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Developing Performance Standards and Monitoring for Stream Mitigation

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Performance Standards Definitions

- *Performance standards* are observable or measurable physical (including hydrological), chemical and/or biological attributes that are used to determine if a compensatory mitigation project meets its objectives.
- Required as part of mitigation plan.

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Performance Standards

- Based on attributes that are objective and verifiable.
- Based on the best available science that can be measured or assessed in a practicable manner.
- Based on variables or measures of functional capacity.

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Functional Capacity

- *Functional capacity* means the degree to which an area of aquatic resource performs a specific function.
- *Functions* means the physical, chemical, and biological processes that occur in ecosystems.

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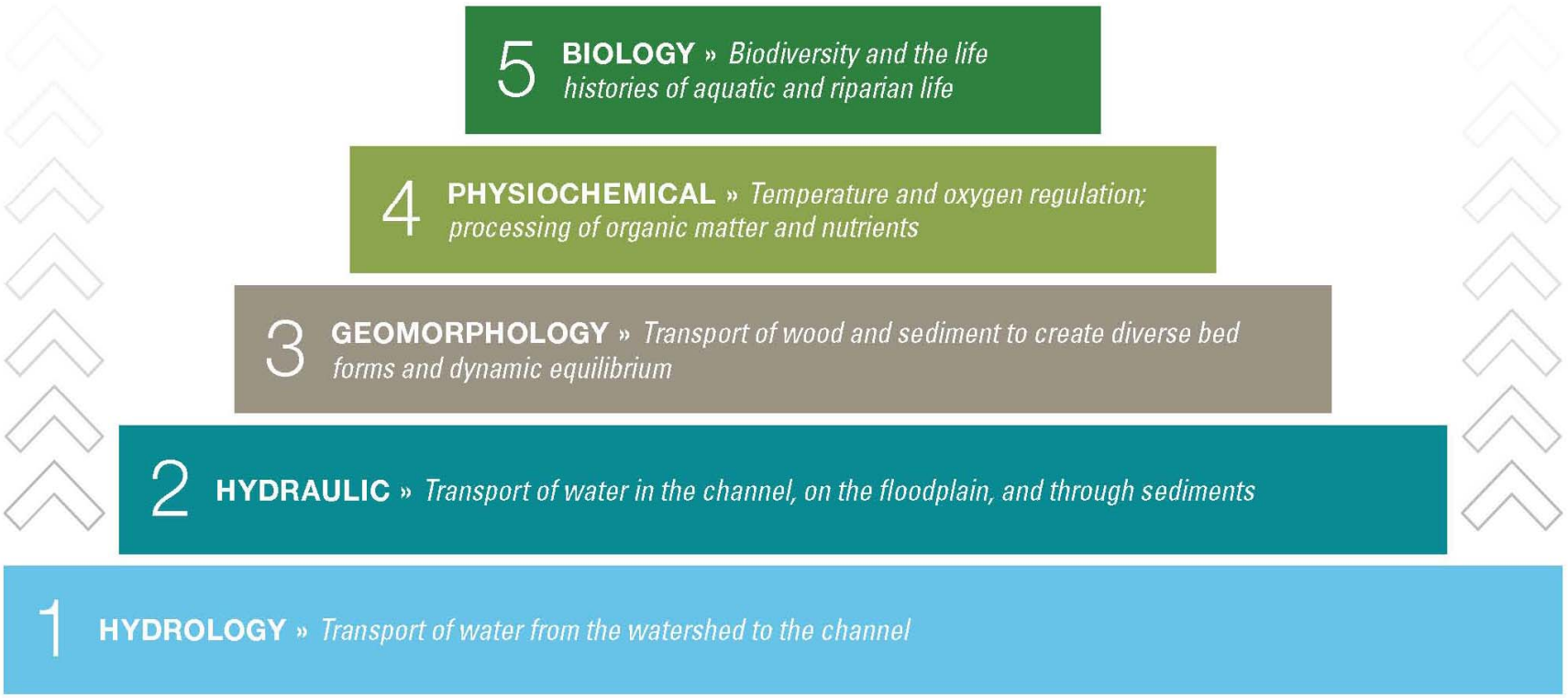
Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW



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Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » FUNCTIONS & PARAMETERS

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Performance Standards

- The use of reference streams to establish performance standards will help ensure that those performance standards are reasonably achievable, by reflecting the range of natural variability.
- Where practicable, performance standards should take into account the expected stages of the aquatic resource development process.
  - Channel Evolution

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How do we put this into practice?

- Find and Assess Reference Reaches
- Develop a Reference Reach Database
  - But know the difference between design criteria and reference reach ratios
- Develop Function-Based Assessments
- Develop Performance Standards and Monitoring Program

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Reference Reach Versus Design Reach

Reference reach with mature forest

Stream restoration project immediately after construction; floodplain devoid of vegetation

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	Reference Reach		Design Criteria	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**
Stream Type (Rosgen)	C/E 4		C/E 4	
Drainage Area (sq mi)	0.5	20	0.5	20
Bankfull Mean Velocity, Vbkf (ft/s)	3.5	5.0	3.5	5.0
Width to Depth Ratio, W/D (ft/ft)	**5.0**	12.0	**10.0**	**14.0**
Riffle Max Depth Ratio, Dmax/Dbkf	1.2	1.4	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.1	1.0	1.1
Meander Length Ratio, Lm/Wbkf	7.0	12.0	7.0	12.0
Rc Ratio, Rc/Wbkf	**1.2**	**2.5**	**2.0**	**3.0**
Meander Width Ratio, Wblt/Wbkf	**2.0**	8.0	**3.5**	8.0
Sinuosity, K	1.20	1.60	1.20	1.60
Valley Slope, Sval (ft/ft)	0.0050	0.0150	0.0050	0.0150
Riffle Slope Ratio, Srif/Schan	1.5	2.0	1.5	2.0
Run Slope Ratio, Srun/Srif	0.50	0.80	0.50	0.80
Glide Slope Ratio, Sglide/Schan	0.30	0.50	0.30	0.50
Pool Slope Ratio, Spool/Schan	0.00	0.20	0.00	0.20
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.5	2.0	3.5
Pool Width Ratio, Wpool/Wbkf	**0.8**	**1.2**	**1.3**	**1.7**
Pool-Pool Spacing Ratio, Lps/Wbkf	2.0	7.0	**3.0**	7.0

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Design Criteria, Success Criteria, Performance Standards

- Design Criteria can equal Success Criteria
  - Can be different than reference reach
- Performance standards show whether success criteria were met
- Monitoring creates data for performance standard
  - Can be rapid or intensive

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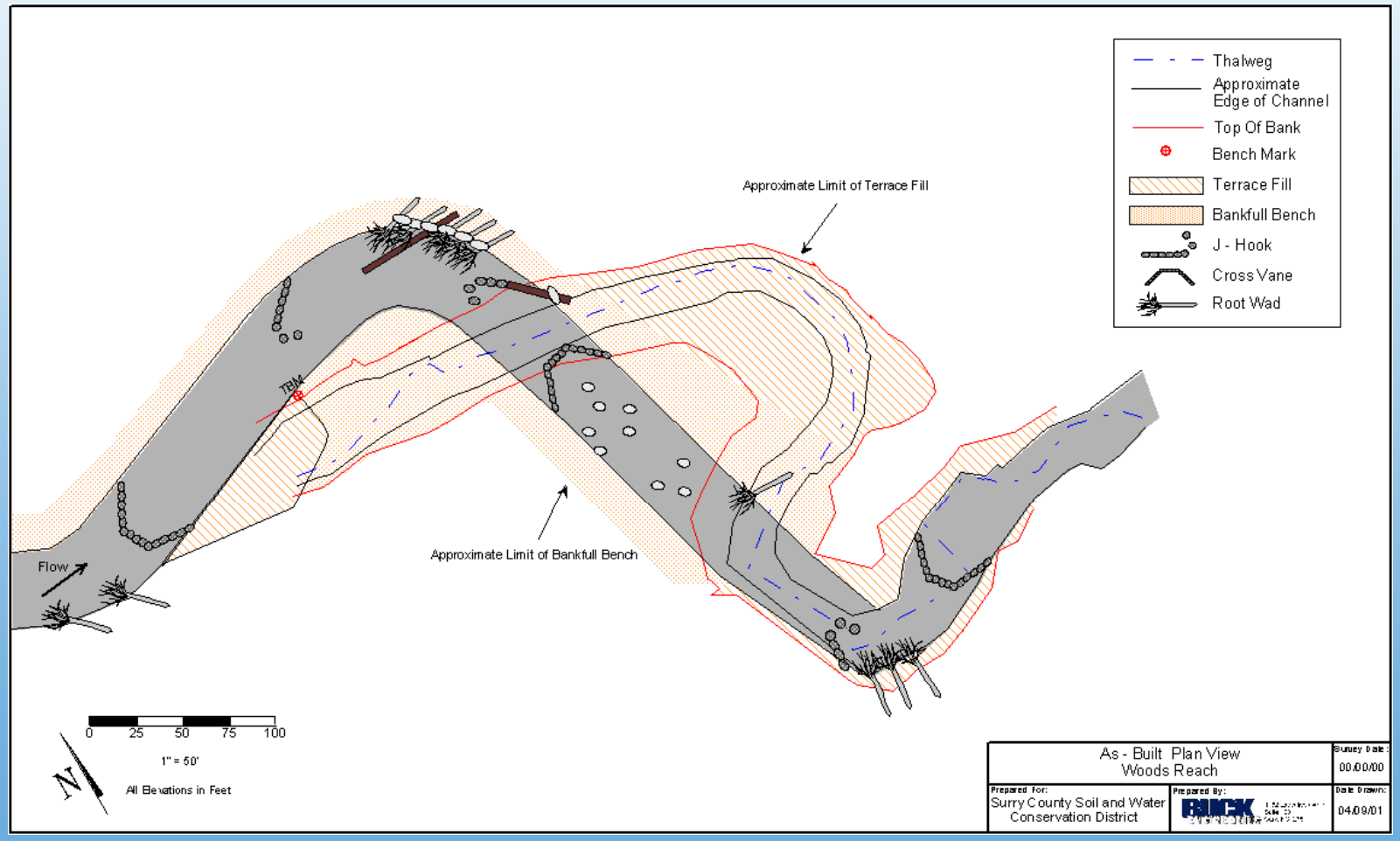
For Example



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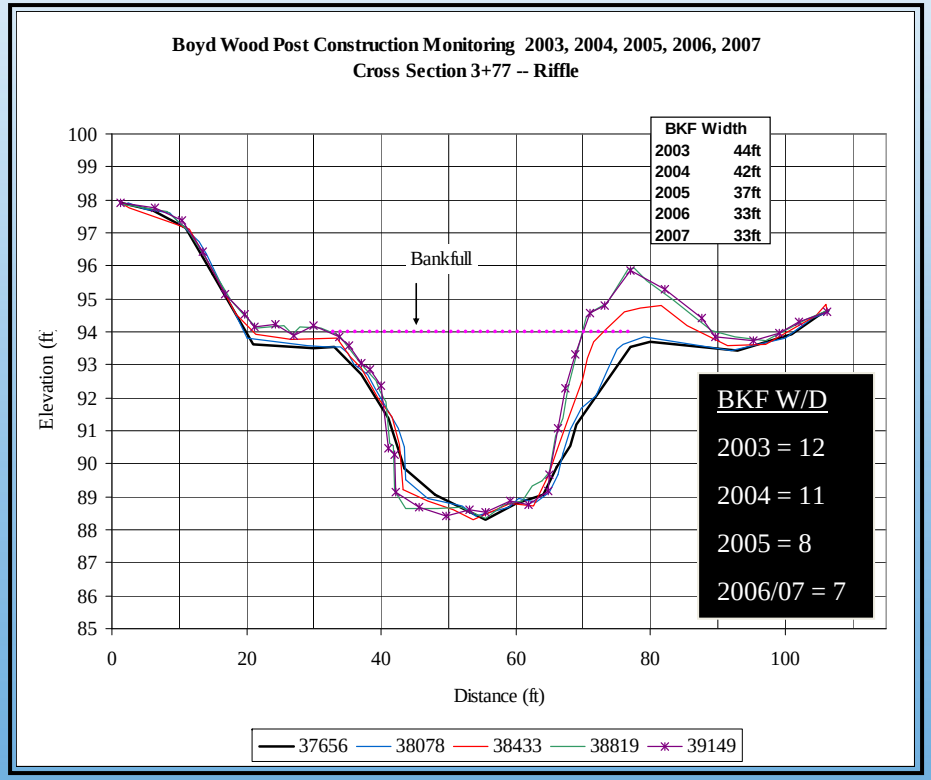
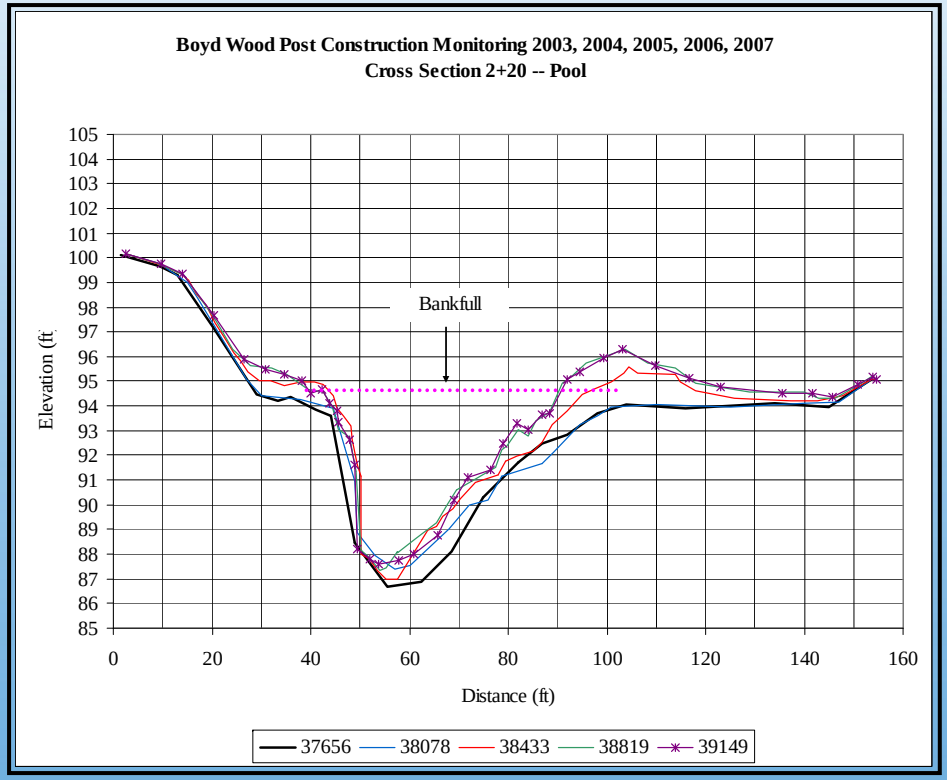
Woods Reach, NC – Channel Dimension Adjustment





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Riffle Section

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Pool Section

Summer 2002

Summer 2005

Summer 2006

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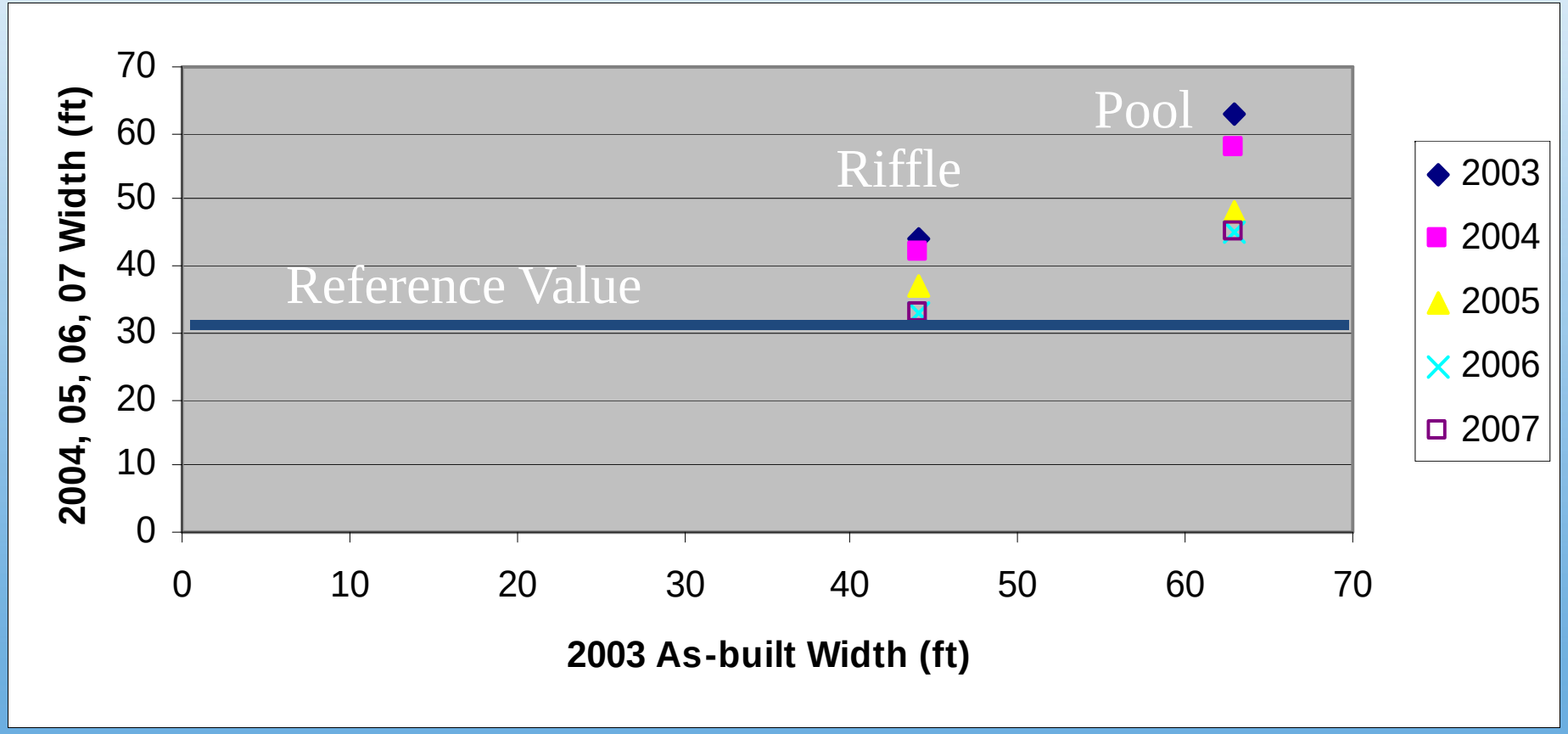
Woods Reach
Pool and Riffle Width Evolution



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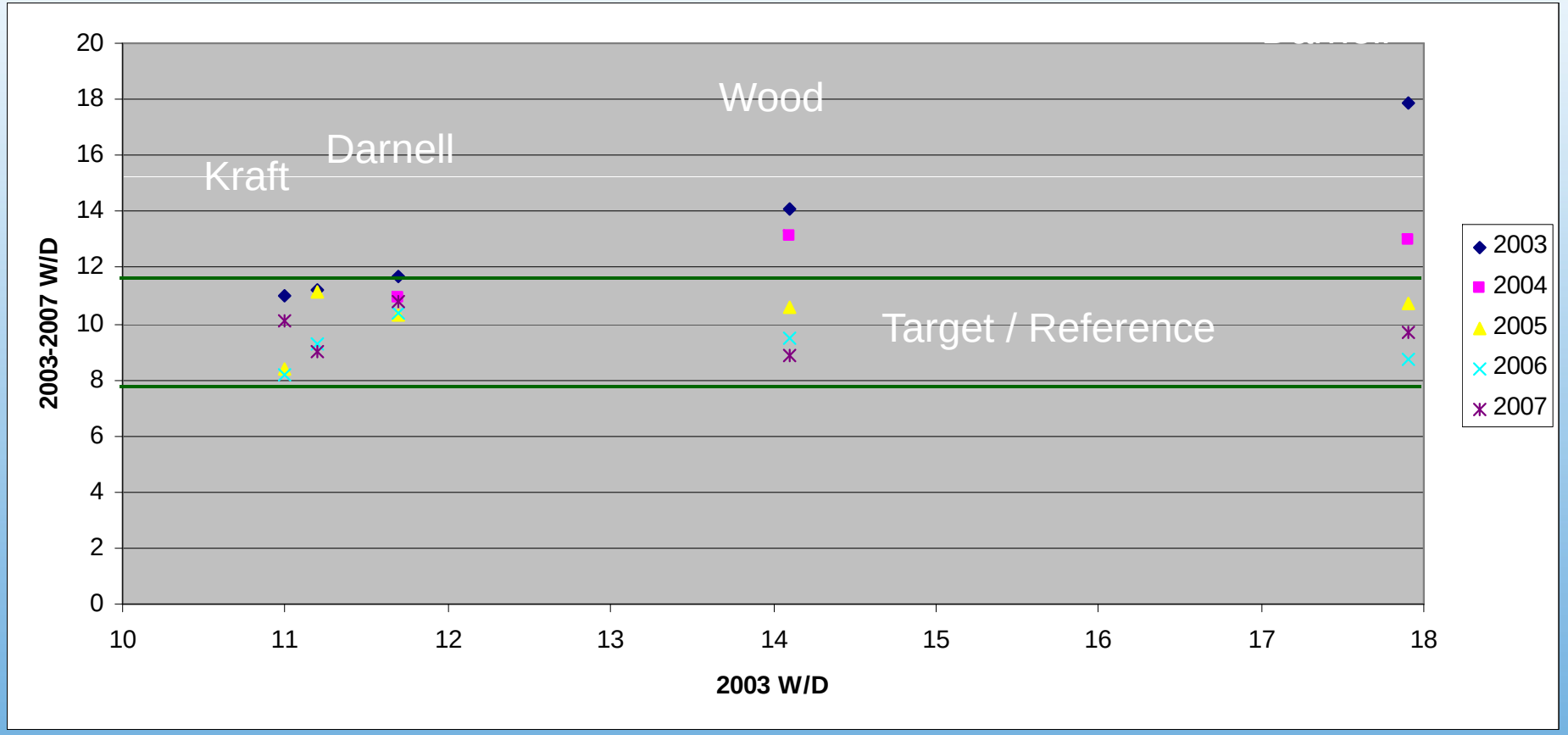
Changes in Riffle W/D for Kraft, Darnell, and Woods



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Hurricane Frances

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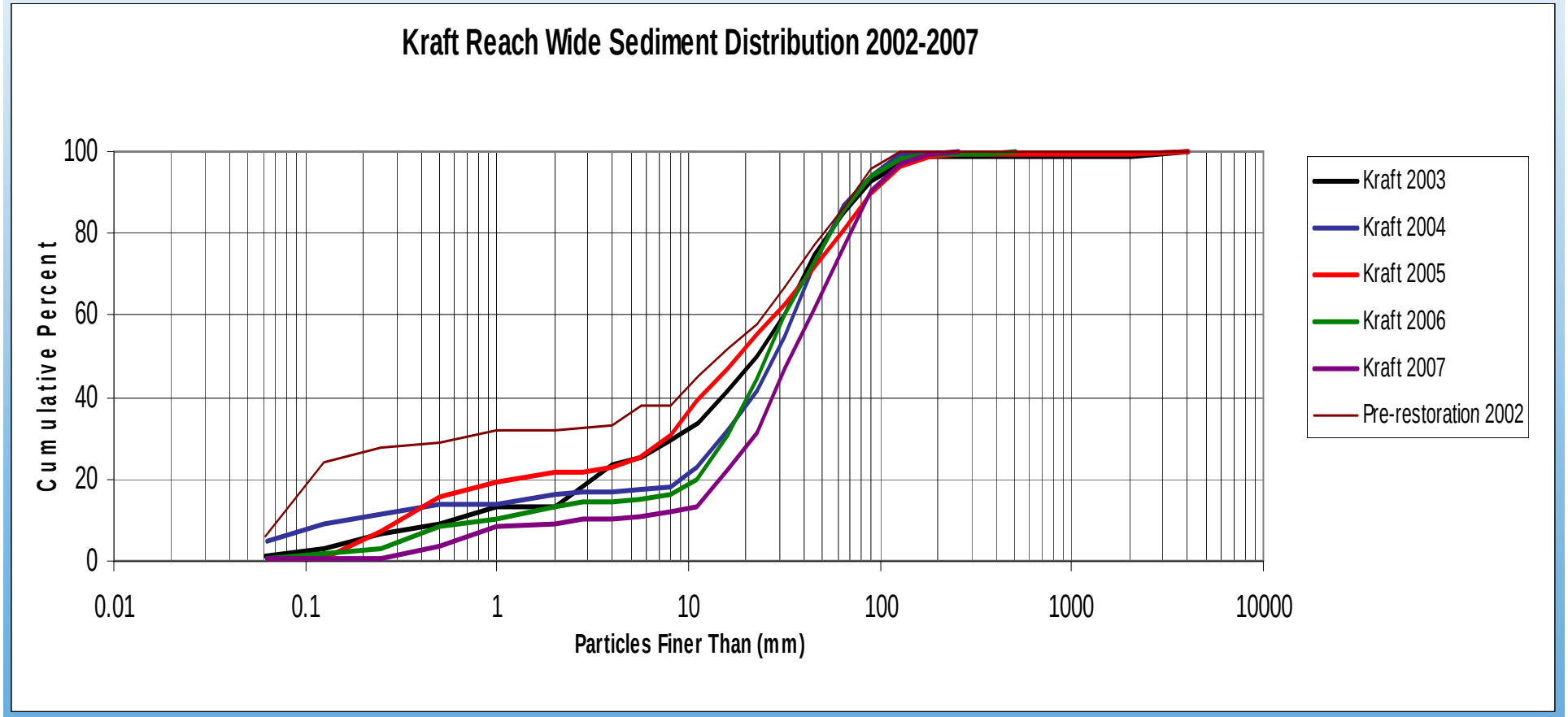
Kraft Reach
Bed Material Changes After Restoration



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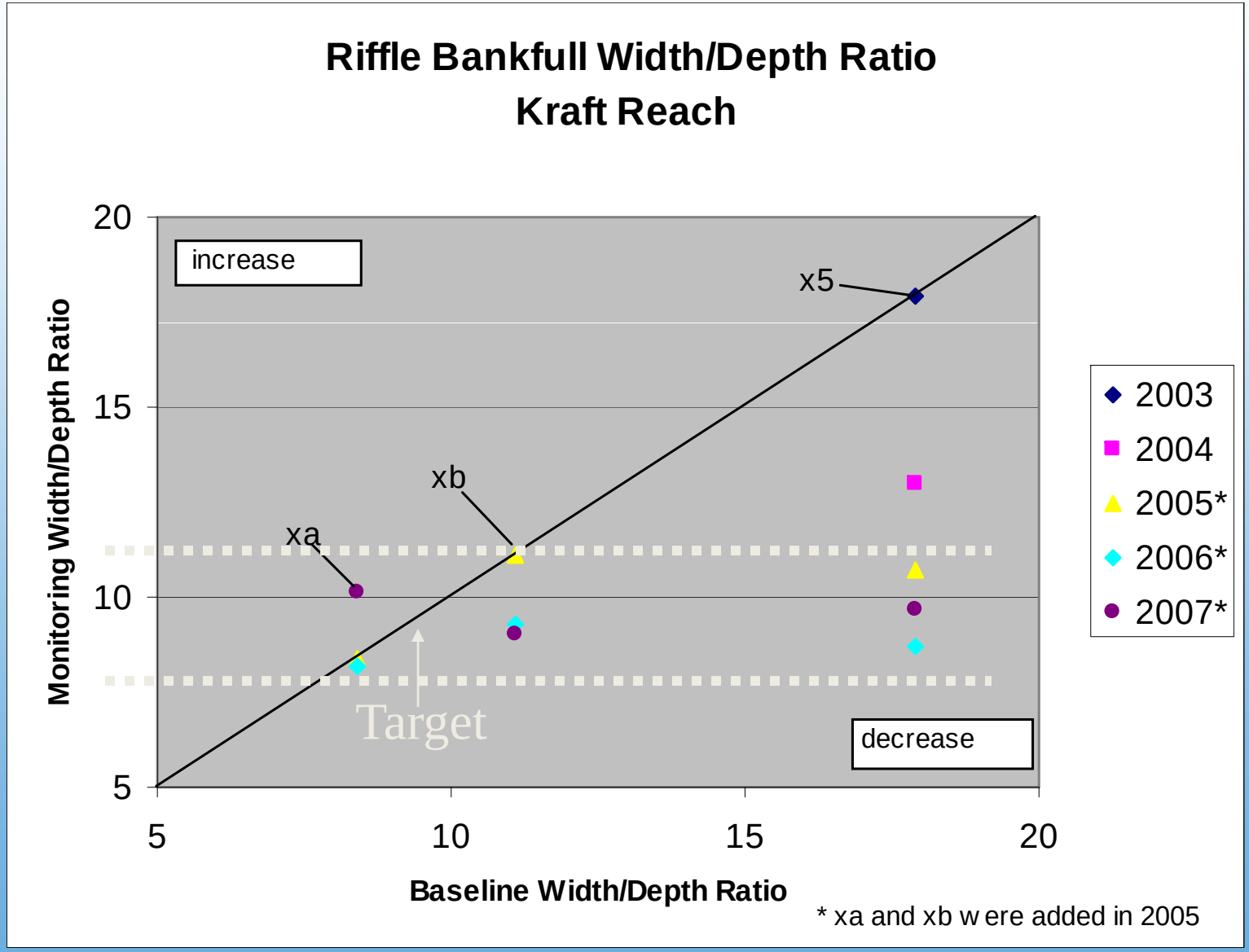

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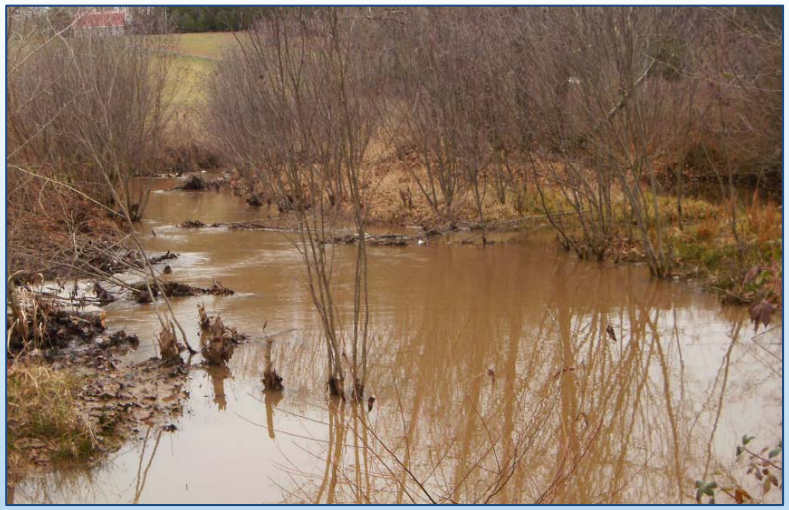
Is this good or bad?



Think about functions and parameters that describe those functions

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Performance Standards Conclusion

- Do not create performance standards that prevent the channel from evolving.
  - Use ranges from reference reach analysis
- Recognize that stream restoration is not a cure all for the watershed.
  - Align monitoring with goals.
  - May be more physical than biological.
- Recognize that stream restoration is still evolving.
  - Best available science is still to come.
- We need competent stream designers and competent permit reviewers.

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Floodplain Connectivity Performance Standards

Metric	Functioning	Functioning-At-Risk	Not Functioning
Bank Height Ratio (BHR)	1.0 to 1.2	1.3 to 1.5	> 1.5
Entrenchment Ratio (ER) for C and E Stream Types	> 2.2	2.0 to 2.2	< 2.0
Entrenchment Ratio (ER) for B and Bc Stream Types	> 1.4	1.2 to 1.4	< 1.2
Dimensionless rating curve	Project site Q/Q_{bkf} plots on the curve	Project site Q/Q_{bkf} plots above the curve	Project site Q/Q_{bkf} of 2.0 plots above 1.6 for $d/_{dbkf}$

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Levels of Monitoring

- Simple
  - Walk the Project and look for problems
  - Photo documentation
  - Rapid Assessments, e.g. RBP
- Moderately Complex
  - Measure dimension, pattern, and profile
  - Vegetation Plots
  - Photographs
  - Vertical and lateral stability estimates
  - Bed material
  - Basic chemistry (pH, DO, Temp, Conductivity)
- Complex
  - Everything above, plus
  - Bug and Fish Monitoring
  - Hydrologic and Sediment Transport Studies
  - Water Chemistry
  - Organic and Nutrient Processing

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Simple Monitoring

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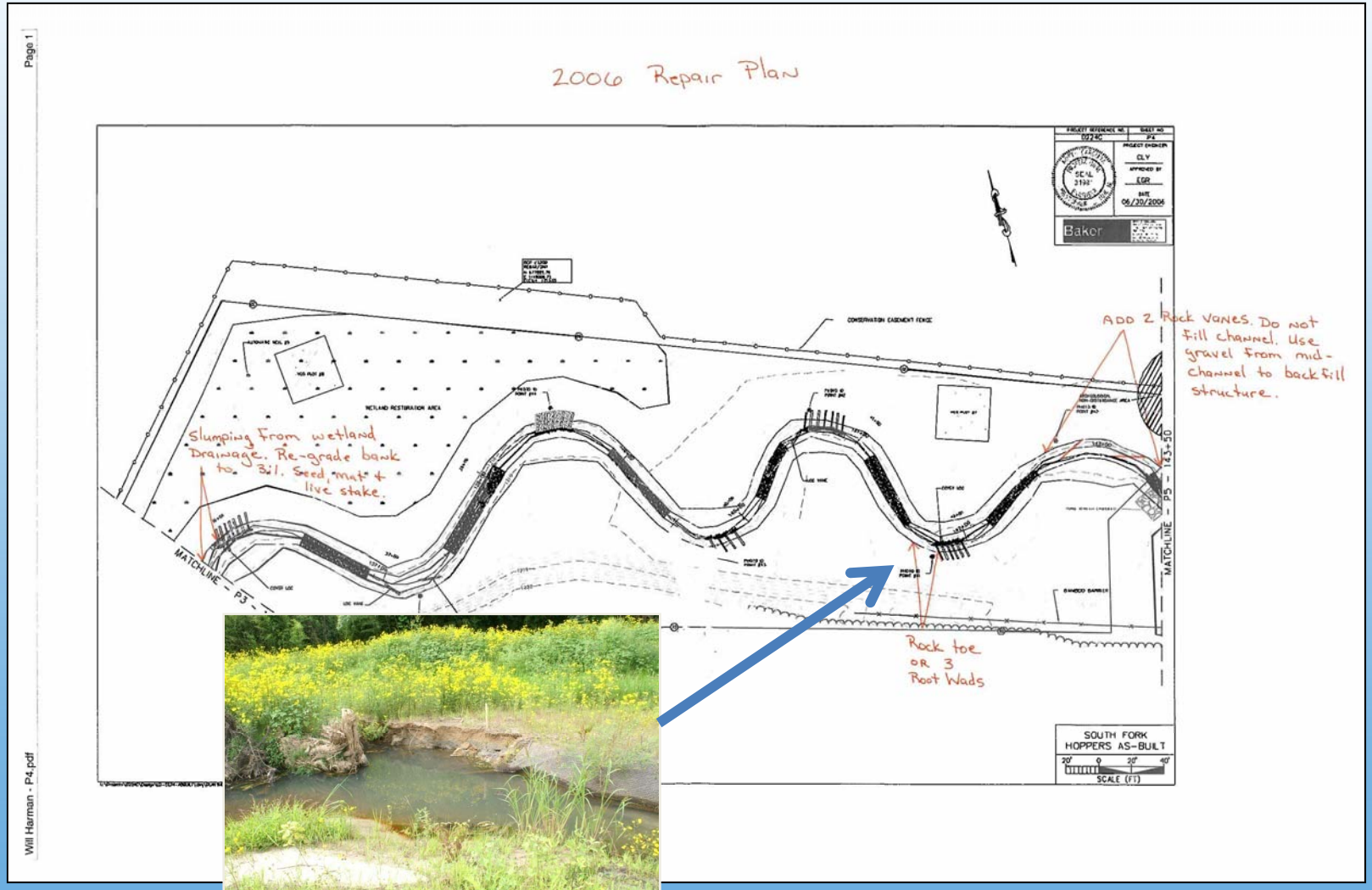
Simple Monitoring



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Moderately Complex

- Quantitatively and Qualitatively Answers the Questions:
  1. Is the project stable?
  2. Is the correct stream type located in the correct valley type?
  3. Is there diversity in bedforms?
  4. Is there a suitable riparian buffer?
  5. Is there aquatic and terrestrial habitat structure?
  6. Can the stream support aquatic life?

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Complex

- Channel dimension, pattern, and profile measurements
- Vegetation plots sampling
- Photo documentation
- Vertical and lateral stability estimates
- Bed material sampling
- Macro and fish sampling
- Hydrologic and sediment transport studies
- Stream metabolism
- Organic / nutrient processing

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Select the right monitoring approach based on the goals and objectives of the project

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Acknowledgment

- Special thanks to Michael Baker Corporation for project photos and select illustrations.