Low Slopes – if applicable!

Parts 301/303 of NREPA: Definition of a Stream

A **river, stream, creek, drain**, or any other body of water with:

1. Defined banks,
2. Bed
3. Visible evidence of continued flow or continued occurrence of water

- Includes the St. Mary's, St. Clair, and Detroit Rivers
- May or may not be serving as a drain as defined in the Drain Code of 1956
- Changes to definitions of WOTUS do not affect Michigan's statute.

Stream Functional Pyramid

Macroinvertebrates and Fish

Temperature, Bacteria, Nutrients, and Dissolved Oxygen

Bedform Diversity, LWD, BEHI/NBS

Bank Height Ratio, and Entrenchment

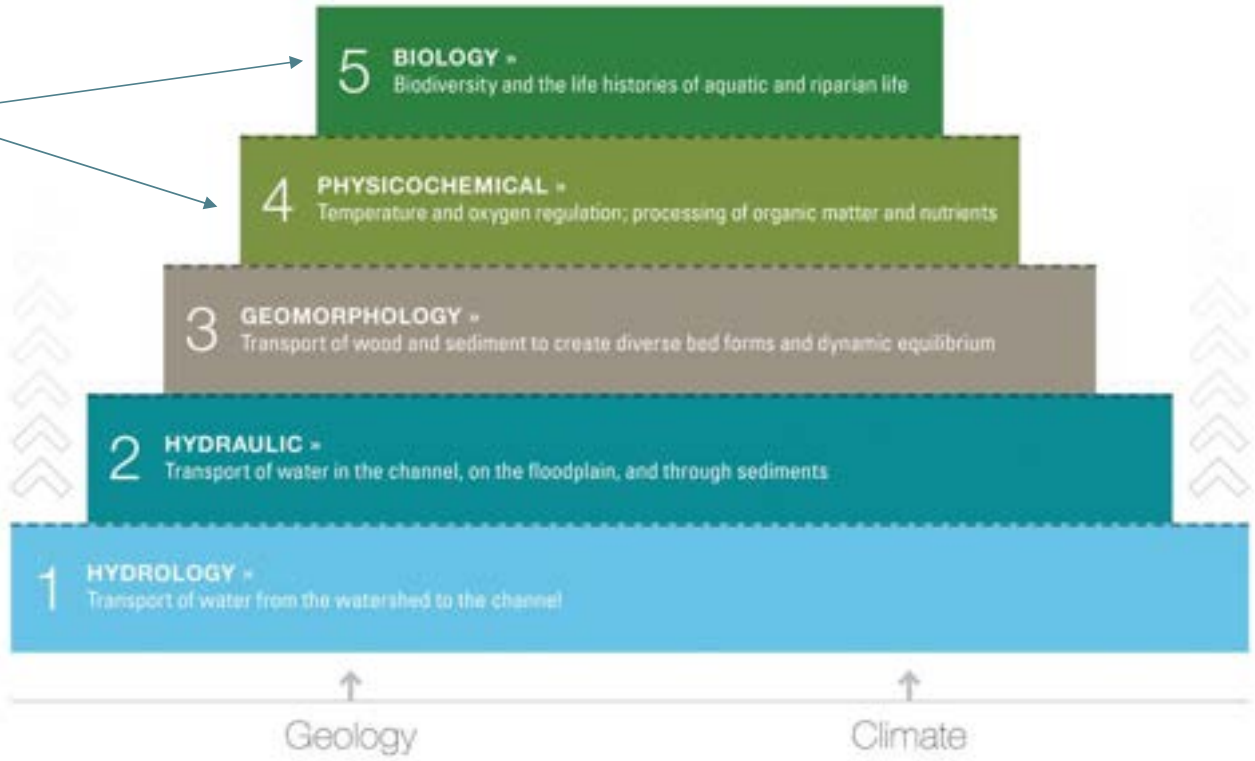
Reach Runoff

Stream Functional Pyramid and Wetlands

- Hydrology
  - Functioning reach runoff, hold the water
- Hydraulics
  - Floodplain Access
  - Sediment Deposition
  - Groundwater levels
- Geomorphology
  - Bank Stability, Sediment Transport
- Physicochemical
  - Water Temperature/Quality/Nutrient Levels
- Biology
  - Improved Vegetation and Aquatic Life

Site Selection and the Functional Pyramid

Goal is to achieve Function here



Site Selection – Other Factors to Consider

- Headwater Streams
  - Smaller Drainage Area
  - Reduces risk of US affects
- Upstream and Downstream Conditions
  - Land-use
  - Stream Condition
- SQT Analysis
  - Can be used to gauge site condition

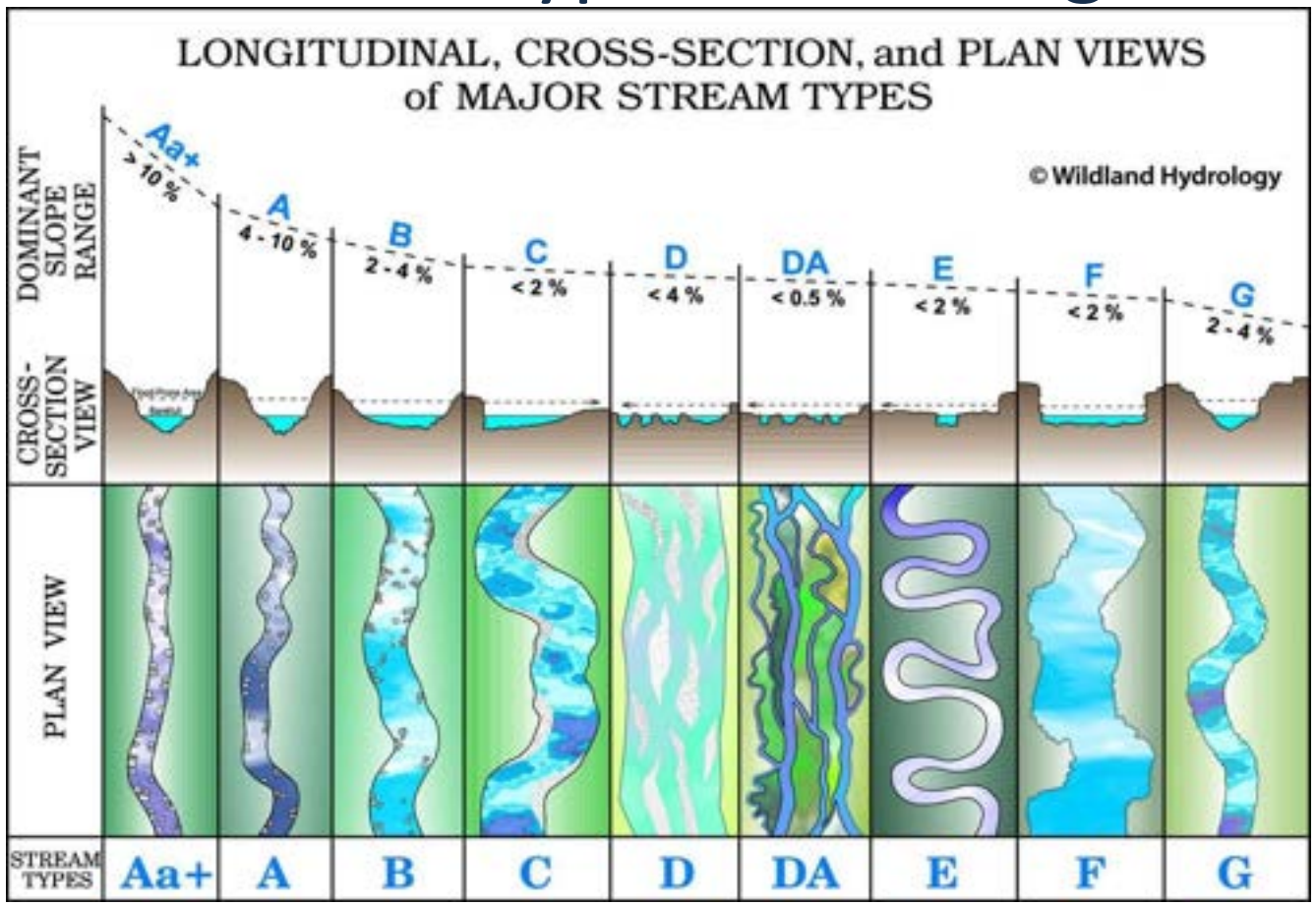
Don’t Force Site Improvements

- Not every site improvement is worth the impact.
- A bad wetland doesn’t mean the stream is not-functioning.
- A poor stream in a functioning wetland is harder to fix.

So you found your site? Now what?

- Collect reference data
  - Bed form Diversity
    - Riffle Slopes
    - Pool Spacing and Depth
  - Riparian Vegetation
    - Don’t fight native plants
- Assess all incoming drainage
- Break up reaches

Stream Types and Design

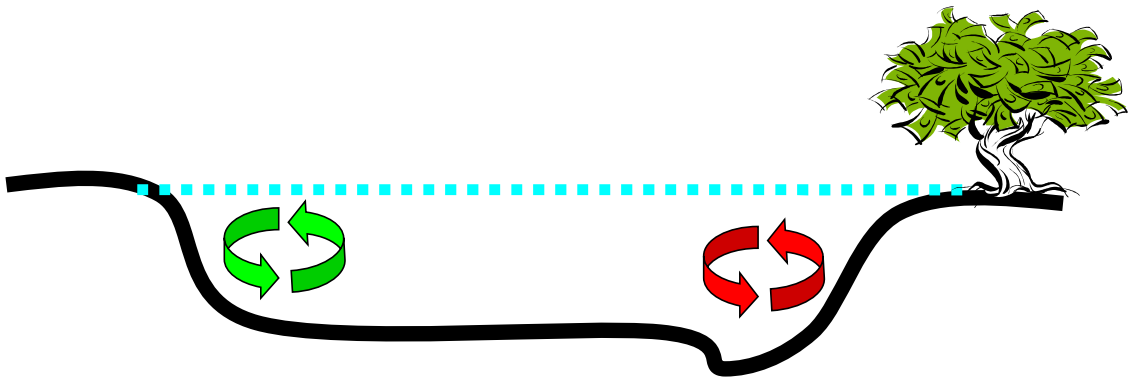


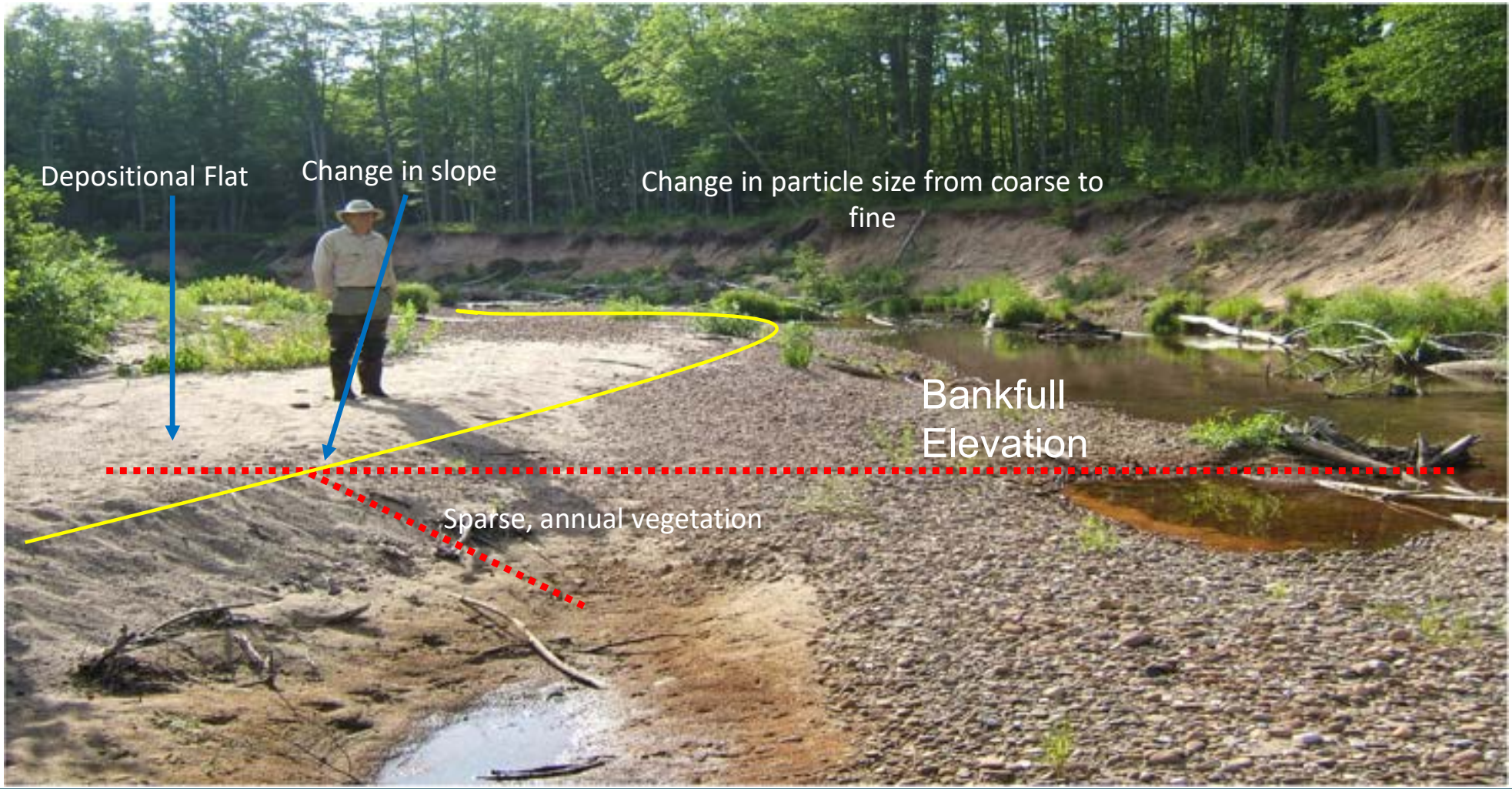
Stream Types and Wetlands

- Da is most common stream associated with wetlands
  - Not often designed, hard to control, monitor
- C and E are most common designed stream types. Provide good stability through functioning entrenchment and bank-height ratios.
- Both C and E are typically <2%.
- Avoid F, G, or any streams with bad entrenchment and incision.

Bankfull Stage/Elevation

- The elevation where flood waters fill the channel and just begin to overflow onto the floodplain
- Triggers maximum deposition & erosion circulation cell development

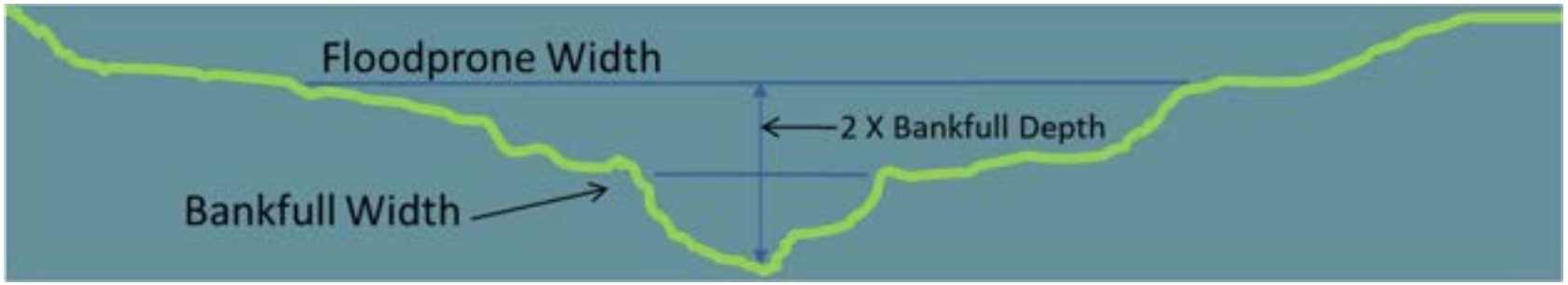



Depositional Flat
Change in slope
Change in particle size from coarse to fine
Bankfull Elevation
Sparse, annual vegetation

Floodplain Connectivity

Can the stream easily access its floodplain to dissipate energy, deposit sediment.

- Bank Height Ratio
- Entrenchment Ratio



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Floodplains and Wetlands

- Proper floodplain access is essential to healthy stream/wetland complexes.
- Without proper access, water tables can drop, and wetland vegetation can suffer.
- Don’t create a steep valley with your floodplain. Aim for close to flat lateral slopes with positive drainage downstream.
- Vernal Pools and pilot channels can be implemented when appropriate.

Channel Sizing

- Use Onsite Reference Data
- Use Regional Curves
  - Mean Depth
  - Area
  - Bankfull Width
  - Flow
- Verify
  - HEC-RAS, Runoff calcs

Combined SLME Regional Hydraulic Geometry And Discharge Equations

$$Width = 7.79\ x\ DA^{.47}\ (R^2 = 0.86)$$

$$Depth = 1.11\ x\ DA^{.17}\ (R^2 = 0.34)$$

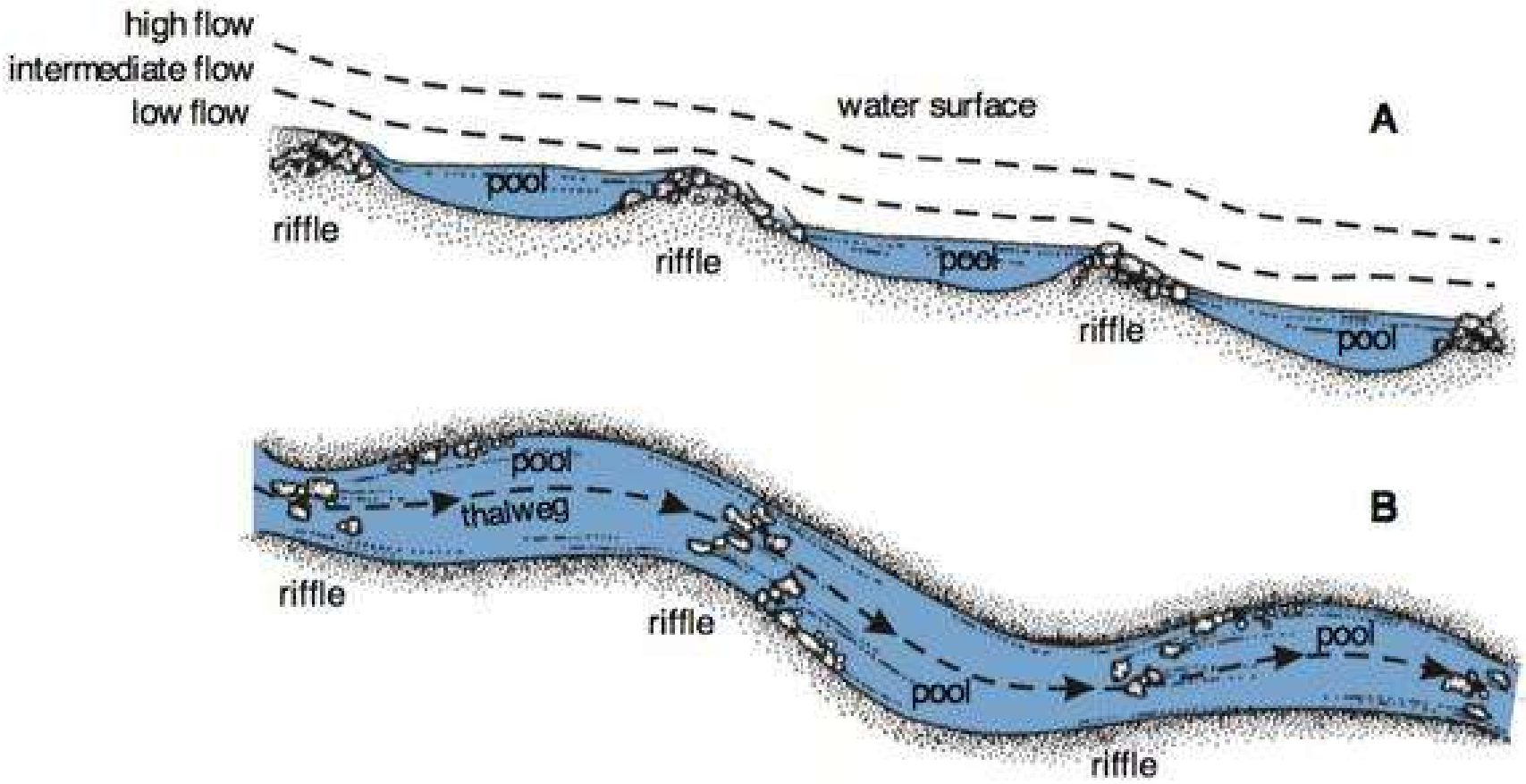
$$Inner\ Berm = 4.55\ x\ DA^{.64}\ (R^2 = 0.98)$$

$$Area = 8.78\ x\ DA^{.65} (R^2 = 0.96)$$

$$Discharge = 18.19\ x\ DA^{.68}\ (R^2 = 0.89)$$

Stream Bedform Diversity

- Any design needs to account for proper bedform diversity.
  - Appropriate Riffle Slopes
  - Pool Spacing
  - Pool Depth
- Help for energy creation and dissipation
- Sediment Transport


high flow
intermediate flow
low flow
water surface
A
pool
riffle
riffle
pool
riffle
pool
pool
thalweg
B
riffle
riffle
pool
pool
riffle


Riffle
Run
Pool
Glide
Riffle

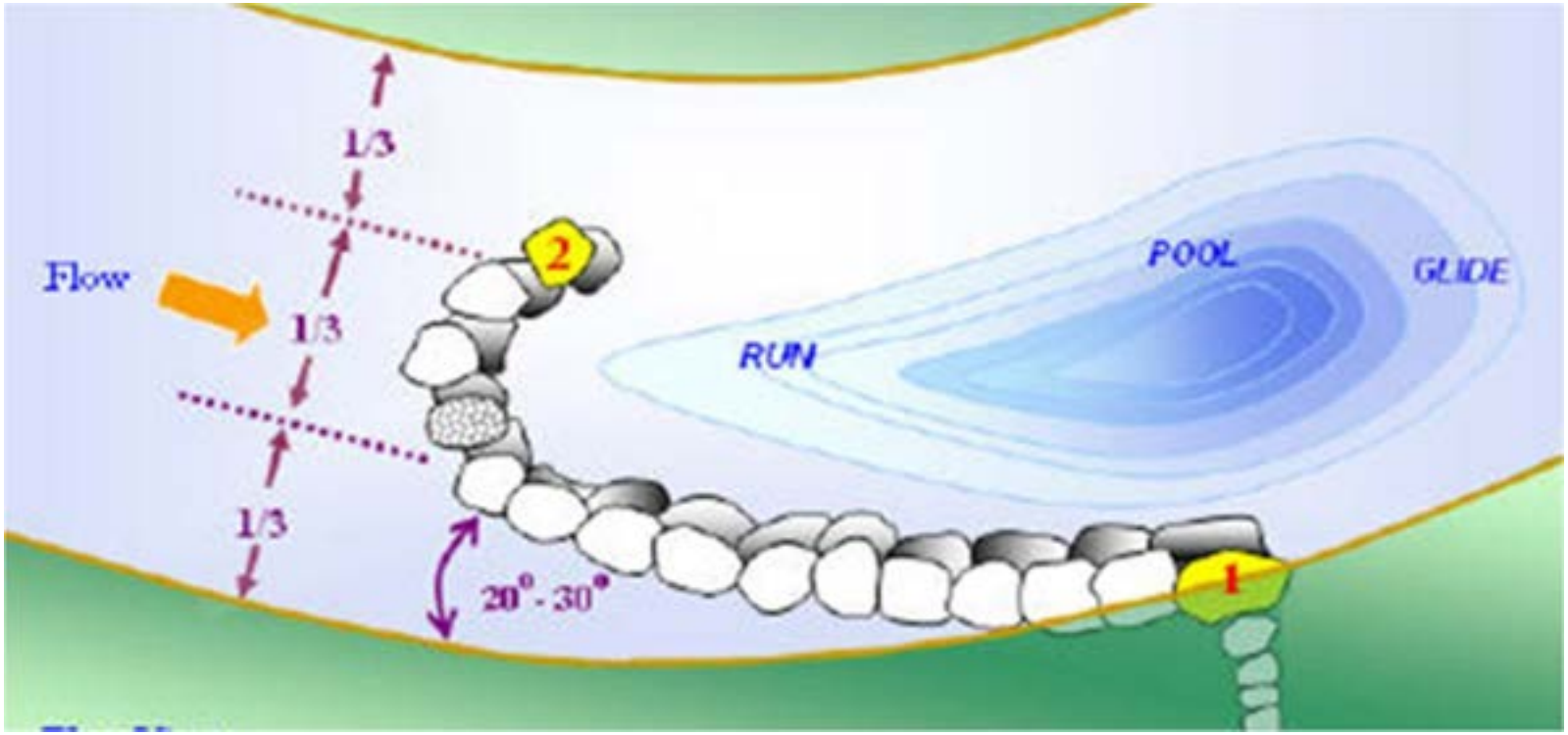
Stream Structures

- Help stabilize streams in higher risk areas
- Incorporate natural material
  - Provides habitat!
- Examples include Wood Toe, Soil Lifts, Log Vanes, J-Hooks, and Woody Debris Riffles
- Stream Structures are helpful but don't have to be installed
- Not always applicable to low slope wetland systems

Toe Wood

Example Project - Cross-Vanes

Example Projects – J-Hooks/Cross-Vanes



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Riparian Vegetation

- Plants used for wetland sites can also be used for stream sites.
- Good riparian stream sites use a wide variety of plants
  - FACW, FACN, FAC
- Use good spacing when planting
- Spread out your species
- Use live whips to stabilize banks

Planting Transplants

- Slices of vegetation and topsoil that are taken from onsite and transplanted onto newly constructed channel.

Floodplain Access can limit vegetation

Planting Examples (Just a few!)

Trees

- Speckled Alder
- Bog Birch
- Silky Dogwood
- Red Osier Dogwood
- Eastern Cottonwood
- Swamp Rose
- Red Maple
- Buttonbush
- Ninebark

Shrubs/Herbaceous

- Grass-leaved Goldenrod
- Water Sedge
- Soft Rush
- Swamp Aster
- Boneset
- Virginia Wild Rye
- Royal Fern
- Rattlesnake Grass

Final Thoughts

- Wetland and Stream Design can be combined when the situation is appropriate.
- Focus on low slopes, floodplain access, appropriate vegetation, and proper reference data.
- Be sure to think through all aspects of your design from channel design, bedform diversity, structures etc.

Contact Information

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