

# *Use of the RIVERMorph Software for Assessing and Designing Natural Channels*

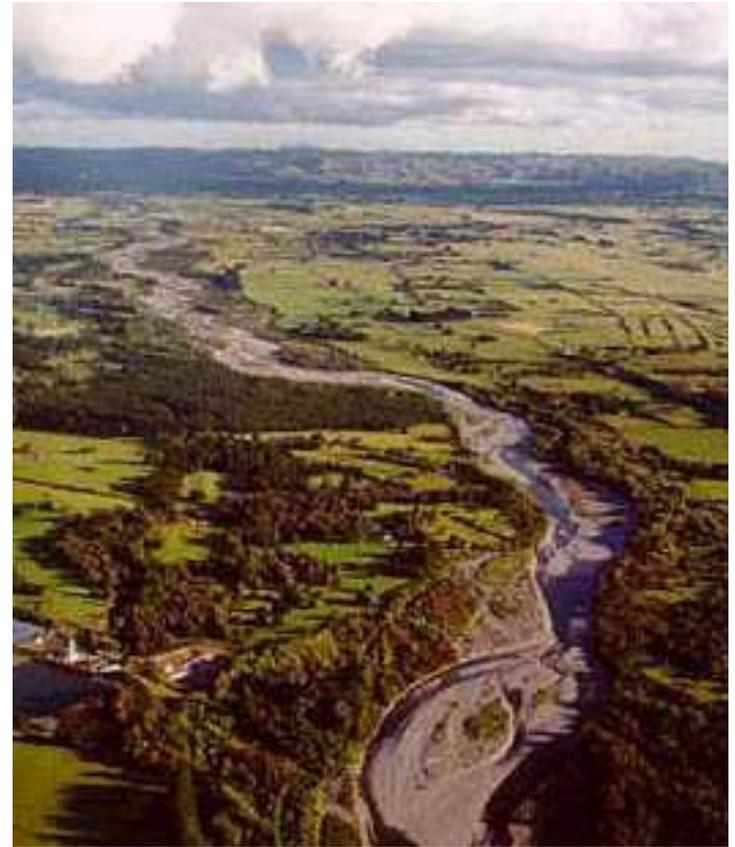
Presented by:  
George Athanasakes, P.E.

Putting a New Face on Mining  
Reclamation  
Farmington, New Mexico  
September, 2006

# Outline



- Brief History of Software
- Main Features & Components
- Latest Enhancements
- Pocket RIVERMorph
- Example Use of the Software
- Summary



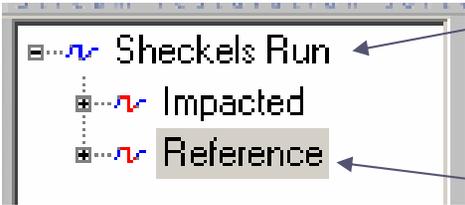
# Brief History



- Development Initiated in 1998
- Extensive Beta Testing
- Released in 2002
- Significant Input from Dave Rosgen
- Currently Used by Numerous Agencies and Consulting Firms
- Continue to Advance the Software

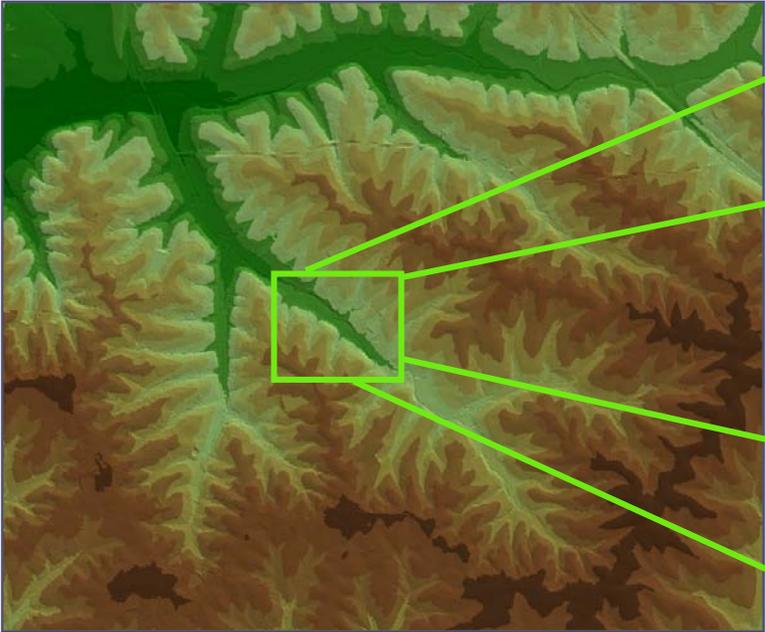


# Database Structure

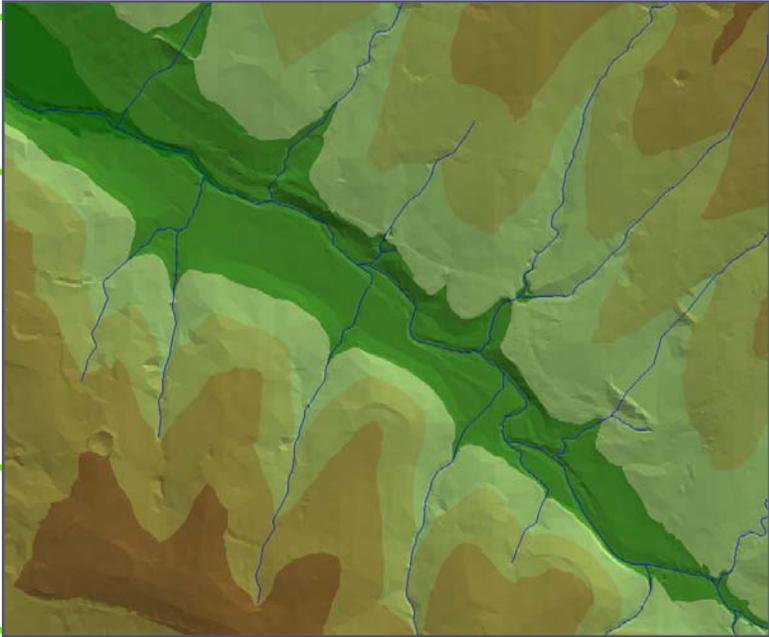


River

Reach



River Scale



Reach Scale – (20 to 30) x  $W_{bkf}$

# Graphical User Interface

➤ River Tree View

➤ Main Working Area

➤ Pop Up Tools

**RIVERMorph 3.1 Professional - RMMilck**

File Tools Help

Eagle Creek  
Ref. Reach  
Survey Data  
Cross Sections  
Profiles  
Particles  
Classification  
Ratios  
Pfankuch  
BEHI  
SWAP  
Designs  
Notes  
Mill Creek  
Weminuche Creek

Get Ratios Get Riffle D<sub>50</sub> Get D50 Classify Reset Sliders

Riffle Cross Sections: XS-1 RF  
Reach Pebble Counts: Reach D50 = 25.73 mm.

Valley Morphology

Valley Type: Type VIII  
Valley Slope (ft/ft): 0.0058  
Drainage Area (sq mi): 5.6

Location and Date of Survey

State: Kansas  
County: Brown  
Latitude: 0  
Longitude: 0  
Date: 03/22/02

Stream Classification

Bankfull Channel Data (Riffle Cross Section)

Single Thread Multiple Channels

Width (ft)	38.06
Mean Depth (ft)	1.73
Flood-Prone Width (ft)	183.66
Channel Materials D50 (mm)	25.73
Water Surface Slope (ft/ft)	0.00402
Sinuosity	1.45
Discharge (cfs)	292.72
Velocity (fps)	4.55
Cross Sectional Area (sq ft)	65.21
Entrenchment Ratio	4.83
Width to Depth Ratio	22

Entrenchment Ratio Adjustment  
Width to Depth Ratio Adjustment

Override Calculated Classification

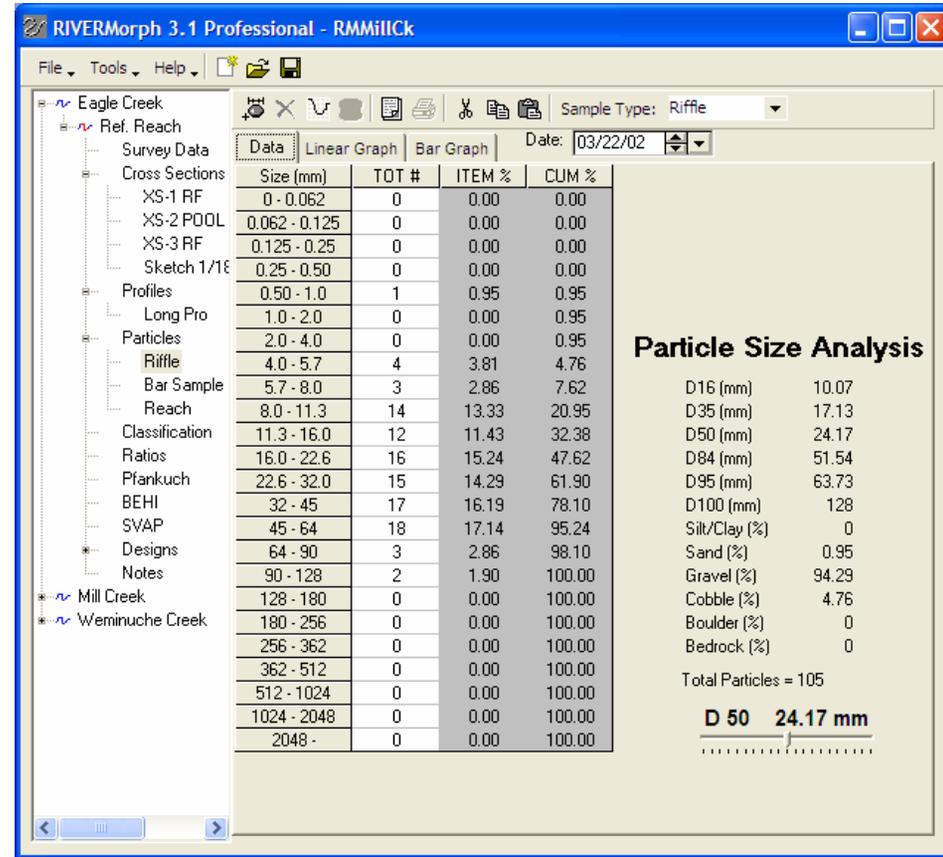
This Reach has some bedrock control  
 This Reach is a Reference Reach

**C 4**

# RIVERMorph Components

## CHANNEL MEASUREMENT

- Survey Data (Differential & Total Station)
- Cross Sections
- Longitudinal Profile
- Particle Size Analyses (Pebble Count & Sieve Analysis)
- Stream Classification
- Dimensionless Ratios

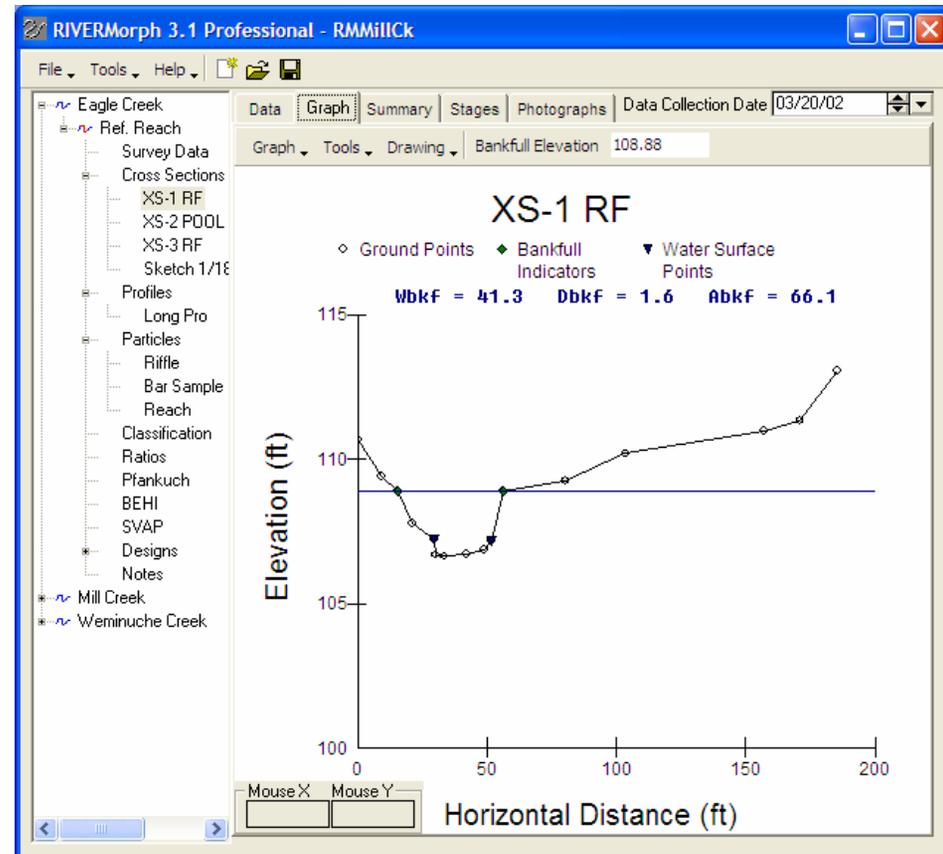


# RIVERMorph Components



## CROSS SECTION

- Total Station or Differential Level Data
- Graphically Adjust Bankfull
- Ability to Export Data & Graphs for Insertion in Reports
- Numerous Tools to Efficiently Analyze Data
- Hydraulics by Stages
- Storage of Photographs





**RIVERMorph**  
Stream restoration software

# RIVERMorph Components



## ASSESSMENT TOOLS

- Pfankuch Channel Stability
- NRCS Stream Visual Assessment Protocol
- EPA Rapid Bioassessment Protocol
- Bank Erosion Hazard Index

Upper Bank		
Landform Slope	3	Good ?
Mass Wasting	9	Fair ?
Debris Jam Potential	4	Good ?
Vegetative Protection	11	Poor ?

Lower Bank		
Channel Capacity	3	Fair ?
Bank Rock Content	4	Good ?
Obstructions to Flow	2	Excell ?
Cutting	4	Excell ?
Deposition	4	Excell ?

Channel Bottom		
Rock Angularity	3	Fair ?
Brightness	2	Good ?
Consolidation of Particles	4	Good ?
Bottom Size Distribution	5	Good ?
Scouring and Deposition	6	Excell ?
Aquatic Vegetation	3	Fair ?

08/21/02

Rating - 67

Condition - Good

Use Reach Classification

Poor Fair Good

# RIVERMorph Components



## DESIGN TOOLS

### Natural Channel Design

- Pattern
- Dimension
- Profile

### Vane Structures

The screenshot displays the RIVERMorph software interface with the following data:

Planform Geometry	
Meander Wavelength (Lm)	264.36
Channel Length (Lc)	296.08
Sinuosity (K)	1.12
Radius of Curvature (Rc)	69.59
Bankfull Slope (Sb <sub>bf</sub> )	0.00313
Meander Belt Width (w <sub>bf</sub> )	65.48
Meander Width Ratio (MWR)	3.13

Riffle Geometry	
Width to Depth Ratio (W/D)	16.57
Entrenchment Ratio (W <sub>ipa</sub> /W <sub>bkf</sub> )	5.12
Floodprone Width (W <sub>ipa</sub> )	107.26
Bankfull Width (w <sub>bkf</sub> )	20.95
Bankfull Mean Depth (D <sub>bkf</sub> )	1.26
Riffle Slope	0.00313
Riffle Slope to Bankfull Slope Ratio	1

Riffle Hydraulics	
Bankfull Velocity (V <sub>bkf</sub> )	2.15
Bankfull Hydraulic Radius (HR)	1.13
Bankfull Shear Stress (T <sub>bkf</sub> )	0.22
Required Roughness (n)	0.0419
Movable Particle Size	27.01

Sediment Transport Competency	
D50 bed / D50 bar	1.123
Crit. Dim. Shear (1)	0.0753
Depth Needed (1)	7.04
D <sub>i</sub> bar / D50 bed	3.091
Crit. Dim. Shear (2)	0.0141
Depth Needed (2)	1.32
Min. Mean Depth	1.32

Rosgen Stream Classification: REF. C 4 NCD C 4 EX. F 4

# Natural Channel Design



**RIVERMorph 2.0 Professional**

RMTraining

Reference Reach | Boundary Conditions | Results | Plan View | Long Pro | Typical Sections

Report | Reset | Reload Dimensionless Ratios

Planform Geometry

Meander Wavelength (Lm)	200.1
Channel Length (Lc)	232.12
Sinuosity (K)	1.16
Radius of Curvature (Rc)	47.77
Bankfull Slope (Sbkf)	0.00301
Meander Belt Width (wblt)	57.921
Meander Width Ratio (MWR)	2.58

Deflection Angle (rad)

Riffle Geometry

Width to Depth Ratio (w/D)	18.05
Entrenchment Ratio (w/fpa/wbkf)	5.12
Floodprone Width (w/fpa)	114.94
Bankfull Width (w/bkf)	22.45
Bankfull Mean Depth (Dbkf)	1.24

Riffle Hydraulics

Bankfull Velocity (Vbkf)	2.04
Bankfull Hydraulic Radius (HR)	1.12
Bankfull Shear Stress (Tbkf)	0.21
Required Roughness (n)	0.0431
Movable Particle Size	25.5

Sediment Transport Competency

D50 bed / D50 bar	1.125
Crit. Dim. Shear (1)	0.0753
Depth Needed (1)	7.31
Di bar / D50 bed	3.091
Crit. Dim. Shear (2)	0.0141
Depth Needed (2)	1.37
Min. Mean Depth	1.37

Rosgen Stream Classification

REF. C 4 NCD C 4 IMP. F 4

GIS  
Regional Curves  
Resistance Equations

## ANALYSES & DESIGN

- Slider Controls for Design Iterations

# Incorporates Design Calculations for Structures

Report Add Delete Refresh

Reach Inputs

BEHI Bank ID	
Bank Height (ft)	1.2
Bankfull Height (ft)	1.2
Shear Stress (lbs/sq ft)	0.232
NBS (lbs/sq ft)	0.232

Bankfull Slope (ft/ft)	0.00344
Bankfull Width (ft)	30
Radius of Curvature (ft)	65.5

Rc / Wbkf	2.18
-----------	------

Bank ID not found for Cross-Vane 1

Vane Design Results

Cross-Vane 1  
J-Hook 1

Plan View Vane Angle (d)	20
Vane Spacing (ft)	704.3
Vane Length (ft)	28.7
Minimum Rock Size (ft)	2.2
Min Protrusion Height h (ft)	0.12
Min Footing Depth (ft)	0.36
Layers of Footing Stones	1
Vane Slope (%)	4.2

Sandy Bottom



# RIVERMorph Components



## CALCULATORS & TOOLS

- Everything You Need at Your Fingertips
- Easy to Use
- Pop Up Forms Allow Continuous Work in Main Window
- Data Integration

Regime Equation Calculator

Report Set Units Close

$L_m = \alpha W b k f^\beta$

721.68 = 67

Y	Meander Wavelength	Sd + (%)	65
X	Bankfull Width	Sd - (%)	39
$\alpha$	7.5	R:	0.96
$\beta$	1.12	N:	191

Williams, 1986  User Defined

Drag variables into the X and Y placeholders to define an equation or create your own by selecting the User Defined option. Type a value into the white text box to get a result.

# RIVERMorph Components



## CALCULATORS & TOOLS

- ☛ GIS
- ☛ Regional Curves
- ☛ Resistance Equations
- ☛ Regime Equations
- ☛ TR-55 Peak Flow
- ☛ Andrews Equations
- ☛ Shields Curve
- ☛ Gage Analysis
- ☛ PowerSed/FlowSed

**Resistance Equation Calculator**

Calculate Close

Manning Chezy Darcy-Weisbach Pipe Flow

Manning Roughness Coefficient (n)

Limerinos Cowan Stream Type Known

Mean Depth or Hydraulic Radius (ft)

Bed Material D84 (mm)

Manning's n:

Cross Sectional Area (sq ft)

Wetted Perimeter (ft)

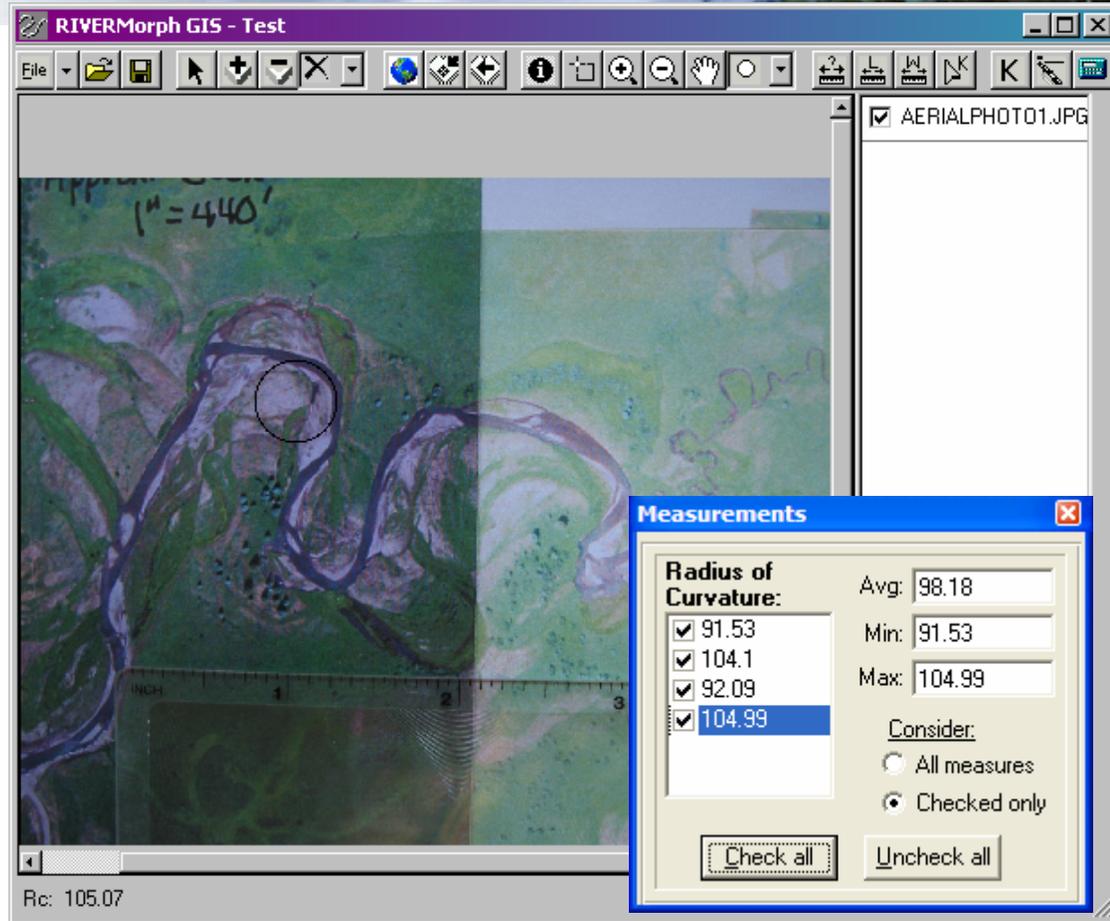
Hydraulic Slope (ft/ft)

Velocity (fps):

Discharge (cfs):

$$U = \frac{C_m}{n} R^{2/3} S^{1/2}$$

# RIVERMorph GIS



Ability to Set Scale

Key Planform Measurements

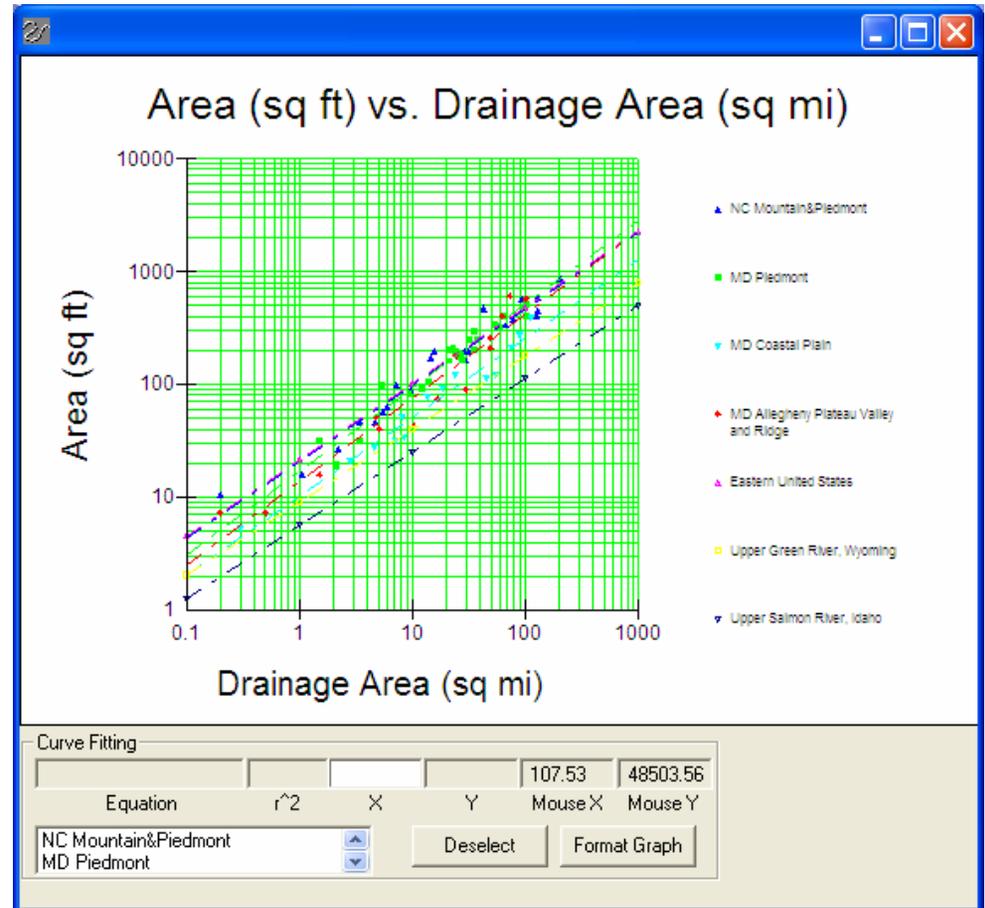
- Sinuosity
- Radius of Curvature
- Meander Wavelength
- Belt Width

Upload to Dimensionless Ratios

# Regional Curves

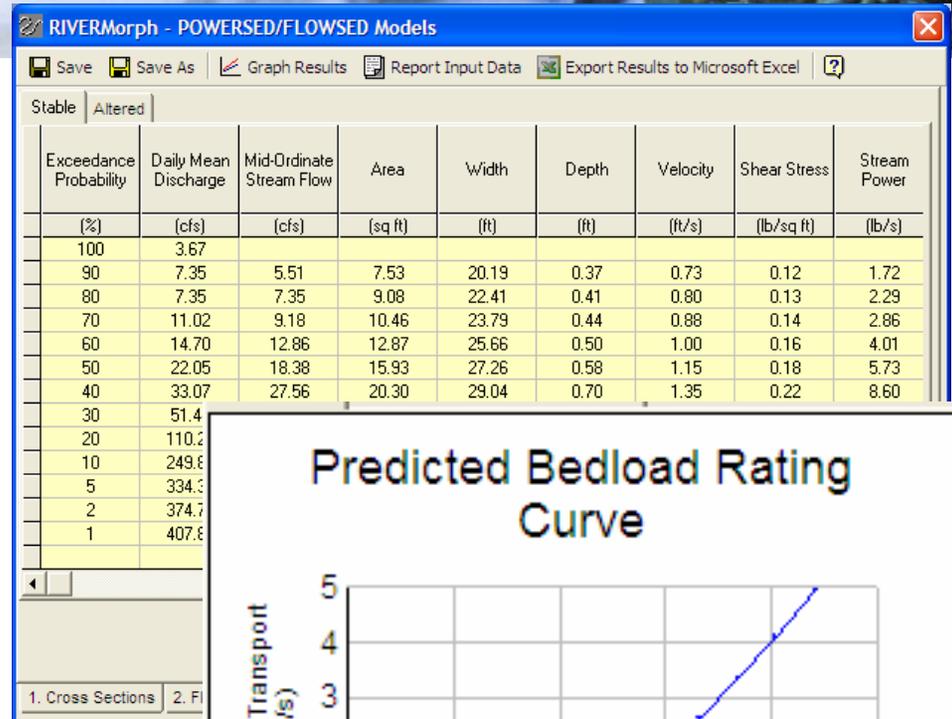


- Graphs of Drainage Area Versus
  - Discharge
  - Area
  - Width
  - Depth
- Default Curves
- Creates New Curves with a Click of a Mouse
- Website Source for Latest Regional Curve Data



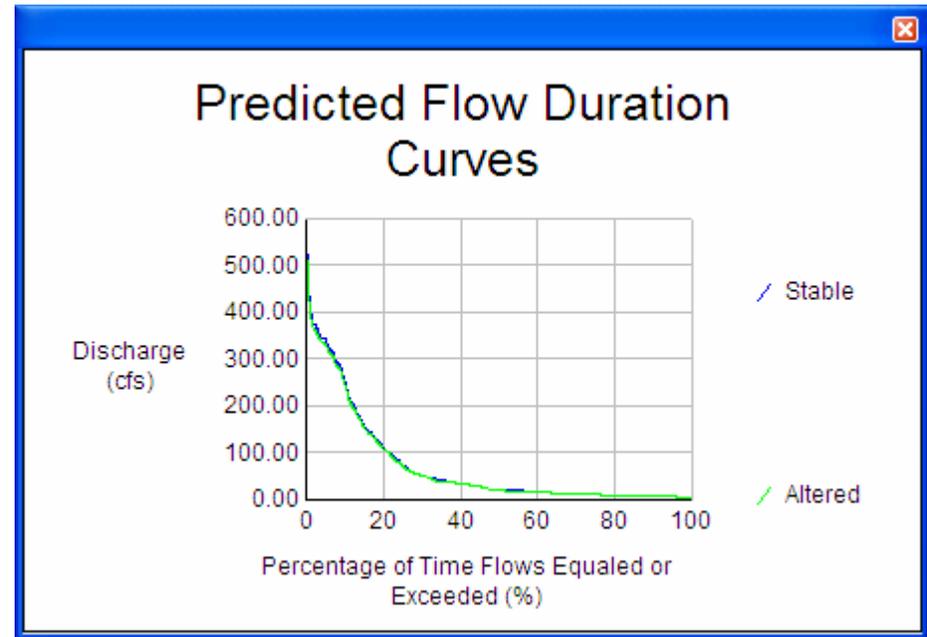
# Latest Enhancements

- PowerSed Sediment Transport Model
- Linkage w/ Natural Regrade Software
- Bank Profile Module
- Enhance Total Station Functionality
- Enhance Gage Analysis Tools
- Forms/Reports



# PowerSed Model

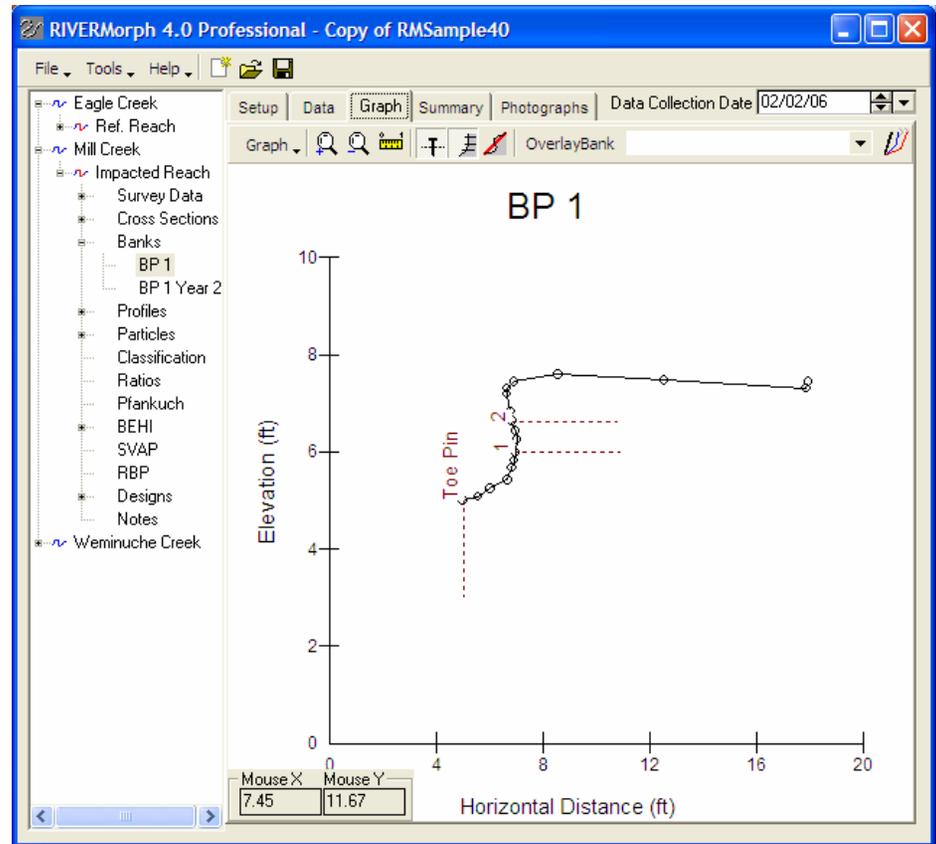
- Used to Calculate Sediment Transport Capacity
- Requires a Measured Bedload and Suspended Sediment Reading at Bankfull
- Can be Used to Predict Response to Channel Alteration
- Recently Developed by Dave Rosgen as Part of WARSSS (Watershed Assessment for River Stability and Sediment Supply) Study for EPA
- Reference: EPA WARSSS Website <http://www.epa.gov/warsss/>



# Bank Profile Module



- Used to Assess Streambank Erosion
- Follows BEHI Protocol
- Customized Tools to Facilitate Measurement of Erosion
- Reports and Graphs



# Pocket RIVERMorph

- ✓ Quicker Analysis
- ✓ Includes Most Data Entry Screens in RIVERMorph
- ✓ Opportunity to Validate Your Data While in the Field
- ✓ Tools to Calculate Bankfull and View Graphically
- ✓ Easily Loaded on to Waterproof PDA
- ✓ Instantly Syncs with RIVERMorph



# Natural Channel Design Using the Geomorphic Approach

- Stable Reference Stream in Same Hydro-physiographical Region
- Streams Exist in Dynamic State of Equilibrium
- Requires a Number of Geomorphic Measurements - Range of Dimensionless Ratios
- Gravel Bed Channels – Check Sediment Transport Competency & Capacity
- Sand Bed Channels – Check Sediment Transport Capacity

**Dimensionless Ratios and Ranges of Values**

Dimension Profile Hydraulics

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
B 4c	II	10.06	0.0035	112	3.1

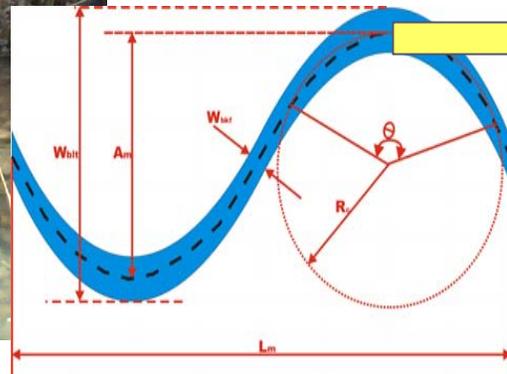
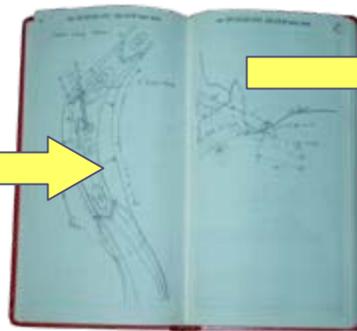
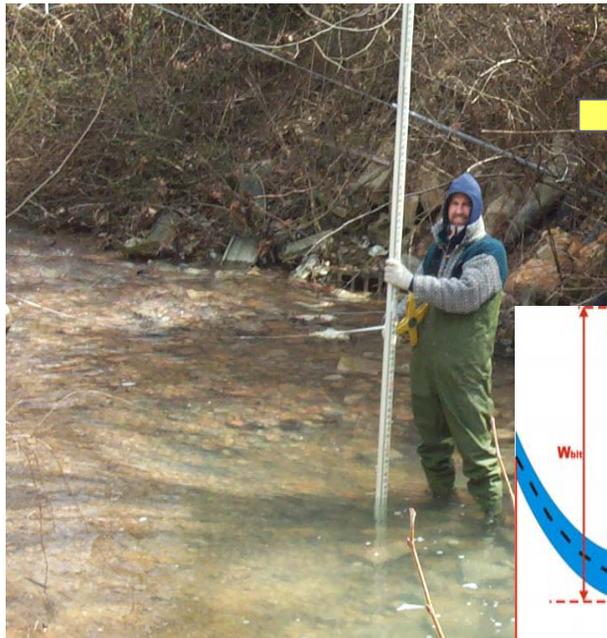
  

Variable	Min	Ave	Max
Floodprone Width	31.56	35.21	38.86
Riffle Area	26.15	32.49	38.83
Riffle Max Depth	2.32	2.62	2.92
Riffle Mean Depth	1.27	1.52	1.76
Riffle Width	20.55	21.32	22.08
Pool Area	28.87	33.58	37.28
Max Pool Depth	2.50	2.85	3.12
Mean Pool Depth	2.14	2.35	2.54
Pool Width	12.30	14.31	15.89
Run Area	32.35	34.52	36.54
Max Run Depth	2.45	2.65	2.90
Mean Run Depth	2.04	2.10	2.22
Run Width	12.20	14.28	14.36
Glide Area	28.72	29.97	31.45
Max Glide Depth	2.21	2.45	2.58
Mean Glide Depth	1.95	2.13	2.23
Glide Width	12.05	14.06	14.25

Note: Maximum depths from this screen are saved to the database as the reach average values. Refer to the "Profile" tab for more options.

View as Actual Values View as Dimensionless Ratios

# NCD Example – Dimensionless Ratios



**Dimensionless Ratios and Ranges of Values**

Dimension | Pattern | Profile | Hydraulics

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
B 4c	II	10.06	0.0035	112	3.1

Variable	Min	Ave	Max
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View as Actual Values | View as Dimensionless Ratios



**RIVERMorph**  
Stream restoration software

# Summary



- ☞ Software Stores all Data in a Database for Easy Retrieval During the Assessment & Design Process.
- ☞ Features an Intuitive Graphical User Interface
- ☞ Streamlines the Processing of Geomorphic Data and Natural Channel Design Calculations
- ☞ Quickly Enter & Analyze Data in the Field Using Pocket RIVERMorph





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