

The Application of 'Full Spectrum' River Restoration Design in Colorado



Stillwater Sciences



PREPARED FOR
SCW CONFERENCE 2019
WESTIN RIVERFRONT RESORT
AVON, CO



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New Tools and Perspectives on River Restoration Design

Overview/Background

COLORADO STATE UNIVERSITY (CSU)

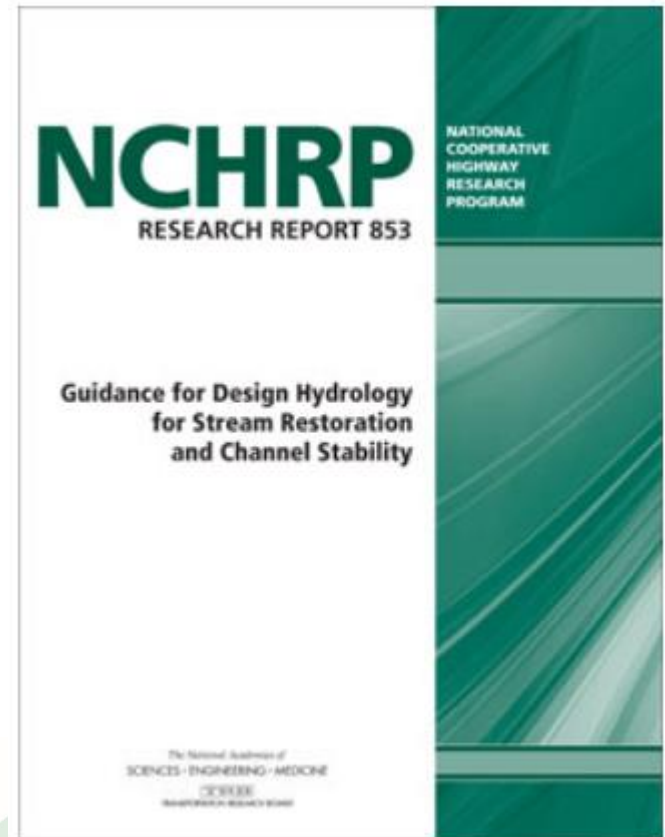
- MASTER'S IN HYDRAULIC ENGINEERING/RIVER MECHANICS/STREAM RESTORATION
- NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP) RESEARCH REPORT 853
 - Dr. Brian Bledsoe
 - Dr. Peter Nelson
 - Dr. Dan Baker
 - Dr. Joel Sholtes
 - Tyler Rosberg
 - Travis Stroth

STILLWATER SCIENCES

- RIVER RESTORATION DESIGN AND GEOMORPHIC ASSESSMENTS
- GEOMORPHIC ENGINEERING



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LEVEL OF DESIGN BASED ON STREAM RESPONSE POTENTIAL



Stream Response Potential

Low

Medium

High

Very High

Poor / no analog available

Good analog available

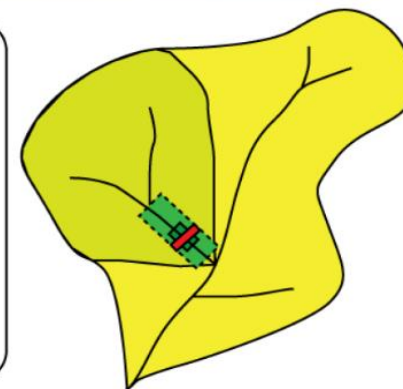
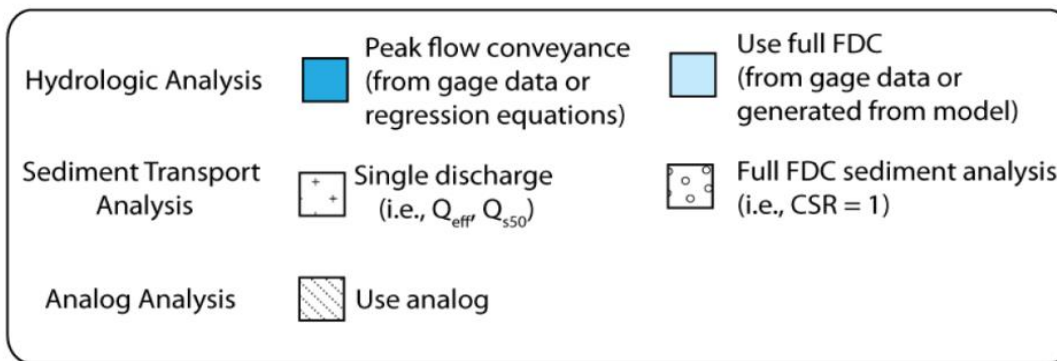
Analysis Domain

Right-of-way

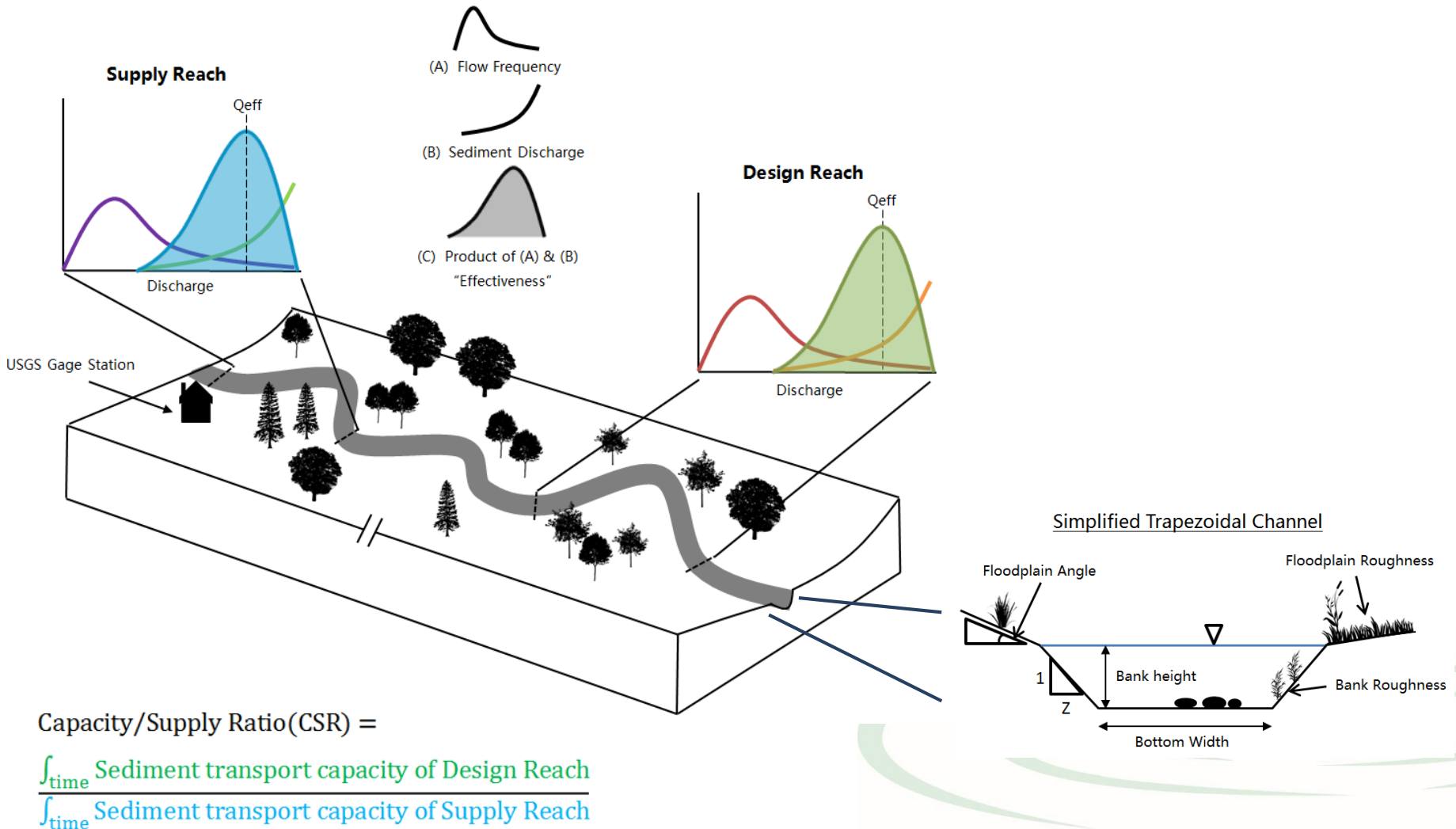
Reach

Sub-watershed

Watershed



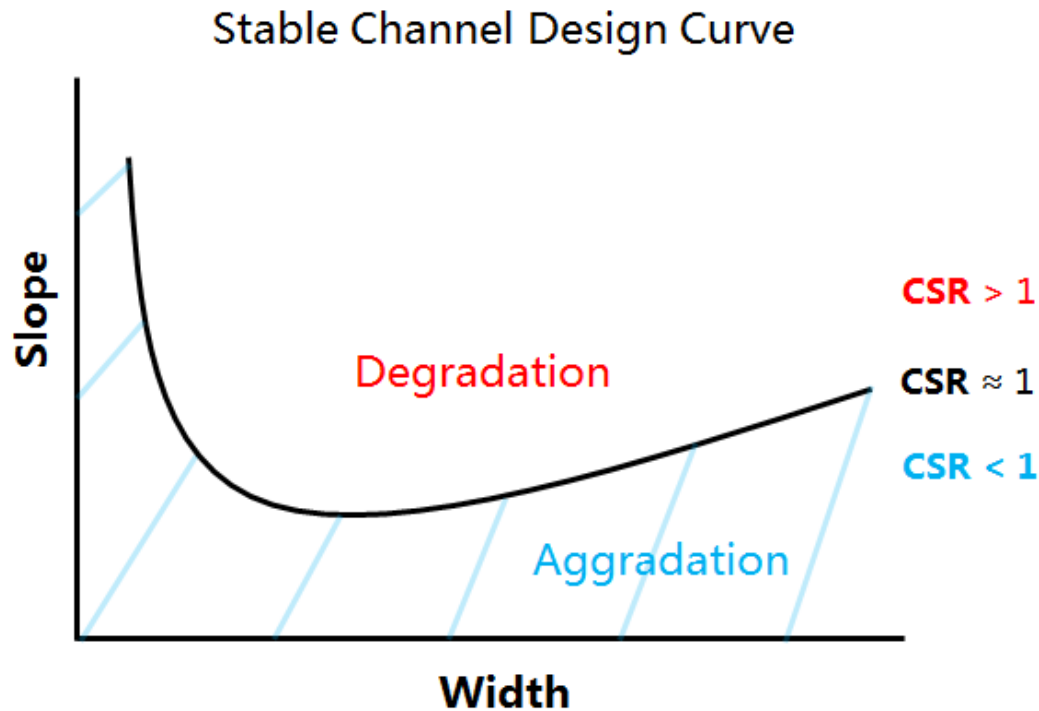
Capacity/Supply Ratio Tool (CSR Tool)



CSR Tool Solutions

Capacity/Supply Ratio(CSR) =

$$\frac{\int_{\text{time}} \text{Sediment transport capacity of Design Reach}}{\int_{\text{time}} \text{Sediment transport capacity of Supply Reach}}$$

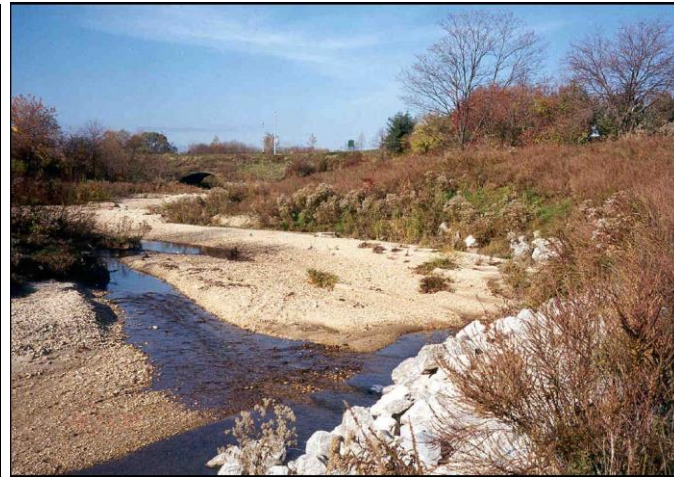


Using 'Full Spectrum' Capacity Balance

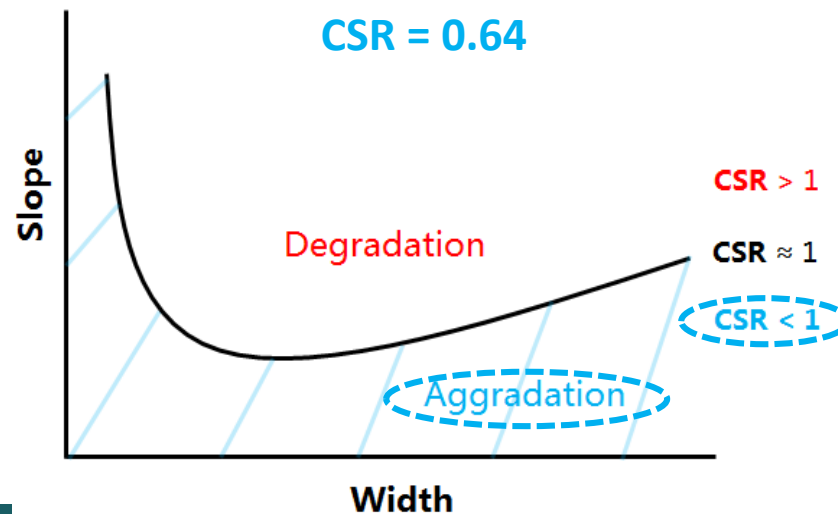
White Marsh Run, Maryland



September 1996



November 1998



SOAR AND
THORNE (2001)

4-DIMENSIONAL FRAMEWORK

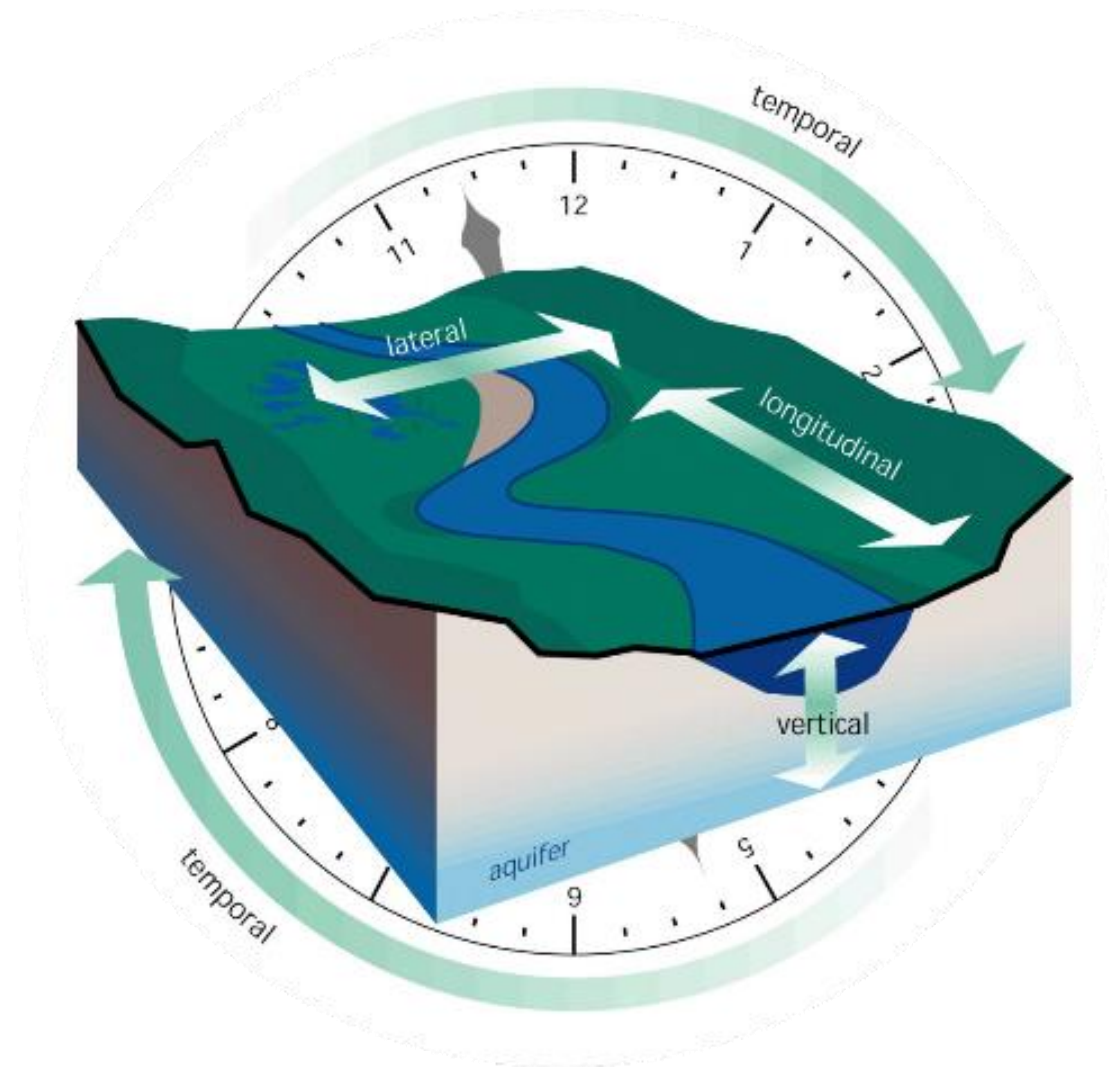
SPACE

VERTICAL

LATERAL

LONGITUDINAL

TEMPORAL



FISRWG (1998)

Engineering/Geomorphology as a Spectrum

HOW DO WE PERCEIVE CHANNEL STABILITY?

TRADITIONAL ENGINEERING

- NO CHANGE/RESPONSE EQUALS STABILITY

FLUVIAL GEOMORPHOLOGY/ECOLOGY

- THE ABILITY TO CHANGE/RESPOND EQUALS STABILITY

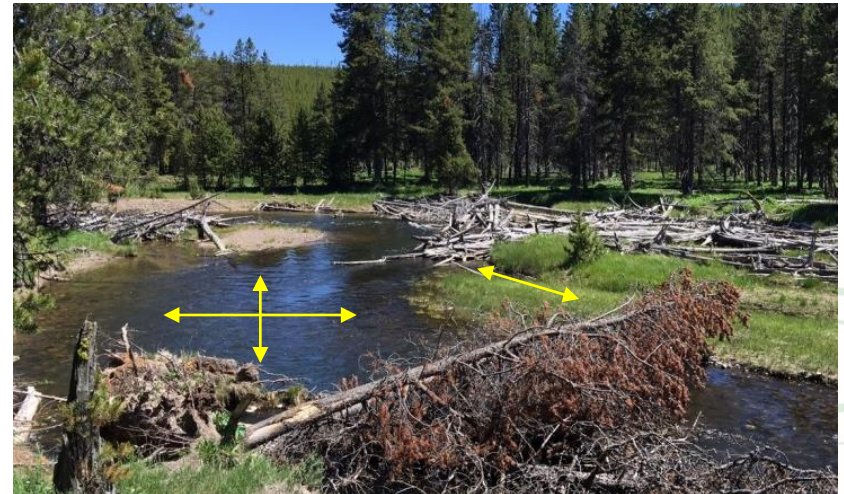


Channel Stability

Static



Dynamic





Application of 'Full Spectrum' River Restoration and CSR Tool

River Bluffs Open Space River Restoration

Cache la Poudre River
near Windsor, CO

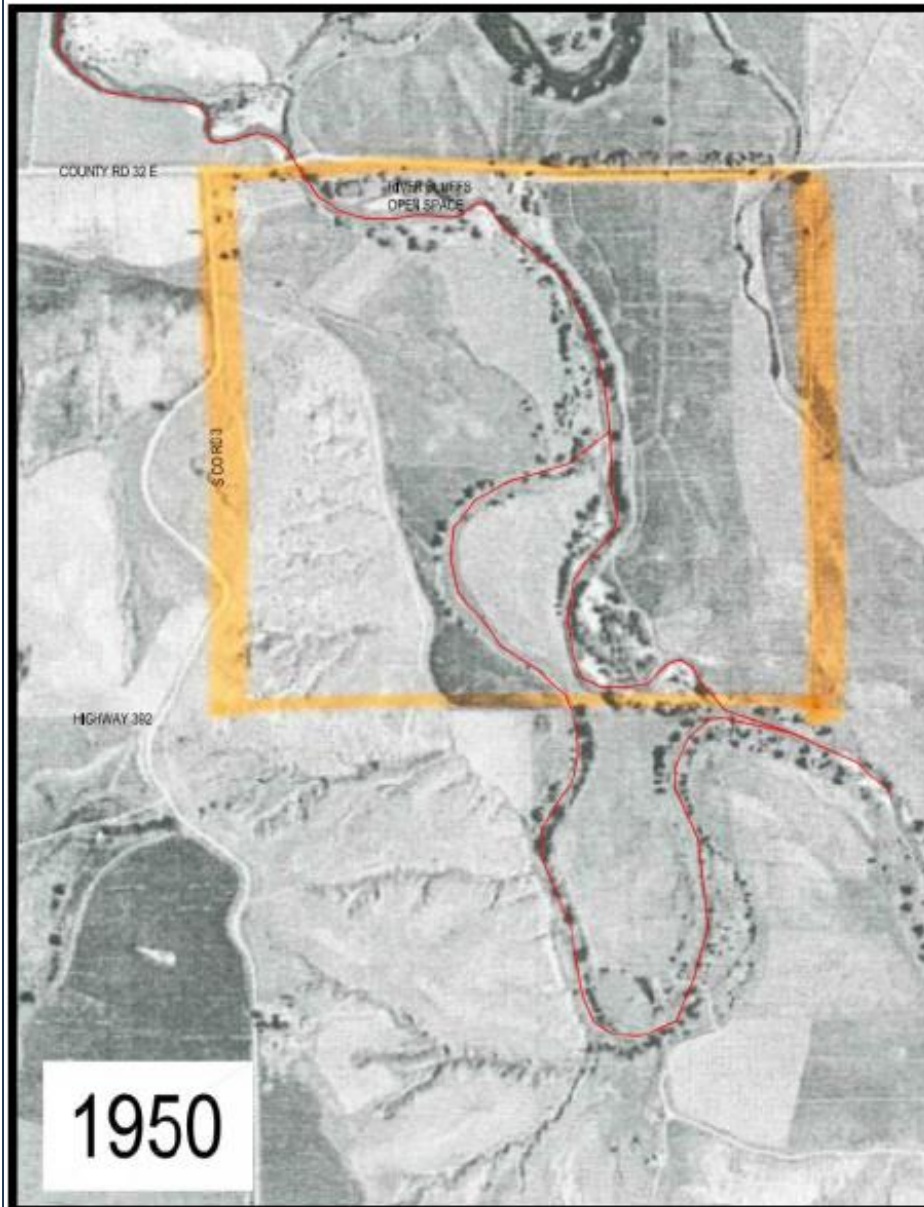
$\frac{3}{4}$ Mile Reach but worked
focused on downstream
half

\$1.3 million budget
(~150k for design)

Historically channelized
and bermed in 50's

Main goal of project is to
increase riverine health
and function







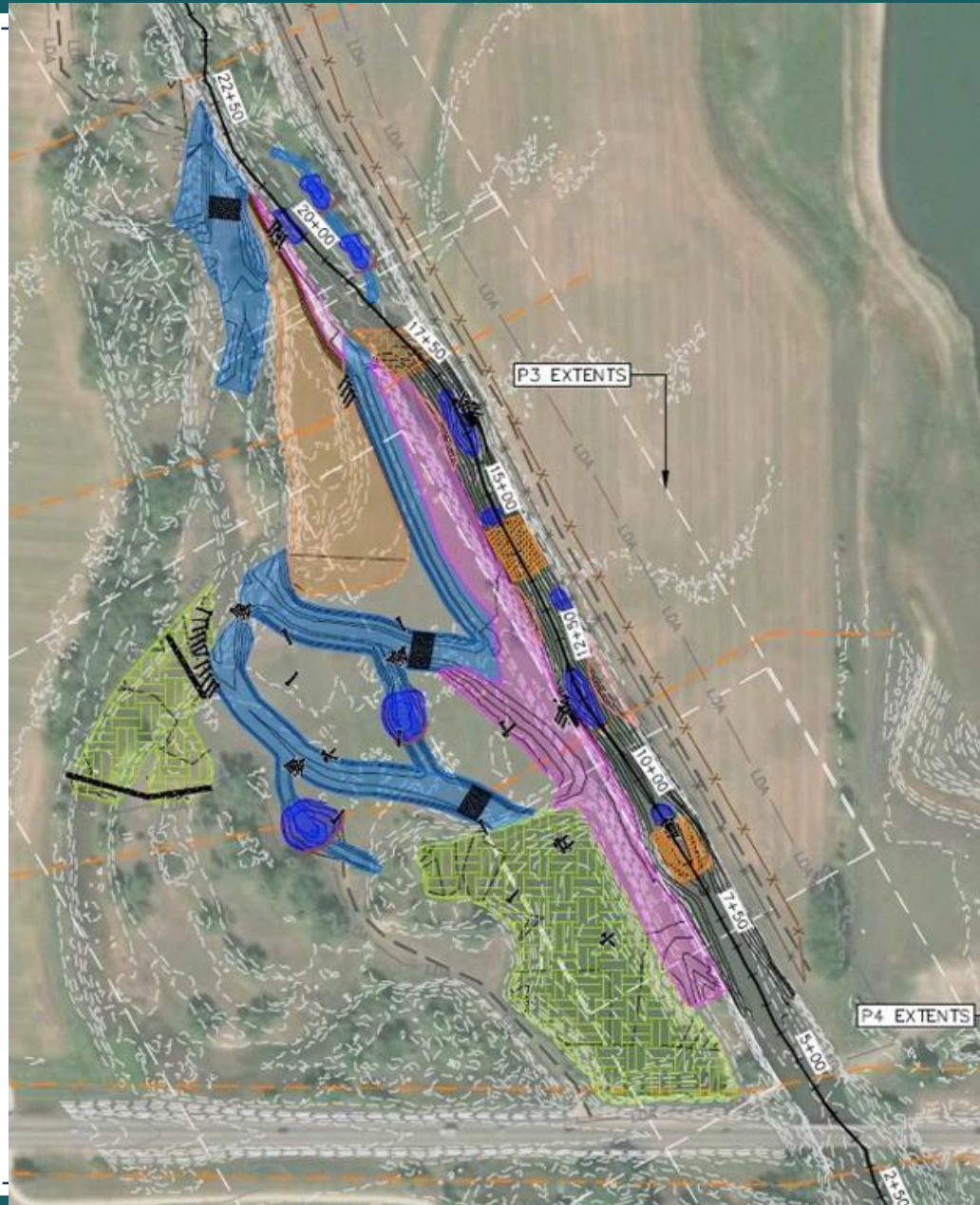
River Bluffs Design

Cutting down berms

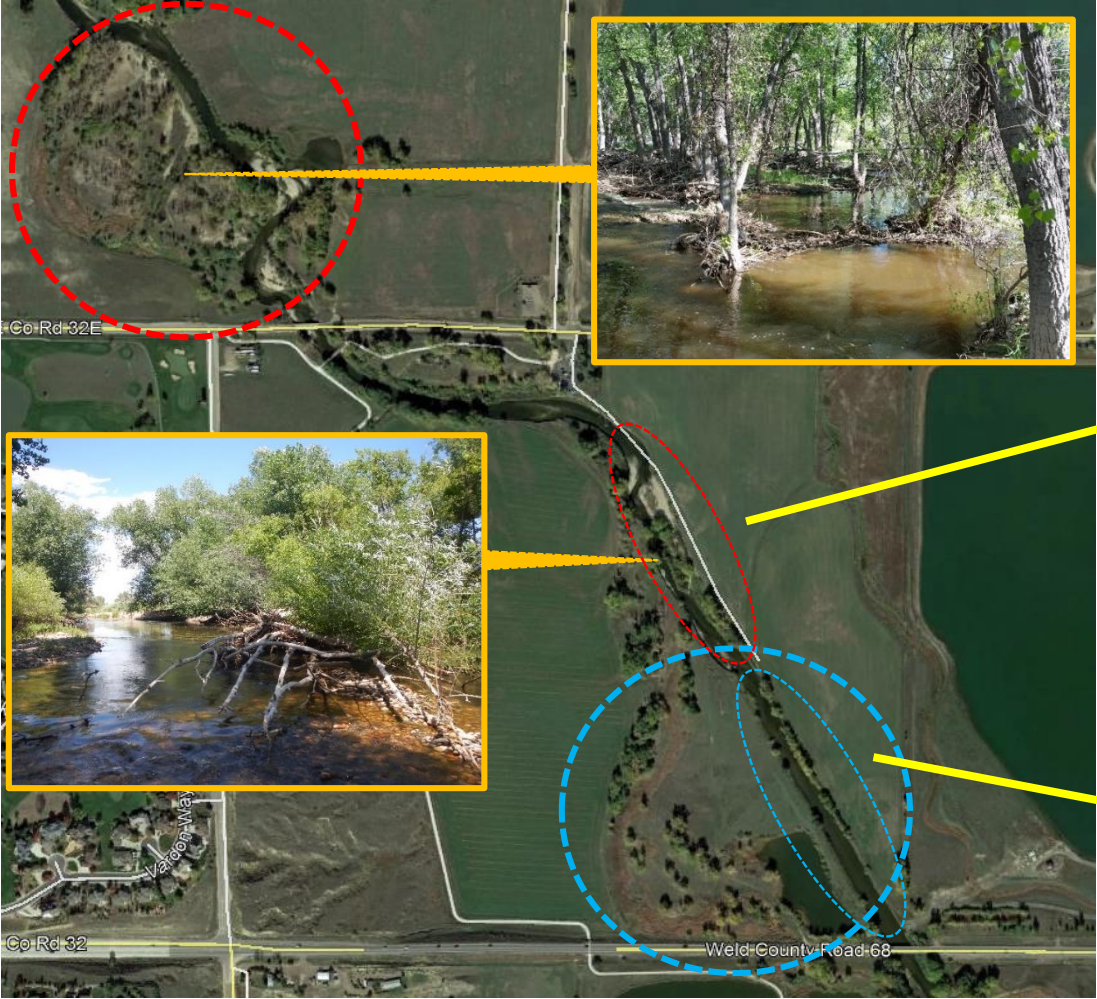
Reconnecting relic channel as overflow path with multiple flow paths back to river

Narrowing and reconnecting main channel

Installed ~140 pieces of wood in ELJs



Supply Reach & Reference Areas

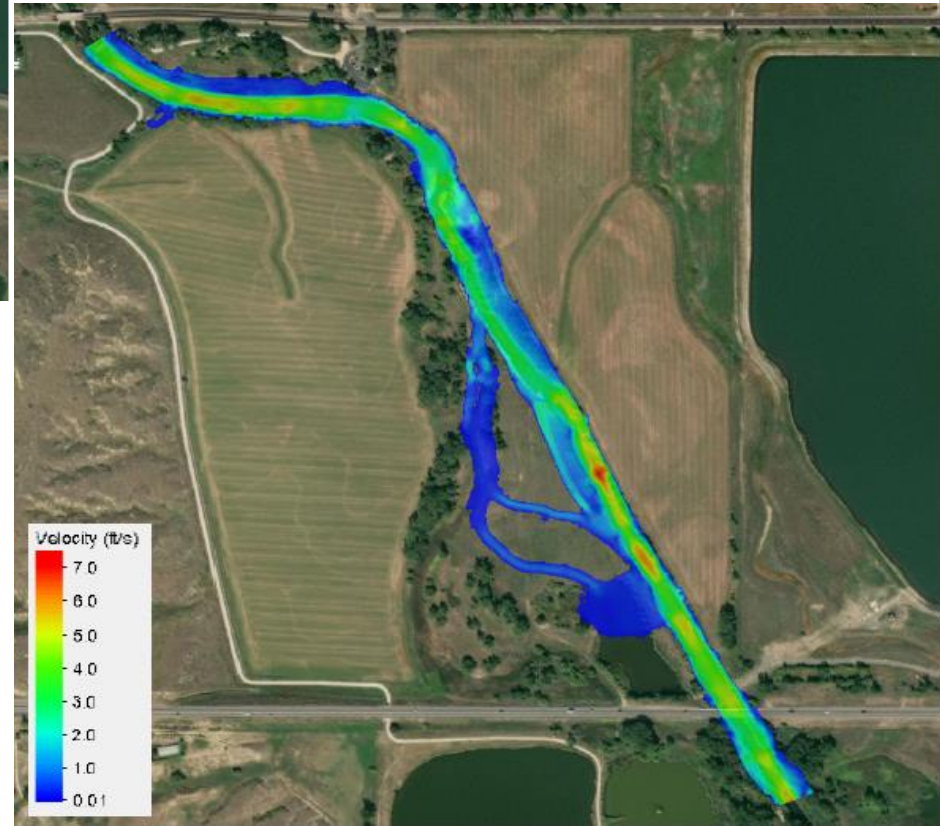


2-D Hydraulic Modeling

Proposed Conditions
Velocity @ Q2 flow

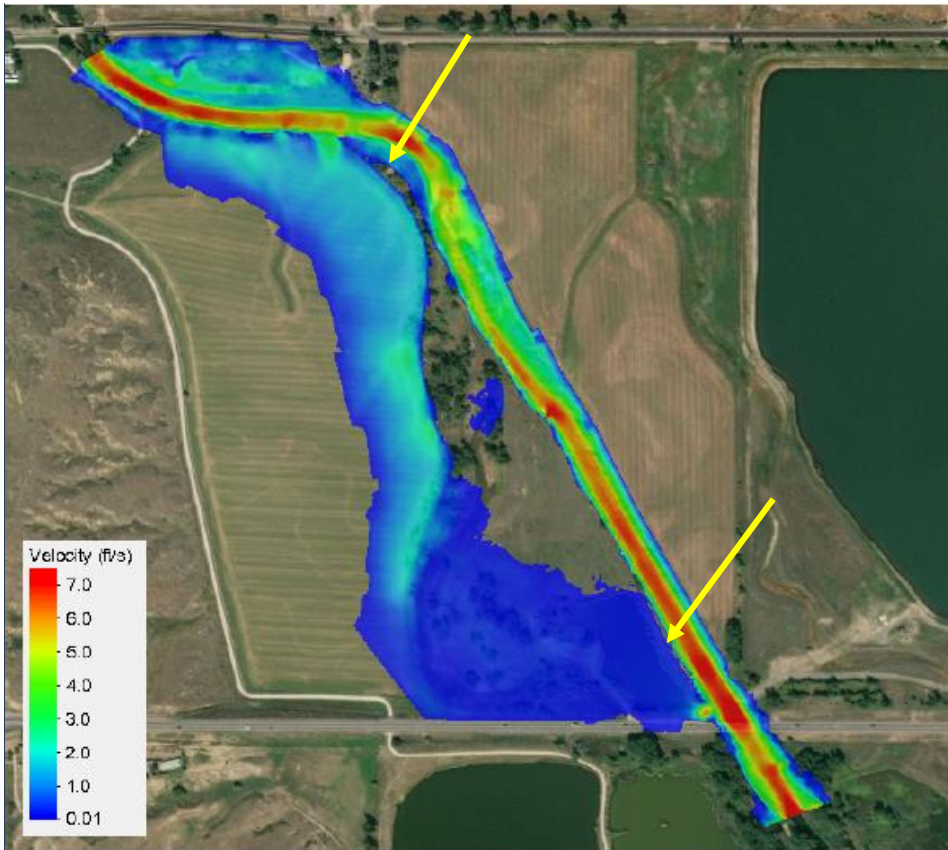


Existing Conditions
Velocity @ Q2 flow

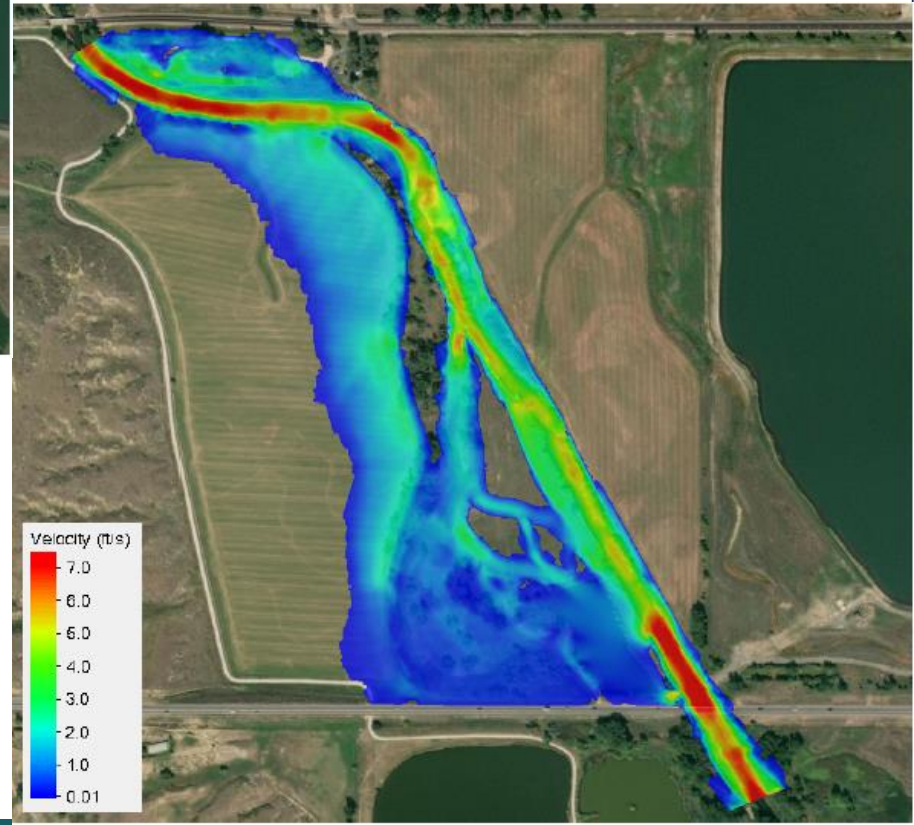


2-D Hydraulic Modeling

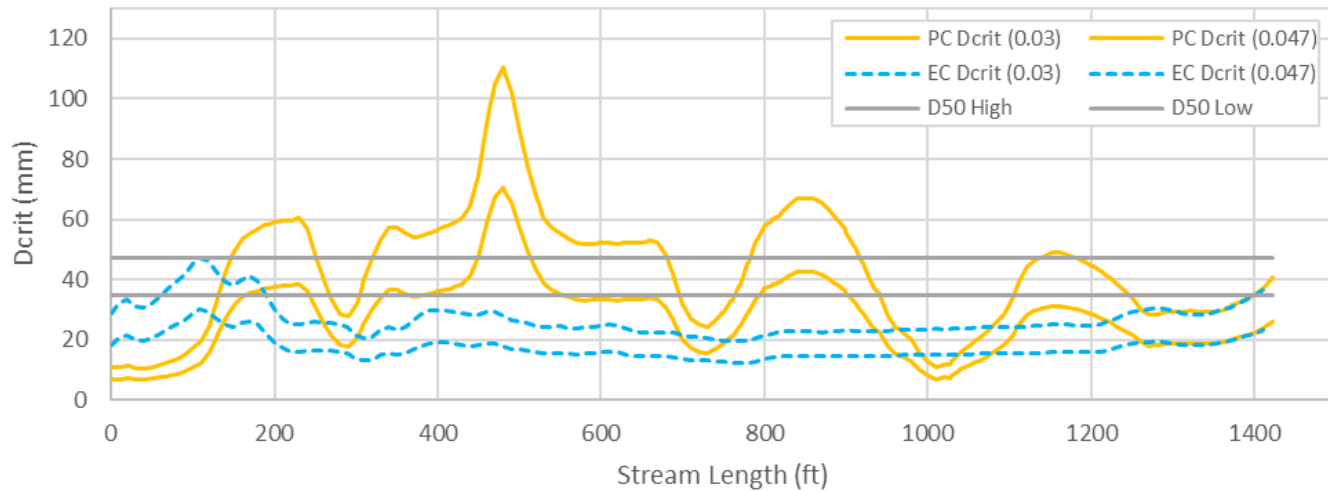
Proposed Conditions
Velocity @ Q5 flow



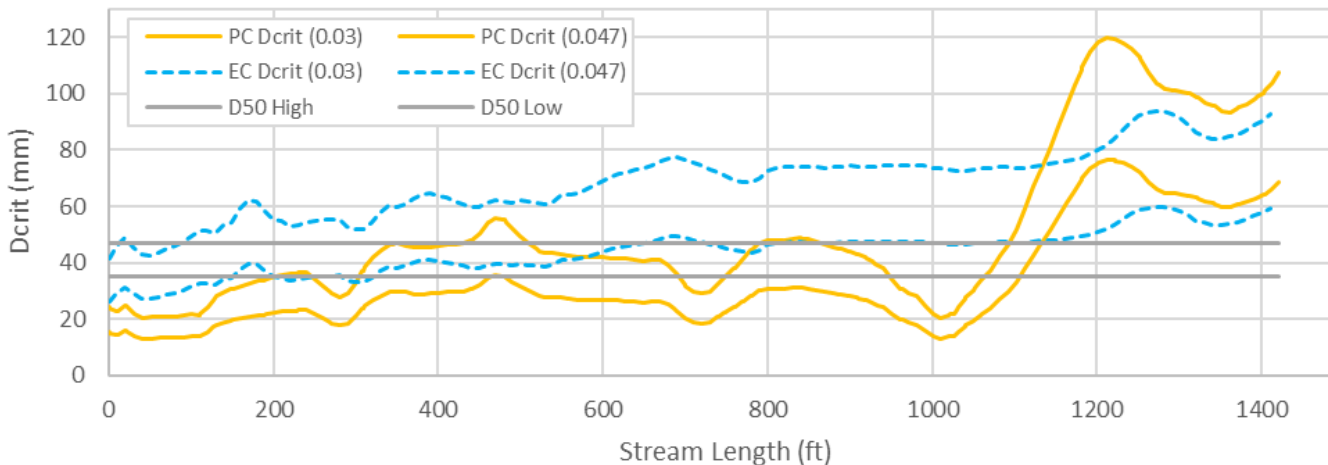
Existing Conditions
Velocity @ Q5 flow



Incipient Motion using 2D Outputs



USING $Q_{1.5}$
INCREASED
CAPACITY AND
VARIABILITY

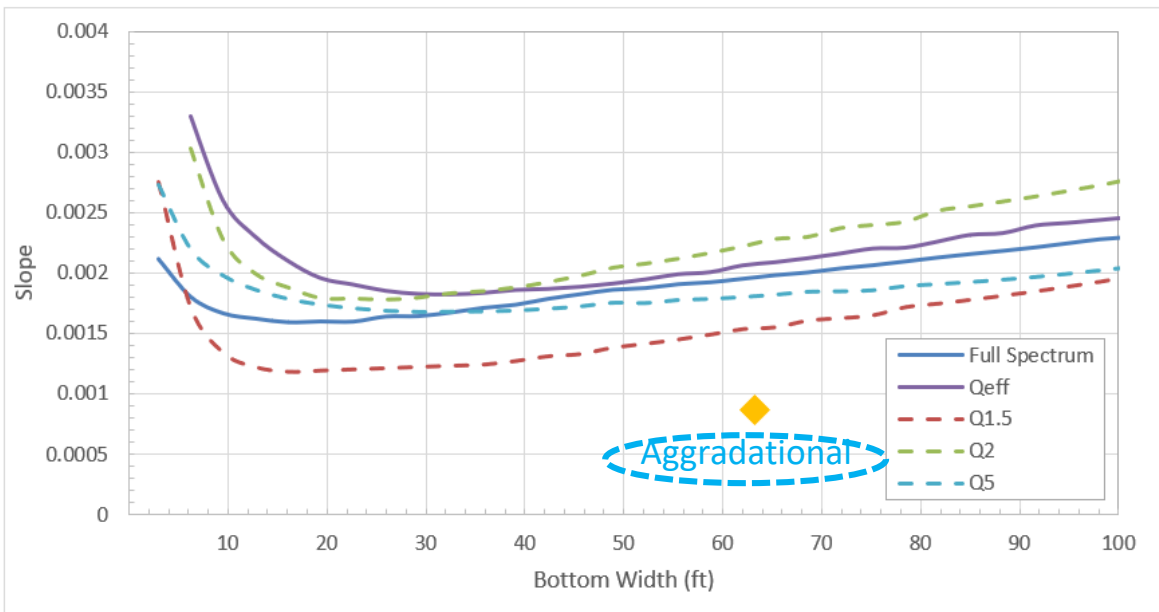


USING Q_5
DECREASED
CAPACITY



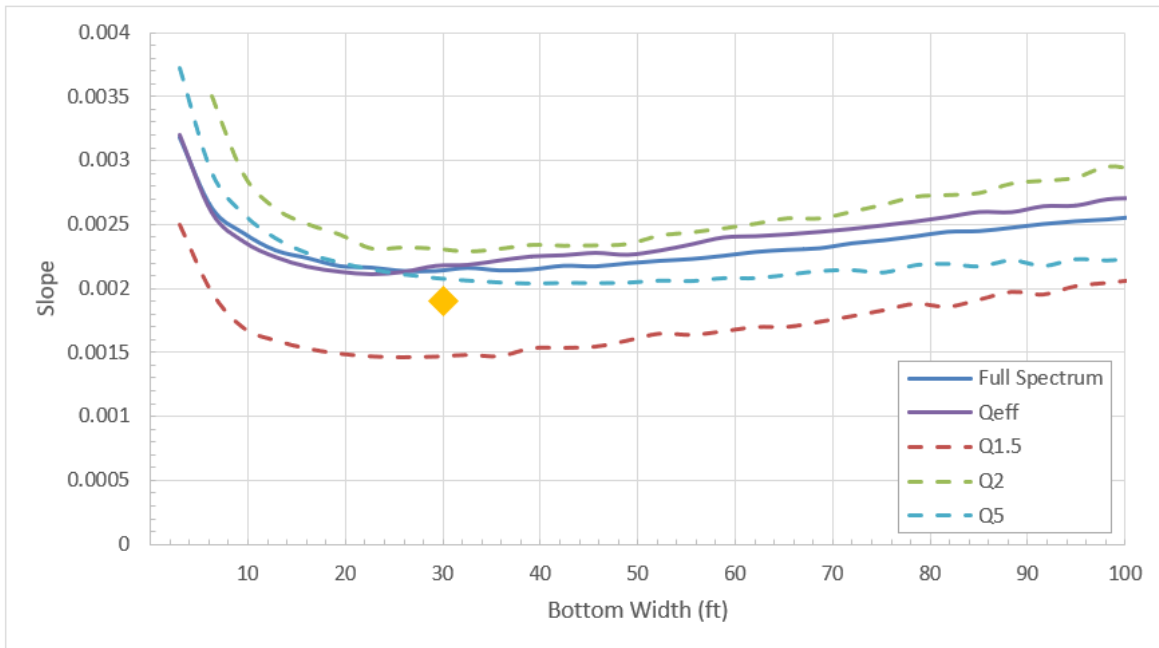
Existing Conditions

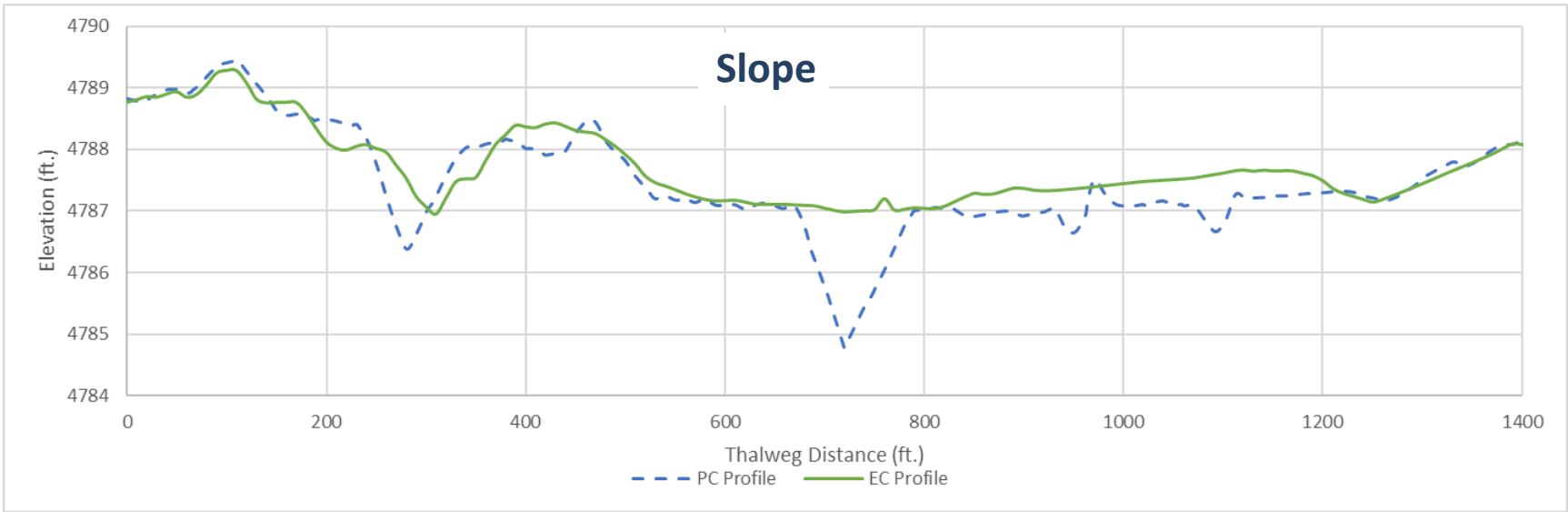
- CSR predicts very aggradational



Proposed Conditions

- CSR predicts close to balance through time





Narrowed channel with mid- channel bar



Google Earth
©2016 Google



Google Earth
©2016 Google



Reconnected the floodplain



Used native materials





Floodplain wood





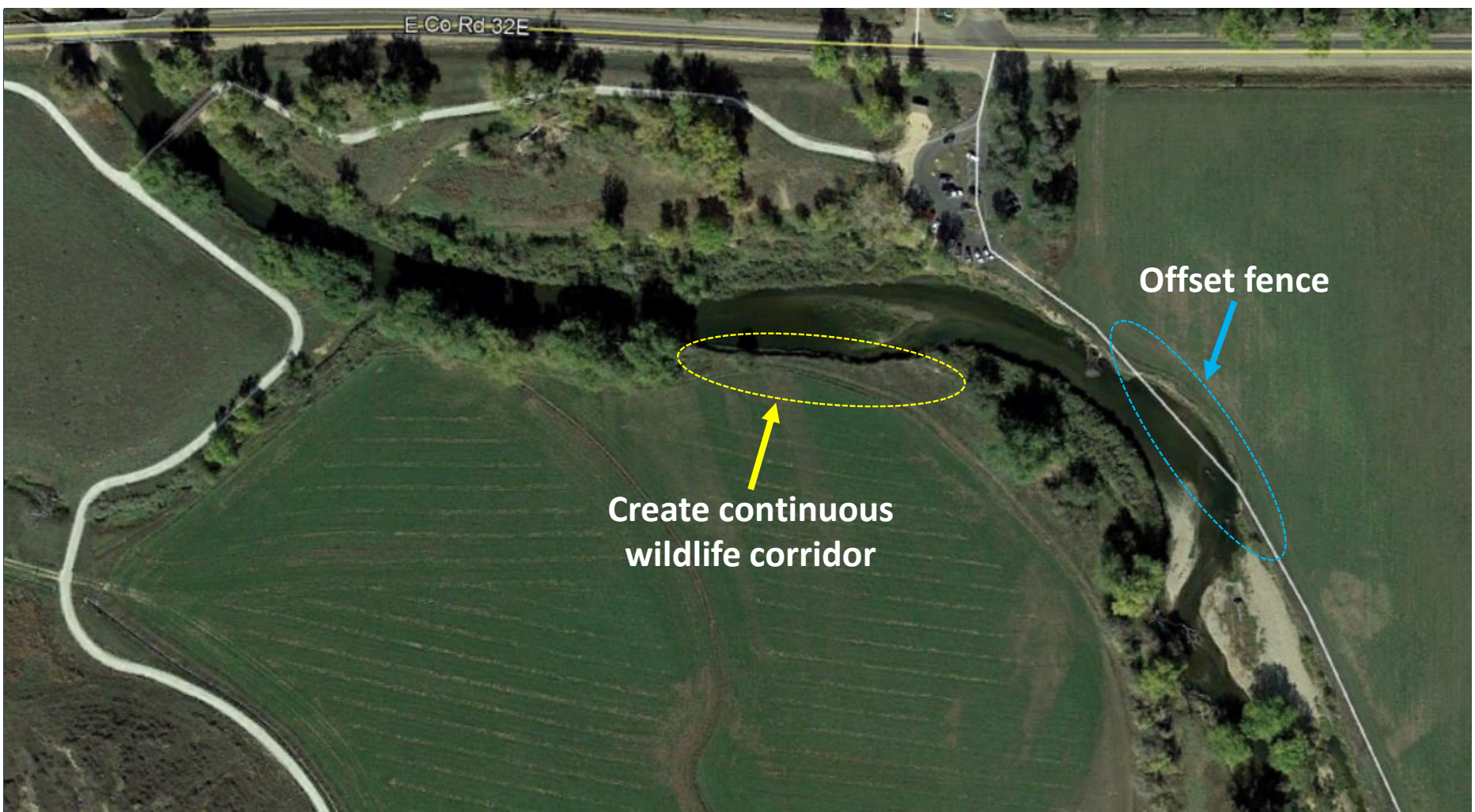
Channel Wood





Moved fences back





Passive Approaches







2019 Runoff





Post 2019 Runoff





Conclusions



New Design Tools and Perspectives

- Tools provide useful new outlooks to aid in design
- Keep pushing towards ecological stability or resilience

NEXT STEPS

- Continued monitoring
 - Geomorphological
 - Ecological
- Collaborating with UNC and CSU to continue monitoring

Google: "NCHRP Report 853"



Supplemental Slides

Engineering & Geomorphology as a Spectrum



Engineering/Structural Solution

- Artificially harden bank and bed with rip-rap, concrete, etc.



Geomorphic/Engineering Solution

- Use bioengineered/ biotechnical approaches to stabilize banks, train flows

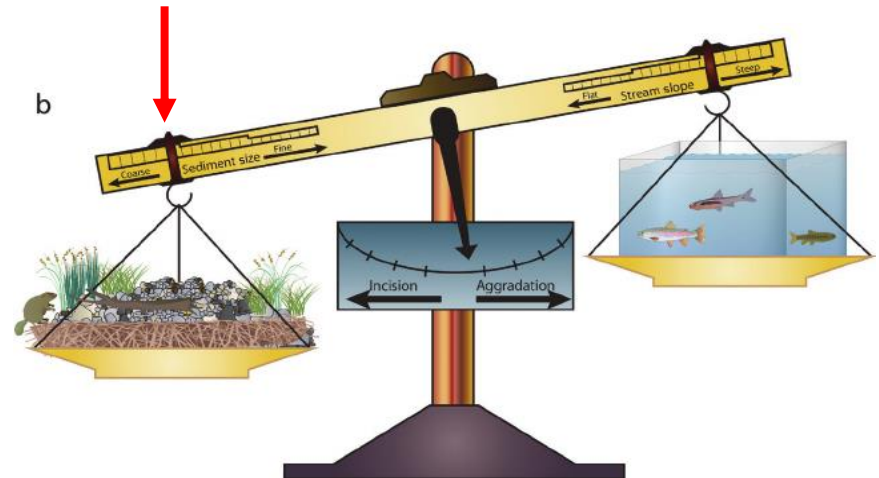
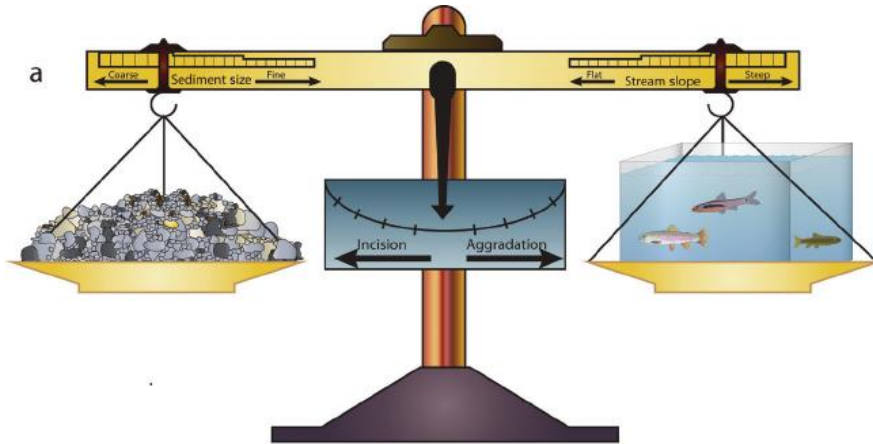


Natural/Geomorphic Solution

- Let river 'fix itself' through time and perform natural processes



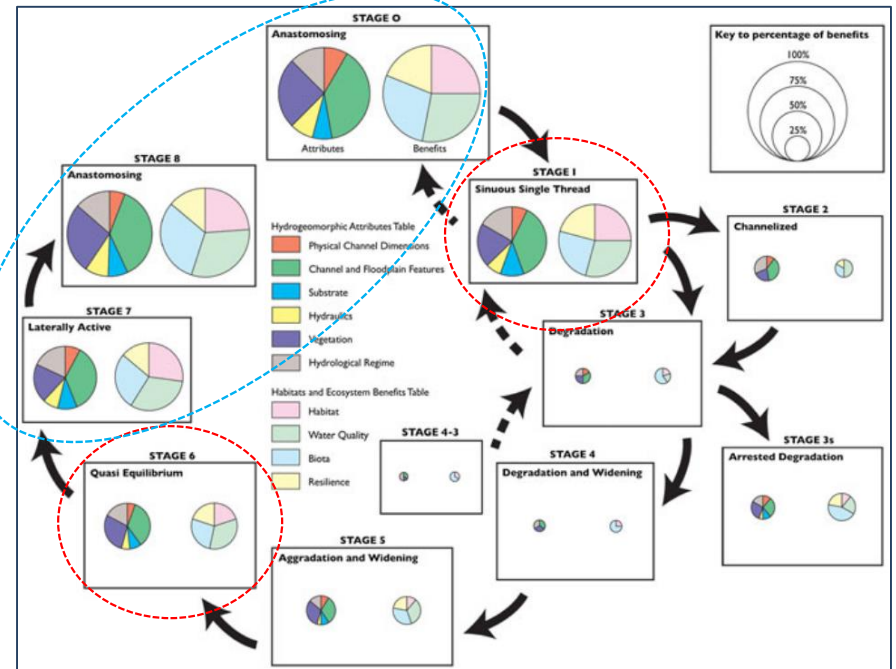
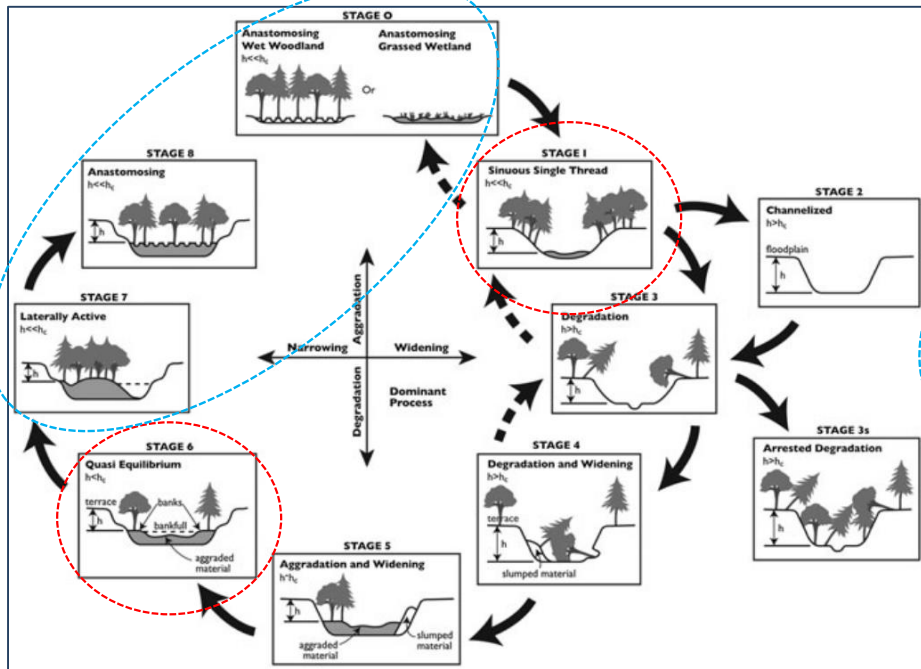
Sediment Transport Balance (CSR = 1)



Perfect Balance is Not Always Desired



Stream Evolution Model (SEM)



Cluer and Thorne 2013