STREAM & RIPARIAN REHABILITATION PHILOSOPHY AND OTHER STUFF

by dave derrick

A RESTORATION ANALYSIS IS KIND OF LIKE AN ARSON INVESTIGATION…

Goal and Function-Based Design

(WHAT IN THE WORLD ARE YOU TRYING TO ACCOMPLISH?)

THINK MINIMUM STRUCTURE & MAXIMUM EFFECT (FUNCTION) especially for urban systems

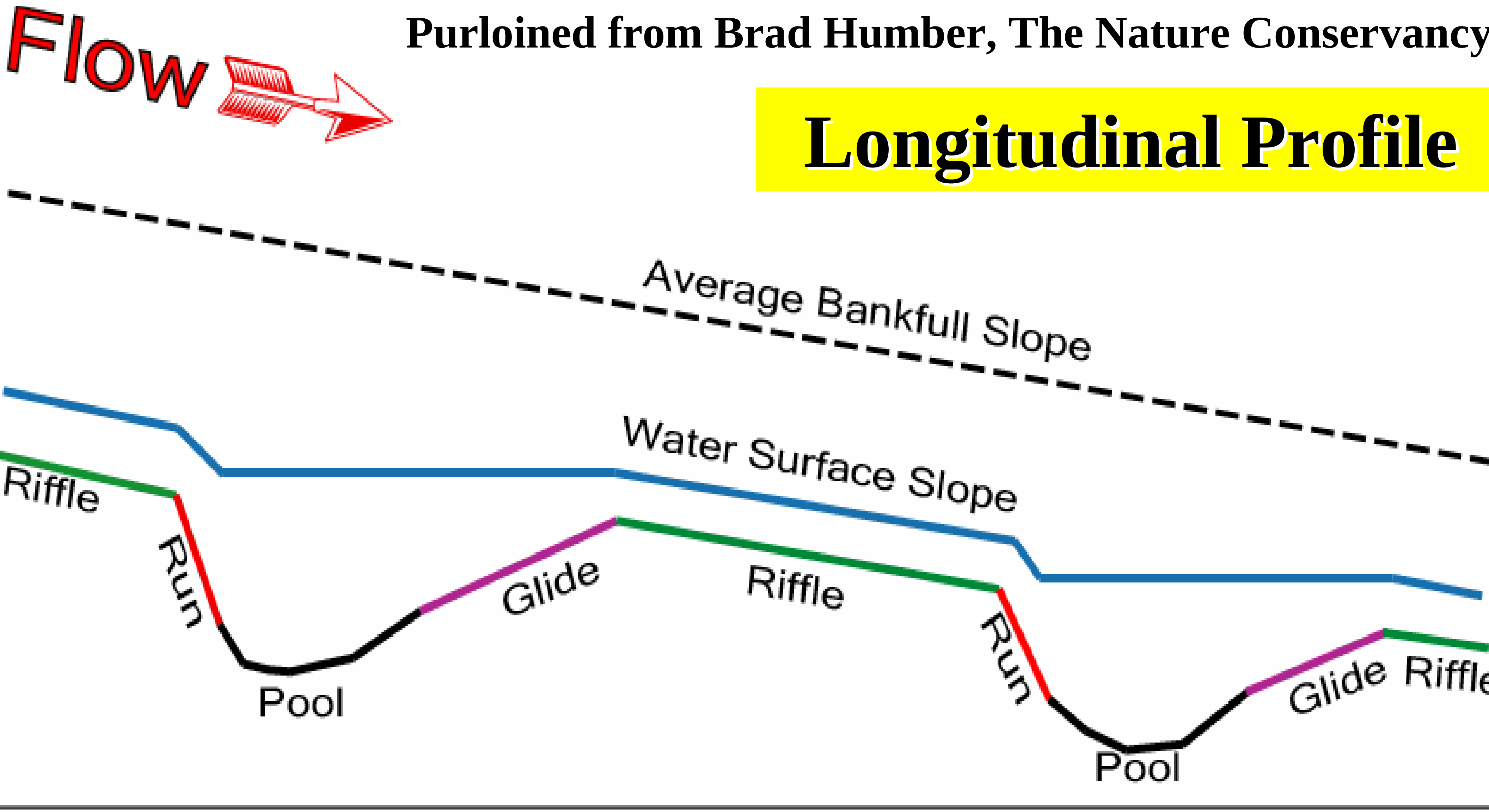
TOP 6 REASONS THAT I SEE STREAM PROJECTS FAIL

- Project goals and functions not thoroughly thought out
- Start and end points wrong (project did not go far enough upstream or downstream, or both)
- Scour at the toe, or foundation failure of foundation – dependant stabilization methods
- Inadequate keys
- Inappropriate use of redirective methods (not applicable)
- Folks simply did not understand where water was going and what was guiding it. YOU HAVE TO THINK LIKE WATER AND SEE WHAT WATER SEES!!!

HOW DO STREAMS DISSIPATE ENERGY ???

HOW STREAMS NATURALLY DISSIPATE ENERGY !!

Purloined from Brad Humber, The Nature Conservancy

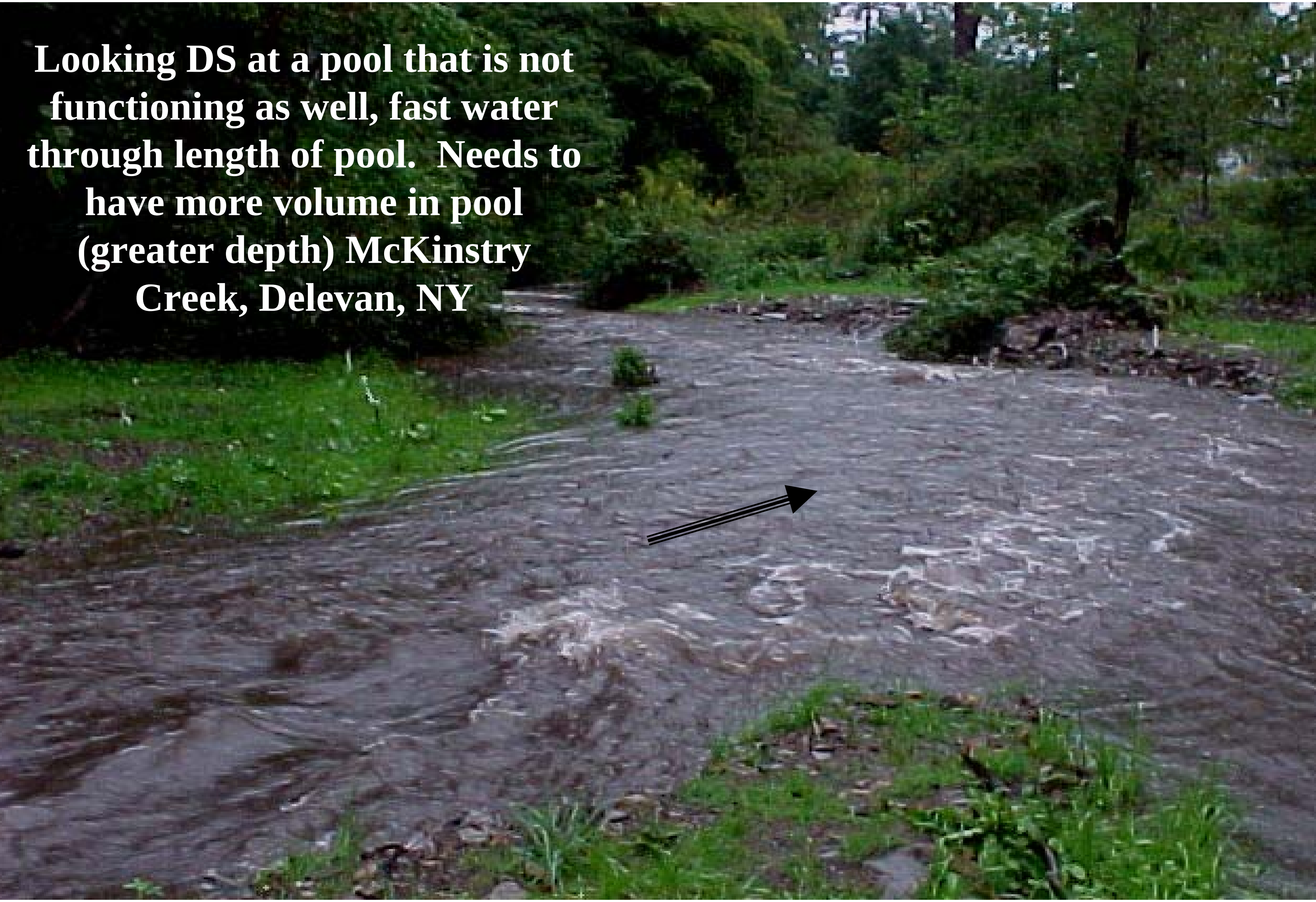


HOW TO TELL WHEN A POOL IS WORKING PROPERLY

Looking US at a properly functioning pool, note rooster tail dies out at DS end of pool during bankfull event, McKinstry Creek, Delevan, NY

Gravel-cobble bed, 1% slope, rural, pool-riffle-pool

Looking US at a properly functioning pool, note rooster tail dies out at DS end of pool during bankfull event, McKinstry Creek, Delevan, NY


Looking DS at a pool that is not functioning as well, fast water through length of pool. Needs to have more volume in pool (greater depth) McKinstry Creek, Delevan, NY

PLANTING PLANTS WITH LARGE YELLOW MACHINES

Transplanting a giant multi-trunk alder

Photo: Deb Freeman


ALDER
BOB


Transplanted
alder
Looking DS at
pool & Alder
during Katrina's
rains, Sept 1, 2005

THE REACTIVE STREAM STABILIZATION (RS2) RESEARCH

Knowledge by Dr. Chester Watson

Anaerobic Reaction Zone

Denitrification

$NO_3^- \rightarrow N_{2\,(g)}$

Carbon source (sawdust)

Saturated (anaerobic)

Phosphorus removal

Alum based water treatment residuals (WTR)

Ratio of…

- sawdust (20 vol %)
- coarse sand (35%)
- silt sand (35%)
- native soil (10%)

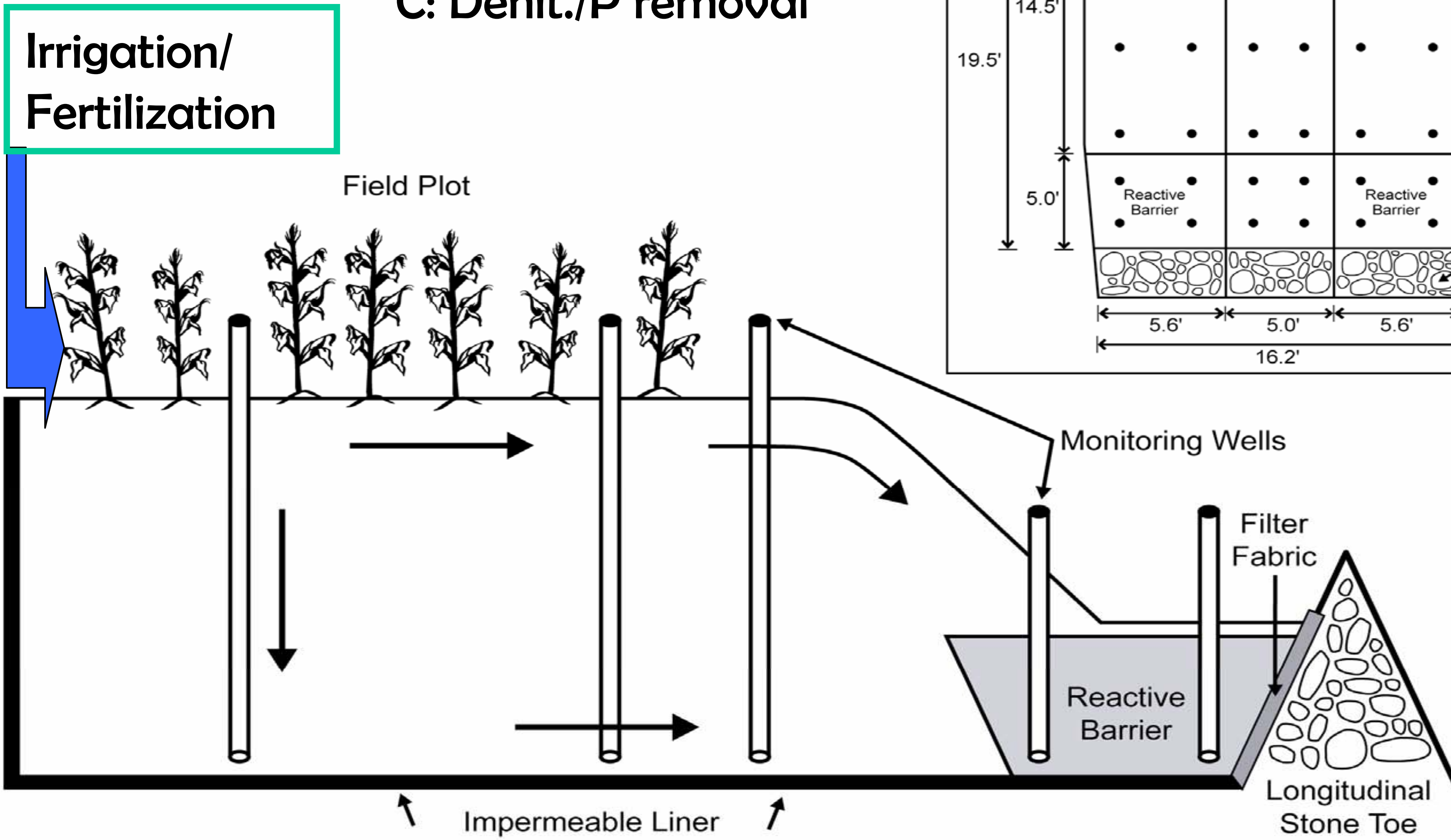
Ratio of…

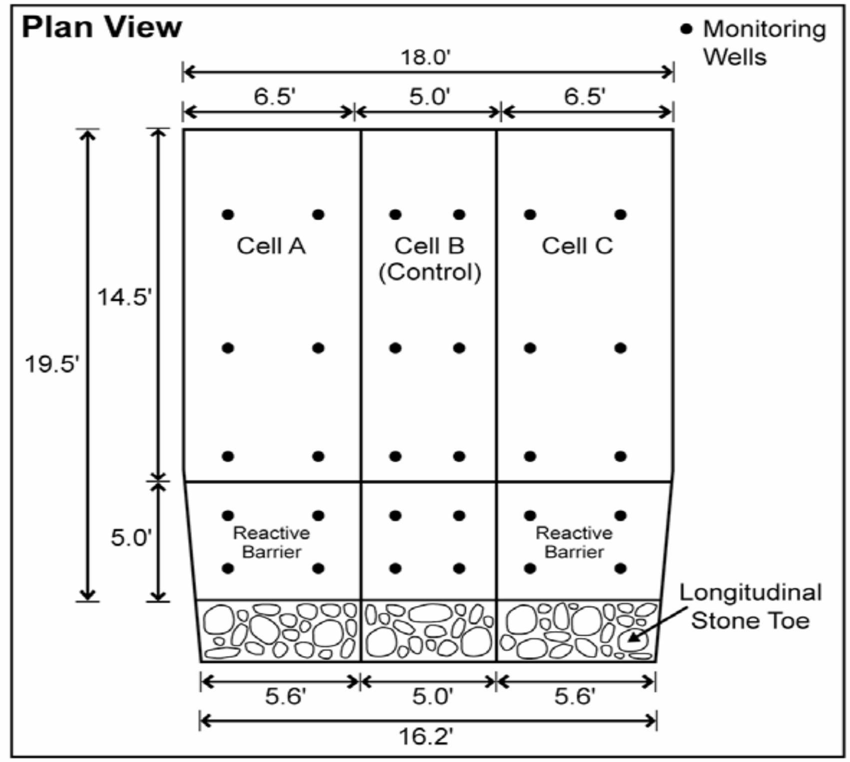
- sawdust (19 vol %)
- coarse sand (33%)
- silt sand (33%)
- native soil (10%)
- WTR (5%)

A: Denitrification

B: Control

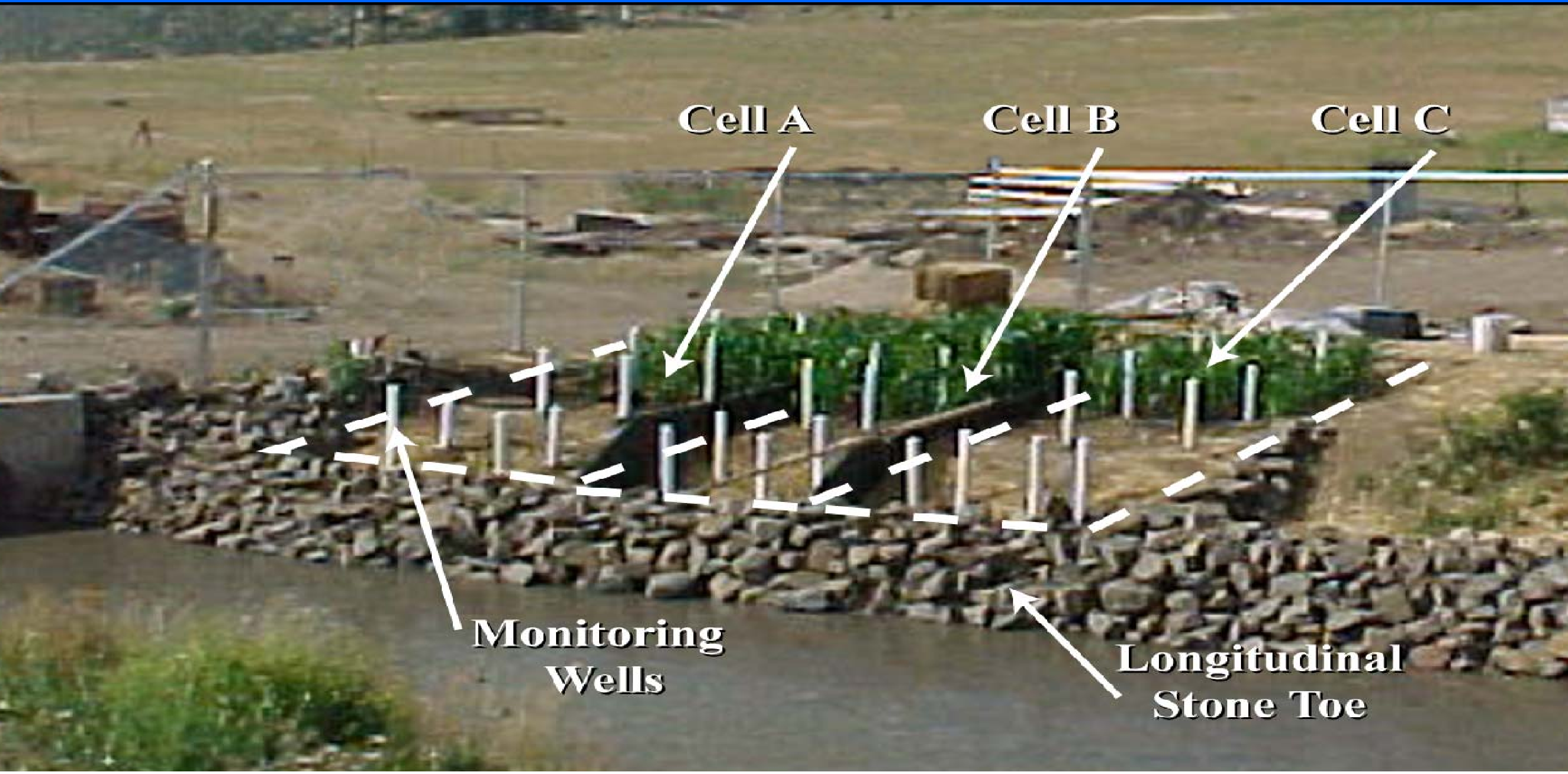
C: Denit./P removal





Research Monitoring & Analysis

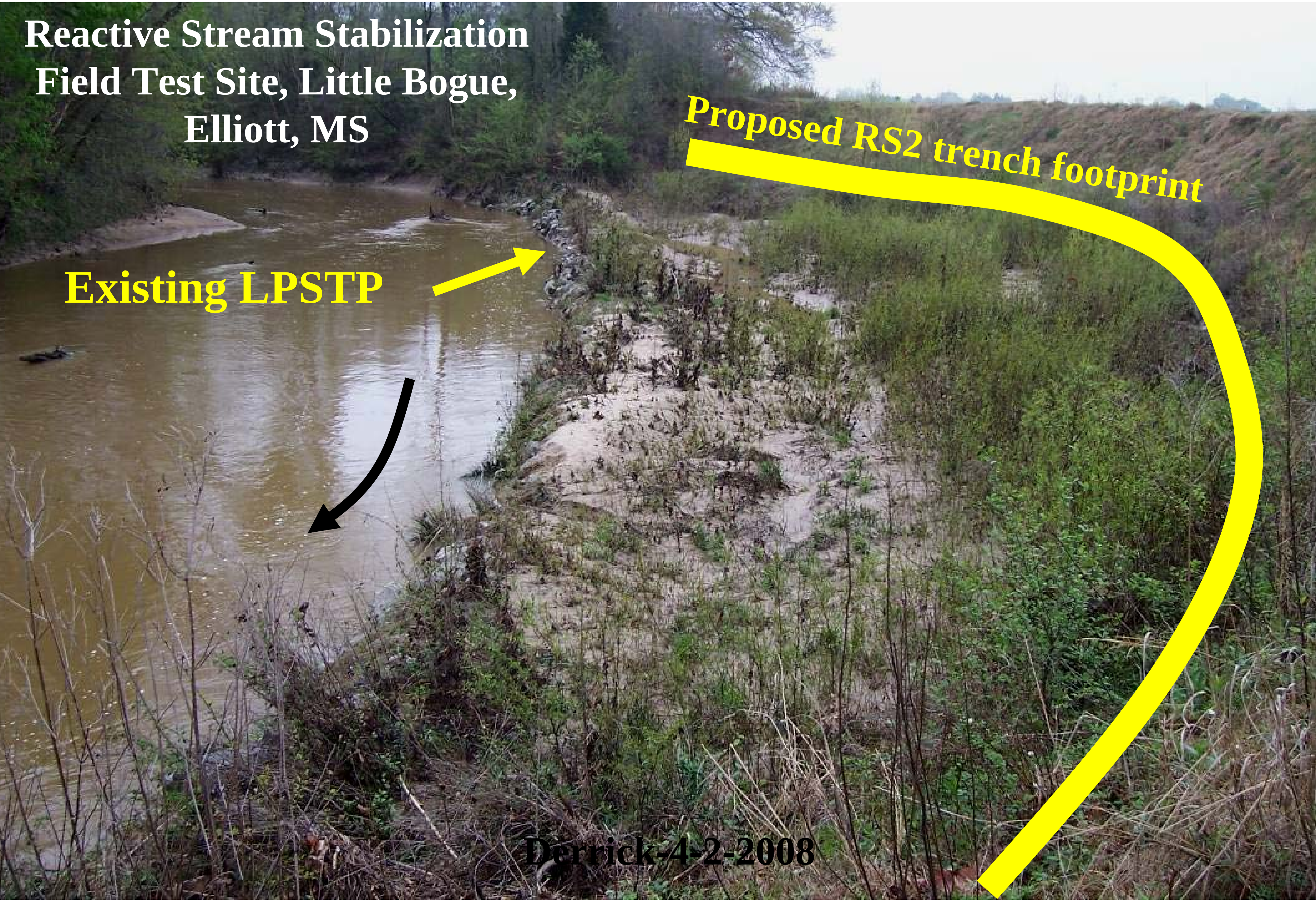
- Hydrolab used to measure DO, ORP, temp, conductivity, turbidity & pH
- Lab measurement of ortho-P, NO_3-N, TOC, alkalinity and NH_3-N



LITTLE BOGUE, ELLIOTT, MS,

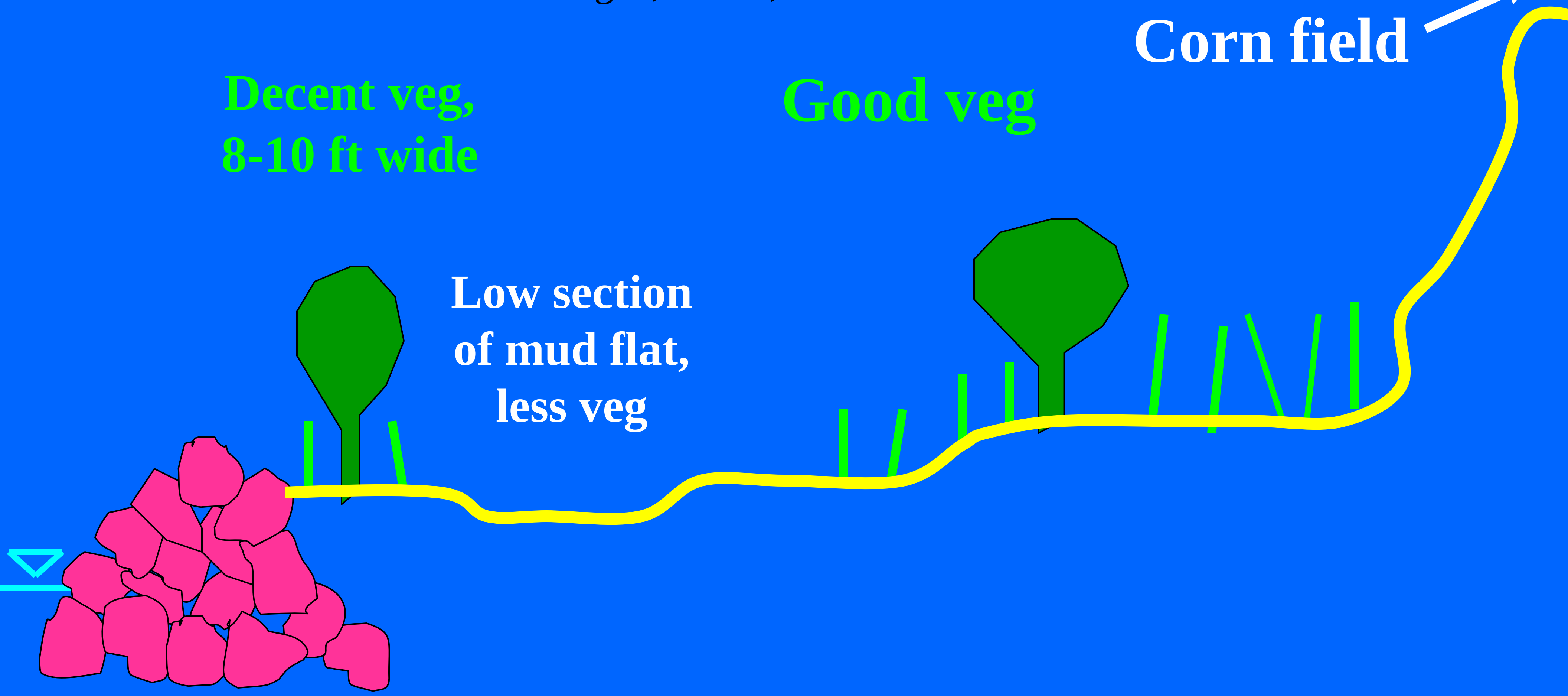
FULL-SIZED TEST SITE – SCHEDULED FOR CONSTRUCTION FALL 2008

Drawings by Dave Derrick



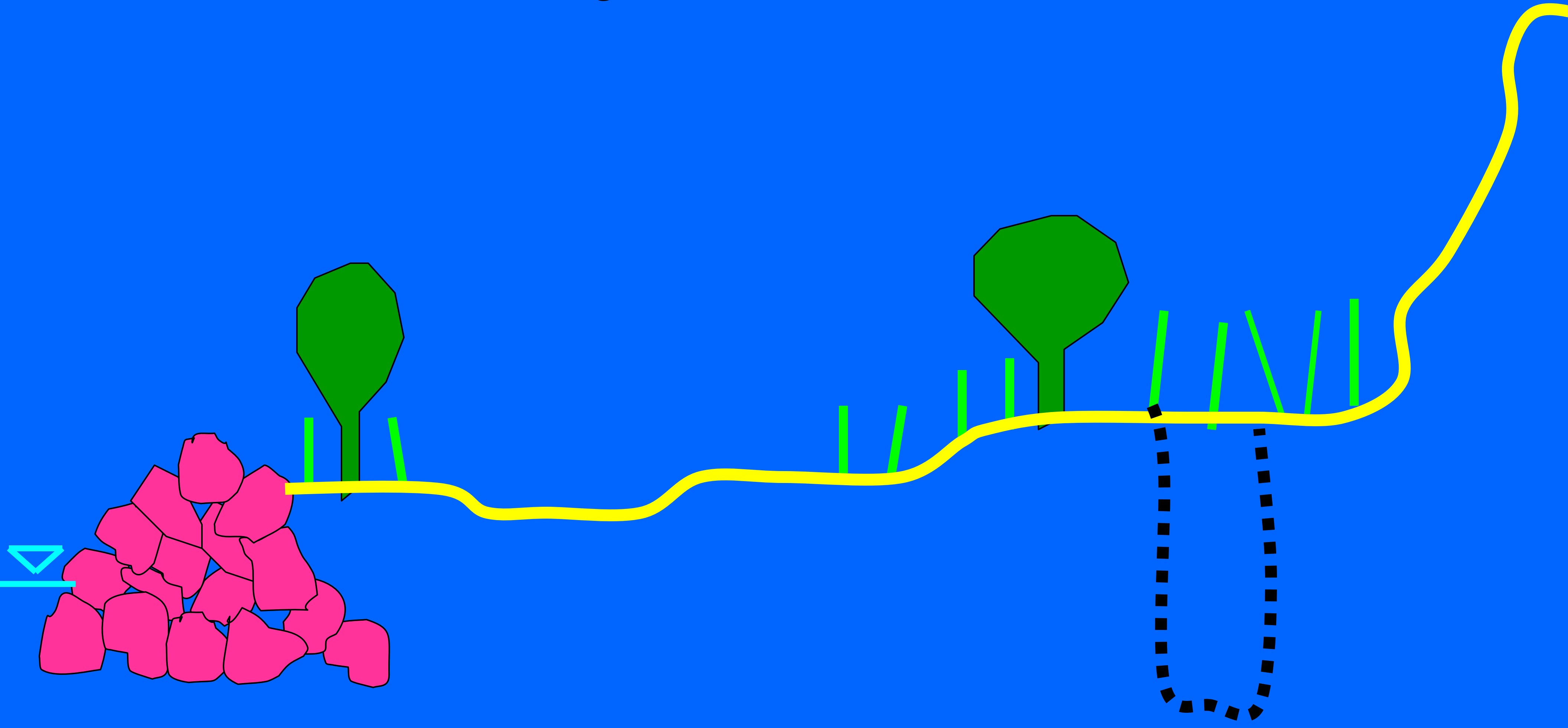
Reactive Stream Stabilization
Field Test Site, Little Bogue,
Elliott, MS
Proposed RS2 trench footprint
Existing LPSTP
Derrick-4-2-2008

RS2 Test Site: Little Bogue, Elliott, MS



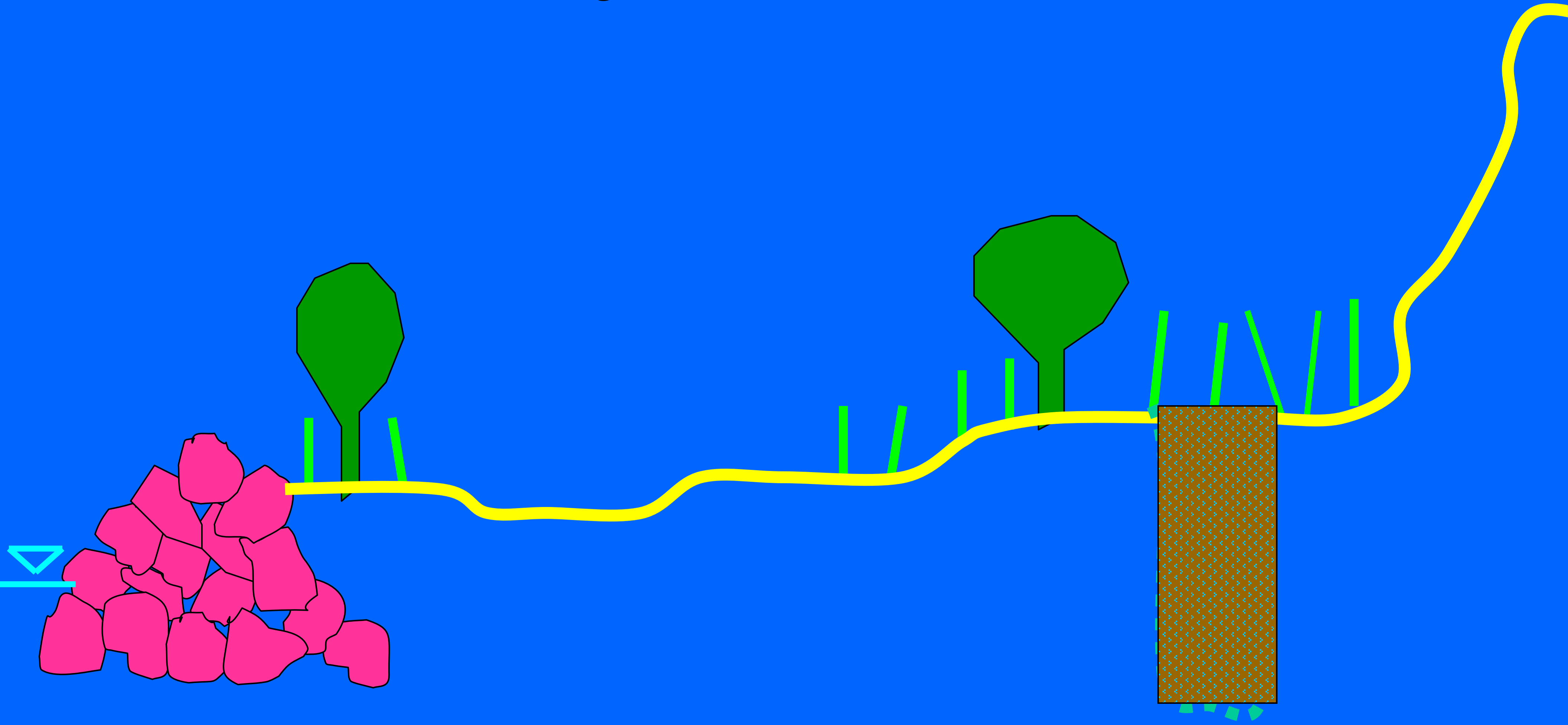
Existing condition of floodplain landward of existing LPSTP

RS2 Test Site: Little Bogue, Elliott, MS



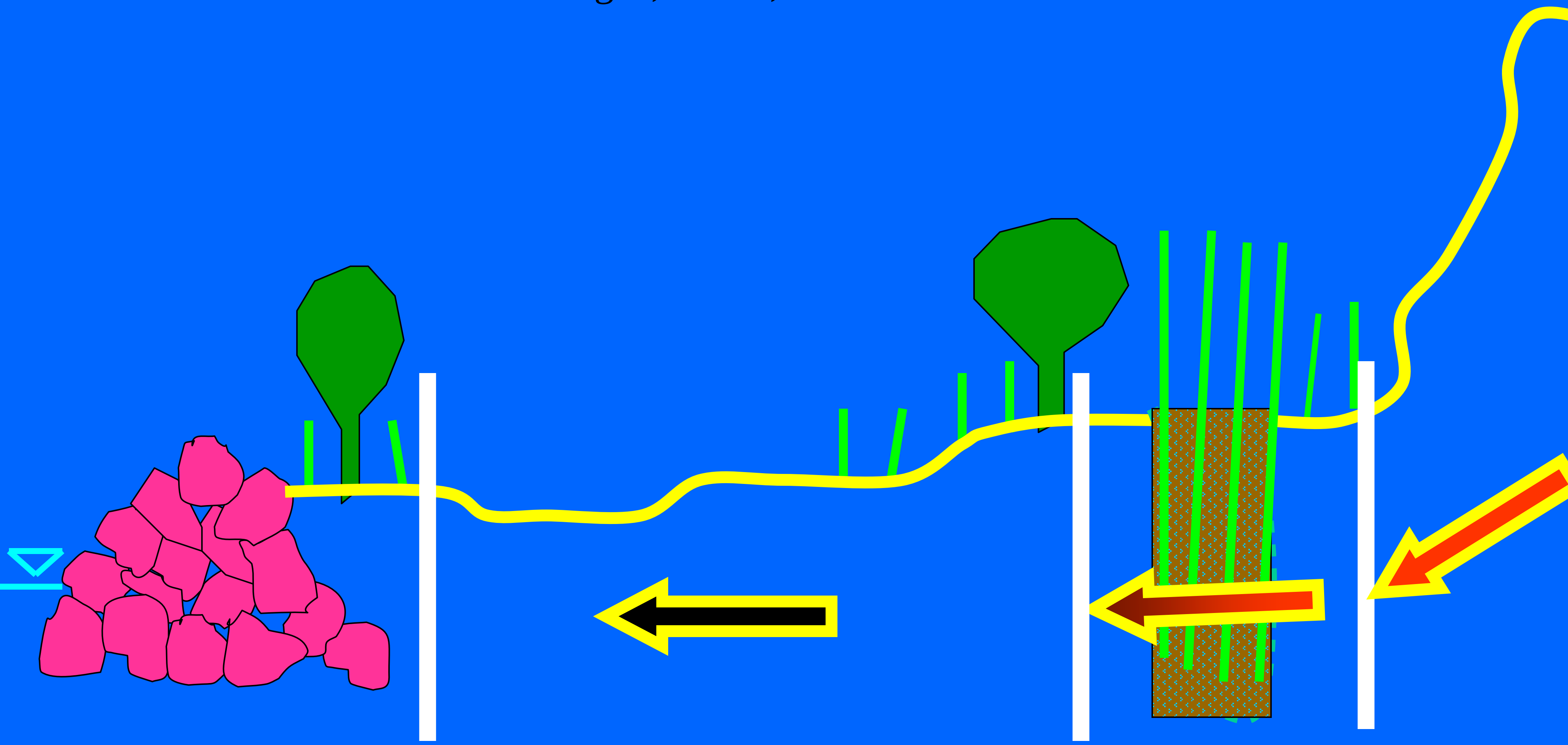
Mechanically remove a bucket width (3 ft wide by 1 or 2 ft deeper than the water table) section of overbank.

RS2 Test Site: Little Bogue, Elliott, MS



Use various techniques to place Water Treatment Residual (WTR) and reactive mix in trench.

RS2 Test Site: Little Bogue, Elliott, MS

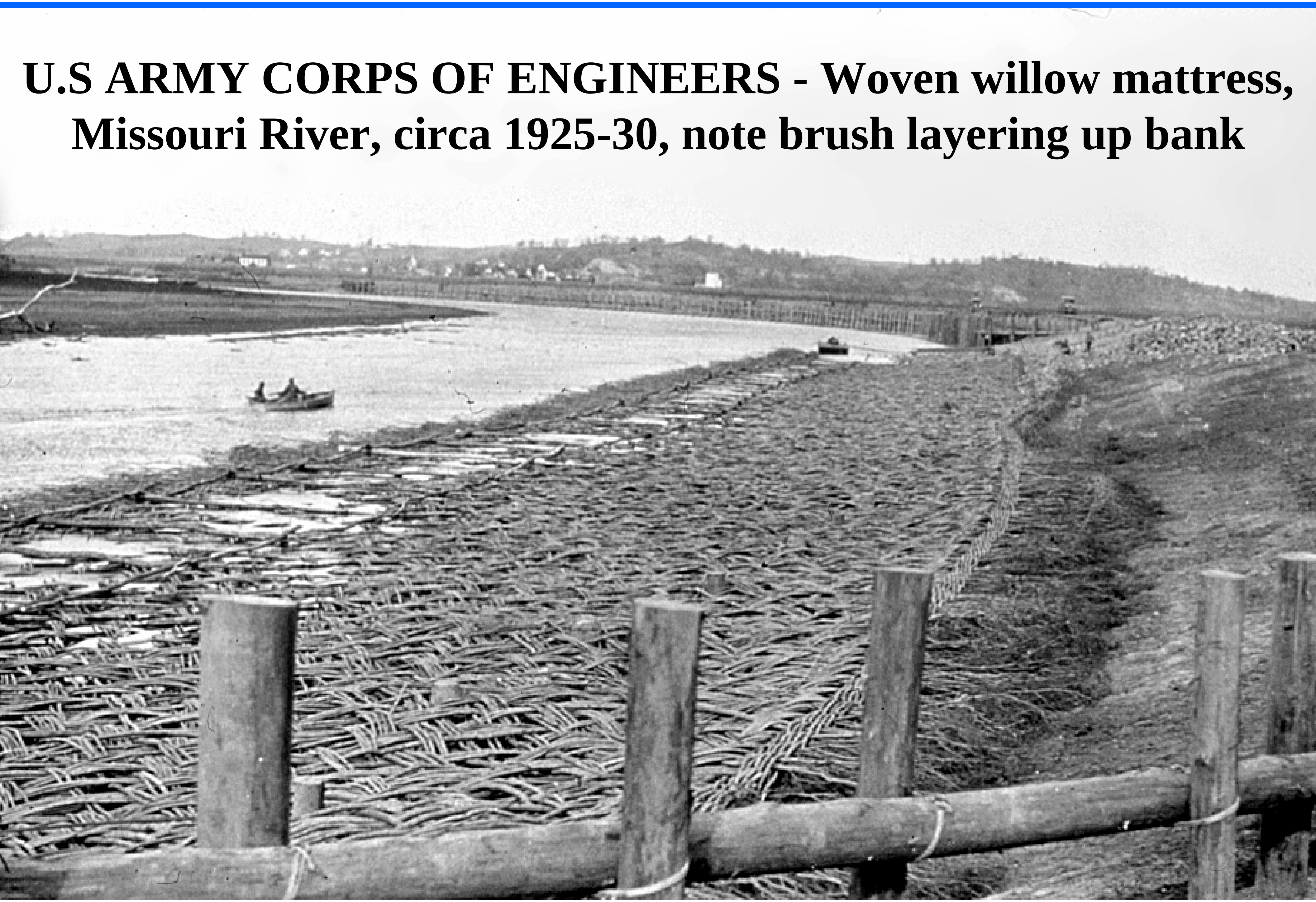


Chemical load to stream reduced, monitoring instruments determine performance of tests.

CATEGORIES OF METHODS:

RESISTIVE
REDIRECTIVE
PROPRIETARY
BIOENGINEERING

U.S ARMY CORPS OF ENGINEERS - Woven willow mattress, Missouri River, circa 1925-30, note brush layering up bank



Conceptually, LIST PLANT CHARACTERISTICS NEEDED (not a specific plant) to satisfy performance goals

BIOENGINEERING

***??WHAT ARE YOU TRYING TO DO?? ***

DID I MENTION, FUNCTION-BASED DESIGN?????

- PROBLEMS: For rills & gullies from overland flow, strong and dense rooted ground covers or grasses might function well.
- Use pioneer species that will stabilize the bank and evolve into a climax forest?
- Plant specific plants for use by specific fauna?
- Do you need an understory, mid-story and overstory? Or not?
- Will the overstory shade out the understory?
- Vegetative roughness or living dikes to reduce flow velocities & catch sediment?
- Do you need shade and canopy over the stream? Microhabitats?
- Insect production for the stream?
- Tall veg and canopy to keep cool moist air over the stream?
- Flood concerns? Use herbaceous plants!?!?


What’s the effective root depth??

Bioengineering Planting Considerations

- First look up, then look down, (up to analyze for amount of light and overhead power lines, down for suitable soil & pipeline right-of-ways), then look around for exotic plant competition, and where (or if) the plants of choice are growing naturally. Plants on opposite banks might grow in different elevation bands. If plants are not found naturally, why?
- Plant materials can be obtained through commercial growers, NRCS plant material centers, grown in-house, or harvested from the wild.
- Harden-off rooted-stock plants (place outside greenhouse) before planting.
- Harvested cuttings should be kept moist and out of direct sunlight.
- Some cuttings benefit from soaking (up to 31 days for Black Willow). Water that plants are soaked in should be fresh.
- Very important to have good soil-to-stem contact, this must be carefully specified in contracts
- Plantings need to be closely monitored for insect infestation and mortality, some replanting can be expected during the second growing season.
- Is irrigation needed? Weed control? Browsing control?

How Vegetative Treatments Stabilize Banks

- Foliage slows floodwaters on and near the eroding bank.
- Root network helps to bind soil together.
- Trunks and stems can trap debris and upslope failed material.
- Vegetation removes soil moisture through transpiration.
- Larger branches/trunks planted deep can sometimes mechanically stabilize soil, and could possibly pin shallow failure faults.
- Can induce sedimentation.
- Most importantly, the resulting stable bank allows for the establishment of volunteer plant growth and subsequent vegetative succession.


Cottonwood 4
Weed 88

ONONDAGA COUNTY BUILT A PROJECT WITHOUT A PERMIT

BUFFALO DISTRICT REGULATORY ASKED ME TO BRING THEM INTO COMPLIANCE

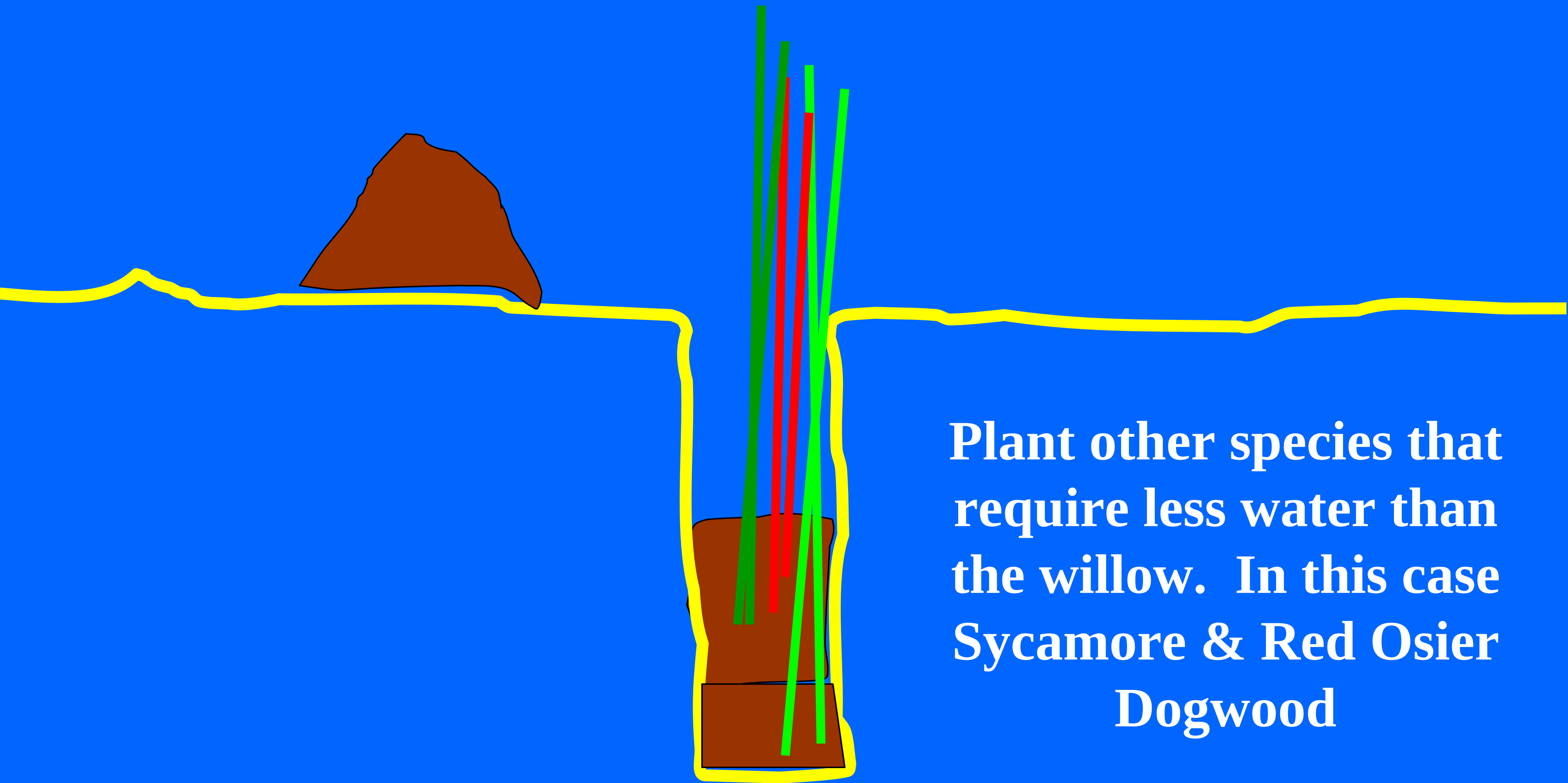
RESULT: 1-DAY HANDS-ON WORKSHOP FOR 44 PEOPLE

2700 PLANTS PLANTED IN 6 HRS

Rubber tired backhoe digs 4-5 ft deep trench with a narrow bucket. Pix by Bill Frederick

Many hands get things done quickly, 2,740 plants planted in about 6 hours. That’s why they call it a workshop. Pix by Derrick

TWO-STAGE SLIT TRENCH TECHNIQUE



Plant other species that require less water than the willow. In this case Sycamore & Red Osier Dogwood

BIOENGINEERING INFO SOURCES

- **Federal Interagency Stream Restoration Working Group, 1998.** Stream Corridor Restoration: Principles, Processes, and Practices. National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia
- **Gray, Donald H. & Sotir**, **Robin B.** (1996) Biotechnical and Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control. John Wiley & Sons, Inc. New York, NY
- **Schiechtl, Hugo**, (1980) Bioengineering For Land Reclamation & Conservation. The University of Alberta Press
- **Schiechtl, Hugo** M., & Stern, R. (1996) Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection. Blackwell Science, Inc.
- **GOOGLE: F. Douglas Shields; Donald Roseboom; Andrew Leiser; Robin Sotir; John McCullah; Phillip Balch; S.R.Pezeshki**

Stability Thresholds for Stream Restoration Materials

by Craig Fischenich[1]

May 2001

Complexity	Value as a Planning Tool	Cost
Low — Moderate — High	Low — Moderate — High	Low — Moderate — High

OVERVIEW

Stream restoration projects usually involve some modification to the channel or the banks. Designers of stabilization or restoration projects must ensure that the materials placed within the channel or on the banks will be stable for the full range of conditions expected during the design life of the project. Unfortunately, techniques to characterize stability thresholds are limited. Theoretical approaches do not exist and empirical data mainly consist of velocity limits, which are of limited value.

Empirical data for shear stress or stream power

When the ability of the stream to transport sediment exceeds the availability of sediments within the incoming flow, and stability thresholds for the material forming the boundary of the channel are exceeded, erosion occurs. This technical note deals with the latte case of instability and distinguishes the presence or absence of erosion (threshold condition) from the magnitude of erosion (volume).

Erosion occurs when the hydraulic forces in the flow exceed the resisting forces of the channel boundary. The amount of erosion is a function of the relative magnitude of these forces and

LET'S SEE HOW IT GROWS


BEFORE 5-15-2007
8:00am. Pix by Derrick


AFTER 5-15-2007
3:00pm . Pix by Derrick

Aug 3, 2007 {less than 3 months after installation}. Looking US at right bank floodplain. Pix by Mark Schaub

Oct 16, 2007 {5 months after installation}. Looking US at left bank floodplain. Pix by Mark Schaub

BIOENGINEERING INFO SOURCES

- **Federal Interagency Stream Restoration Working Group, 1998.** Stream Corridor Restoration: Principles, Processes, and Practices. National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia
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Erosion occurs when the hydraulic forces in the flow exceed the resisting forces of the channel boundary. The amount of erosion is a function

SMALL STREAM → BIG RIVER

Locked Logs on a stream:

18 Mile Creek

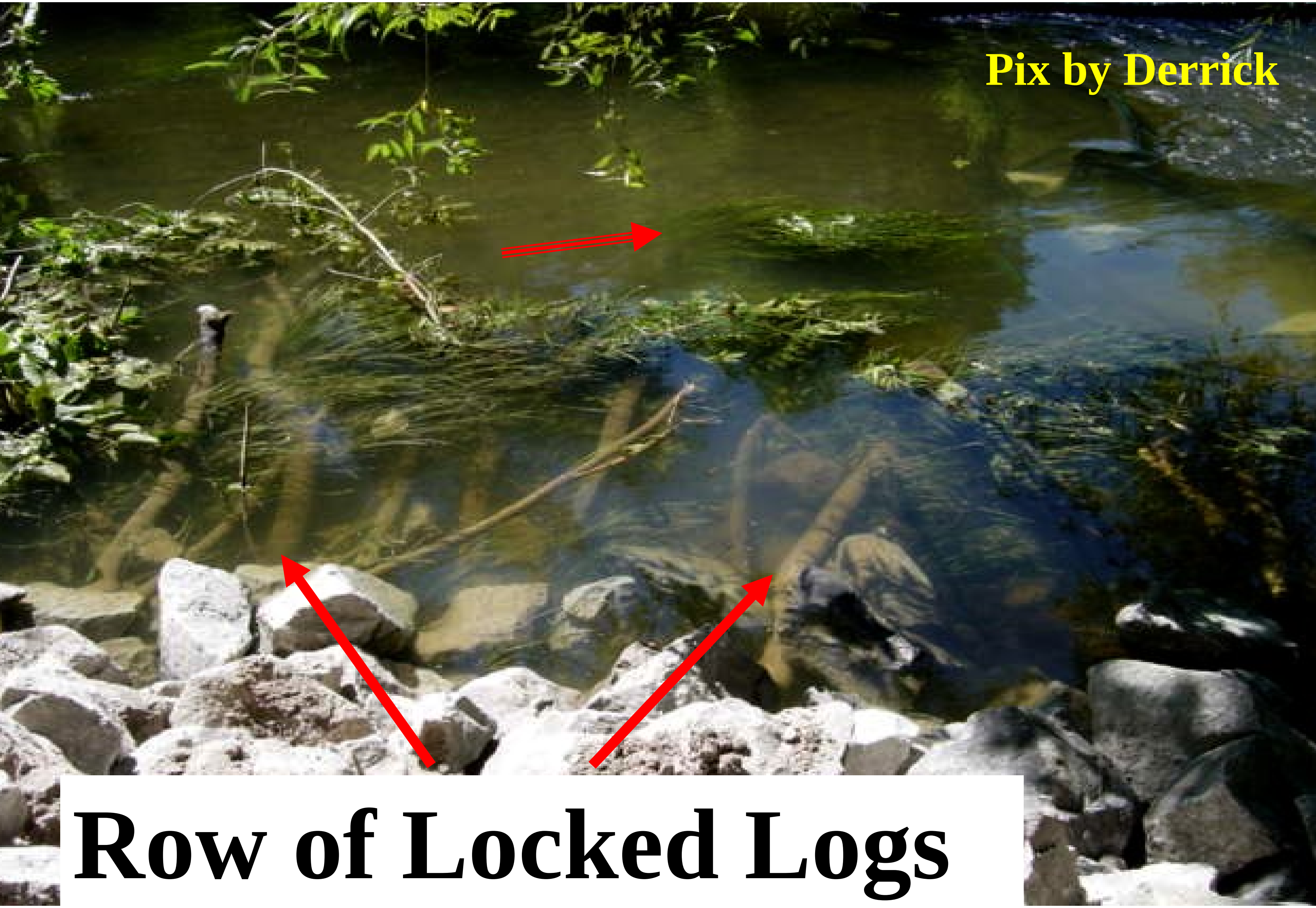
Lockport, NY.

Locked Logs ready for stone riprap-18 Mile Creek Lockport, NY

Pix by Derrick

Everything is now “locked” in place with stone

Pix by Derrick



Row of Locked Logs

ANY REDIRECTIVE METHOD IS AN ENERGY MANAGEMENT & THALWEG MANAGEMENT TOOL. IT WILL NOT PROVIDE COMPLETE PROTECTION FROM BANK EROSION. DURING A LARGE FLOOD EVENT, TYPICALLY SOME BANK SCOURING CAN BE EXPECTED TO OCCUR BETWEEN STRUCTURES!!!!

Luxuries We Like To Have

- **The "Luxury of Space"**
- **The "Luxury of Time" (nature strengthens the project over time)**
- **The "Luxury of Monitoring"**
- **The "Luxury of Adaptive Management"**

NOTE: Think <u>conceptually</u> regarding functions, use Derrick's "LAW OF EXTREMES" to understand how things work.

DRILLING & PEGGING STONES WITH METAL RODS TO BEDROCK (IN THE TOE TRENCH)

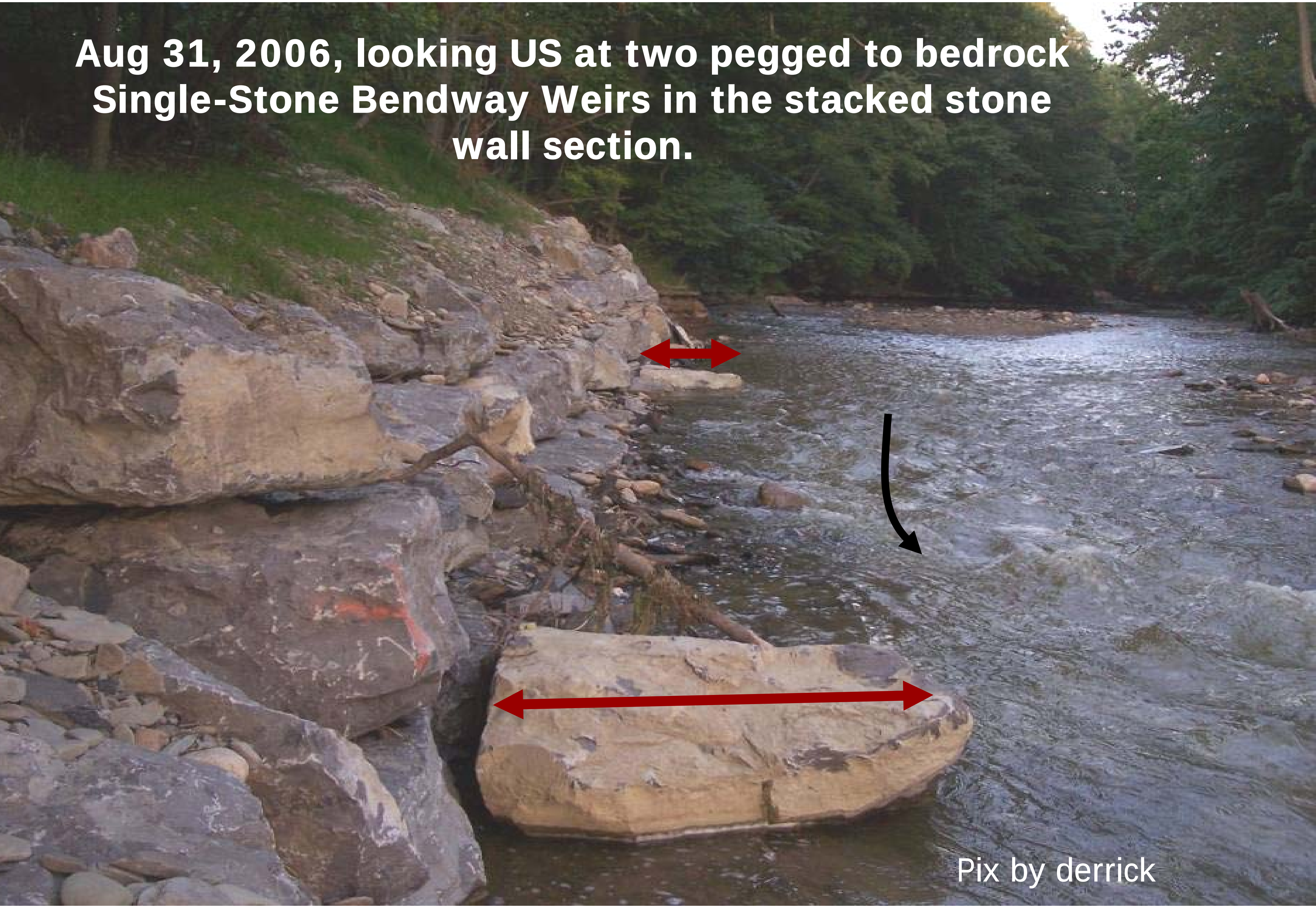
Construction June 2006. 2.5 inch diameter rods for pegging stone to bedrock.

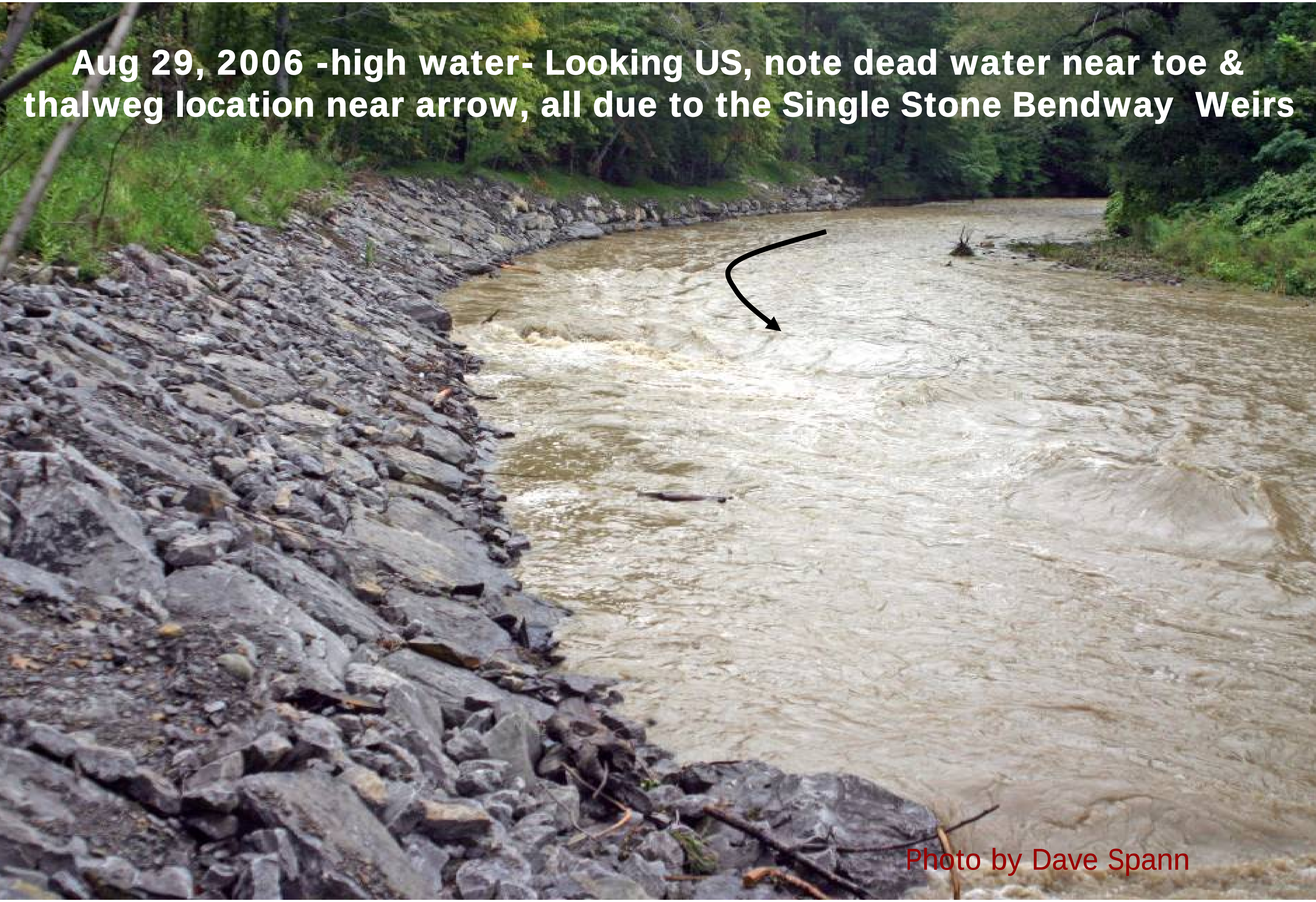
Pix by Joe Galati


Construction June 2006. Looking DS. Drilling holes to peg stone to bedrock
INGERSOLL-RAND
ECM-590
JUN 9 2006
Pix by Joe Galati

Construction June 2006. Looking US. Metal pinning rods not cut off yet.

Looking upstream at the SINGLE-STONE BENDWAY WEIRS


Aug 31, 2006, looking US at two pegged to bedrock Single-Stone Bendway Weirs in the stacked stone wall section.
Pix by derrick


Aug 29, 2006 -high water- Looking US, note dead water near toe & thalweg location near arrow, all due to the Single Stone Bendway Weirs
Photo by Dave Spann

A high water flow event. Mar 14, 2007

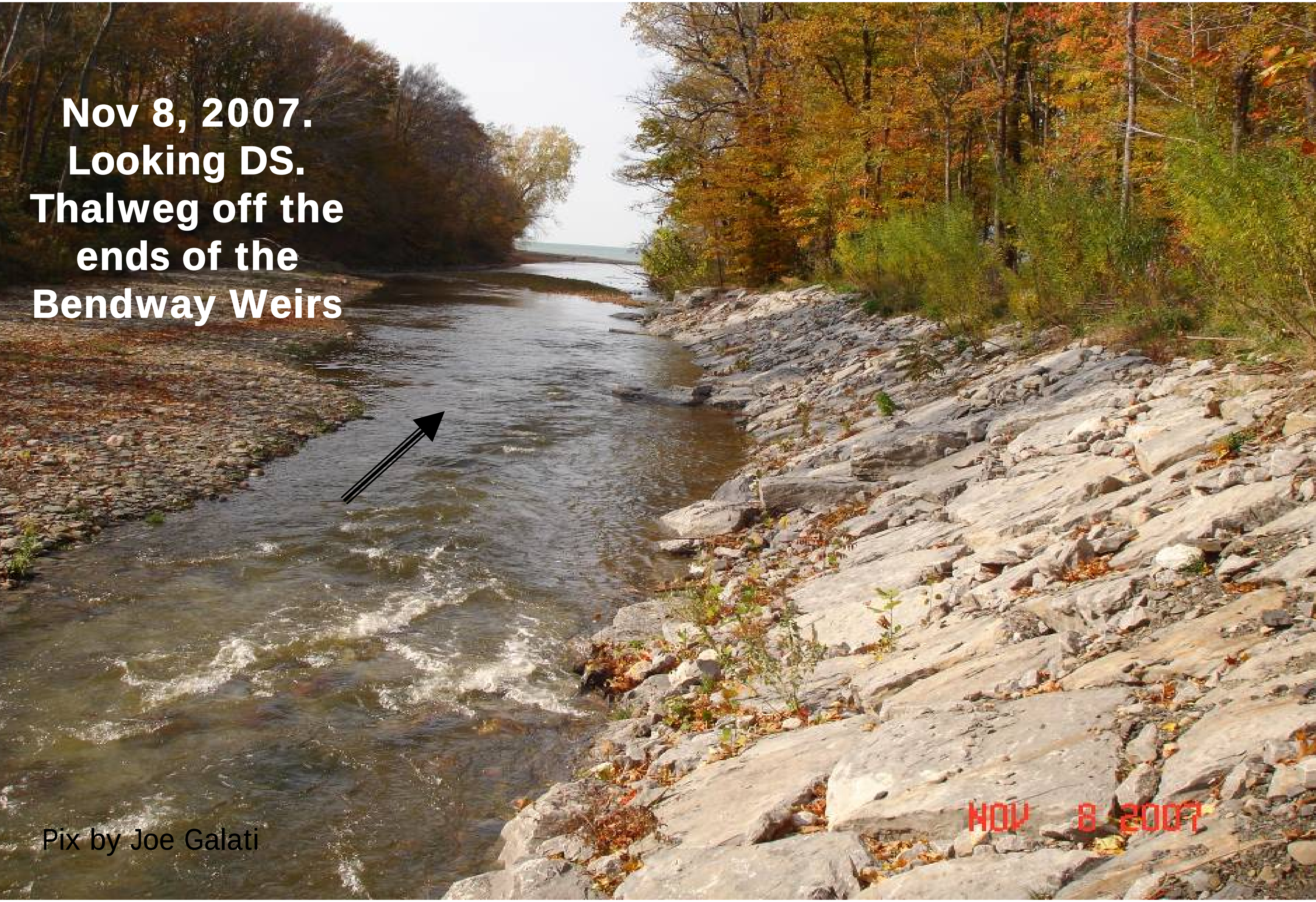

Mar 14, 2006. Looking DS. Note slow water near right bank due to Single Stone Bendway Weirs
Pix by Joe Galati
MAR 14 2007


Mar 14, 2006. Looking DS. Three submerged Bendway Weirs can be located due to surface disturbance
Pix by Joe Galati
MAR 14 2007

Mar 14, 2006. Looking DS. Close-up of two submerged Bendway Weirs

Pix by Joe Galati

16 MONTHS AFTER CONSTRUCTION NOV 2007


Nov 8, 2007.
Looking DS.
Thalweg off the
ends of the
Bendway Weirs
Pix by Joe Galati
NOV 8 2007

GRADE CONTROL

Nine Mile Run

6.9 million dollars to build, 63% of structures had functionally failed in 20 months:

- 100K & 10 days to re-rehabilitate
- 800 tons of stone
- 3,000 plants
- gobs of stone reused (use used stone)

Flanked perpendicular grade control structure

April 2007

Constructed Engineered Rocked Riffle with extended vegetated keys

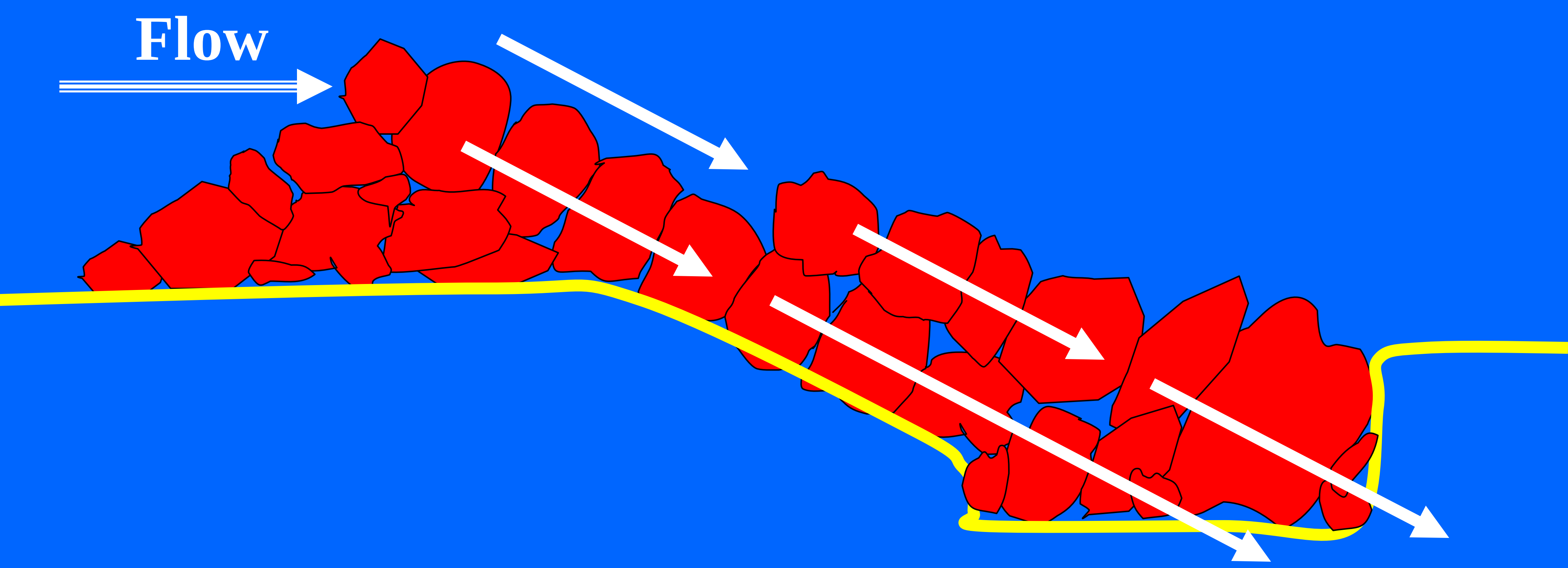
9 mile run-Looking US at a Cross-Vane. Fish passage???

April 2007

ENGINEERED ROCK RIFFLES WITH ALL STONES IN COMPRESSION

AN ENGINEERED ROCKED RIFFLE WITH INTEGRATED FISH LADDER

Compression forces are transferred into the ground



Looking US-Structure 18: Engineered Rock Riffle (Structures 17 and 16 in background)

GOODWIN CREEK NEAR BATESVILLE, MS.

CONSTRUCTED AS A HANDS-ON WORKSHOP MARCH 2007

Dave Derrick teaching some of the 44 workshop participants

GOODWIN CREEK–CONSTRUCTION-FEB 27, 2007–DANNY KLIMETZ

The cutting, toting, & planting crew, I mean the workshop participants

GOODWIN CREEK–CONSTRUCTION-FEB 27, 2007–DANNY KLIMETZ

Rolling and spreading hay - BEND #1

GOODWIN CREEK – CONSTRUCTION - FEB 2007 –SHARLA LOVERN

BEFORE & AFTERS OVER TIME

BEND #1

Looking US, Oct 1, 2005 - BEND #1

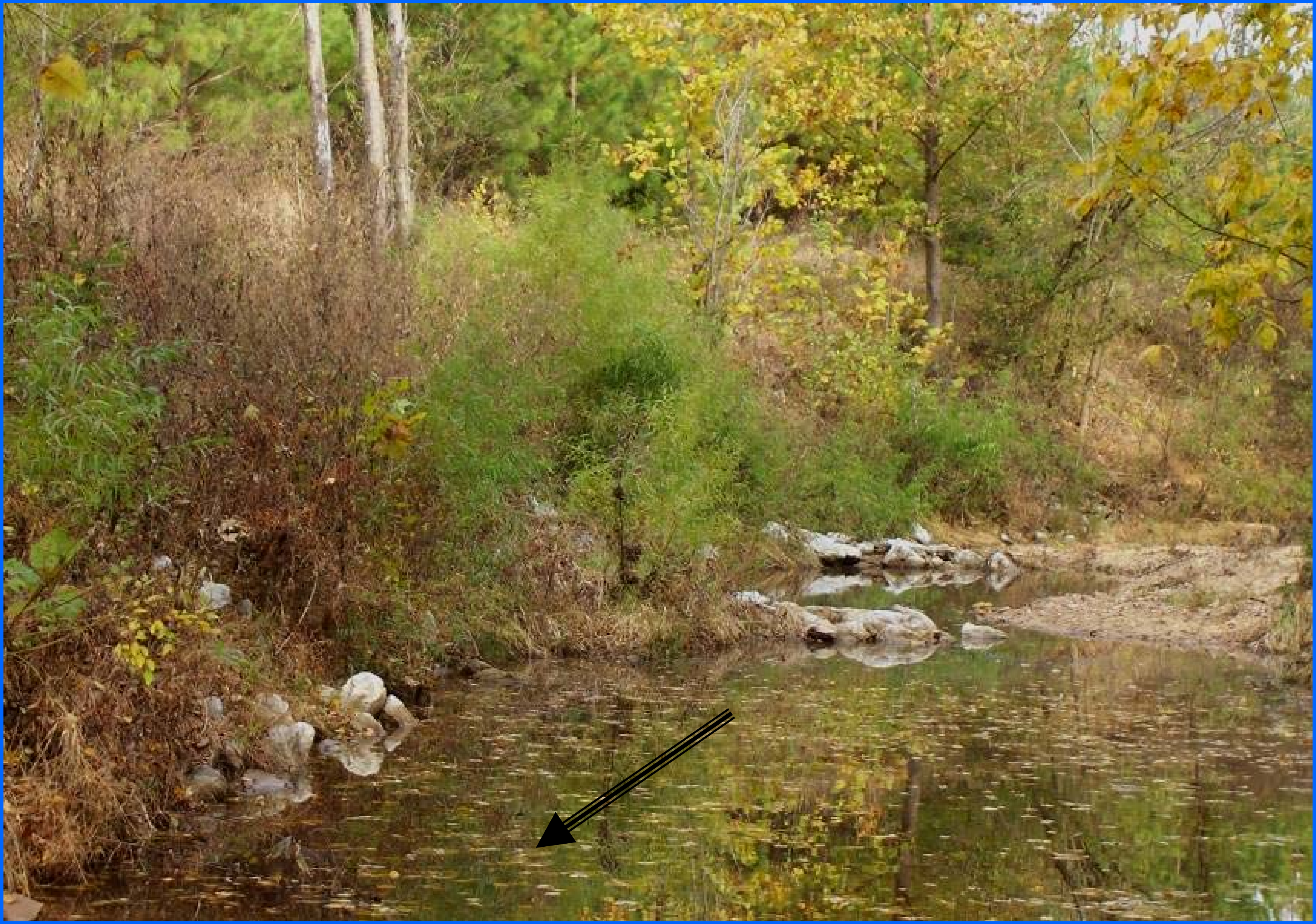
Looking US – Construction Complete - BEND #1

GOODWIN CREEK – CONSTRUCTION - FEB 2007 –NICK JOKAY

Looking US @ Bend #1 – 2.5 months later

GOODWIN CREEK – 2.5 MONTHS – May 18, 2007 – DAVE BIEDENHARN

Looking US @ Bend #1–8 months later-some plants dormant

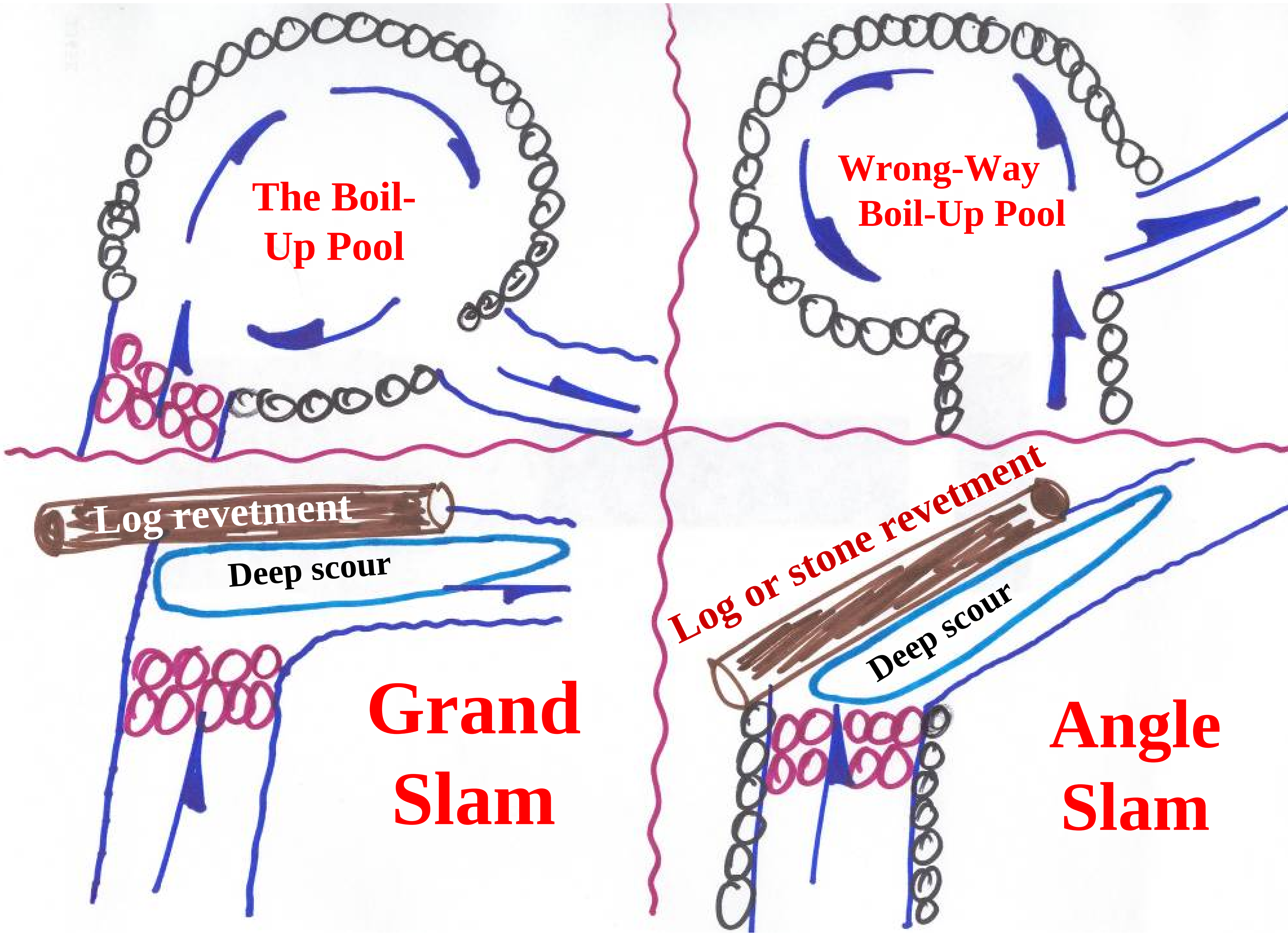


GOODWIN CREEK – 8 MONTHS LATER– NOV 12, 2007 – FROM DERRICK

PROPOSED WRAP HANDS-ON WORKSHOP KANAPOLIS, KS

- **Wrong Way Boil-Up Pool**
- **Grand Slams & Angle Slams**
- **Kink with Curved Stone Slam**
- **“Missing Tooth” Stone Transverse Bar with Curved Stone Slam**
- **Single Stone Bendway Weirs with TCS & Cedar Tree Revetment**
- **Contraction Stones**
- **Corner LUNKERS with Half Log Roof**
- **Log Align & Catch Structure**
- **Stone Squeezer**
- **Transverse Bar with Curved Stone Slam**
- **Log Squeezer**

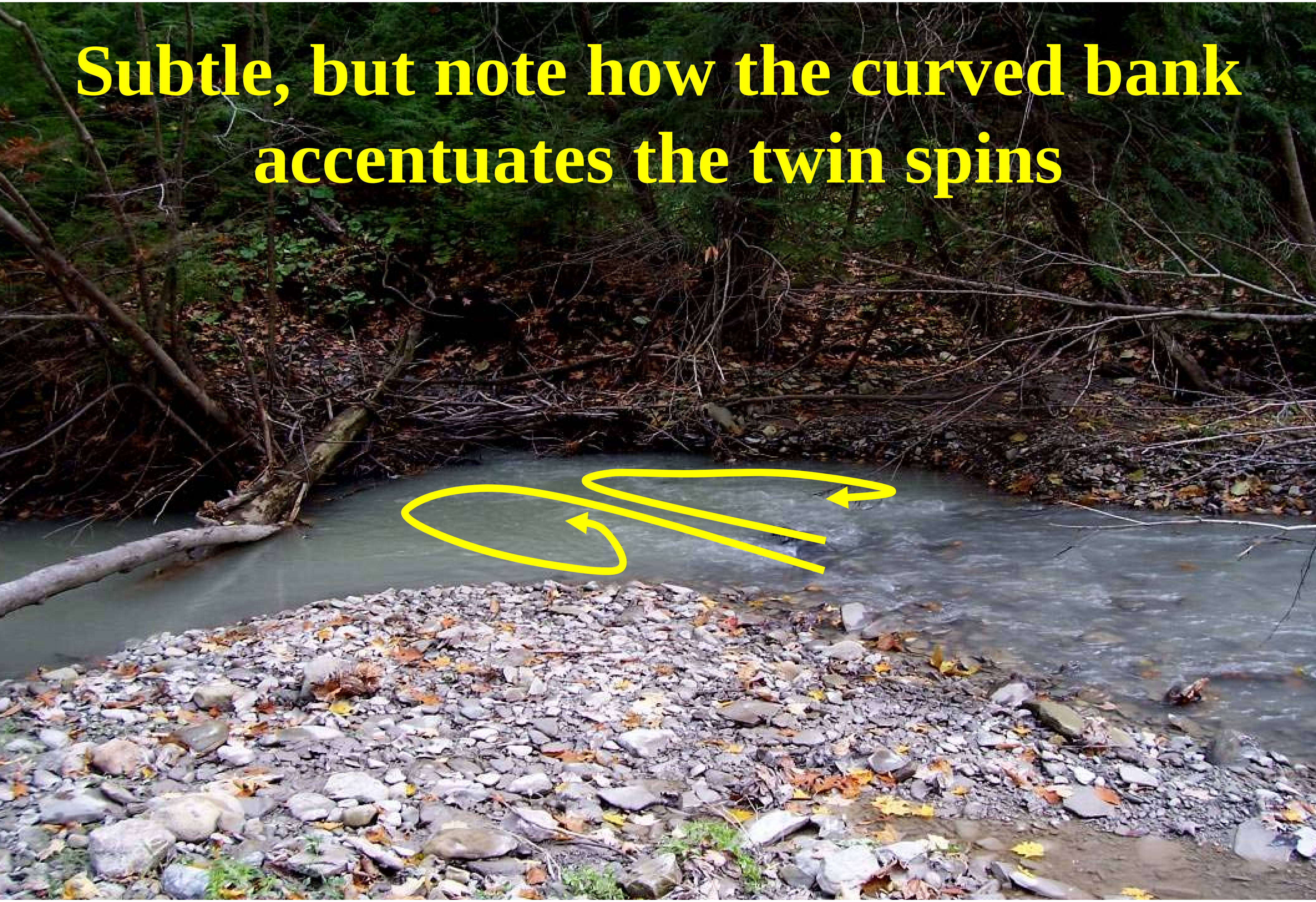
Abrupt Planform Modifers



The World's largest Wrong-Way Boil-Up pool, Niagara River gorge @ the Spanish Aero cable car

Photo by derrick, 10-15-2007

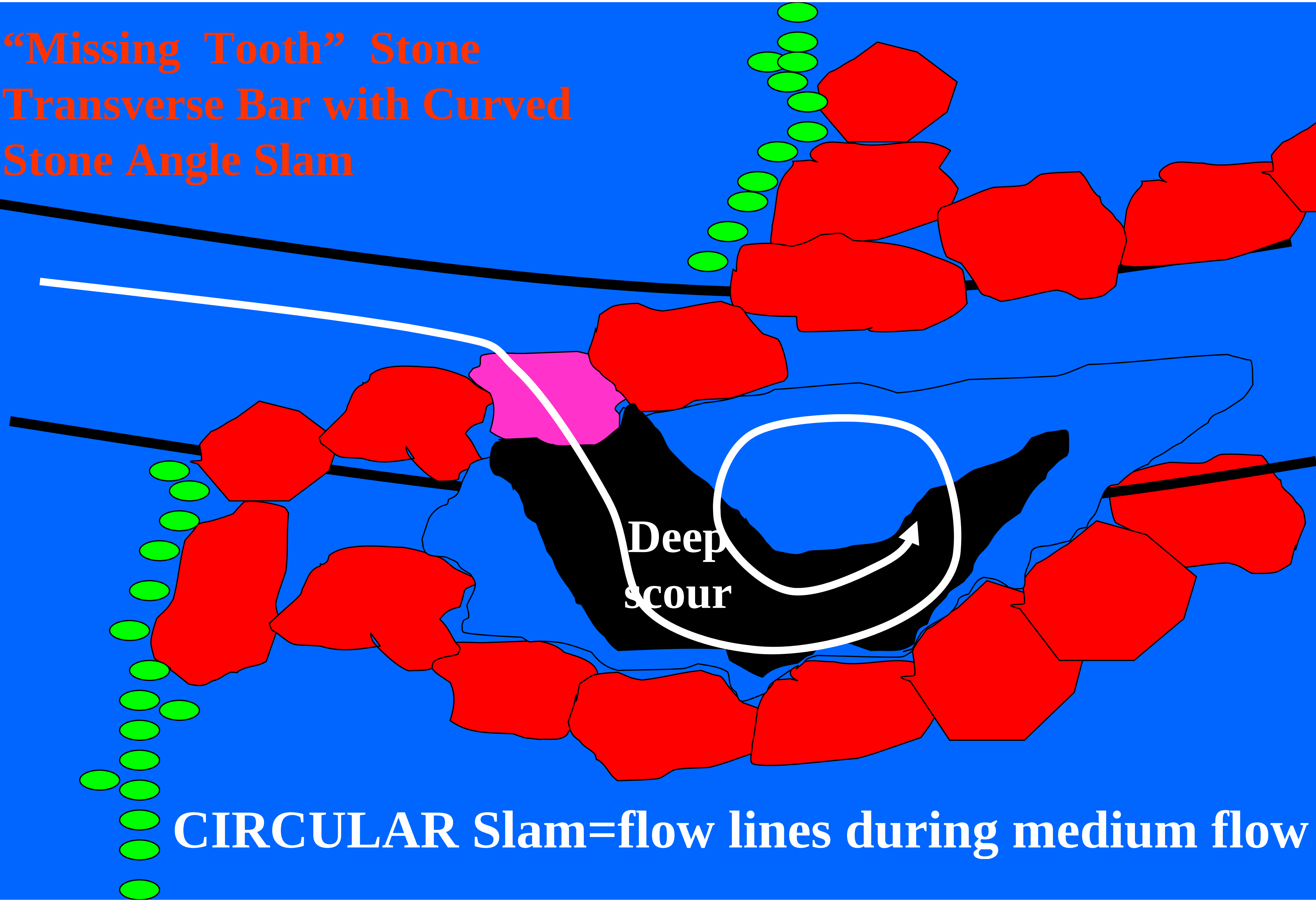
The World’s largest Wrong-Way Boil-Up pool, Niagara River gorge @ the Spanish Aero cable car


Subtle, but note how the curved bank
accentuates the twin spins

Angle Slam, Reach 7, McKinstry Creek, Delevan, NY.

“Missing Tooth” Stone Transverse Bar with Curved Stone Angle Slam

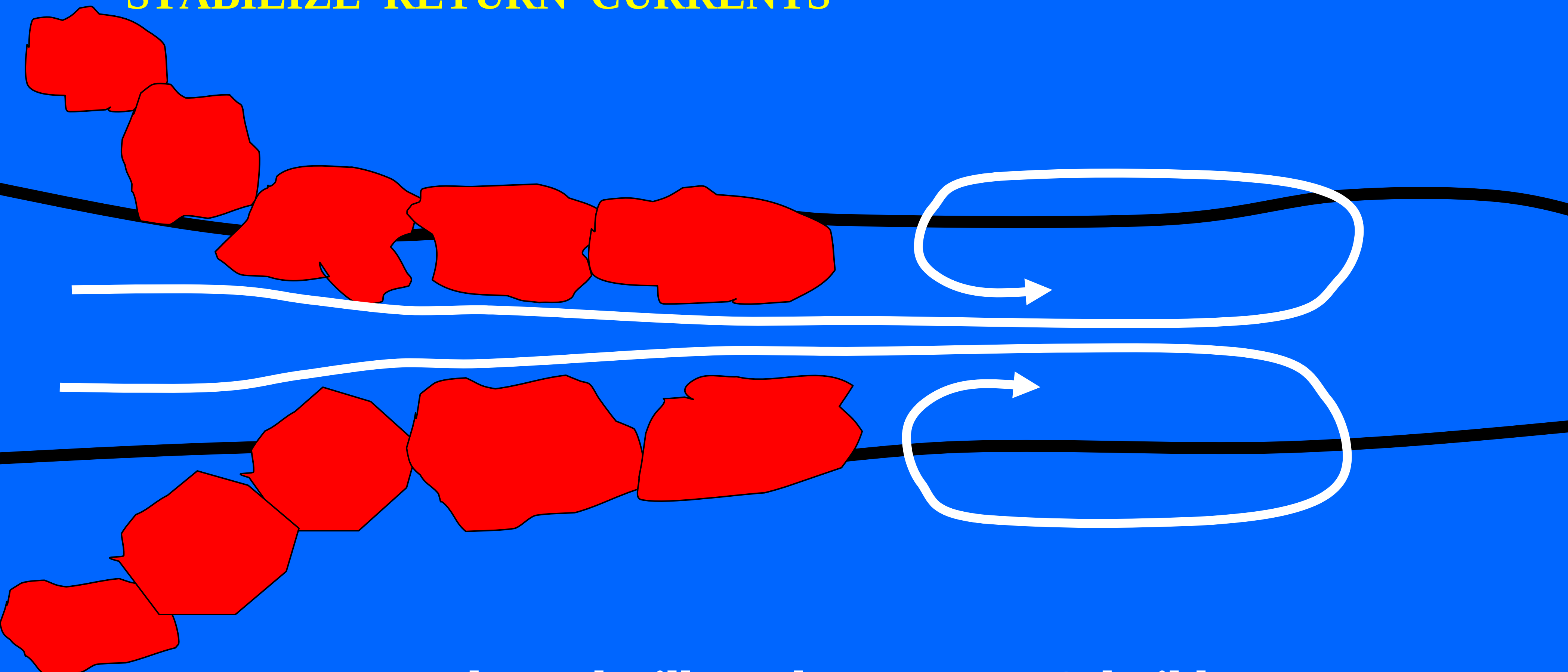
(at low flow will act like a Boil-Up, at high flow will act like a slam)



"Missing Tooth" Stone
Transverse Bar with Curved
Stone Angle Slam
Deep
scour
CIRCULAR Slam=flow lines during medium flow

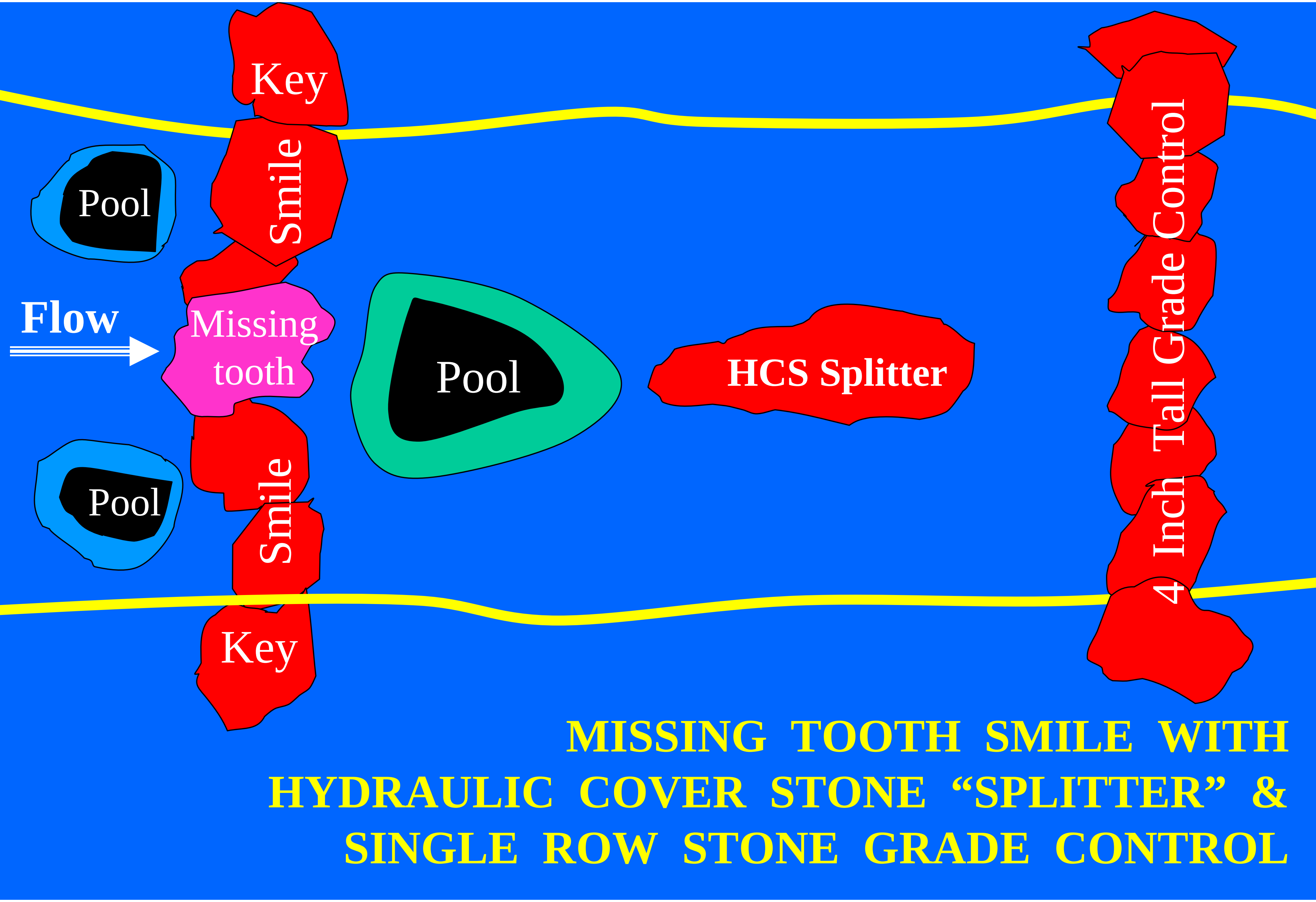
Stone "Squeezer" With Downstream "LUNKERS"

"SQUEEZER" STONES DESIGNED TO PROVIDE POOL HABITAT WITH DOWNSTREAM "LUNKERS" USED TO STABILIZE RETURN CURRENTS



Narrow channel will accelerate water & build momentum to dig downstream pool. Sudden expansion at the DS end of the contraction area will result in strong twin return flow currents

MISSING TOOTH SMILE WITH DOWNSTREAM HYDRAULIC COVER STONE “SPLITTER” & SINGLE ROW STONE RIFFLE GRADE CONTROL STRUCTURE

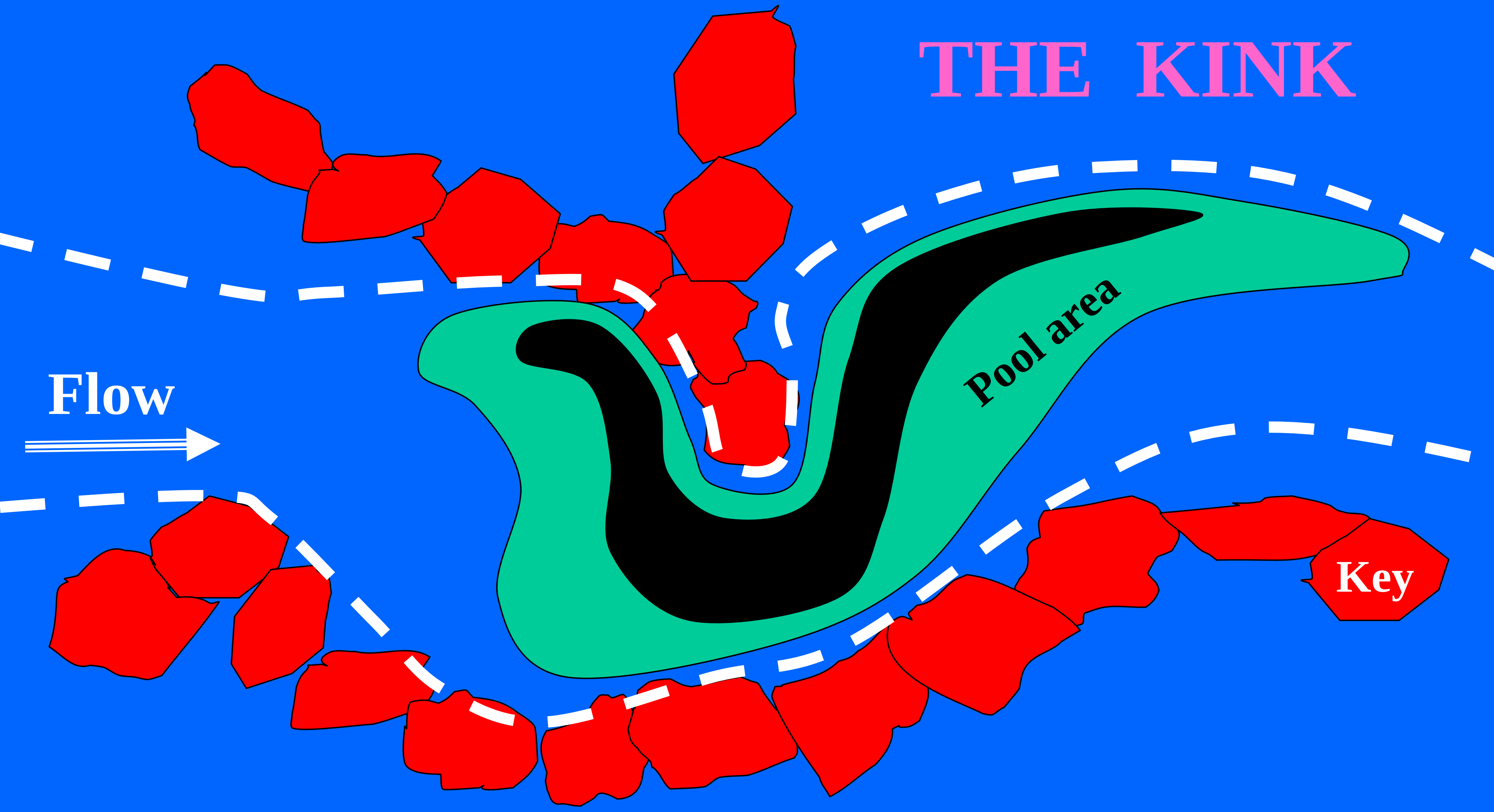

Key
Smile
Pool
Flow
Missing tooth
Pool
HCS Splitter
Pool
Smile
Key
4 Inch Tall Grade Control
MISSING TOOTH SMILE WITH HYDRAULIC COVER STONE "SPLITTER" & SINGLE ROW STONE GRADE CONTROL

MISSING TOOTH SMILE W/ HCS "SPLITTER" & SINGLE ROW GC

HCS splitter divides concentrated flow from MT Smile, DS GC provides tailwater for all to work

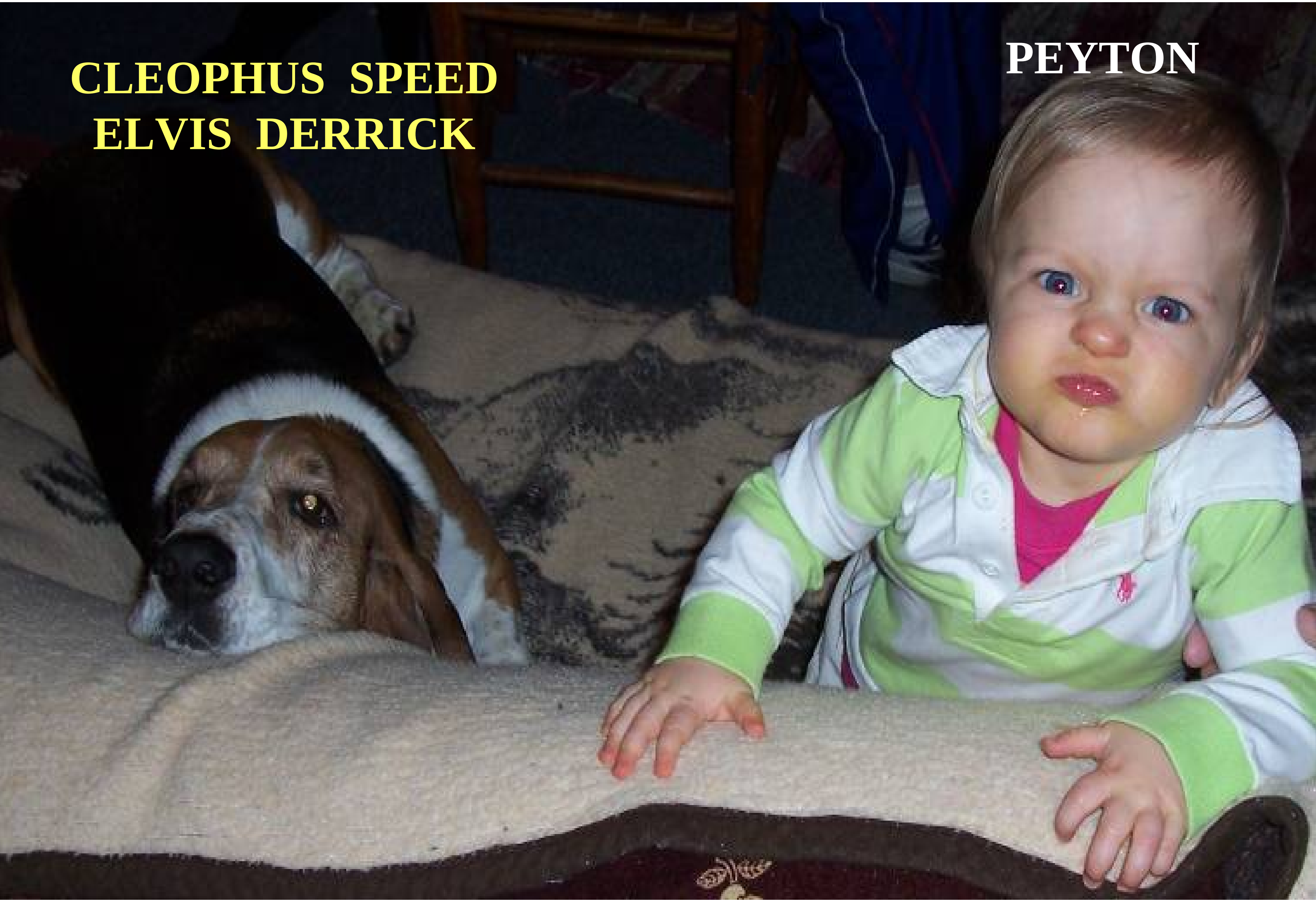
THE KINK (with apologies to Ray & Dave Davies)

THE KINK



White dashed lines delineate where new bank lines would be.

WHAT OPPORTUNITIES ARE PRESENTED??


CLEOPHUS SPEED
ELVIS DERRICK
PEYTON