Sharing River Restoration S.H.A.R.E.D

WHERE?

10-27-16

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What is River Restoration

- activities that initiate or accelerate the recovery and enhancement of ecosystem or river health, integrity, and sustainability (SER, 2004)

- River Engineering

"Planned human intervention in the course, characteristics or flow of a river with the intention of producing some defined benefit"

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2012/08/02

2012/08/02

Design Philosophy – Not Bad .. But

- Connect Goals and Objectives with Design Parameters
- Understand the System – Geomorphic and Watershed Assessment
- Quantify the Risk and Uncertainty
- Restoration to set the Trajectory of Stabilization
- Work with materials on-site
- Optimize the design – 3D design
- The Answers are in the River – Fieldwork
- Training and Education – Internal, Clients and Public

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S.H.A.R.E.D. Philosophy

- **S**hare knowledge with humility.
- **H**ave patience and discernment for innovation.
- **A**dvocate excellence.
- **R**espect the risk and uncertainty in river systems.
- **E**mpower, challenge and question.
- **D**ocument and learn from unexpected results.

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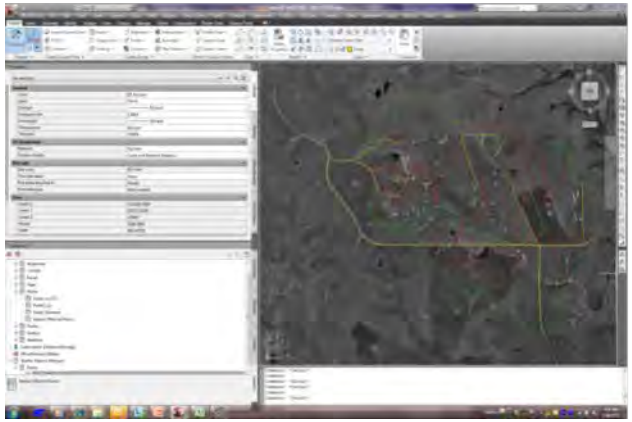
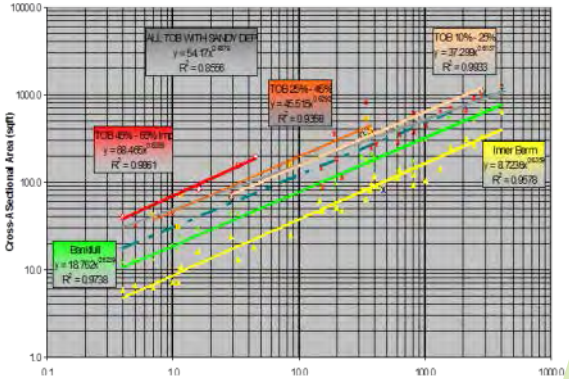
Share knowledge with humility

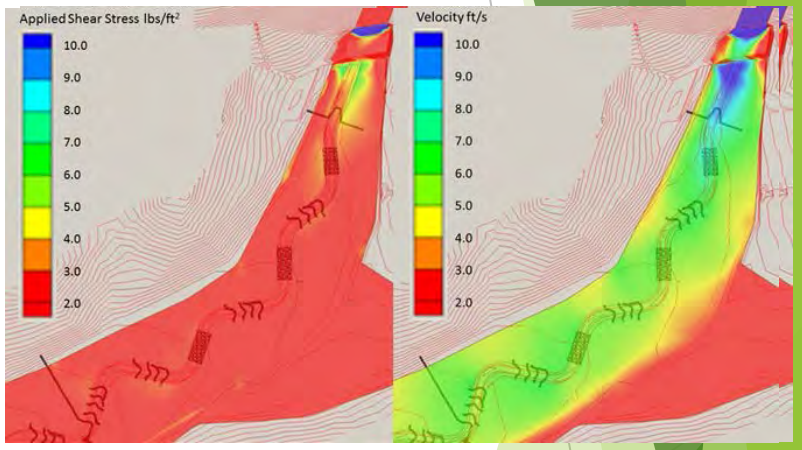
- Trade secrets are not good for maturing an industry, our understanding of river processes have come as a result of many other's sharing their knowledge and not keeping trade secrets.





Have patience and discernment for innovation

- Innovation is great but, we must not rush innovation or lose sight of the established processes that have led to the innovation.



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Advocate excellence

- Stay commitment to excellence and define excellence on all project. Strive to promote excellence throughout the profession

		Stream Stability GOAL			Water Quality GOAL				Buffer GOAL								
		Stop in-stream headcutting	Self-sustaining, natural, stable stream	Stream and floodplain manage shear stresses	Improve water quality and habitat of stream	Reduce sediment deposition and supply	Improve floodplain functions of water storage and habitat	SW control feature in watershed	Minimize impacts to wetland vegetation	Improve riparian buffer functions of stability, habitat, and aesthetics							
	Concept Option Description	*2*	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*Linear Feet of Proposed Project*	*Required Fill (yd3)*	*Fill cost ($10/yd3)*	*Preliminary Cost Estimate of Proposed Project*	*UNIT COST*	**MCDA Matrix Score**	**MCDA RANKING**
Option #1	Tie into wetland floodplain as long as possible step down channel gradually; Higher slope at top, lower slope at bottom	1	1	3	1	1	1	0	1	1	1170	6000	$60,000	$ 1,330,000.00	$ 1,136.75	**12**	3
Option #2	Tie into wetland floodplain as long as possible step down channel gradually; More-or-less consistent slope	1	1	2	1	1	1	0	1	1	1170	7000	$70,000	$ 1,340,000.00	$ 1,145.30	**10**	1
Option #3	Stay very high and flat coming out of the wetland	1	1	2	1	1	1	0	1	1	1170	10000	$100,000	$ 1,320,000.00	$ 1,128.21	**10**	1
Option #4	Lower in Wetland and then inbetween 1 and 2	2	1	2	1	1	1	0	1	1	1170	6500	$65,000	$ 1,335,000.00	$ 1,141.03	**12**	3
Option #5	60% Design as drafted	2	3	4	1	1	1	0	2	1	1170	500	$5,000	$ 1,270,000.00	$ 1,085.47	**19**	6
Option #6	30% Design as drafted	2	2	3	1	1	2	0	2	1	1170	6000	$60,000	$ 1,330,000.00	$ 1,136.75	**16**	5

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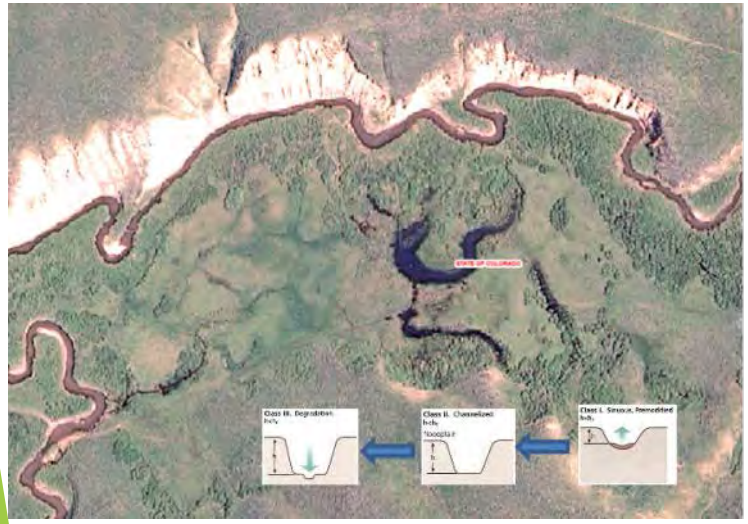
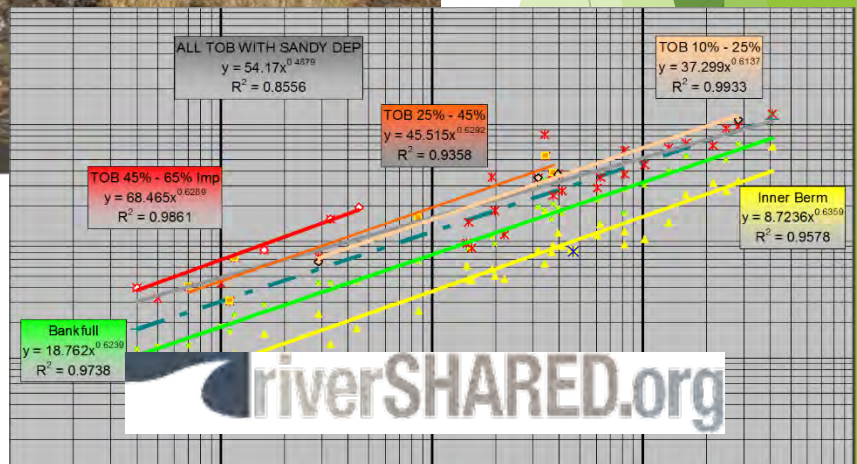
Respect the risk and uncertainty in river systems

- Rivers are complex, the more learned about riverine/riparian systems the more that is appreciated about the complexity of these systems. Innovation and modeling can be great tools, but the answers are still in the science and observation of the river.





Empower, challenge and question

- Empower others by encouraging them to question and challenge the design and geomorphic assumptions as well as conclusions. Others include, clients, design team, reviewers, regulators, grandmothers and others.

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Document and learn from unexpected results

- Rivers are complex systems that have a high degree of uncertainty and sometimes our remedial alternatives produce unexpected results. Sometimes our results are very unexpected. Document uncertainty and learn from unexpected results so that we may have a better understanding of why the unexpected result has occurred.

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Phases to River Restoration (Rosgen 2008)

- **Phase I: Restoration Goal/Objectives**
- **Phase II: Regional and Local Relations**
- **Phase III: Watershed/River Assessment**
- **Phase IV: Change overall management (Passive restoration)**
- **Phase V: Stream Restoration/Natural Channel Design**
- Phase VI: Design Stabilization and Fisheries Enhancement Structures
- Phase VII: Implementation
- Phase VIII: Monitoring and Maintenance Plan

Phase I: Restoration Goal/Objectives

- Obtain clear and concise statements of restoration objectives
- Associate Specific restoration objectives with physical processes
- Uncertainty and Risk associated Assessment and Design
- Communicate uncertainty and risk to the stakeholders

Phase I: Restoration Goal/Objectives
Is this a Successful Project?

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Phase I: Restoration Goal/Objectives
Restoration Objectives

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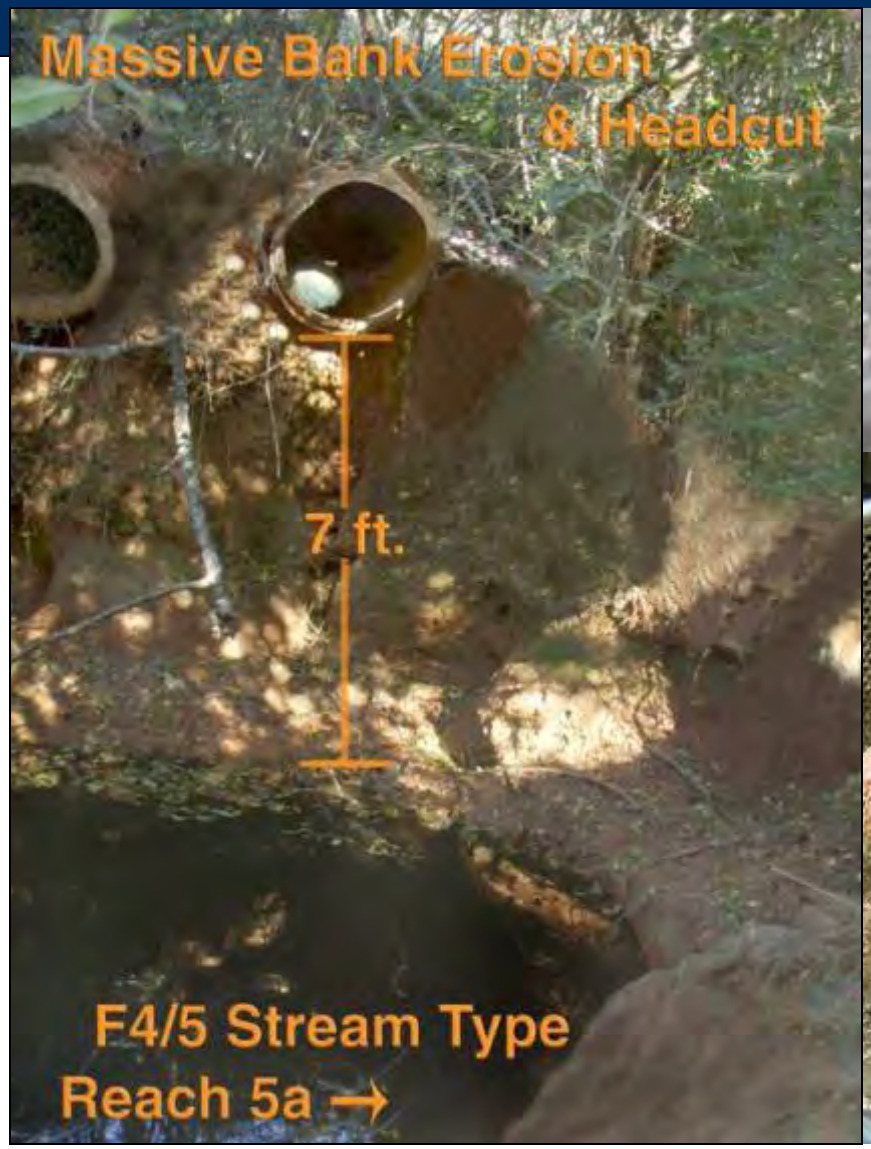
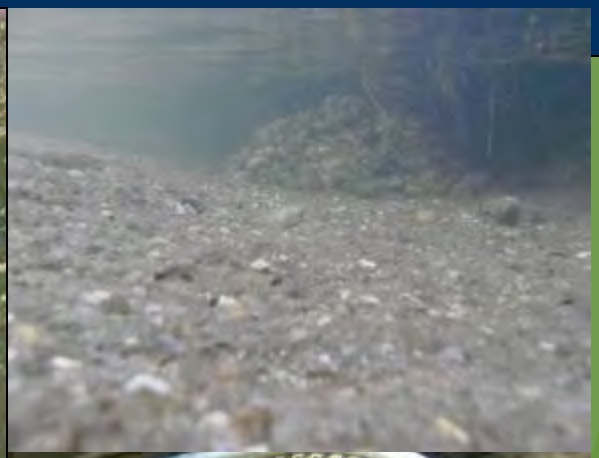
Phase I: Restoration Goal/Objectives Link Physical Processes





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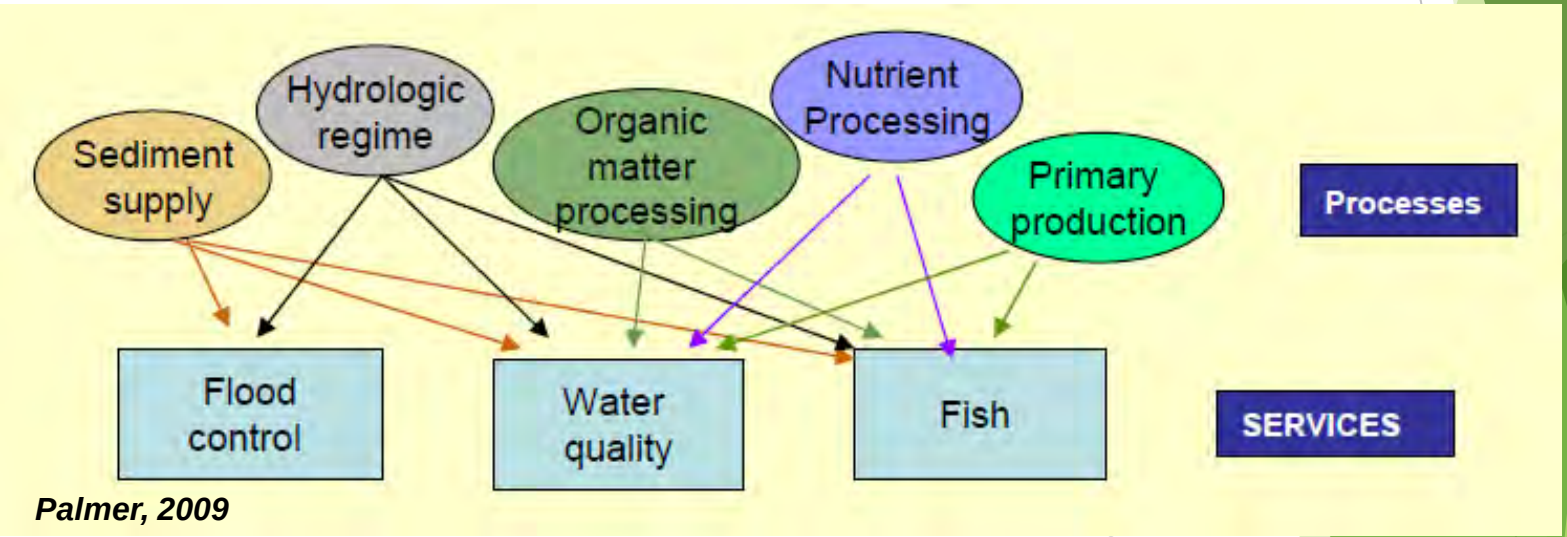
Phase I: Restoration Goal/Objectives Link Physical Processes

- Process based design is a design that is targeted to increase the function of a process to meet the goals and objectives of a project.



Palmer, 2009

Phase I: Restoration Goal/Objectives Uncertainty and Risk Assessment and Design

14 Mile Creek -- Brampton, Ontario

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Phase II: Regional and Local Relations

- Active deposition features
- Multiple depositional surfaces at varying stages
- Does Bankfull matter on urban streams or any River?
- Define risk level of channel design
- Mini- Regional curves

Phase II: Regional and Local Relations
Active Deposition Features

Green's Bayou-- Houston, Texas

Phase II: Regional and Local Relations
Active Deposition Features – Bankfull Channel

Williams Gully -- Houston, Texas

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Phase II: Regional and Local Relations
Multiple Depositional Surfaces

Spring Creek- Harris County, Texas

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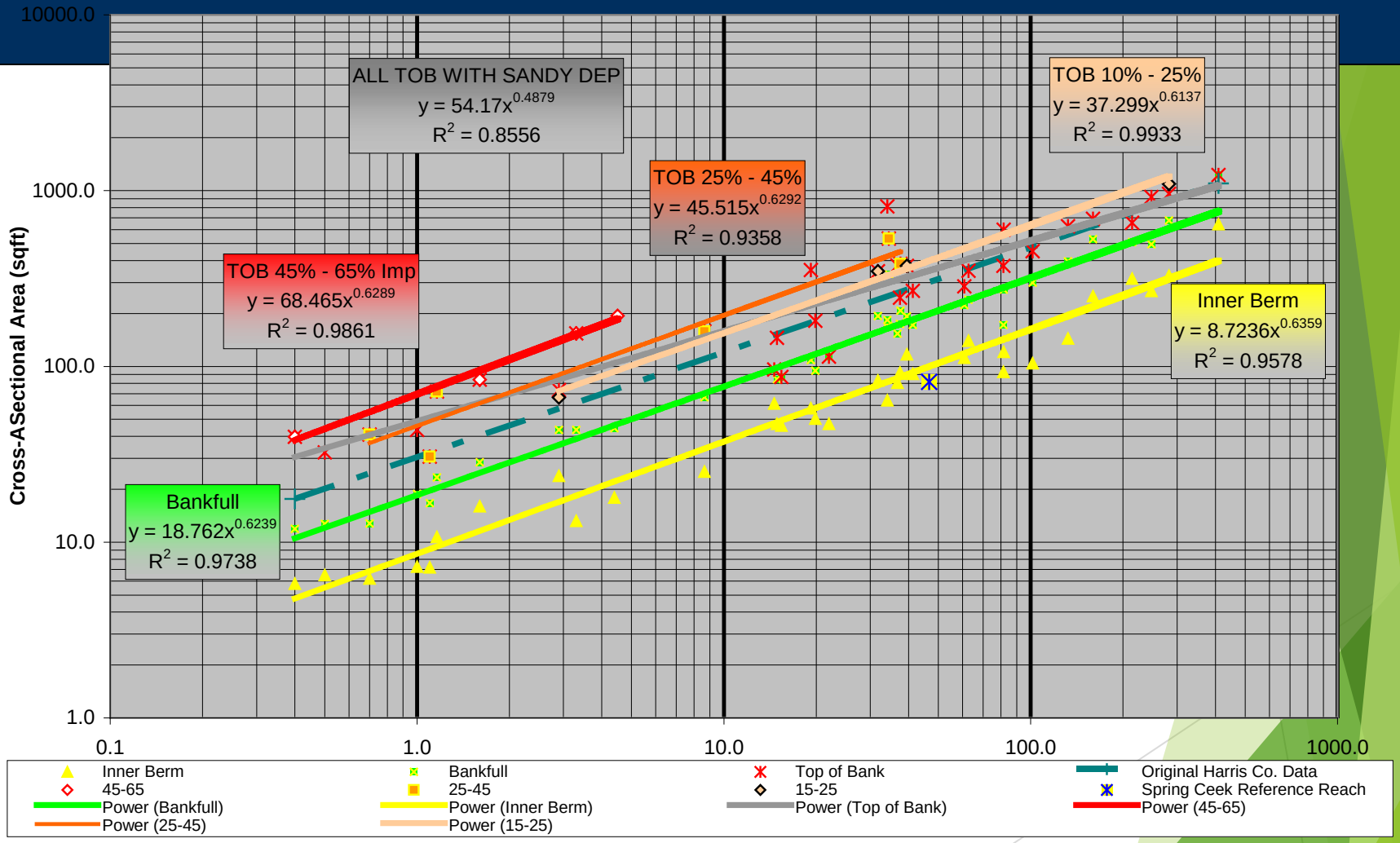
Phase II: Regional and Local Relations Multiple Depositional Surfaces



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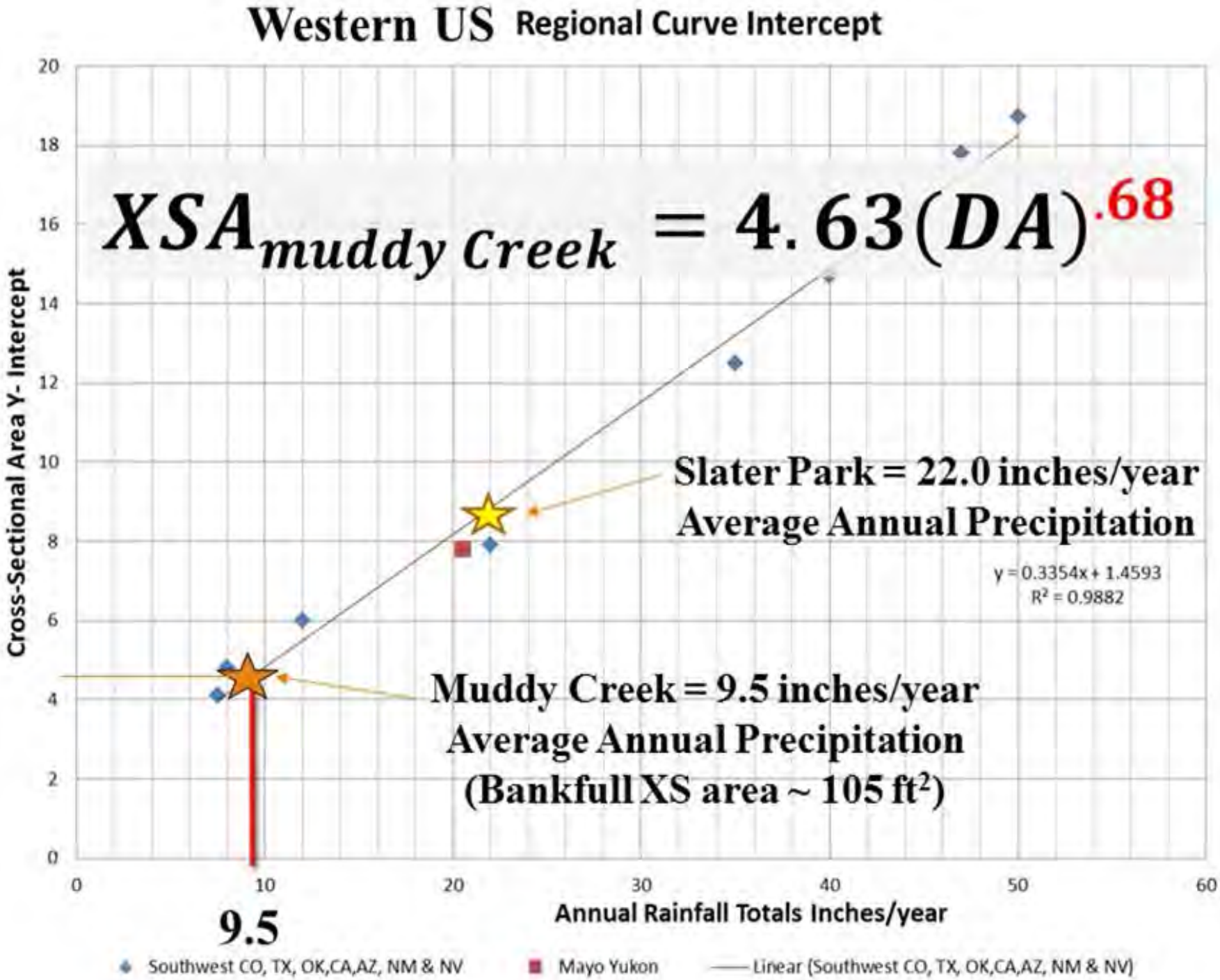
Western US Regional Curve Intercept
$XSA_{muddy\ Creek} = 4.63(DA)^{.68}$
Slater Park = 22.0 inches/year
Average Annual Precipitation
y = 0.3354x + 1.4593
R² = 0.9882
Muddy Creek = 9.5 inches/year
Average Annual Precipitation
(Bankfull XS area ~ 105 ft²)
9.5
Cross-Sectional Area Y- Intercept
Annual Rainfall Totals Inches/year
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
Southwest CO, TX, OK,CA,AZ, NM & NV
Mayo Yukon
Linear (Southwest CO, TX, OK,CA,AZ, NM & NV)

Phase II: Regional and Local Relations
Does Bankfull matter on Urban Streams?
- Vegetation and Sediment Transport

UT Price Park Greensboro, NC

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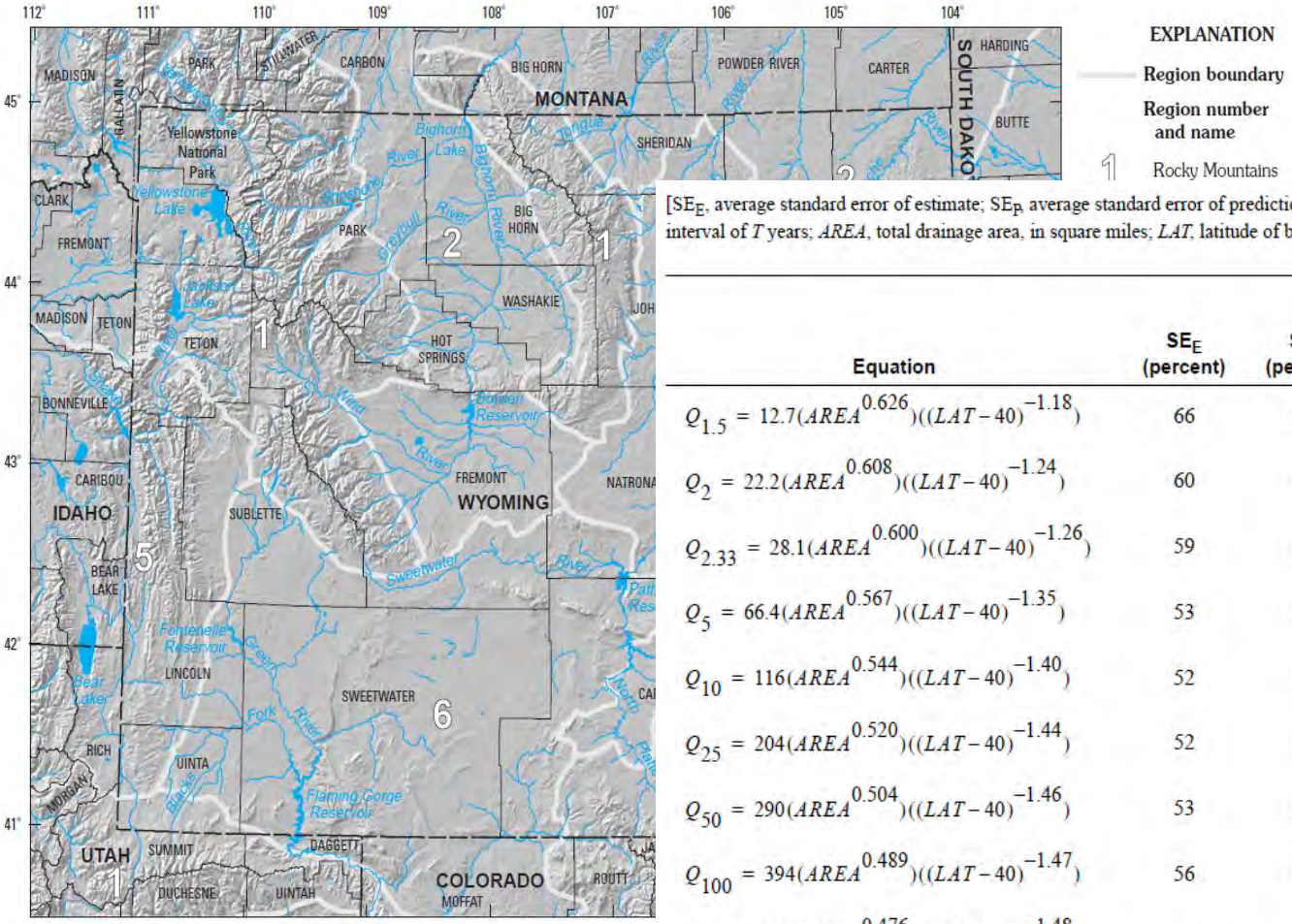
Phase II: Regional and Local Relations Define Risk Level of Channel Design



EXPLANATION

Region boundary

Region number and name

1 Rocky Mountains

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of T years; $AREA$, total drainage area, in square miles; LAT, latitude of basin outlet location, in decimal degrees]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 12.7(AREA^{0.626})((LAT-40)^{-1.18})$	66	72	3.2	0.266	3.76
$Q_{2} = 22.2(AREA^{0.608})((LAT-40)^{-1.24})$	60	66	3.2	.292	3.43
$Q_{2.33} = 28.1(AREA^{0.600})((LAT-40)^{-1.26})$	59	64	3.3	.301	3.32
$Q_{5} = 66.4(AREA^{0.567})((LAT-40)^{-1.35})$	53	59	4.7	.328	3.05
$Q_{10} = 116(AREA^{0.544})((LAT-40)^{-1.40})$	52	57	6.4	.336	2.98
$Q_{25} = 204(AREA^{0.520})((LAT-40)^{-1.44})$	52	58	8.5	.331	3.02
$Q_{50} = 290(AREA^{0.504})((LAT-40)^{-1.46})$	53	60	9.7	.320	3.13
$Q_{100} = 394(AREA^{0.489})((LAT-40)^{-1.47})$	56	63	10.4	.304	3.29
$Q_{200} = 519(AREA^{0.476})((LAT-40)^{-1.48})$	59	67	10.9	.286	3.49
$Q_{500} = 719(AREA^{0.459})((LAT-40)^{-1.49})$					83

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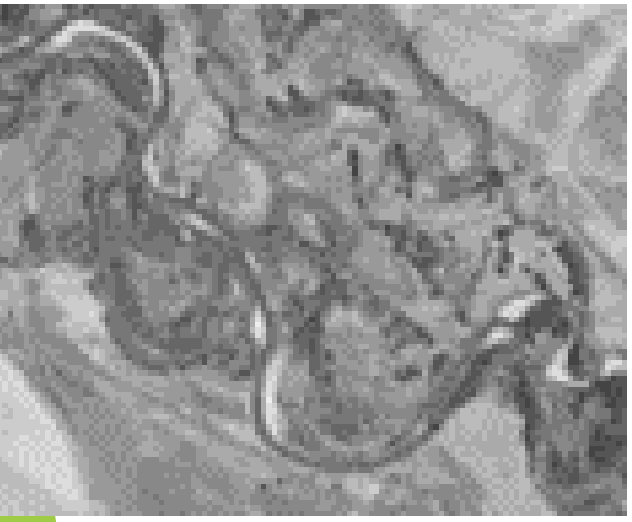
Phase III: Watershed/River Assessment

- Quantifying the Causes and Consequences of Changes
- Highlight uncertainties and potential risk of failure
  - Floodplain Shear Stress with Field Indicators
- Modify goals and objectives that are conflicting or are not achievable
- Bank Erosion Prediction – Property Loss
- Sediment Supply and Transport

Geomorphic Reference

Advocate excellence

- Geomorphic Assessment and Reference Reach comparison as a comparison on all river systems



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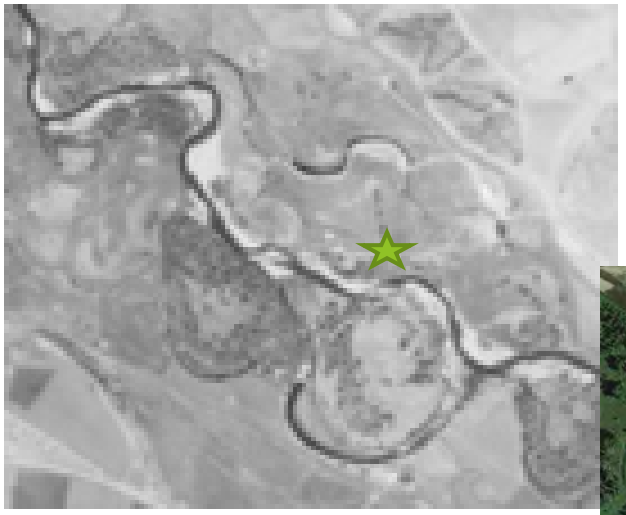

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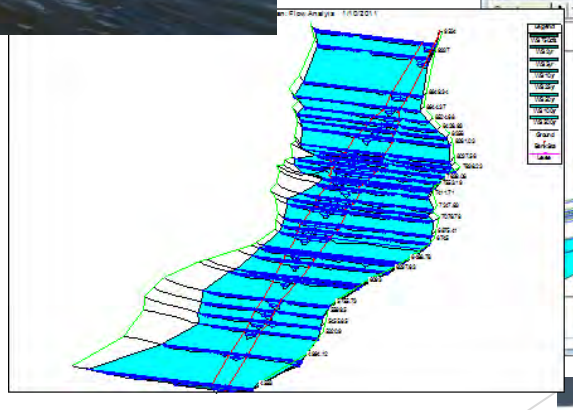
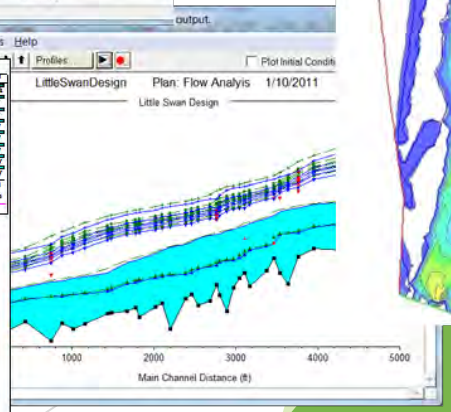
Geomorphic Reference

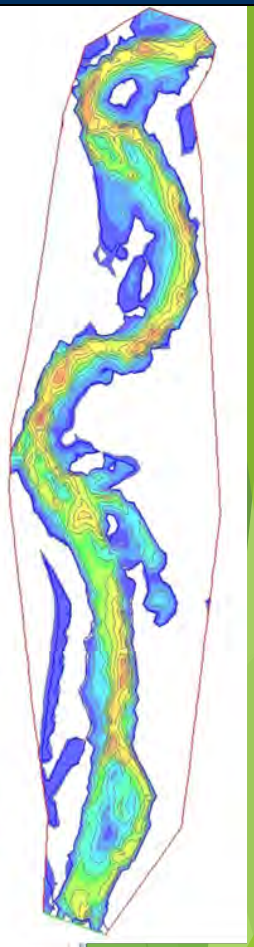
Advocate excellence

	Reference Reach - Upstream Dry Spotted Creek Composite		Dry Spotted Tail Creek - Reference Reach #1		Dry Spotted Tail Creek - Reference Reach #2		Dry Spotted Tail Creek - Disturbed Reach	
Geomorphic Parameter	Min	Max	Min	Max	Min	Max	Min	Max
Stream Slope	0.13%	0.13%	0.36%	0.39%	0.30%	0.33%	0.16%	0.16%
Bankfull Width	24	26	20	22	28	36	23	28
Bankfull Area	50	55	36	38	38	42	50	55
Bankfull Depth	2.1	2.1	1.8	1.7	1.4	1.2	2.2	2.0
Inner Berm Area	20.0	22.0	15.0	18.0	17.5	19.0	N/A	N/A
Bank Height Ratio	1.0	1.0	1.00	1.10	1.00	1.30	1.20	1.30
WDR	12	12	11	13	21	31	11	14
Linear Wavelength Ratio	9	10	7.3	9.3	5.4	7.5	7.8	8.7
Linear Wavelength	216	260	145	185	150	210	180	200
Meander Width Ratio	2.5	4.0	3.8	6.0	2.3	3.3	1.3	1.7
Belt Width	60	104	75	120	65	120	30	40
Radius of Curvature to Width Ratio	2.5	3.5	1.9	2.8	1.6	2.3	5.9	10.9
Radius of Curvature	60	91	38	55	45	65	135	250
Pool to Pool Spacing Ratio	5	7	N/A	N/A	4.3	7.1	4.8	7.2
Pool to Pool Spacing	120	182	N/A	N/A	120	198	110	165
Stream Length	1190	1420	306	2665	1740	569	3770	2500
Valley Length	1000	1000	175	985	1200	314	3650	2350
Sinuosity	1.40	1.45	1.75	2.71	1.45	1.81	1.03	1.06

Phase III: Watershed/River Assessment Quantifying the Causes and Consequences of Changes







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Phase III: Watershed/River Assessment

- Four C's of Natural Channel Design
  - **Cause** of instability, loss of function and impairment
  - **Consequence** of River instability
  - **Correction** - It is always better to first PREVENT the instability
  - **Communication** - It is imperative to first Understand….then be Understood

Phase III: Watershed/River Assessment Quantifying Highlight uncertainties and potential risk of failure

Rocky Branch Raleigh, NC

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Phase III: Watershed/River Assessment Quantifying Bank Erosion Prediction and Sediment Supply

Saamis Coulee Medicine Hat , Alberta

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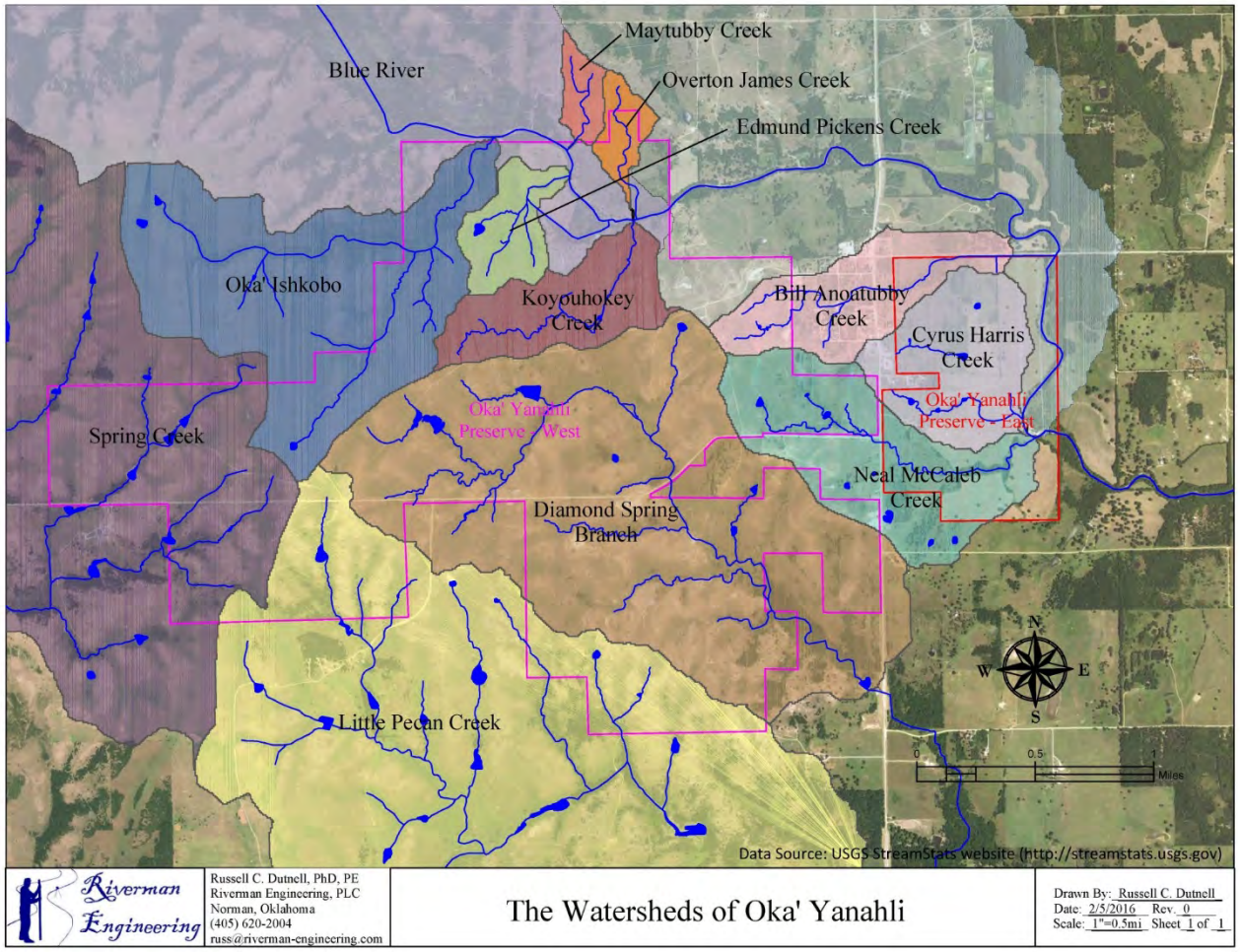
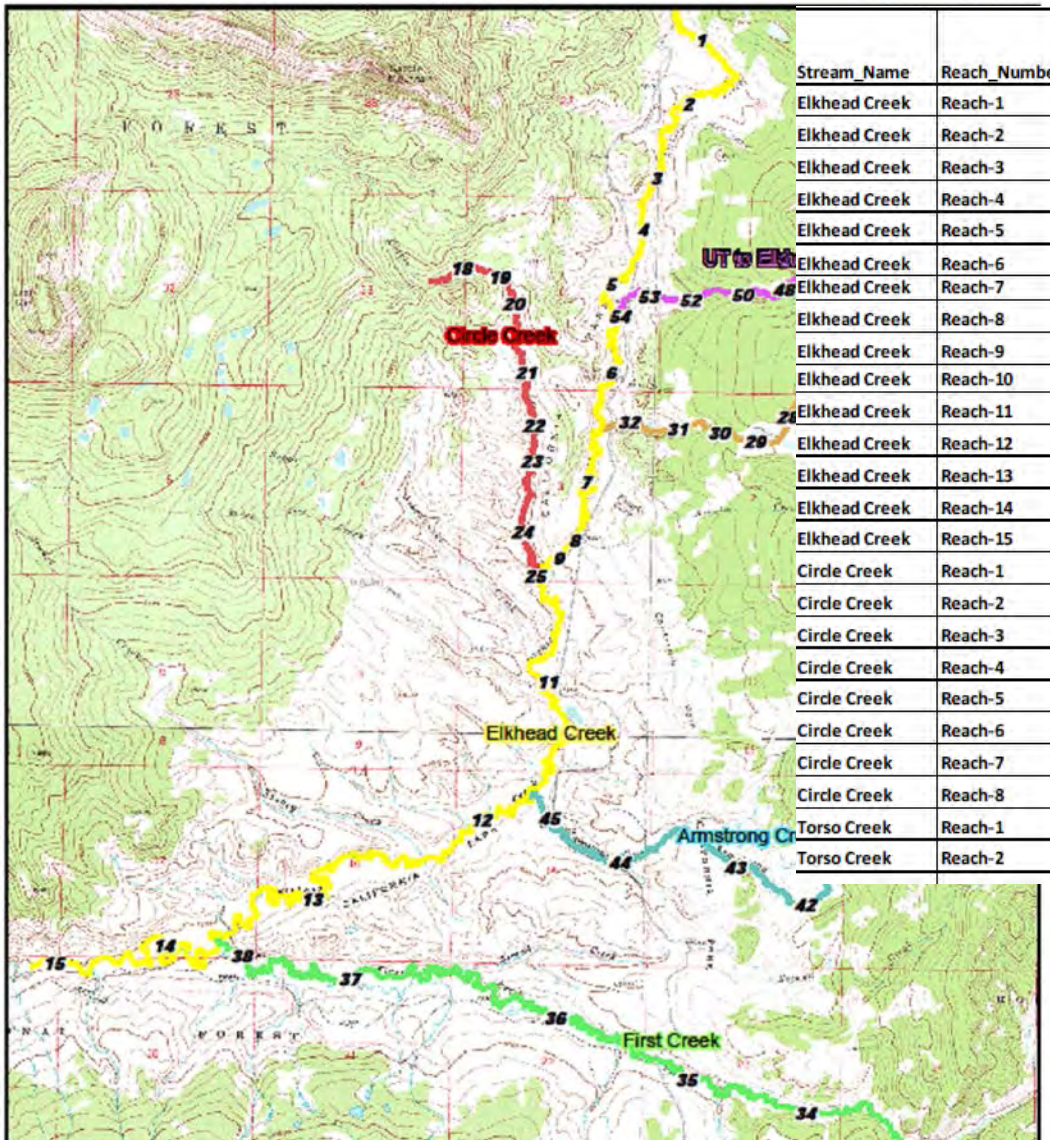
Watershed Planning based on Geomorphic Assessment



Watershed Planning based on Geomorphic Assessment



Stream_Name	Reach_Number	Reach Independence	Reach Dependencies	Cost Low Risk Option #1	Cost/Ton Low Risk	Cost High Risk Option #2	Cost/Ton High Risk
Elkhead Creek	Reach-1	1	0	$ 48,112.50	$ 240.56	$ -	$ -
Elkhead Creek	Reach-2	1	0	$ 107,568.75	$ 268.92	$ -	$ -
Elkhead Creek	Reach-3	1	0	$ -	$ -	$ -	$ -
Elkhead Creek	Reach-4	1	0	$ 47,381.25	$ 189.53	$ -	$ -
Elkhead Creek	Reach-5	2	1	$ 57,840.00	$ 385.60	$ 65,070.00	$ 433.80
Elkhead Creek	Reach-6	2	1	$ 145,110.00	$ 241.85	$ 108,832.50	$ 181.39
Elkhead Creek	Reach-7	1	2	$ 272,650.00	$ 779.00	$ 81,795.00	$ 233.70
Elkhead Creek	Reach-8	1	2	$ -	$ -	$ 20,600.00	$ 824.00
Elkhead Creek	Reach-9	2	0	$ 54,500.00	$ 545.00	$ 21,582.00	$ 215.82
Elkhead Creek	Reach-10	2	0	$ 30,500.00	$ 87.14	0	$ -
Elkhead Creek	Reach-11	1	2	$ 306,550.00	$ 245.24	$ 551,790.00	$ 441.43
Elkhead Creek	Reach-12	3	2	$ 55,590.00	$ 61.77	$ 62,538.75	$ 69.49
Elkhead Creek	Reach-13	3	2	$ 414,750.00	$ 167.91	$ 311,062.50	$ 125.94
Elkhead Creek	Reach-14	2	5	$ 887,900.00	$ 164.43	$ 177,580.00	$ 32.89
Elkhead Creek	Reach-15	1	6	$ -	$ -	$ 24,760.00	$ 247.60
Circle Creek	Reach-1	1	0	$ 13,158.00	$ 657.90	$ -	$ -
Circle Creek	Reach-2	1	0	$ 42,693.75	$ 284.63	$ 30,056.40	$ 200.38
Circle Creek	Reach-3	2	0	$ 48,175.00	$ 481.75	$ 36,131.25	$ 361.31
Circle Creek	Reach-4	2	0	$ 65,580.00	$ 437.20	$ 49,185.00	$ 327.90
Circle Creek	Reach-5	1	1	$ -	$ -	$ -	$ -
Circle Creek	Reach-6	3	0	$ 47,531.25	$ 316.88	$ 28,518.75	$ 190.13
Circle Creek	Reach-7	3	0	$ 71,793.75	$ 717.94	$ 43,076.25	$ 430.76
Circle Creek	Reach-8	2	1	$ 29,820.00	$ 596.40	$ -	$ -
Torso Creek	Reach-1	1	0	$ 8,698.00	$ 869.80	$ -	$ -
Torso Creek	Reach-2	1	0	$ -	$ -	$ -	$ -

Functional Assessment

- PFC
- SVA
- RGI
- BAN
- QT
- FAC
- FAC
- Fish
- Pro

Site Information and Performance Standard Stratification	
Project Name:	Boulder Creek
Reach ID:	Boulder Creek Restoration
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	C
Proposed Stream Type:	C
Region:	Front Range Boulder County
Drainage Area (sqmi):	3
Proposed Bed Material:	
Existing Stream Length (ft):	2475
Proposed Stream Length (ft):	2501
Stream Slope (%):	0.4
Flow Type:	Perennial
River Basin:	Boulder Creek
Stream Temperature:	Coldwater
Data Collection Season:	Winter/Spring

Notes

1. Users input values that are highlighted based on restoration potential
2. Leave values blank for field values that were not measured

FUNCTIONAL LIFT SUMMARY	
Exisiting Condition Score (ECS)	0.28
Proposed Condition Score (PCS)	0.41
Functional Lift Score	0.13
Percent Condition Lift	46%
Existing Stream Length (ft)	2475
Proposed Stream Length (ft)	2501
Additional Stream Length (ft)	26
Existing Stream Functional Foot Score (FFS)	693
Proposed Stream Functional Foot Score (FFS)	1025
Proposed FFS - Existing FFS	332
Functional Lift (%)	48%

BMP FUNCTIONAL LIFT SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	693
Proposed Stream FFS + Proposed BMP FFS	1025
Total Proposed FFS - Total Existing FFS	332
Functional Lift (%)	48%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Runoff		
	Flow Duration		
Hydraulics	Floodplain Connectivity	0.67	0.86
Geomorphology	Large Woody Debris	0.22	0.69
	Lateral Stability	0.57	1.00
	Riparian Vegetation	0.32	0.79
	Bed Material		
	Bed Form Diversity	0.15	0.82
	Sinuosity	0.30	0.70
Physicochemical	Temperature		
	Salinity		
	Bacteria		
	Stream Metabolism		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.40	0.40	0.00
Hydraulics	0.67	0.86	0.19
Geomorphology	0.31	0.82	0.51
Physicochemical			
Biology			

Where - Optimal Site Selection

- Willing Land Owner
- Available Funding
- Highest Functional Uplift
- Reach Dependency and Funding

Sharing River Restoration S.H.A.R.E.D

WHEN?

10-27-16

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When to do a River Restoration Project Ideas – everyone has one or two

- Alternative Analysis
- MCDA
- Geomorphic Trajectory
- Passive or Do nothing
- Reach Dependency
- Seasonal Concerns
- Construction Phasing

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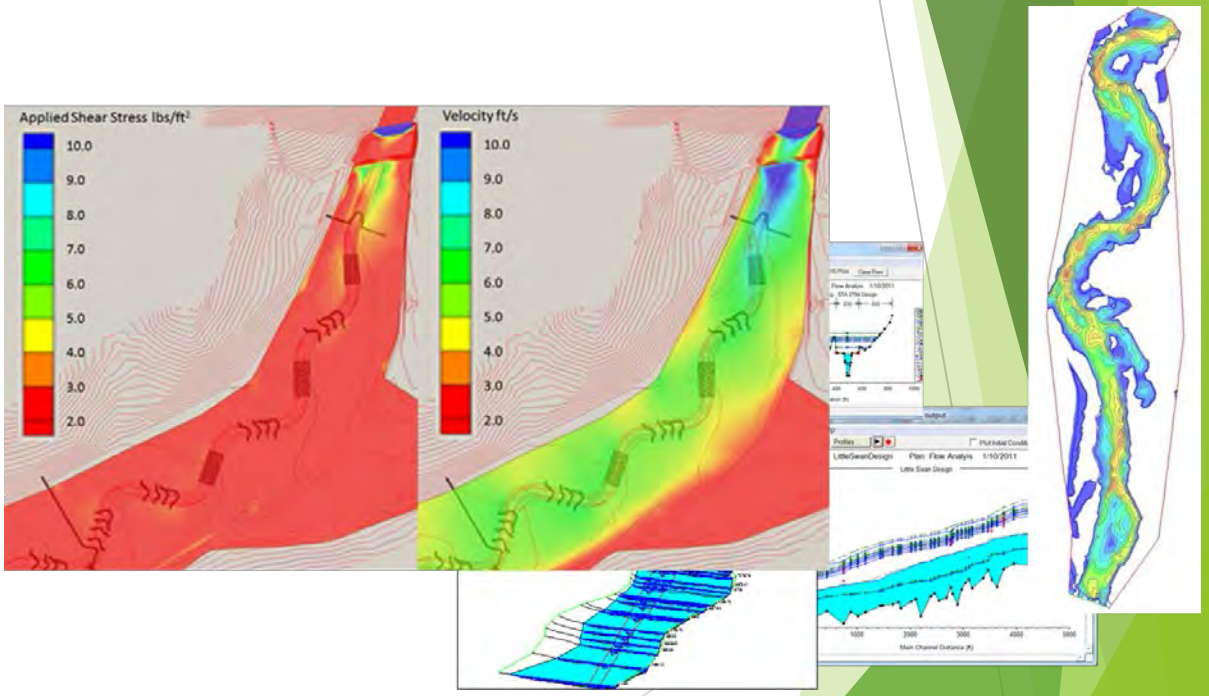
Limiting Factors Analysis for a Successful River Restoration Project

- Lack of Knowledge
- Lack of Communication
  - Mixed messages
    - Jargon
    - Personalities
    - Poor Documentation
  - Muddled messages
    - Personalities
    - Poor Documentation
  - Mute messages
    - Insecurities
    - Time

- **S**hare knowledge with humility.
- **H**ave patience and discernment for innovation.
- **A**dvocate excellence.
- **R**espect the risk and uncertainty in river systems.
- **E**mpower, challenge and question.
- **D**ocument and learn from unexpected results.

Engineering Jargon

- Jargon: Special words or expressions that are used by a particular profession or group and are difficult for others to understand.
  - Bankfull
  - Shear Stress
  - Risk Analysis
  - Unit Stream Power
  - Radius of Curvature
  - Meander Width Ratio
  - Stream Type
  - J-Hook
  - Flood Recurrence
  - Thalweg
  - BEHI/NBS
  - Reynolds – Near-bed
  - NCD



Biological Jargon

- Jargon: Special words or expressions that are used by a particular profession or group and are difficult for others to understand.
  - Nitrogenous Waste
  - Spawning Gravels
  - Chemical Treatment
  - Cottonwood Recruitment
  - Detritus
  - Invertebrates
  - Thalweg
  - Trophic Level
  - Drift
  - Riffle

MCDA Jargon

- Michigan Cannabis Development Association
- Maine Career Development Association
- Multnomah County District Attorney
- Military and Civil Defense Assets

- Multiple Criteria Decision Analysis
  - Goal: An overarching principle that guides decision making
    - Habitat Improvement
  - Objective: Are specific, measurable steps that can be taken to meet a goal.
    - 50% increase In pool depth to provide cover for fish
  - Criteria: Objective based variable scale as compared with other alternatives
    - Depth of pool cover post construction

#1

Have patience and discernment for innovation

- Let Goals and Objective help decide field techniques and design tools

Goals

1. Provide year-round fish passage at the Harmony Diversion site (except for when a call is placed on the river) for all species of fish that occupy the Nowood and Bighorn Rivers;
    a. Specifically shovelnose sturgeon and sauger;
2. Provide reliable supply of irrigation water for ditch user at all discharges;
3. Design and construct an improved instream diversion that can divert the entire river if needed during a call and minimizes instream maintenance;
    a. Designs can in no way compromise the integrity of the existing highway bridge that is upstream of the diversion site.
4. Improve transport of sediment and debris through diversion to avoid entry into headgate/screening structure;
5. Any design should be able to withstand significance ice flow events.

Objectives

1. Designs that leave the channel open and in a more natural state are preferred over designs that rely on a fish ladder to provide fish passage.
2. Designs must allow the landowner to take all flow (no more than 1-3 cfs can flow past the diversion) if the landowner has to put a call on the river.
3. If a fishway were to be considered: Fishway attraction flow of 2-4 ft/s within thalweg of channel and flow depths of 4 ft or more. Fishway passage velocity of 3-4 ft/s is preferred for shovelnose, but shovelnoses have negotiated velocities between 0.8 - 6.0 ft/s (White 2002).
4. New headgate structure and ISI cone shaped fish screens are designed for 40 cfs (20 cfs each screen). The irrigator holds senior water rights which can result in putting a call on the river, so Joyce can receive his water. The State Engineer requires him to divert all water from the river with only 1-3 cfs leaking through.
5. Somehow design an instream structure that will not be a complete dam or barrier. I feel that being in the fish passage program our goals are to remove dams, not to be constructing them. Maybe still look at using an Obermeyer weir. Construct a new structure that requires less maintenance and man hours for the landowner/irrigator.
6. Come up with a design that WYDOT will okay, since their bridge is about 55 ft upstream of the diversion site.

#1

Have patien

- Let
tech

Goals

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2. Provide reliable supply of irrigation water for ditch user at all discharges;
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#2

Advocate excellence

- Use a Multi-Criteria Decision Analysis (MCDA) tool to define Excellence based on Goals and Objectives

				Fish Passage GOAL				Water Delivery and Reliability GOAL			LOW RISK GOAL			Morphology GOAL						
				100% Fish Passage	Natural Looking Channel	Velocity 2-4fps and lower than 6fps BKF	No Dam	100% Dam Recall is made	Maximum Pushup Dam	Maintenance and Cleaning out sediment	No Increase of Future Liability	No Increase of Flooding Upstream to Bridge	Ease of Approval Process	Laterial Migration	Sustainable Sediment Transport Balance					
	Concept Option Description	Low Flow Diversion	Fish Passage Concept	1	1	1	1	1	1	1	1	1	1	1	1	*Linear Feet of Proposed Project*	*Preliminary Cost Estimate of Proposed Project*	*UNIT COST*	MCDA Matrix Score	MCDA RANKING
Option #1	Concrete Dam with Bypass	Pushup Dam at Low Flow	Bypass Natural Channel	1	5	1	5	1	1	4	5	5	5	5	5	200	$ 900,000.00	$ 4,500.00	**48**	10
Option #2	Natural Channel Design Dam with Large Step-Pools with Bypass	Pushup Dam at Low Flow at Designed Glide	Bypass Natural Channel	1	4	1	5	1	1	5	5	5	4	4	5	1000	$ 700,000.00	$ 700.00	**46**	9
Option #3	Natural Channel Design Channel Downstream	Pushup Dam at Low Flow at Designed Glide	Natural Channel Main Reach	1	2	1	4	1	1	4	4	4	4	2	3	5000	$ 1,100,000.00	$ 220.00	**35**	6
Option #4	Natural Channel Design Channel Balance Profile Upstream and Downstream	Pushup Dam at Low Flow at Designed Glide	Natural Channel Main Reach	1	1	1	2	3	2	3	2	3	3	1	2	3000	$ 660,000.00	$ 220.00	**26**	3
Option #5	Change Point of Diversion with Culvert under Bridge	Pushup Dam at Low Flow Upstream	Existing Channel	2	4	2	2	1	2	4	2	3	3	3	3	200	$ 250,000.00	$ 1,250.00	**33**	4
Option #6	Culvert under Road ~ 100ft west of north of the Bridge	Pushup Dam at Low Flow Upstream	Existing Channel	2	3	2	2	1	2	2	1	2	2	2	3	200	$ 200,000.00	$ 1,000.00	**25**	2
Option #7	Fabric Inflatable Dam with Bypass or Fishway	Fabric Dam at Low Flow	Fishway or Engineered Bypass	2	5	1	3	2	2	4	3	3	3	3	4	200	$ 1,000,000.00	$ 5,000.00	**38**	8
Option #8	Do Nothing but Lower Fish Screens	Pushup Dam at Low Flow	Existing Channel	4	3	3	3	3	4	3	1	2	1	4	3	200	$ 100,000.00	$ 500.00	**35**	6
Option #9	Do Nothing	Pushup Dam at Low Flow	Existing Channel	4	3	3	3	3	4	2	1	2	1	4	3	200	$ -	$ -	**34**	5
Option #10	Replace Bridge in adition to Option 3 and Upstream Channel Adjustments	Pushup Dam at Low Flow		1	2	1	2	1	2	2	1	1	2	1	1	200	$ 2,600,000.00	$ 13,000.00	**18**	1

Criteria

Weighting Factors

Options

Components of MCDA tool

		Stream Stability GOAL			No Increase Risk			Water Quality GOAL				Buffer GOAL			
		Stop in-stream head cutting	Self-sustaining, natural, stable stream	Stream and floodplain manage shear stresses	Flooding to Downstream County Road	Dam Failure	Upstream flooding	Improve water quality and habitat of stream	Reduce sediment deposition and supply	Improve floodplain functions of water storage and habitat	SW control feature in watershed	Minimize impacts to wetland vegetation	Improve riparian buffer functions of stability, habitat, and aesthetics	**MCDA Matrix Score**	**MCDA RANKING**
	Concept Option Description	***4***	***2***	***3***	***2***	***3***	***1***	***1***	***1***	***2***	***1***	***2***	***1***		
Option #1	Do Nothing	5	5	5	1	1	1	5	5	5	5	2	2	**82**	**5**
Option #2	Dam and Reservoir Construction	1	5	2	1	4	5	4	1	1	1	5	4	**61**	**4**
Option #3	Enhancement/Stabilization Priority III - Small Floodplains at Existing Elevation grade banks at 4:1	2	2	3	1	1	2	2	2	3	4	3	3	**51**	**3**
Option #4	Restoration Priority II - Large Floodplain at lower Elevation grade floodplain banks at 4:1	2	2	2	1	1	1	1	2	2	3	4	2	**44**	**2**
Option #5	Restoration Priority I - Reconnect floodplain and wetlands	1	1	1	1	1	1	1	1	1	3	1	1	**25**	**1**

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#3

Document and learn from unexpected results

- Always define Goals and Objectives with stakeholders and allow for flexibility in the MCDA Documentation

Goals

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   a. Specifically shovelnose sturgeon and sauger;
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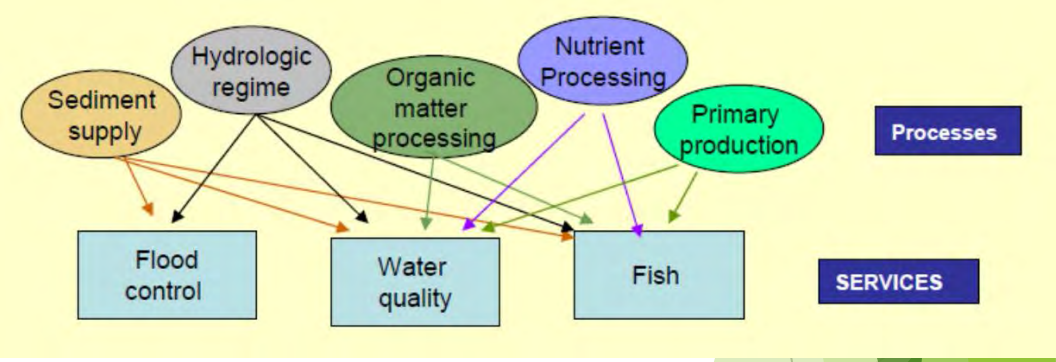
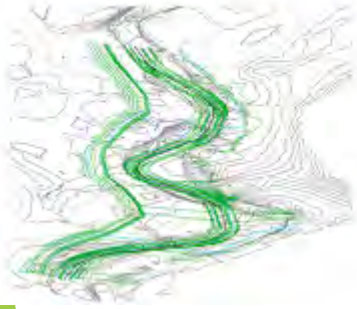


#4

Advocate excellence

- 3-D Design Optimization based on MCDA and Goals and Objectives

Optimization



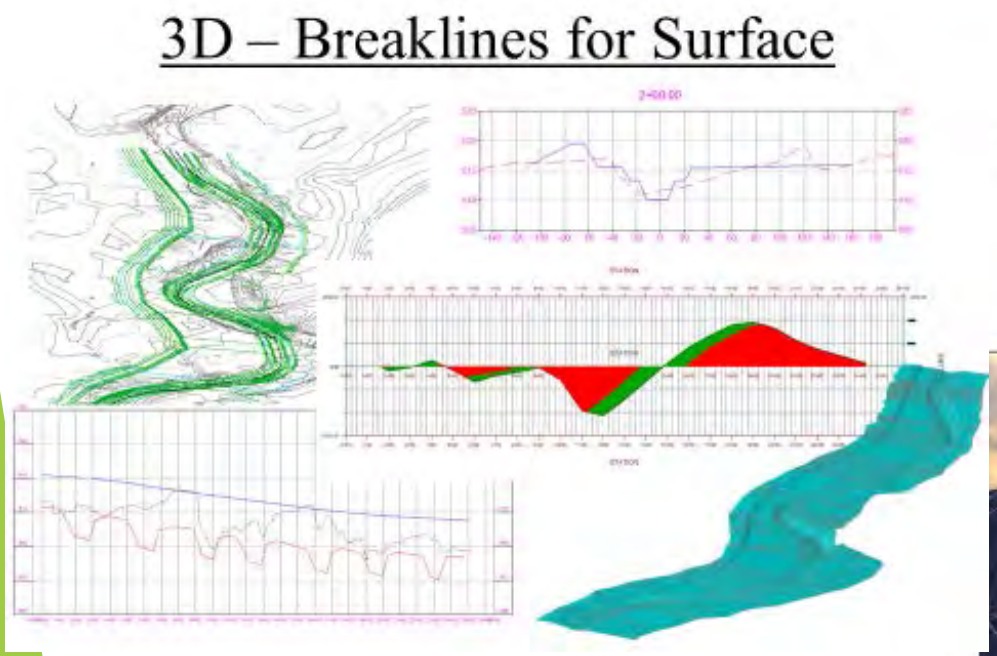
- Hydraulic Modeling is Not Limited
- Easier to Create Design Revisions and Iterations
- Assist in Construction Stakeout
- GPS Guided Construction Equipment

- Good Check for On-site Stupidity During Construction

#4

Advocate excellence

- 3-D Design Optimization based on MCDA and Goals and Objectives



#4

Advocate excellence

- 3-D Design Optimization based on MCDA and Goals and Objectives

		Stream Stability GOAL			Water Quality GOAL				Buffer GOAL								
		Stop in-stream headcutting	Self-sustaining, natural, stable stream	Stream and floodplain manage shear stresses	Improve water quality and habitat of stream	Reduce sediment deposition and supply	Improve floodplain functions of water storage and habitat	SW control feature in watershed	Minimize impacts to wetland vegetation	Improve riparian buffer functions of stability, habitat, and aesthetics	*Linear Feet of Proposed Project*	*Required Fill (yd3)*	*Fill cost ($10/yd3)*	*Preliminary Cost Estimate of Proposed Project*	*UNIT COST*	MCDA Matrix Score	MCDA RANKIN
	Concept Option Description	*2*	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*							
Option #1	Tie into wetland floodplain as long as possible step down channel gradually; Higher slope at top, lower slope at bottom	1	1	3	1	1	1	0	1	1	1170	6000	$60,000	$ 1,330,000.00	$ 1,136.75	**12**	
Option #2	Tie into wetland floodplain as long as possible step down channel gradually; More-or-less consistent slope	1	1	2	1	1	1	0	1	1	1170	7000	$70,000	$ 1,340,000.00	$ 1,145.30	**10**	
Option #3	Stay very high and flat coming out of the wetland	1	1	2	1	1	1	0	1	1	1170	10000	$100,000	$ 1,320,000.00	$ 1,128.21	**10**	
Option #4	Lower in Wetland and then inbetween 1 and 2	2	1	2	1	1	1	0	1	1	1170	6500	$65,000	$ 1,335,000.00	$ 1,141.03	**12**	
Option #5	60% Design as drafted	2	3	4	1	1	1	0	2	1	1170	500	$5,000	$ 1,270,000.00	$ 1,085.47	**19**	
Option #6	30% Design as drafted	2	2	3	1	1	2	0	2	1	1170	6000	$60,000	$ 1,330,000.00	$ 1,136.75	**16**	
Option #7	Do Nothing	5	5	5	5	5	5	0	3	4	1170	0	$0	$ -	$ -	**37**	

MCDA – Got it ??

					Fisheries and Habitat Improvement for Salmonids GOAL											Drainage, Irrigation and Water Rights Goal					Low Project RISK GOAL						Demonstration Project Goal							Funding GOAL			Land Management and Conservation Goal					River Morphology and Stability GOAL				
					Groundwater influenced Coldwater Fishery	Re-establish Riparian Wetlands through PRBE property	Establish Riparian Native Vegetation	Deep Sustainable Pools	Overhead Cover in-bank	Sustainable Spawning Gravels for Riffles 40-70mm	Connectivity to North Platte	Potential Barrier from North Platte	Coldwater Fishery	No additional Heating through in-line Ponds	Increased Fisheries Length	No irrigation structures Impacts	No Drainage Obstruction	No Impacts to Adjacent Landowners Drainage	No Impacts Gage Control Structure	No increase in Evaporative Losses	No Increase or transfer in Future Liability	EMERGENCY PLUG 100yr Design and Overflow	Regulated flows in Design Re-Alignment Channel	No Increase of Scour to Bridge	No Increase of Flood stage on CO 12	Ease of Approval and Permit Process	Walk-in Fishery and Pathway	ADA Access for Fishing and Hiking	Potential Training Courses	Potential Project Phasing	Volunteer involvement Opportunities	Flagship Project and Demo	Opportunities for TU Chapter involvement	Successful NET grant application based on design	Opportunities for others to fund design	Timeline Limitations of Design	Grazing Management Plan	Fencing for Exclusion	Preserve Prairie Dog Town	Exotic Vegetation Removal	Seasonal Wetland Management	Reduction of Bank Erosion and Lateral Bank Migration	Sustainable Sediment Transport Balance	Future Maintenance River		
	Concept Option Description	Length of Unadjusted reach	Length of Restored Re-Aligned Spotted Creek	Upstream Potential Additional Fishery Improvements	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	MCDA Matrix Score	MCDA RANKING
Option #1	Do nothing G4/5c and B4/5c with a sinuosity of 1.01	3975	0	0	5	5	4	3	3	4	2	4	4	1	5	1	1	1	1	1	1	1	5	2	1	1	4	5	5	5	5	5	5	5	5	1	5	5	2	5	5	3	3	3	**132**	9
Option #1b	Do nothing G4/5c and B4/5c with a sinuosity of 1.01 Trail Access, Fencing and Replanting	1000	0	2975	5	5	4	3	3	4	2	4	4	1	5	1	1	1	1	1	1	1	5	2	1	1	2	3	5	5	3	5	3	4	5	2	1	1	1	4	5	3	3	3	**114**	8
Option #2	Original DU Design - E4 sinuosity of 1.8 as originally designed	3600	5200	0	2	2	1	2	1	3	2	2	3	5	2	2	2	3	2	5	2	3	3	2	2	4	2	3	2	2	1	2	1	2	2	3	1	1	1	3	1	2	3	3	**90**	5
Option #3	E4 sinuosity of 1.8 start at middle elevation	2600	5200	0	2	1	1	2	1	2	1	1	2	4	2	2	3	4	2	5	2	2	2	2	3	4	2	3	2	2	1	2	1	2	2	3	1	1	1	3	1	2	3	3	**85**	4
Option #4	sinuosity of 1.8 maximize head upstream Re-alignment	1800	6200	0	1	1	1	1	1	3	1	1	2	3	1	3	3	4	2	5	2	1	2	2	3	4	2	3	2	2	1	2	1	2	2	3	1	1	5	2	1	1	2	2	**82**	3
Option #5	C4/5 with sinuosity of 1.1 MINOR re-alignment within existing Ditch footprint	0	4200	0	5	5	3	2	3	3	2	3	3	1	4	1	1	1	1	1	1	1	5	2	1	1	2	3	3	3	1	3	1	3	4	3	1	1	1	3	5	2	2	2	**93**	6
Option #6	Grade bankfull bench Inplace with no channel work B4/5c sinuousity 1.01 No Re-Alignment	0	0	3975	5	5	3	3	3	4	2	4	4	1	5	1	1	1	1	1	1	1	5	2	1	2	3	4	4	4	2	3	2	3	4	3	1	1	1	4	5	2	3	2	**107**	7
Option #7	E4 sinuosity of 1.8 start at middle elevation	2600	3800	0	2	1	1	1	1	1	1	1	2	4	2	2	3	4	2	5	2	2	2	2	3	4	2	3	2	2	1	2	1	2	2	3	1	1	1	2	1	2	3	2	**81**	2
Option #8	Upstream C4/5 with bankfull bench and MINOR realignment 75% within existing Ditch FootPrint - Downstream E4 sinuosity of 1.8 start at middle elevation	0	3800	2600	1	1	1	1	1	1	1	1	1	1	1	2	3	3	1	1	1	2	1	2	3	3	1	1	1	1	1	1	1	1	1	3	1	1	1	2	1	1	1	2	**55**	1

resourceful. naturally. BARR

	Concept Option Description	MCDA Matrix Score	MCDA RANKING
Option #1	Do nothing G4/5c and B4/5c with a sinuosity of 1.01	132	9
Option #1b	Do nothing G4/5c and B4/5c with a sinuosity of 1.01 Trail Access, Fencing and Replanting	114	8
Option #2	Original DU Design - E4 sinuosity of 1.8 as originally designed	90	5
Option #3	E4 sinuosity of 1.8 start at middle elevation	85	4
Option #4	sinuosity of 1.8 maximize head upstream Re-alignment	82	3
Option #5	C4/5 with sinuosity of 1.1 MINOR re-alignment within existing Ditch footprint	93	6
Option #6	Grade bankfull bench Inplace with no channel work B4/5c sinuousity 1.01 No Re-Alignment	107	7
Option #7	E4 sinuosity of 1.8 start at middle elevation	81	2
Option #8	Upstream C4/5 with bankfull bench and MINOR realignment 75% within existing Ditch FootPrint - Downstream E4 sinuosity of 1.8 start at middle elevation	55	1

Phase IV: Change overall management (Passive restoration)

- Changes in Land Use
- Channel Evolution and Passive Restoration
- Stormwater Management
- Flood Control and Flood Flows
- Reservoir Management
- Grazing Management
- Hydraulic Modeling for Increased Urbanization

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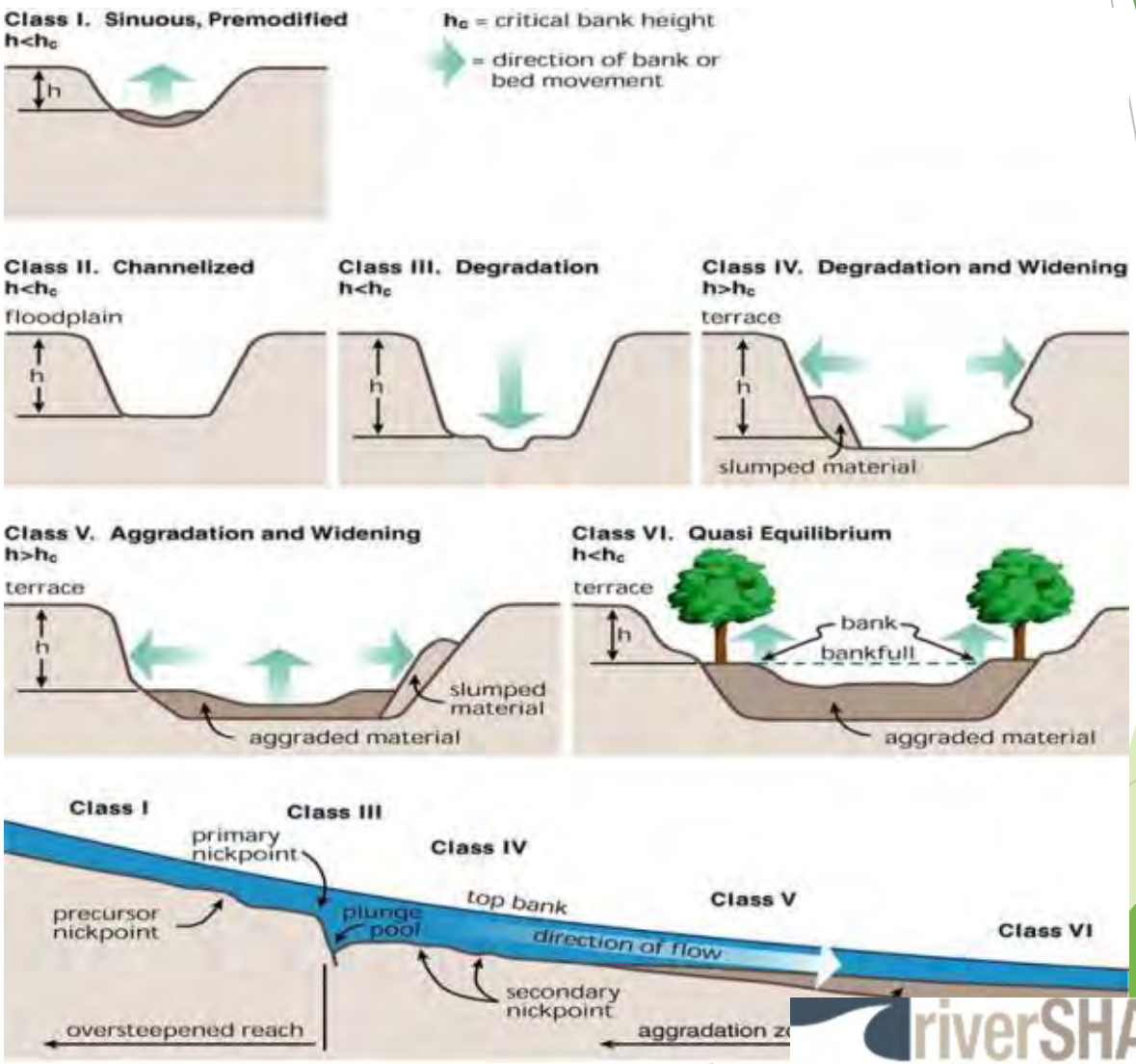
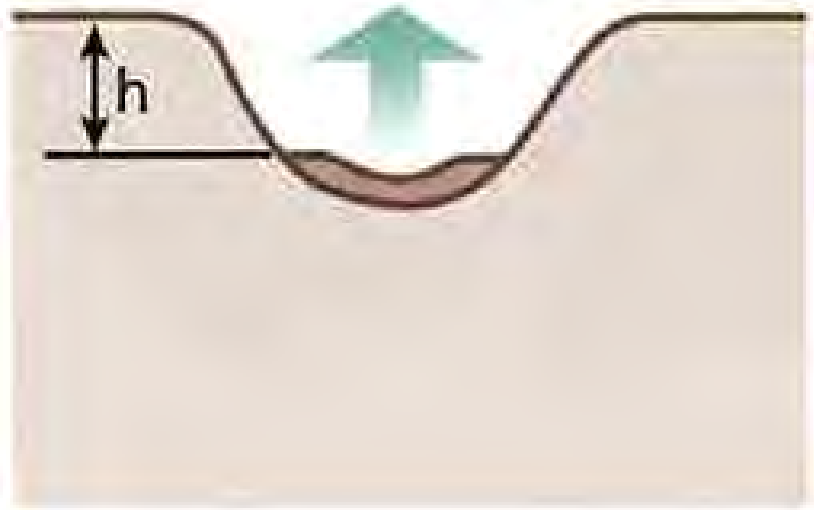
Phase IV: Change overall management
Channel Evolution and Passive Restoration

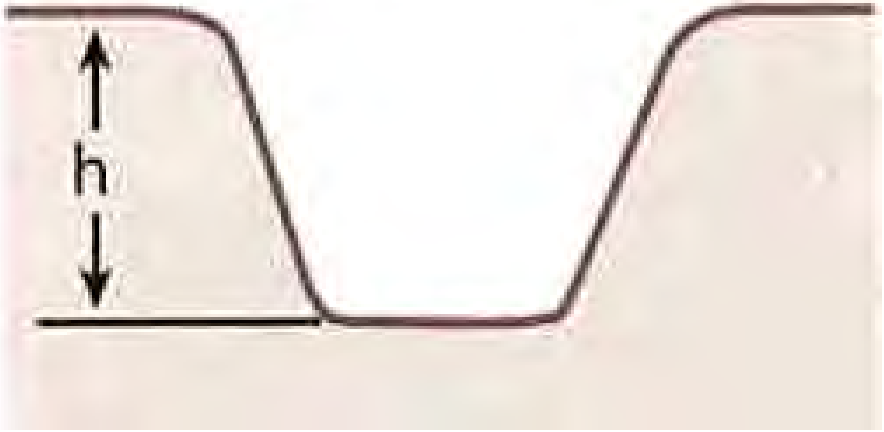


Class I. Sinuous, Premodified
$h<h_c$

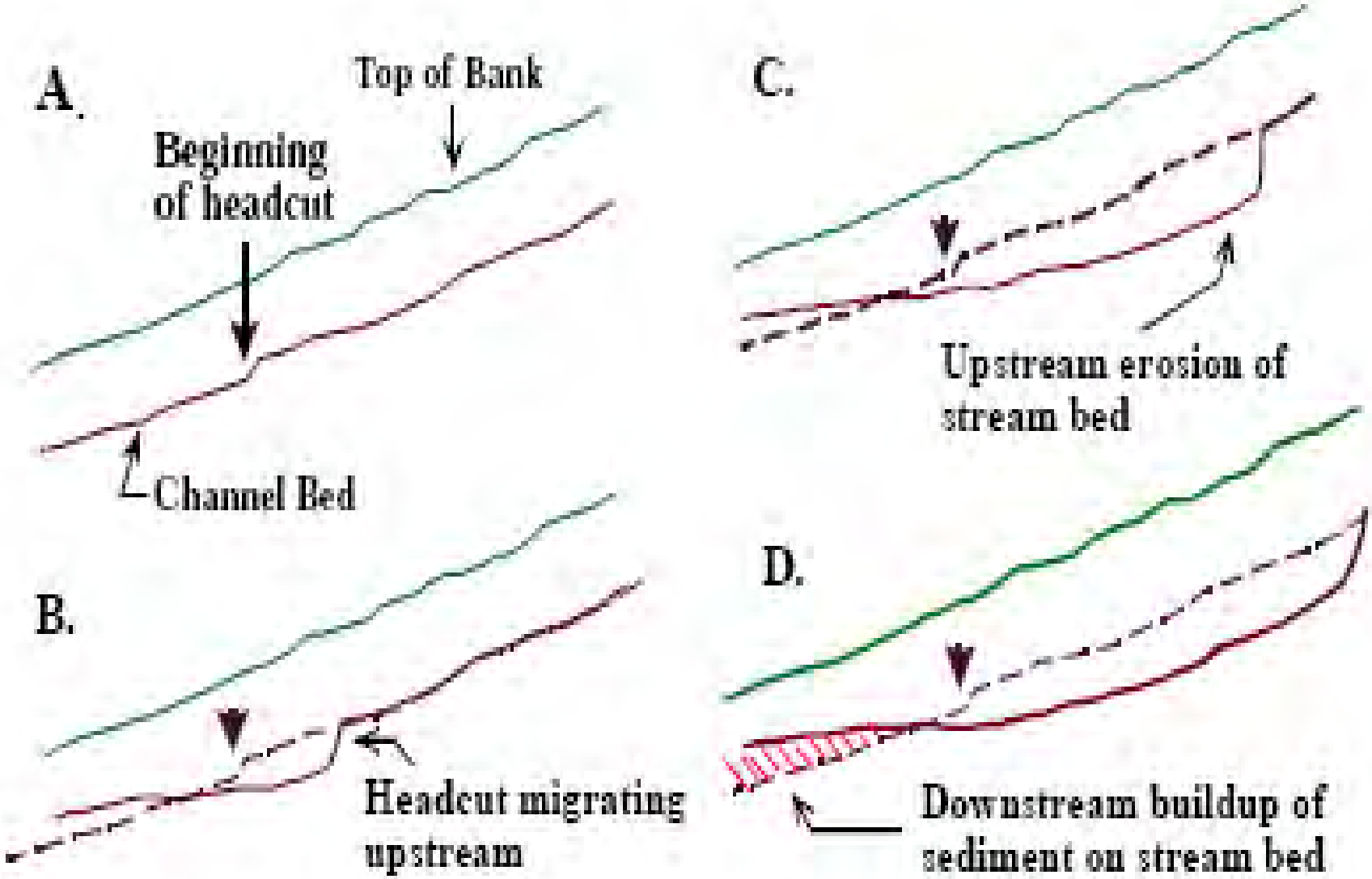


Class II. Channelized
$h<h_c$

floodplain

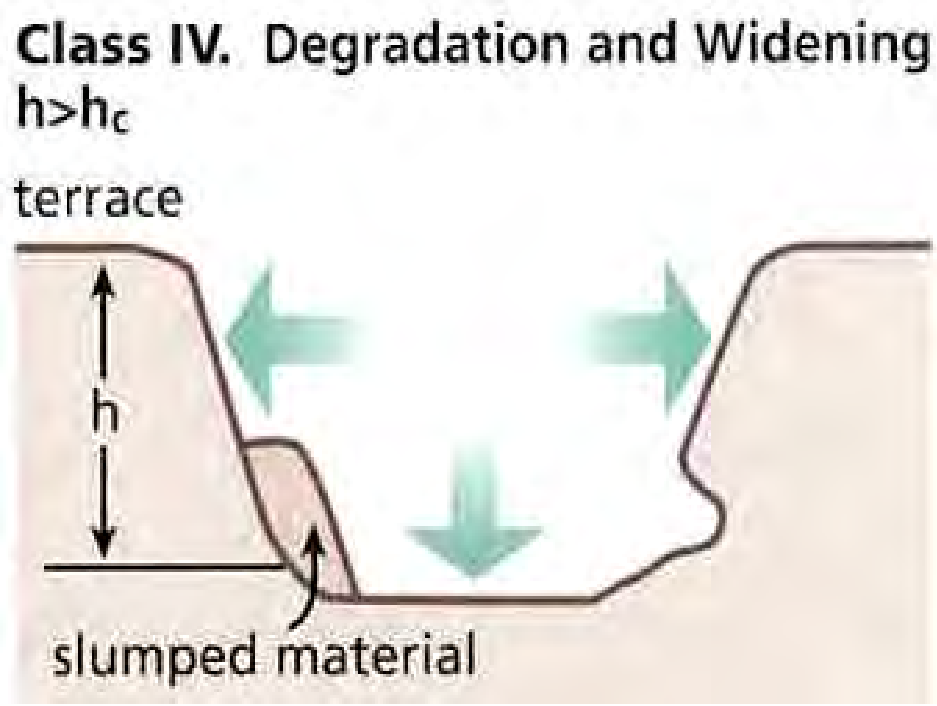


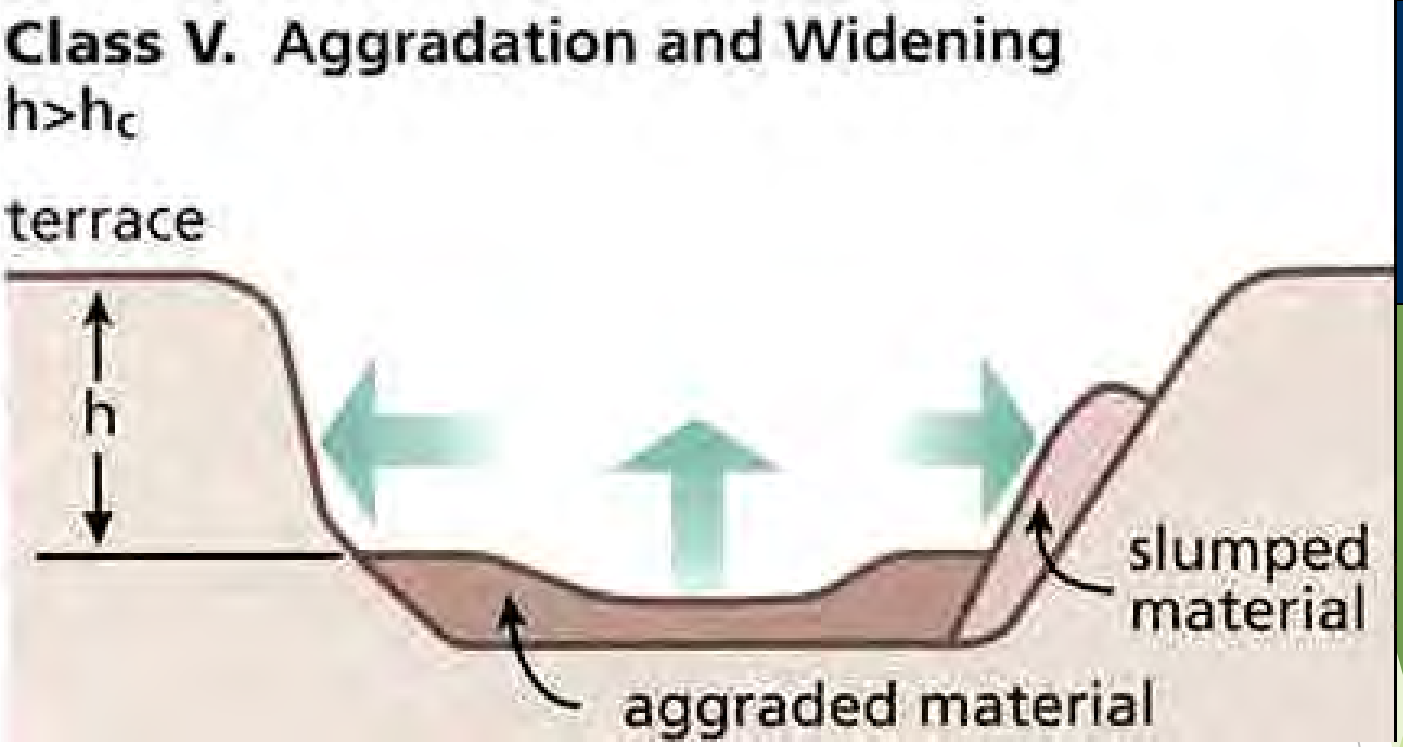
Head Cut

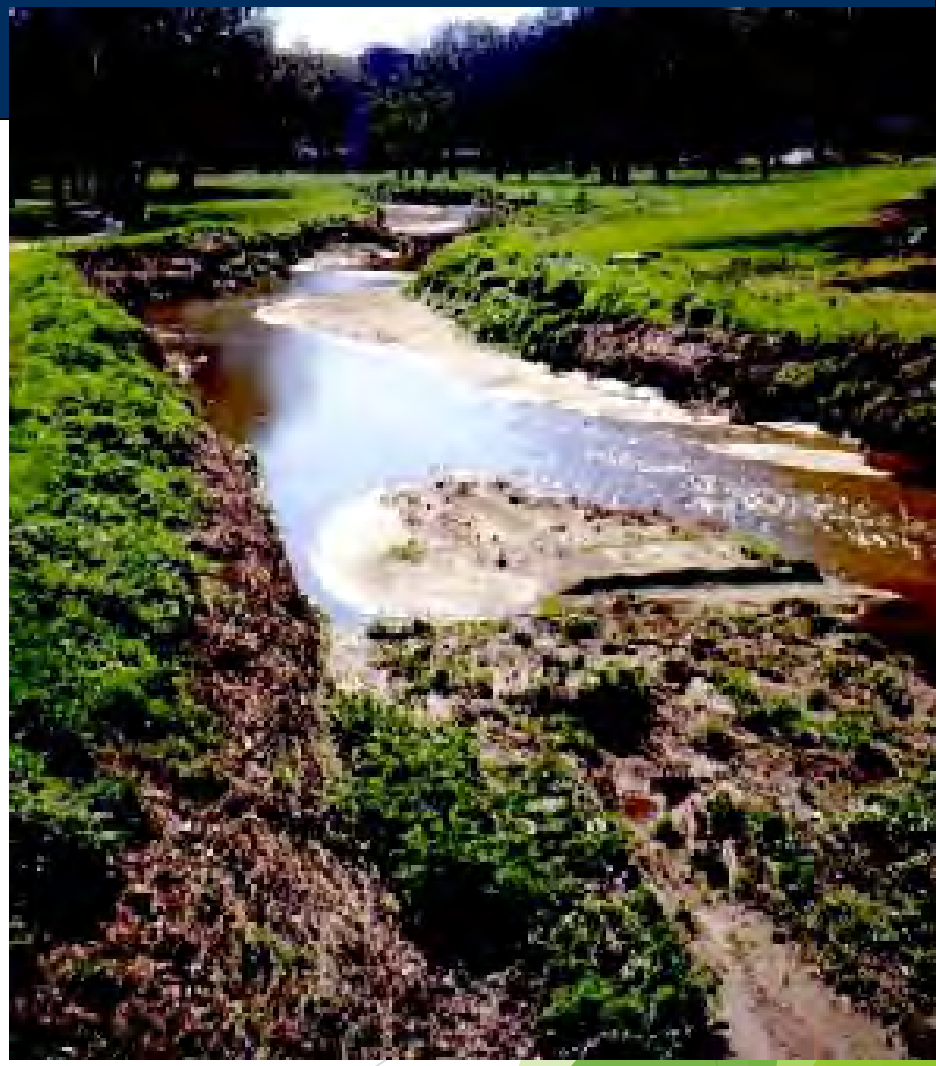

A.
Top of Bank
Beginning of headcut
Channel Bed
B.
Headcut migrating upstream
C.
Upstream erosion of stream bed
D.
Downstream buildup of sediment on stream bed

Class III. Degradation

$h<h_c$


Class IV. Degradation and Widening
h>hc
terrace
h
slumped material


Class V. Aggradation and Widening
h>hc
terrace
h
slumped material
aggraded material



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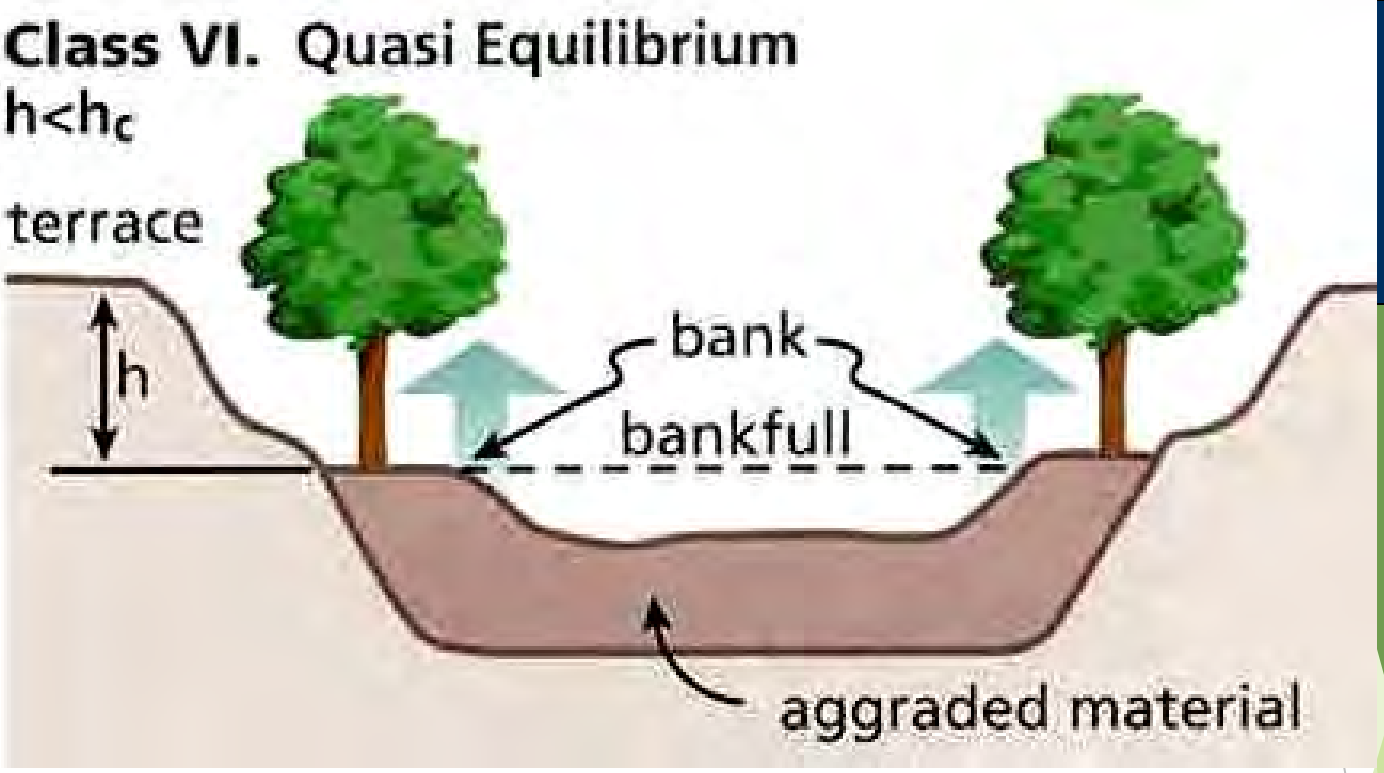
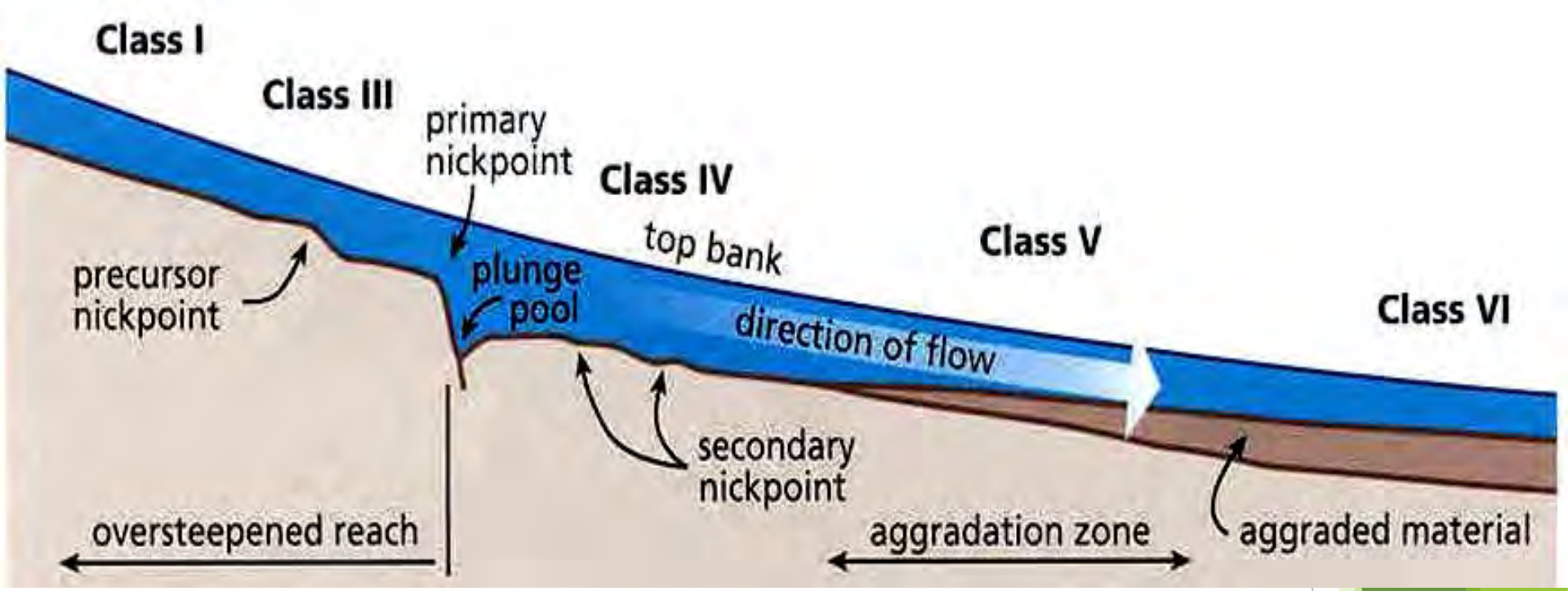
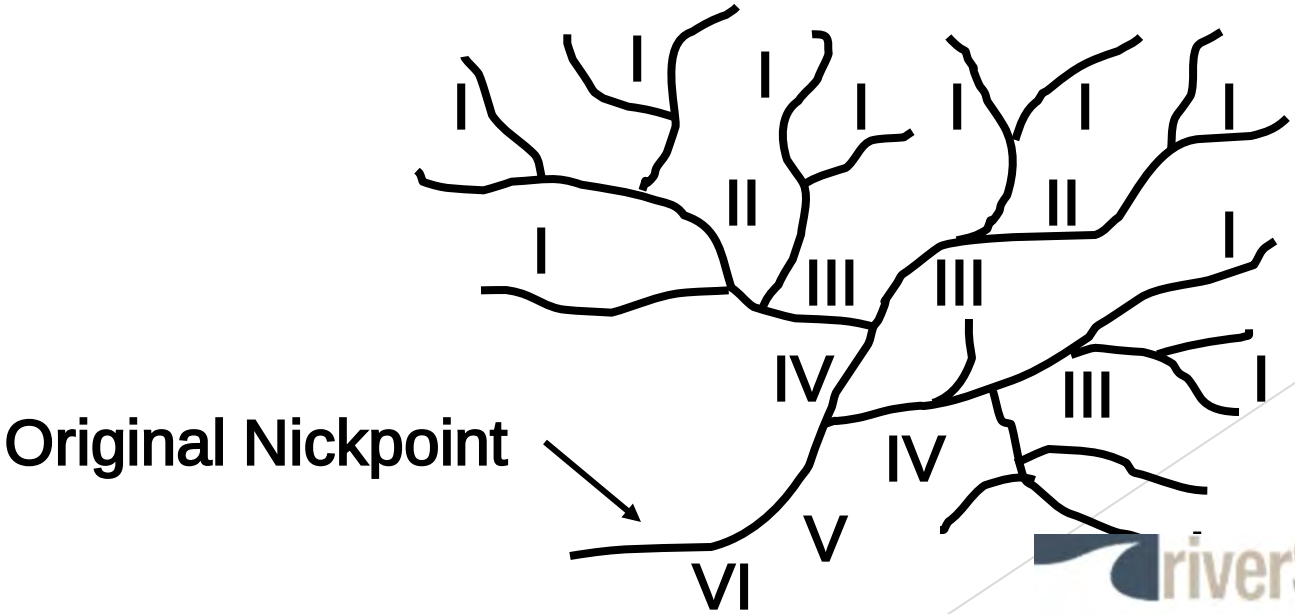
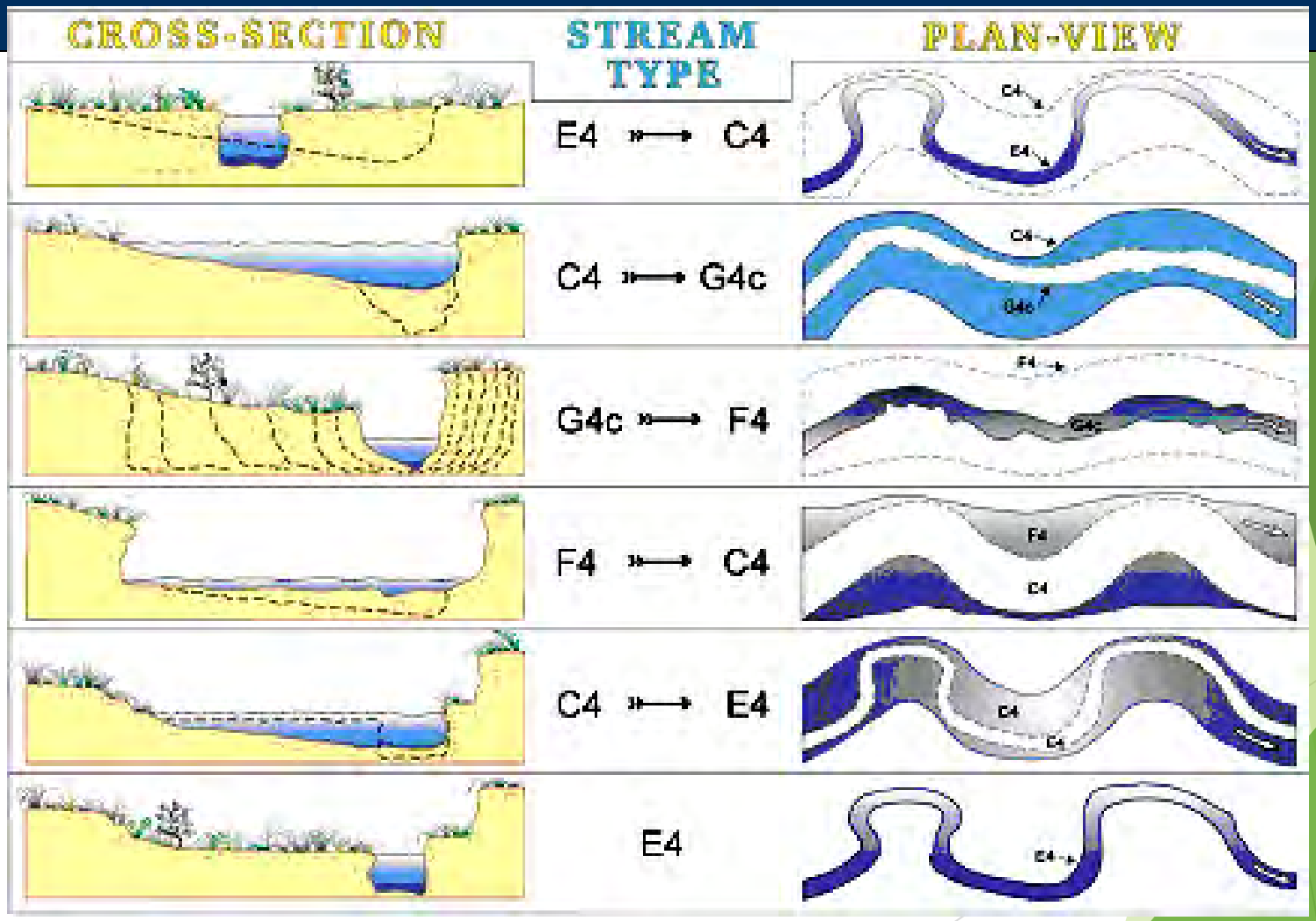

Class VI. Quasi Equilibrium
h<hc
terrace
h
bank
bankfull
aggraded material


Class I
Class III
primary nickpoint
Class IV
top bank
Class V
Class VI
precursor nickpoint
plunge pool
direction of flow
secondary nickpoint
oversteepened reach
aggradation zone
aggraded material

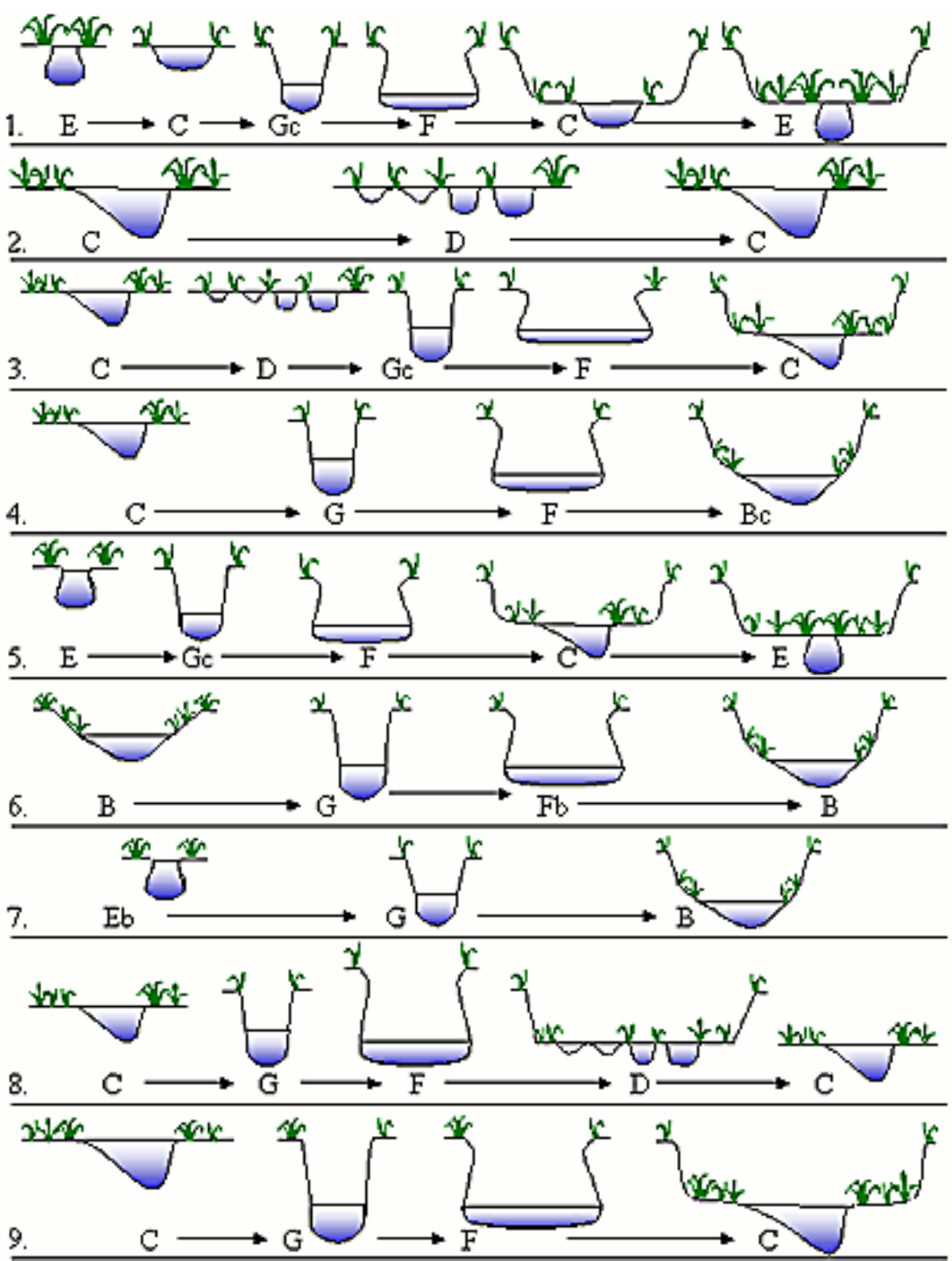

Original Nickpoint
I
II
III
IV
V
VI

G4c Alabama

Stream Channel Succession (WARSSS)



Stream Channel Succession (WARSSS)



http://www.epa.gov/WARSSS/sedsource/successn.htm

riverSHARED.org

Phase IV: Change overall management
Channel Evolution and Passive Restoration

Saamis Coulee Medicine Hat , Alberta

riverSHARED.org

Phase IV: Change overall management Stormwater Management

Rocky Branch Raleigh, NC

riverSHARED.org

Phase IV: Change overall management
Flood Control and Flood Flows

14 Mile Creek -- Brampton, Ontario

riverSHARED.org

Central Tendency of the River

- The answers are in the River
- Use current technology to document existing morphology
  - Scour lines
  - Deposition
  - Bankfull Features when appropriate
  - Pool-Pool spacing
  - Reference Parameters

Central Tendency - Deposition

Williams Gully -- Houston, Texas

Central Tendency - Scour

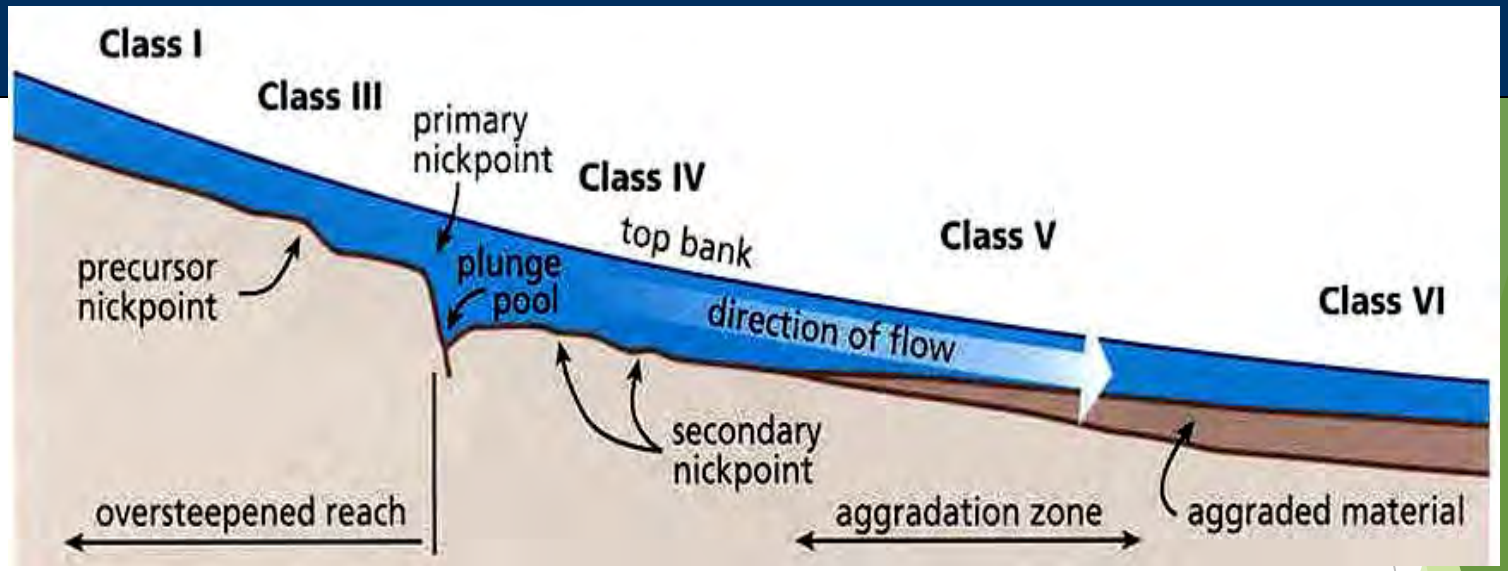
Bank Erosion – Leaching Substance

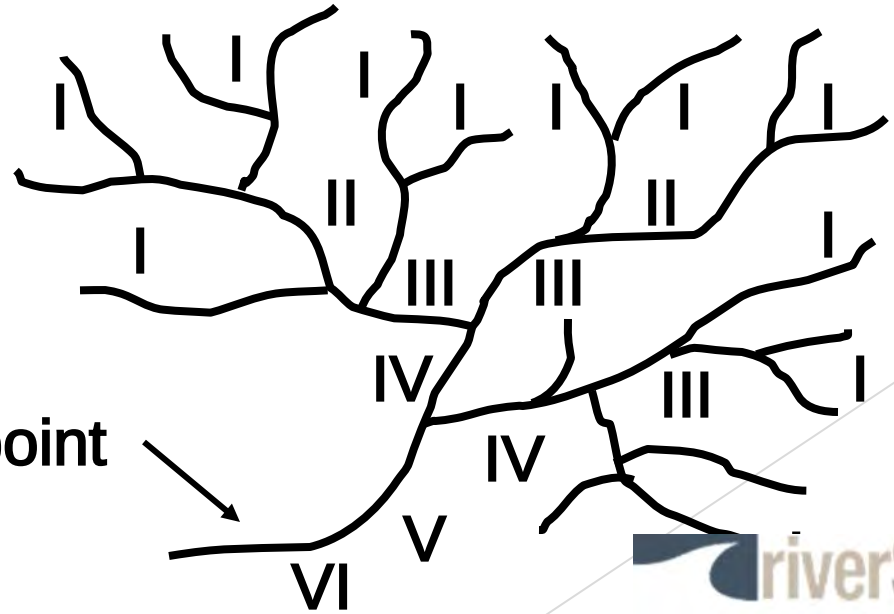
Northrop Creek-- Greece, New York

Phase V: Stream Restoration/Natural Channel Design

- 40 + Step Process of Natural Channel Design
- Reference Reaches in Urban Streams
- Sediment Transport Competence and Capacity
  - Energy Slope
  - Sediment Routing
- Not Intended to Repair and Stabilize Symptoms - Offset the Causes of the Problem
- Multiple Design Flows
- Flood Flows and Critical Shear Stress
- Hydraulic Modeling

Reach Dependency





Original Nickpoint

Seasonal Concerns

- Vegetation
- Fish Spawning
- High water
- Low water/irrigation
- Frozen sod matts
- Snow cover
- Heat

Seasonal Concerns should be discussed with Stakeholders and considered in Goals and Objectives as will as the Project based MCDA

Construction Phasing

- Funding
- Weather
- Materials
- Labor
- Establishment of Vegetation
- Planned adaptive management

Construction Phasing should be discussed with Stakeholders and considered in Goals and Objectives as will as the Project based MCDA

Adaptive Management

Document and learn from unexpected results

- We will always be less than perfect in or pursuit of excellence in river restoration

How Much Water Do you want?

Before Restoration

After Restoration

Adaptive Management

Document and learn from unexpected results

- Structure failures are an opportunity to learn

Adaptive Management

Document and learn from unexpected results

- Adaptive management is a systematic process of learning-by-doing.
- This process involves evaluation of alternative hypotheses through the application of an experimental management program, and improving management decisions in ecosystems based on knowledge gained from those management actions.
- Adaptive management should be central to the planning process for the River Restoration
- Adaptive Management is not an acceptance of recklessness and poor design, but an acceptance of our lack of knowledge even when we can't figure out what we don't know
- Perfect River Restoration projects rarely exist but S.H.A.R.E.D excellence in river restoration can be pursued without discrimination of profession, experience or ability.

Introduction
S.H.A.R.E.D Philosophy

- **S**hare knowledge with humility.
- **H**ave patience and discernment for innovation.
- **A**dvocate excellence.
- **R**espect the risk and uncertainty in river systems.
- **E**mpower, challenge and question.
- **D**ocument and learn from unexpected results.

Questions ?

5SSR
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