Case Studies of Floodplain and Stream Restoration (FSR) Projects and their Potential Use for Flood Hazard Mitigation and Community Resiliency

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MARYLAND ASSOCIATION OF FLOODPLAIN AND STORMWATER MANAGERS
MAFSM

Goals & Objectives

- FSR for Hazard Mitigation and Community Resiliency
- Review of Basic Geomorphic Principles
- Natural Channel Design Overview
- Design of Vane Structures
- Design of Floodplain and Habitat Features
- Case Studies of Floodplain and Stream Restoration (FSR) Projects

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FSR for Hazard Mitigation

- Hazard Mitigation is any action taken to reduce or eliminate long-term risk to life and property from a hazard event.
- FEMA encourages communities to incorporate methods to mitigate impacts of climate change into eligible Hazard Mitigation Assistance (HMA) funded risk reduction activities.
- FSR projects are designed to be self-sustaining and are eligible for HMA funding to mitigate for:
  - Erosion
  - Flood Risk
  - Flood Reduction
  - Drought Mitigation

FSR for Community Resilience

- Community Resiliency is defined as the ability of a community to:
  - Adapt to Changing Conditions including Climate Change
  - Withstand Disruption
  - Recover from Emergencies
- FSR projects have the capacity to provide resilience to threats and hazards to multiple Ecosystem and Natural Resource issues:
  - Water/Hydrological Systems
  - Fisheries
  - Agriculture (Production & Livestock)
  - Wildlife Ecosystems
- FSR projects also address threats and hazards caused by or exacerbated by Climate Change including:
  - Climate Change Adaptation & Mitigation
  - Changing Weather Patterns & Severe Weather
  - Droughts and Floods

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Fluvial Geomorphology

Branch of science concerned with influence of rivers and streams on the formation of the earth’s surface

Governing Processes:

- Erosion
- Sediment Transport
- Sediment Deposition

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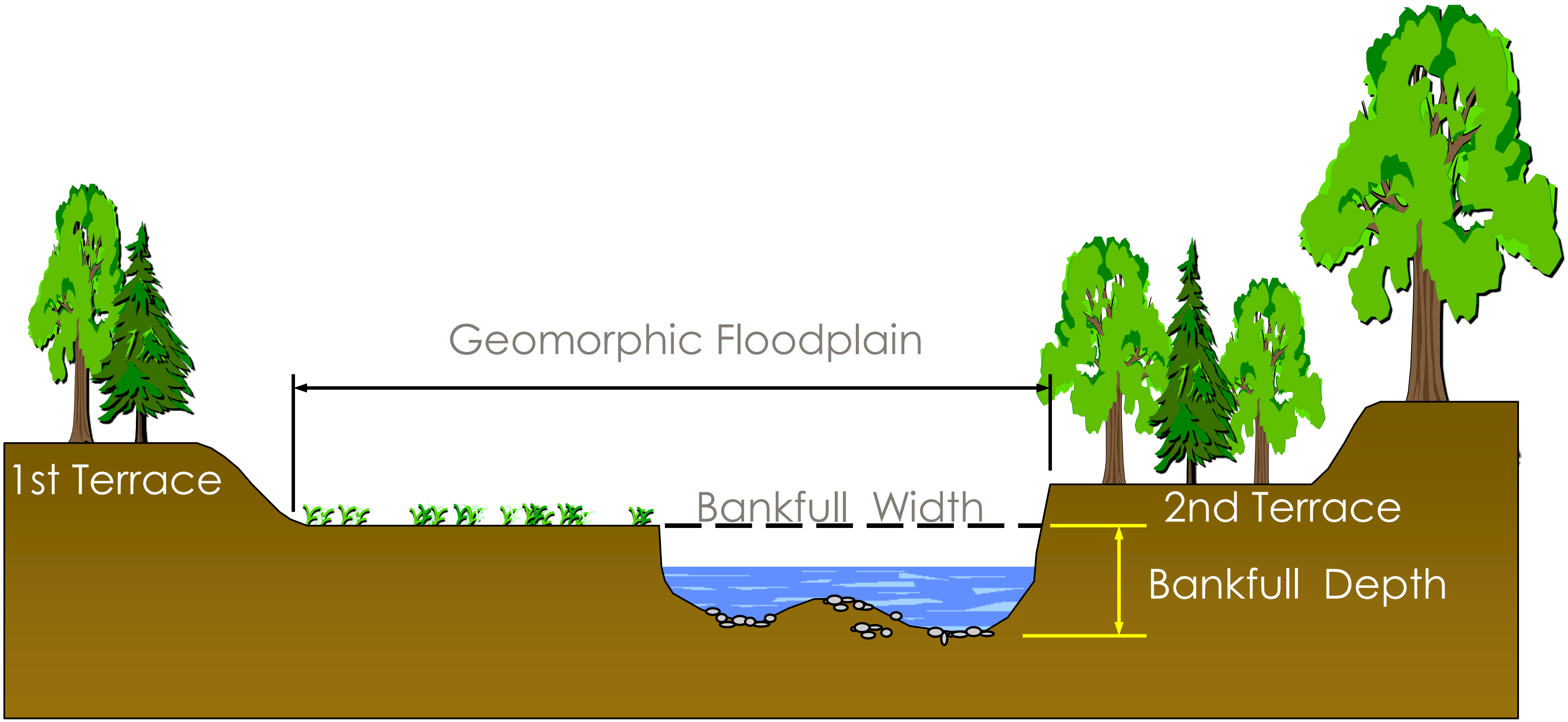
Natural Stream Systems



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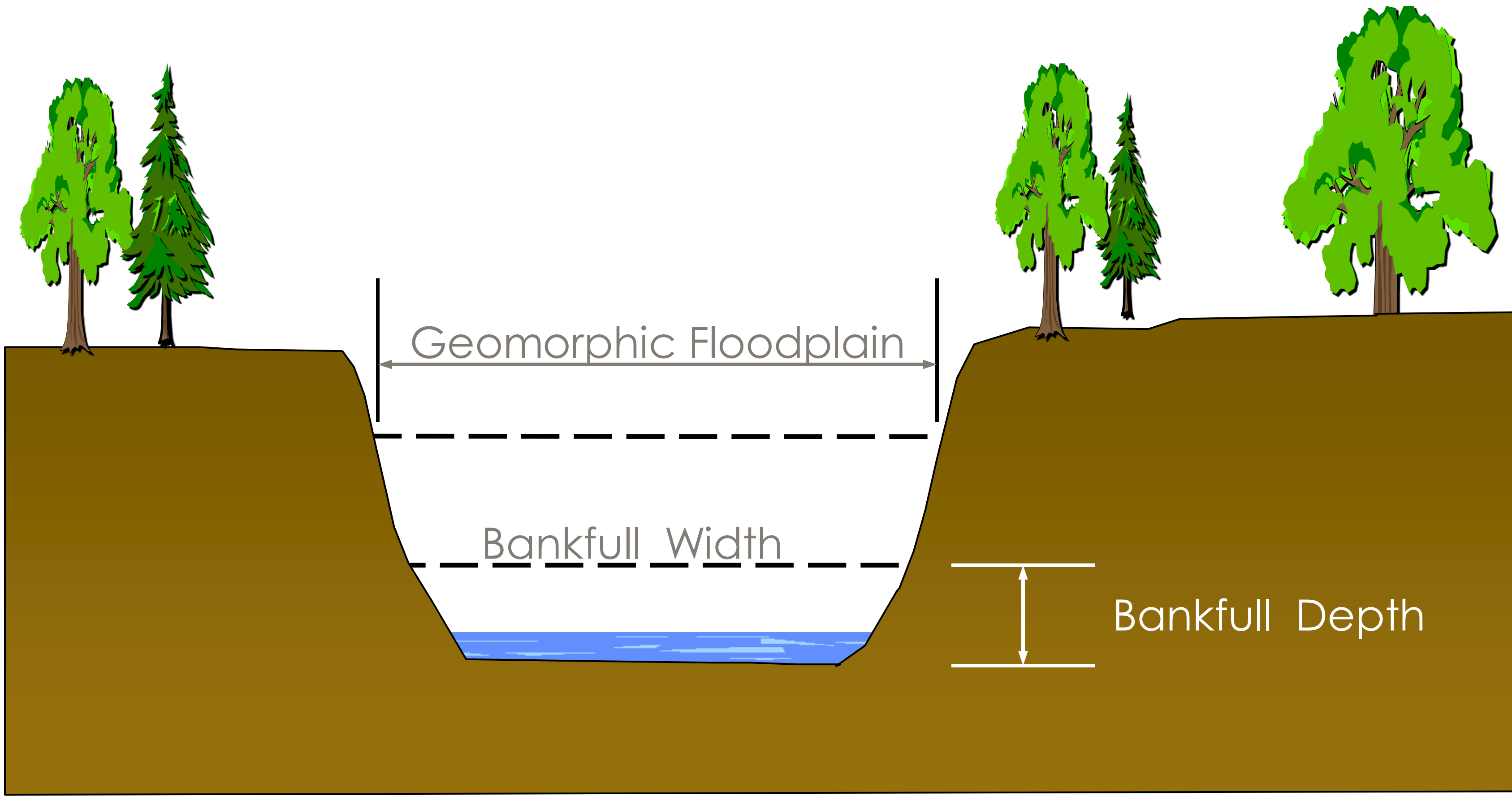
Entrenched Channel



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Bankfull Discharge

- Controls Channel Form
- Corresponds to the Discharge at Which Channel Maintenance is Most Effective
- Recurrence Interval on Order of 1.2 to 1.6 Years
- Higher Recurrence Interval in Urban Watersheds

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Bankfull Indicators

- Flat, Depositional Surface Adjacent to Active Channel
- Height of Depositional Features (Point Bars)
- Change in Vegetation
- Slope or Topographic Breaks or Changes Along the Bank

Past Attempts at Designing Streams to Prevent Flooding

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Past Attempts at Designing Streams to Prevent Flooding

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Past Attempts at Designing Streams to Prevent Flooding

Designing Channels to be Natural and Resilient

Designing Channels to be Natural and Resilient

Differences

CONCEPT	TRADITIONAL	GEOMORPHOLOGICAL
Time	Short-term	Long-term
Model	Theoretical	Field Measurement
Water	Clear	Sediment Laden
Spatial Scale	Reach	Watershed
Boundary	Rigid	Mobile
Maintenance	High	Sustainable
Design Flow	100 yr.	Bankfull Flow
Factor of Safety	Conservative	Balance of Forces

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River Stability Definition

River stability (equilibrium or quasi-equilibrium) is defined as "the ability of a river, over time, in the present climate to transport the flows and sediment produced by it's watershed in such a manner that the stream maintains its dimension, pattern and profile without either aggrading or degrading" (Rosgen, 1994, 1996, 2001)

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Indicators of Instability

- Incision/Bed-cutting
- Channel Filling
- Entrenchment/High Streambanks
- Lateral Migration
- Over Widening
- Lack of Habitat
- Eroded Banks
- Slope Instability

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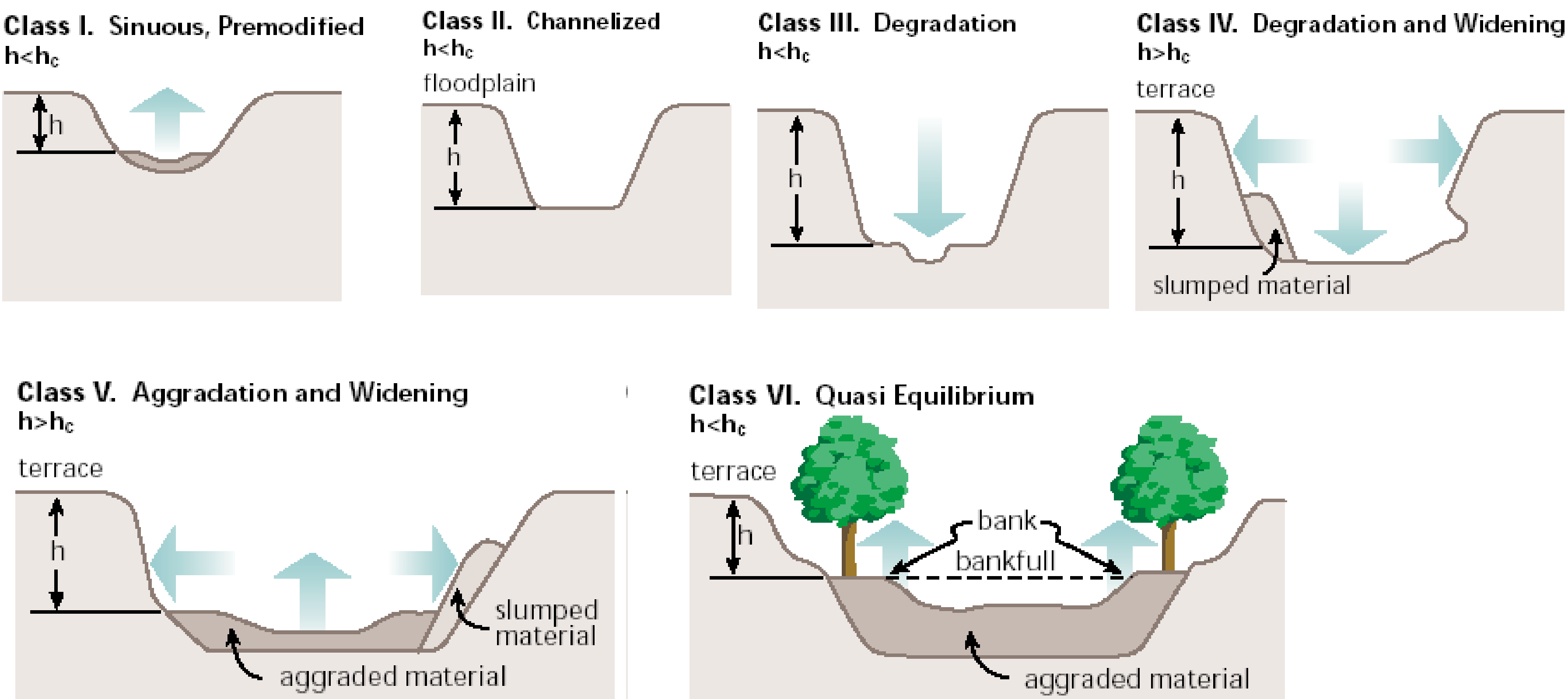
Simon's Modification of Schumm's Model



Natural Channel Design

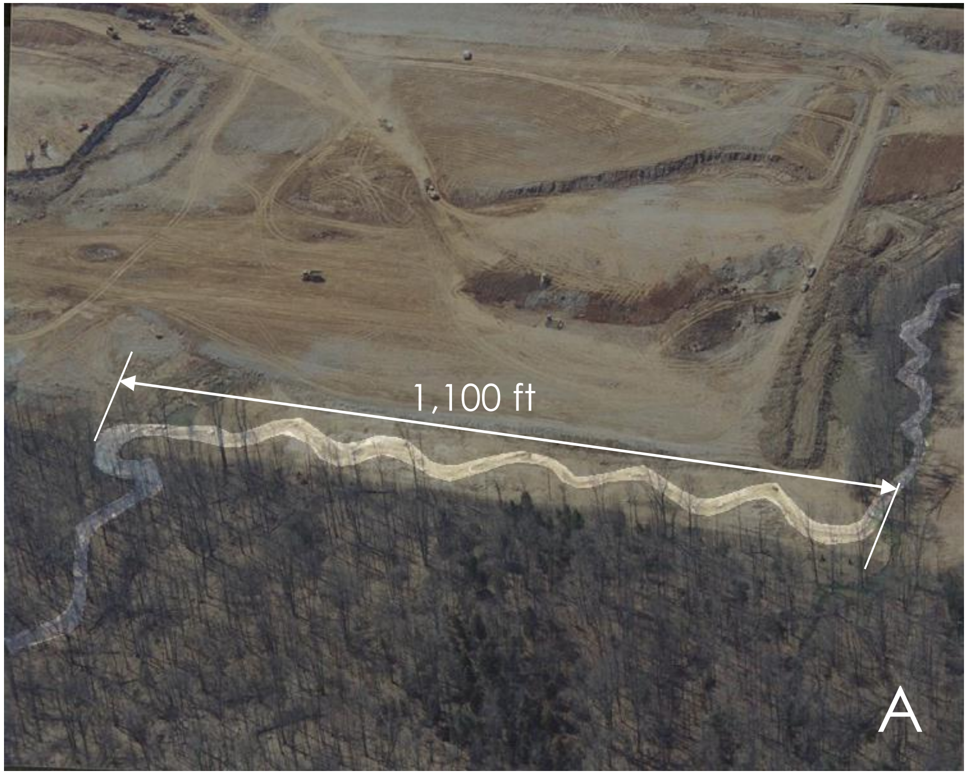
Process by which new or re-constructed stream channels and their associated floodplain riparian systems are designed to be naturally functional, stable, healthy, productive, resilient to changing conditions, and sustainable.

Phases of Natural Channel Design Using a Geomorphic Approach

1. Define Restoration Objectives
2. Develop Regional & Localized Specific Geomorphic and Hydraulic Data
3. Conduct Watershed/River Assessment
4. Assess Potential for Passive Restoration (i.e. Land Use Changes)
5. Initiate Natural Channel Design w/ Analytical Testing of Hydraulics & Sediment Transport
6. Design Stabilization/Enhancement Measures to be Resilient
7. Implement Proposed Design
8. Design & Implement Monitoring & Maintenance Plan

Natural Channel Design Process

- Determine Site Constraints & Design Parameters
- Determine/Design Impact of Flood Flows on Potential Design
- Predict Stable Geometry Based on Reference Reach
- Check Sediment Transport Competency and Capacity
- Iterative Design Until Geometry and Calculated Depths Converge



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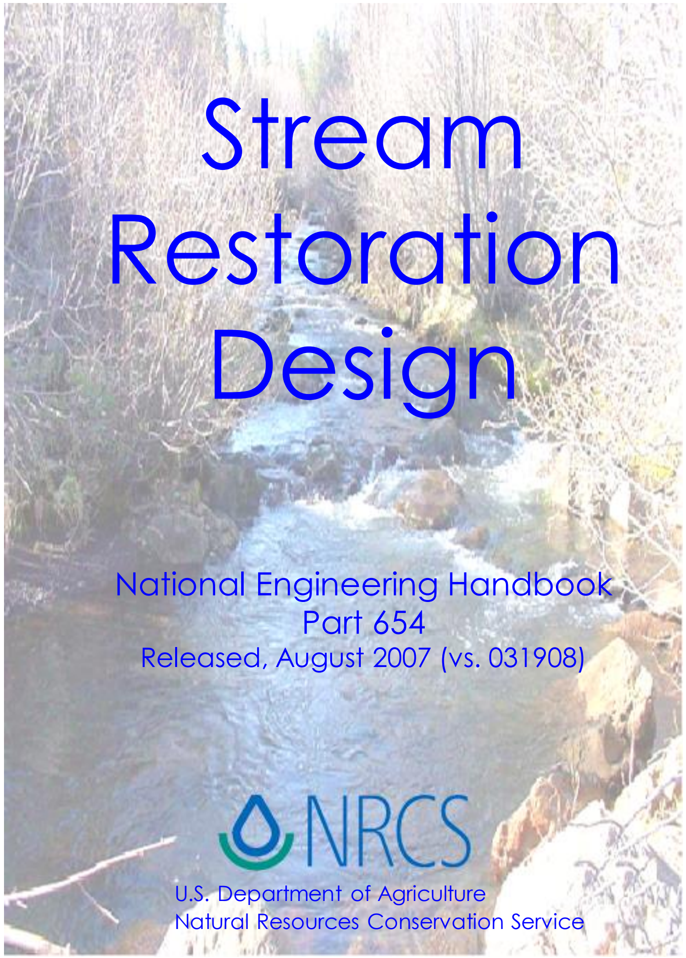
Primary Reference

Chapter 11: Geomorphic Approach for Natural Channel Design

USDA NRCS, *Stream Restoration Design Handbook, 2007*.



Types of Restoration

- Priority I – Raise the Stream up to the Floodplain
- Priority II – Bring the Floodplain Down to the Channel
- Priority III – Do Not Alter Planform but Change Stream Type Along Existing Pattern
- Priority IV – Armour in Place using Soil Bioengineering or More Structural Approaches

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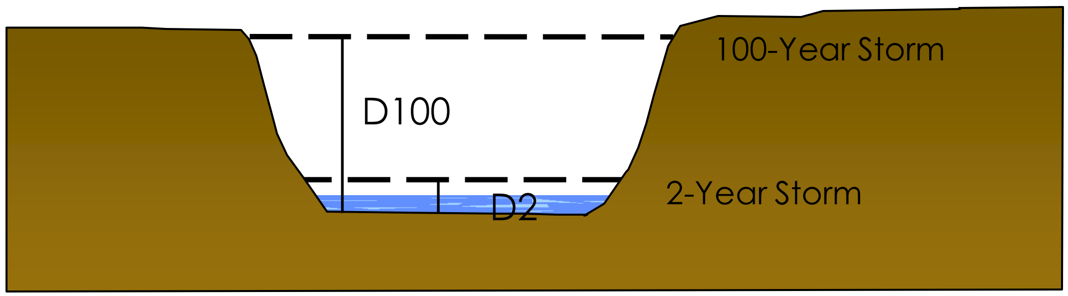
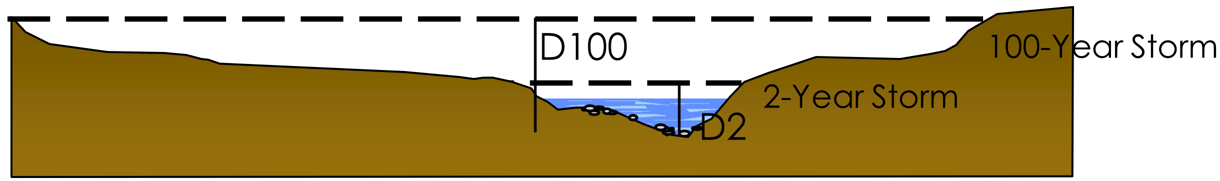
Reduction of Flood Elevation

- Priority II or III - Potential to Reduce Flood Elevation
- Priority II – Excavate Floodplain, Creating Storage
- Priority III – Do not Alter Planform but Alter Cross Section, which Often Lowers Flood Elevation
- Comparing Flood Elevations of Same Precipitation Event

Reduction of Flood Elevation



Degraded or Channelized Stream



Restored Stream

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Use of Structures in Natural Channel Design

- Provide Grade Control
- Maintain Stable Aquatic Habitat
- Maintain Shear Stresses for Sediment Transport
- Decrease Bank Erosion
- Fish Passage at All Flows
- Control During Larger Flows
- Diversion Structures
- Bridge Openings

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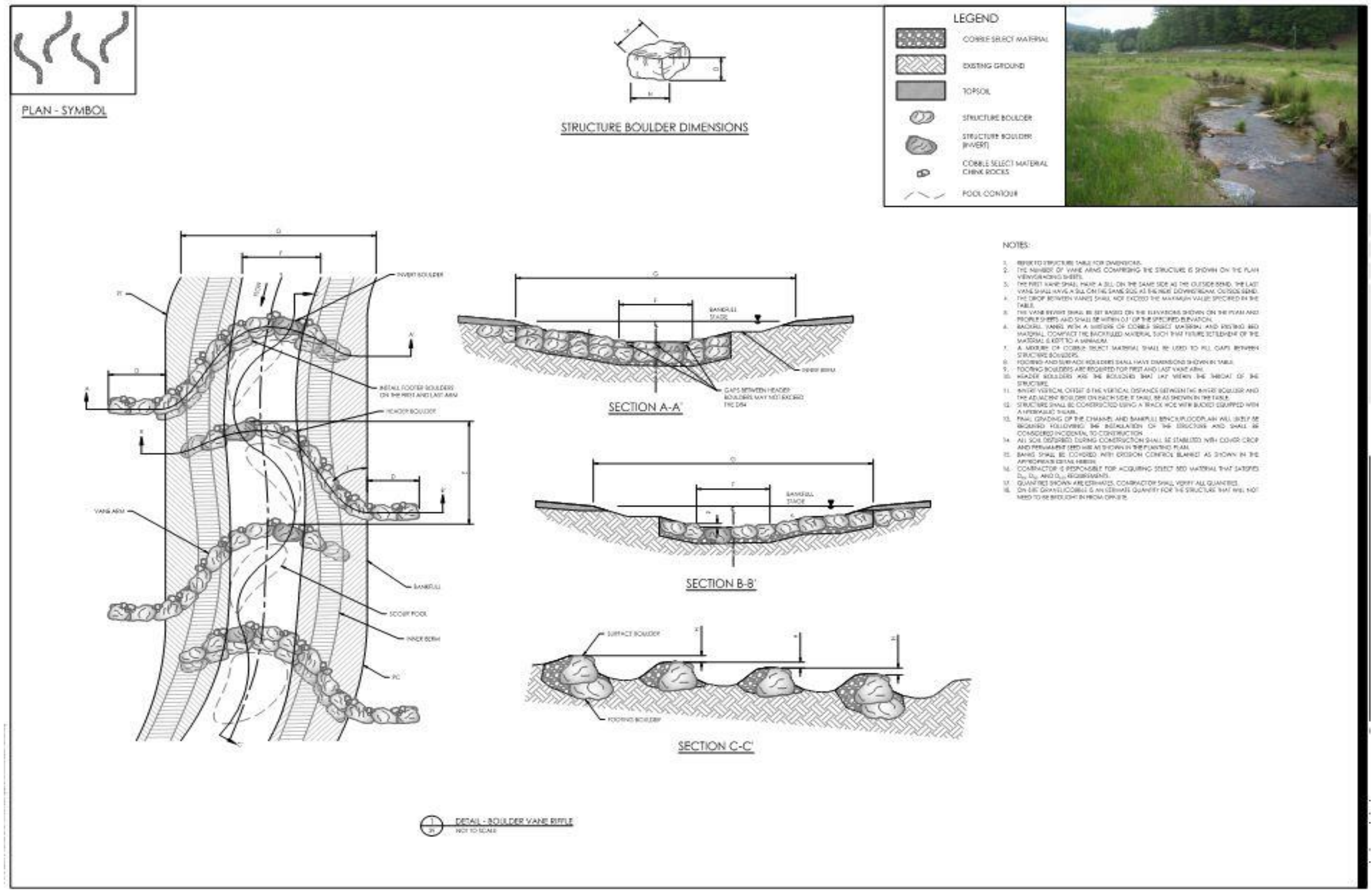
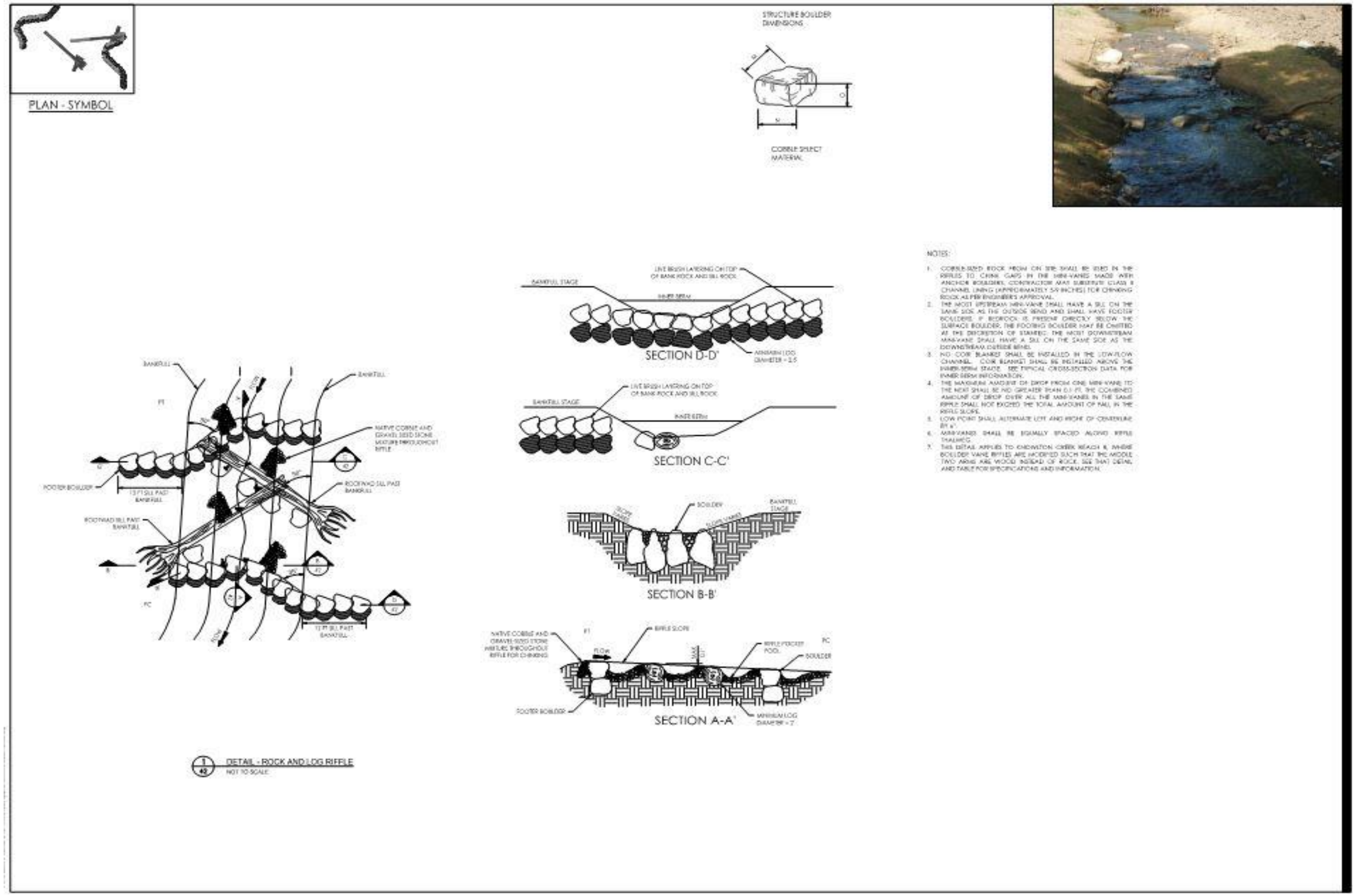
Boulder Vane Riffle



Rock and Roll Riffle



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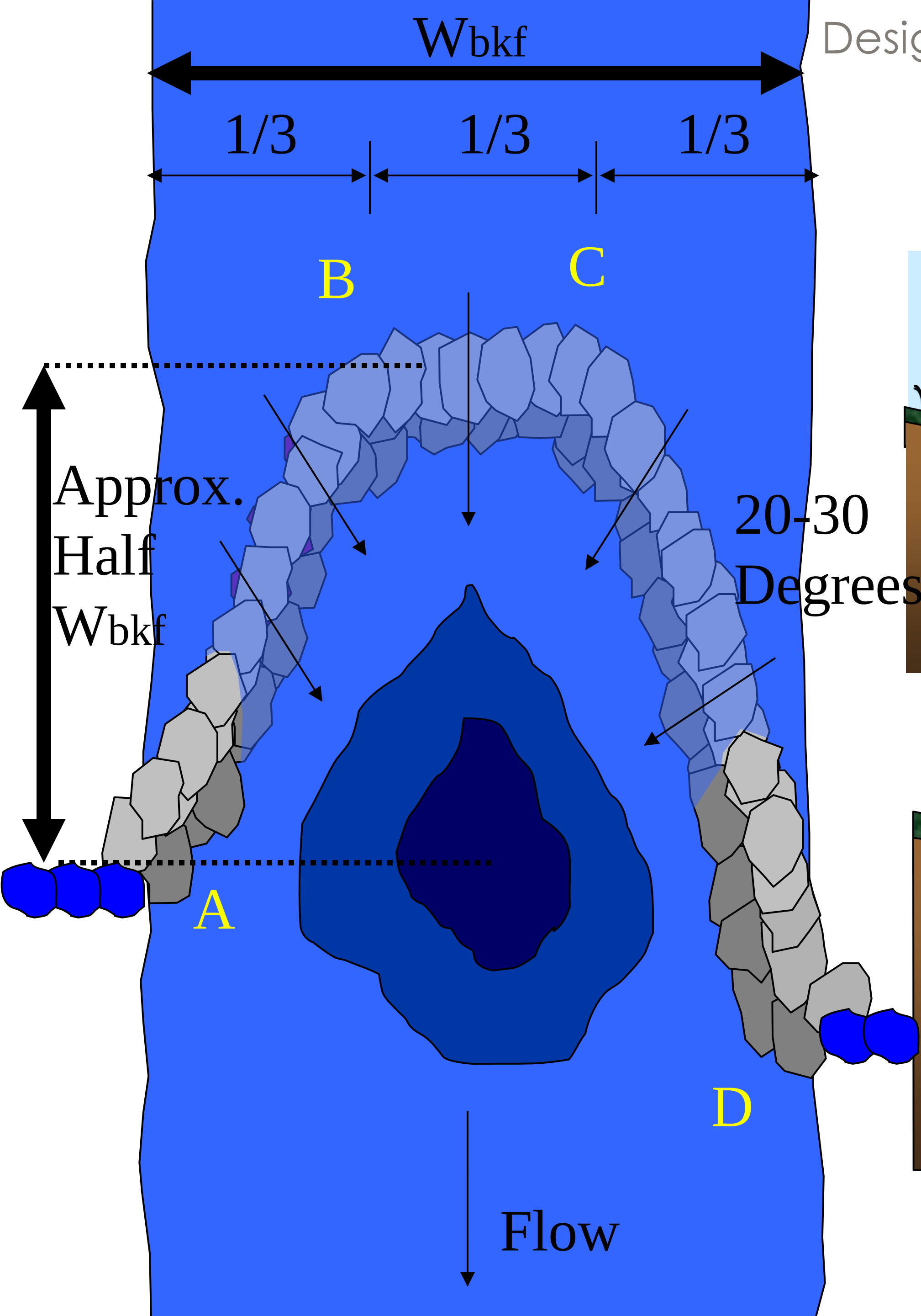
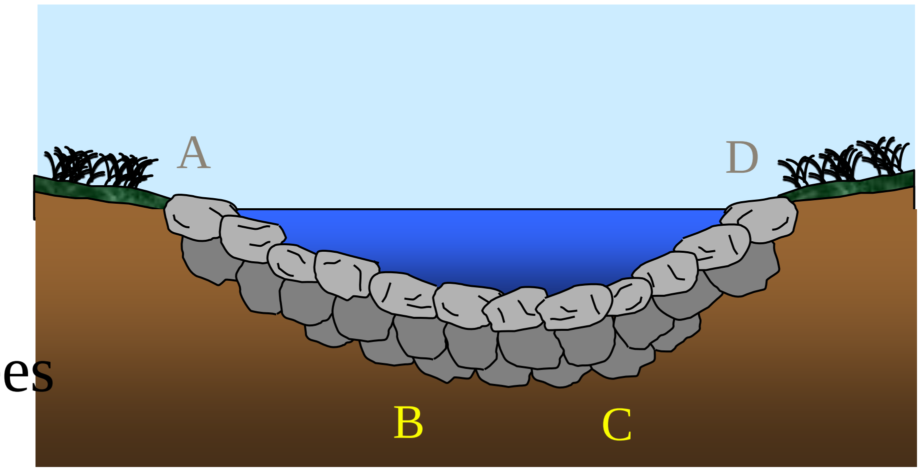
Constructed Riffle

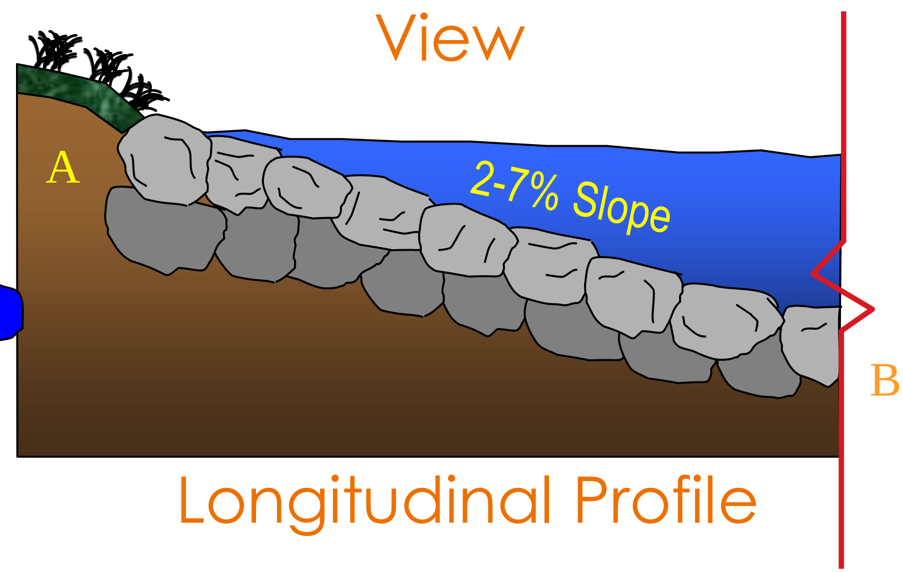
Design of Vane Structures

Cross-Vane



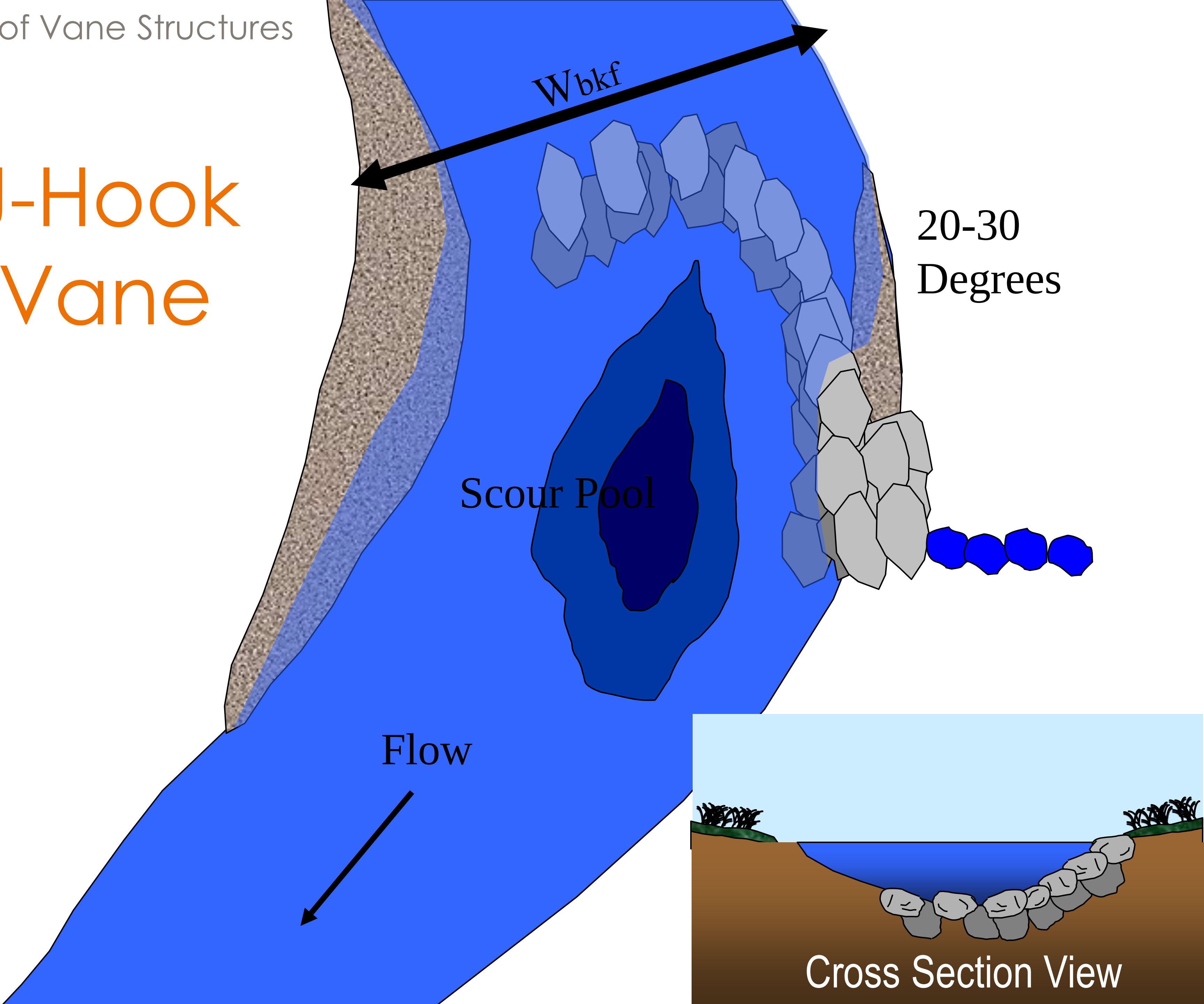


Cross Section View



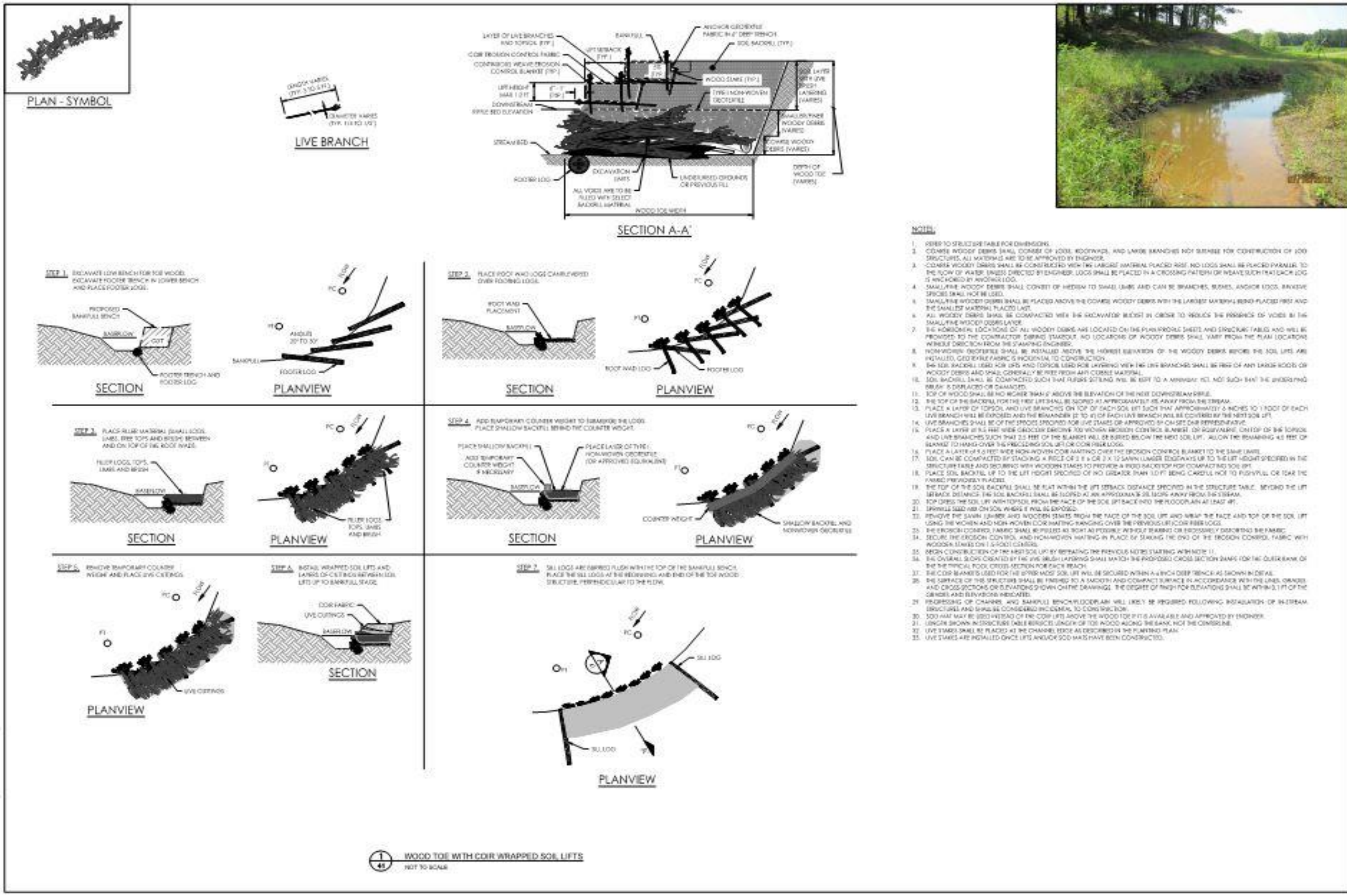
Longitudinal Profile

J-Hook Vane



Log Vane with Sill

Wood Toe


PLAN - SYMBOL
LIVE BRANCH
SECTION A-A'
SECTION
PLANVIEW
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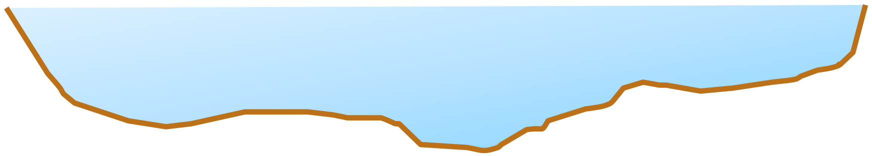
SECTION
PLANVIEW
NOTES:
WOOD TOE WITH COIR WRAPPED SOIL LIFTS
NOT TO SCALE

Woody Toe Sod Mats

Woody Toe Sod Mats

Design of Floodplain & Habitat Features

Oxbows



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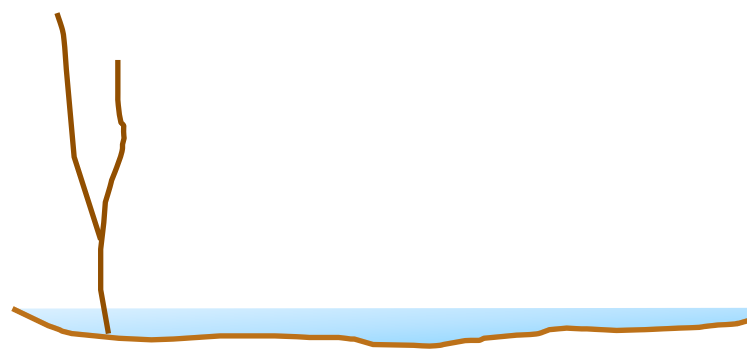
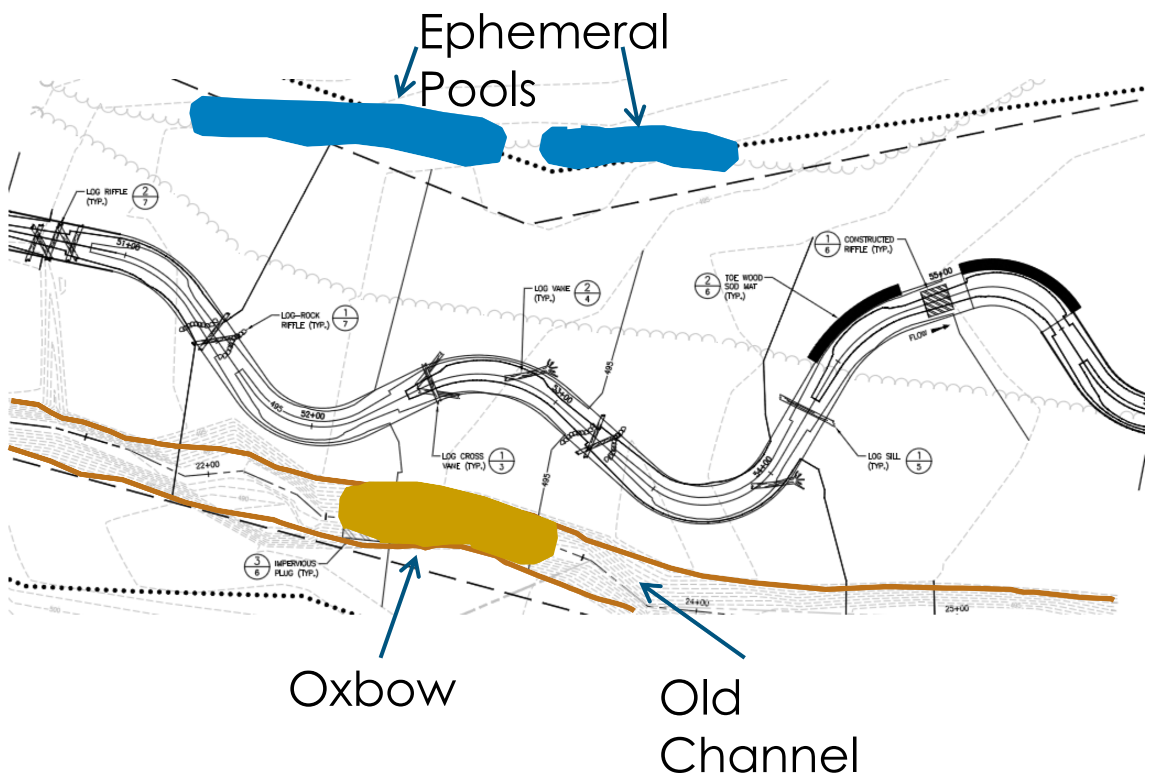
Vernal or Ephemeral Pools



Design Considerations

- Hydrology
- Depth
  - Deep
  - Shallow
- Vegetation
  - In-pool
  - Shading
- Outlet
- Cut/Fill Balance



Functions and Linkages

- Habitat
  - Amphibians
  - Invertebrates
  - Breeding
  - Rearing
  - Refuge
- Nutrient Processing
  - Organic Inputs
  - Hydric Soils
- Ecosystem Functions
- Flood Storage (Oxbows)

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Back Creek Stream Restoration at Lithia Road, Troutville, VA (VDOT)

Pre-Restoration Conditions

- Aggrading Channel as a Result of:
  - Upstream Watershed Conditions
  - Poor Restoration Attempt
- Serious Flooding During Most Rain Events
- Major Road for Area
- Impassable 5X Per Year

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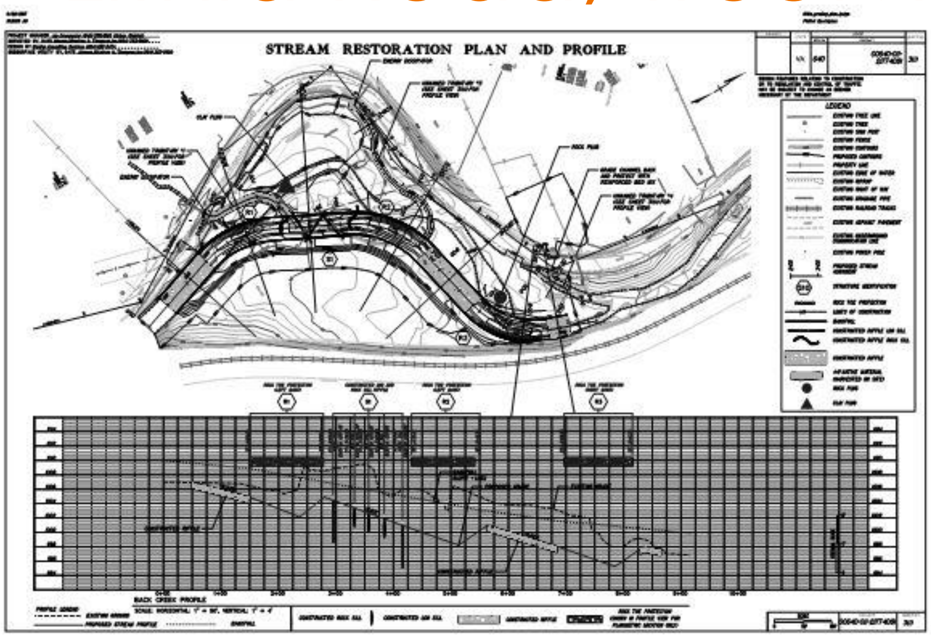
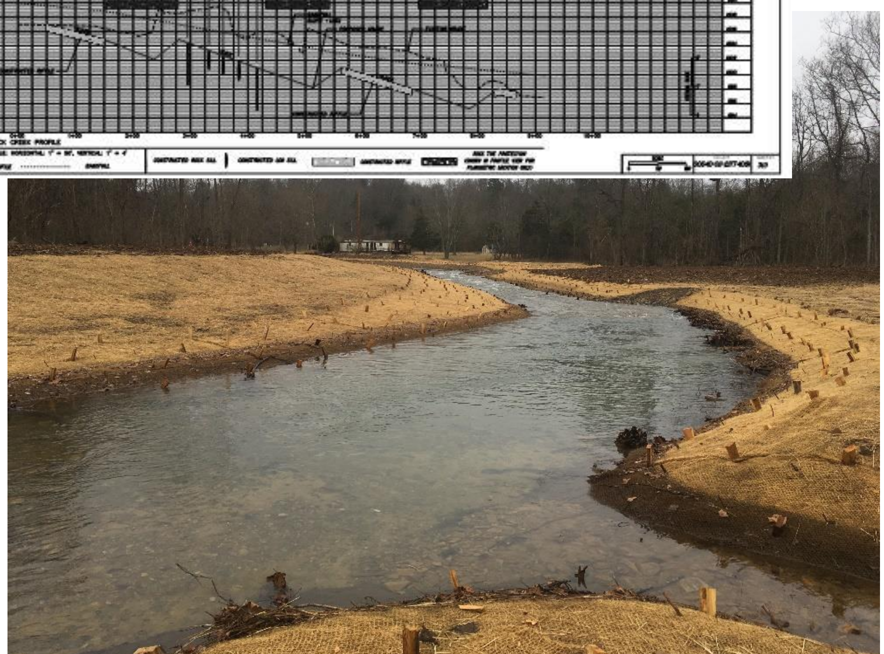
Back Creek Stream Restoration at Lithia Road, Troutville, VA (VDOT)





Restoration Design & Construction

- Proper Assessment of Geomorphic Conditions
- Natural Channel Design Approach
- Fish Habitat Improvement
- Improved Flood Conveyance

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Dare Elementary School Stream Restoration, York County, VA

Pre-Restoration Conditions

- Collapsing Concrete-Lined Channel – 20’ Headcut
- 800 Linear Feet of Channel
- Safety Issue to Adjacent Properties

Pre-Restoration Conditions

- Large Source of Erosion to Downstream Watershed
- Water Quality Problems

Dare Elementary School Stream Restoration, York County, VA

Restoration Design & Construction

- Priority III Restoration Approach
- Designed In-Line BMP Upstream to Provide Peak Flow Attenuation & WQ Treatment
- Stabilized Severe Headcut
- Protected Adjacent Properties
- Maintained Low Flow Channel Connected to Floodplain
- Phosphorus Removed – 141 LB/YR
- Savings Per LB of TP - $8,511
- Value to Watershed - $2.4M
- Total Project Cost - $1.2M

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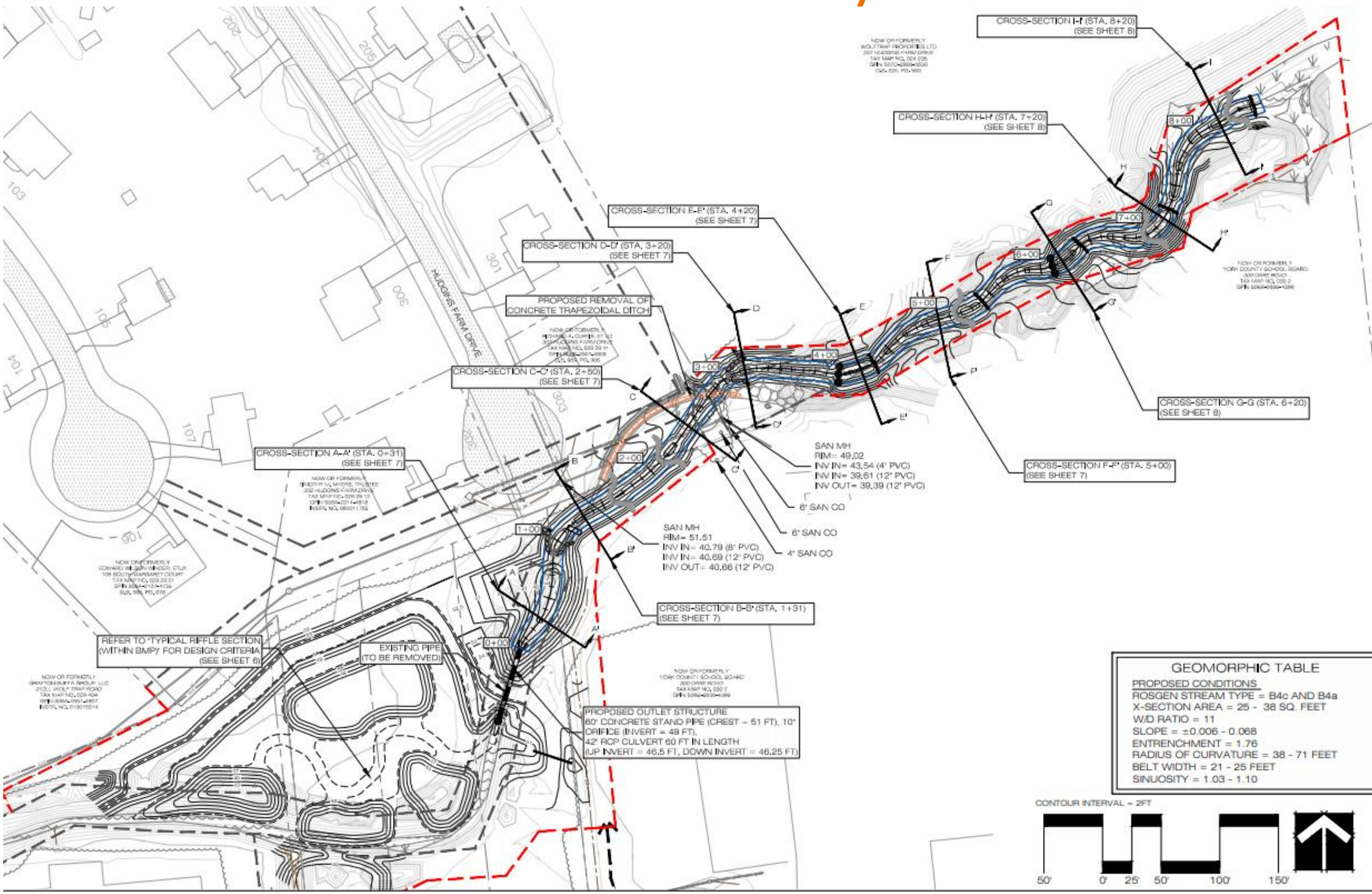
Dare Elementary School Stream Restoration, York County, VA



Dare Elementary School Stream Restoration, York County, VA

Post-Construction Conditions

- Project Stable and Functioning as Designed for 5 Years

Middle Fork of Beargrass Creek at Cherokee Park Stream Restoration, Louisville, KY

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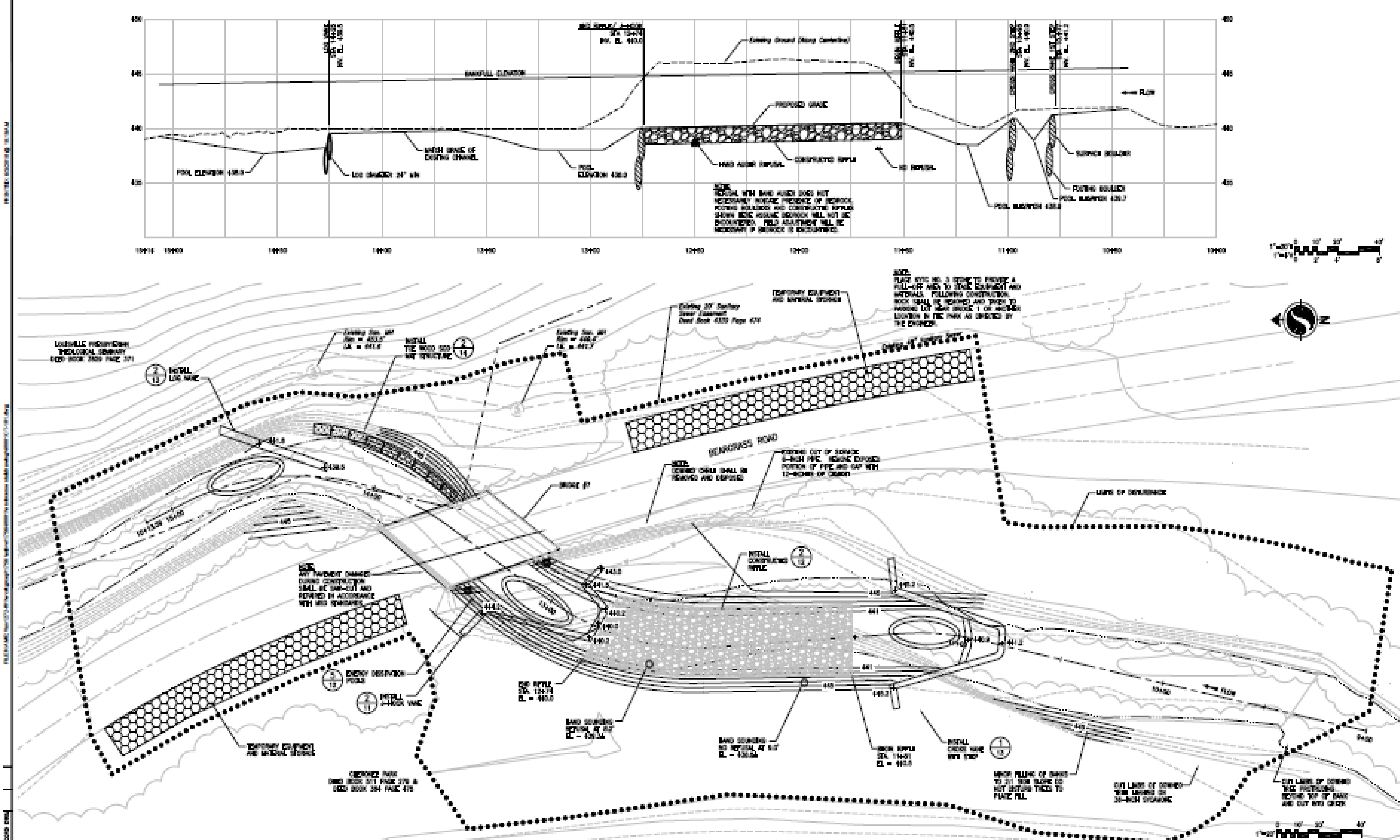

PLANS PREPARED AND SUBMITTED BY:

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CONSTRUCTED BY:

Company Name — Date

FINAL RECORD DRAWING BY:

Company Name

Signature — Date

LOUISVILLE AND JEFFERSON COUNTY METROPOLITAN SEWER DISTRICT

DESIGN APPROVED:

APPROVED FOR CONSTRUCTION:

ALL ELEVATIONS IN THIS SET OF PLANS ARE BASED ON NAD 83 DATUM. ELEVATIONS WILL NOT AGREE WITH ELEVATIONS ON EXISTING PLANS FROM PREVIOUS PLANT CONSTRUCTION PROJECTS.

0 — 1" BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

MSD

MIDDLE FORK BEARGRASS CREEK STREAM ENHANCEMENT PROJECT

CHEROKEE PARK BRIDGE #7
PLAN AND PROFILE
STATION 10+00 TO STATION 15+14

SCALE: 1" = 20'H, 1" = 2'V	Date: 05/26/10	Drawing No.: CT-101


Link-Belt
210
CAT
320C
CAT


20
M.P.H.

QUESTIONS?

November 8, 2018

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