Lessons from a Thousand Streams

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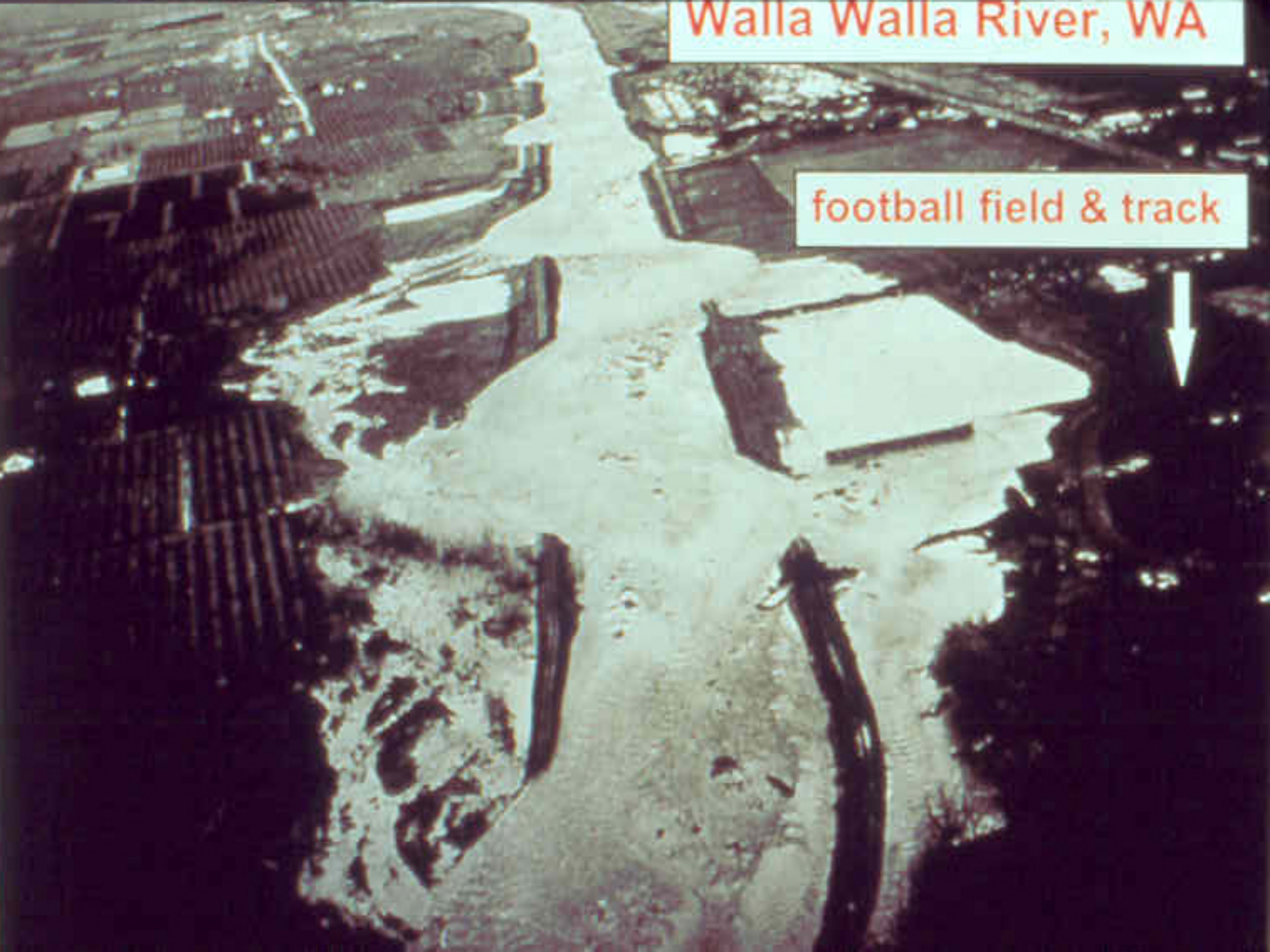
Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades.

Rosgen, Applied River Morphology

Walla Walla River, WA
football field & track
next slide view


Walla Walla River, WA
football field & track

Lesson #1

Work with Nature

- (You Can't Fool Mother Nature!)
- Follow "natural stream" patterns
- Make smooth transitions
- Bank keys are "essential"
- Anticipate future changes

Lesson #2

- Allow for Stream Adjustments--- Vertical and Horizontal

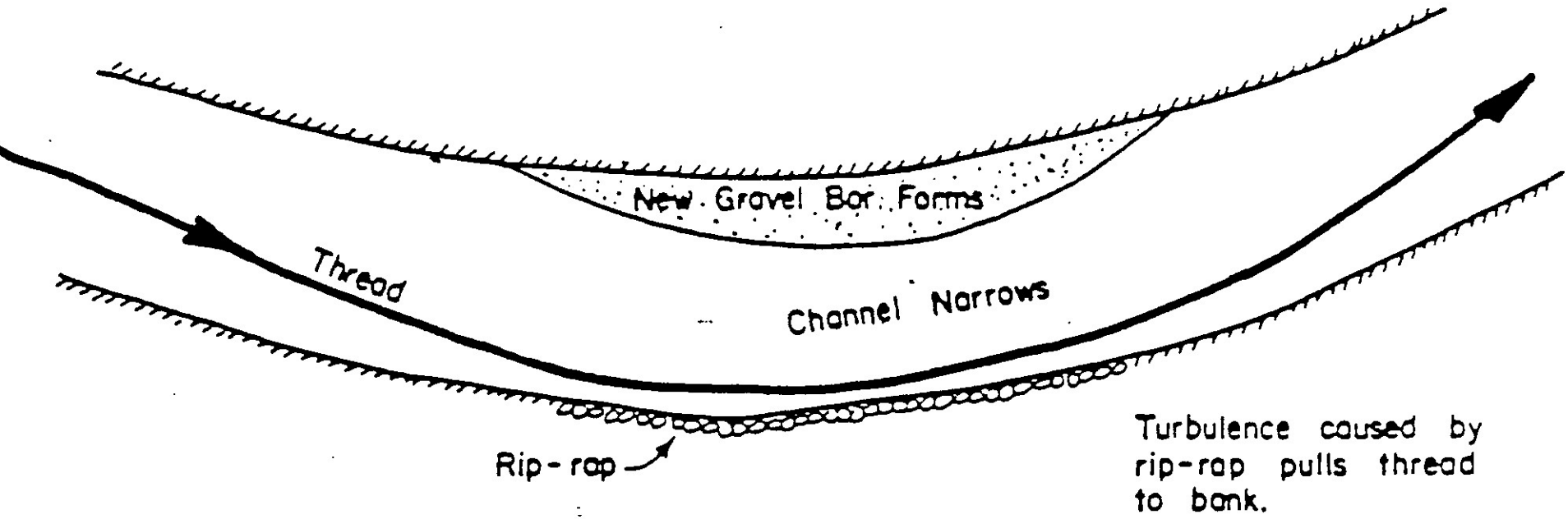
Lesson #3

- A stable toe slope is essential
- Do NOT depend on vegetation for toe protection

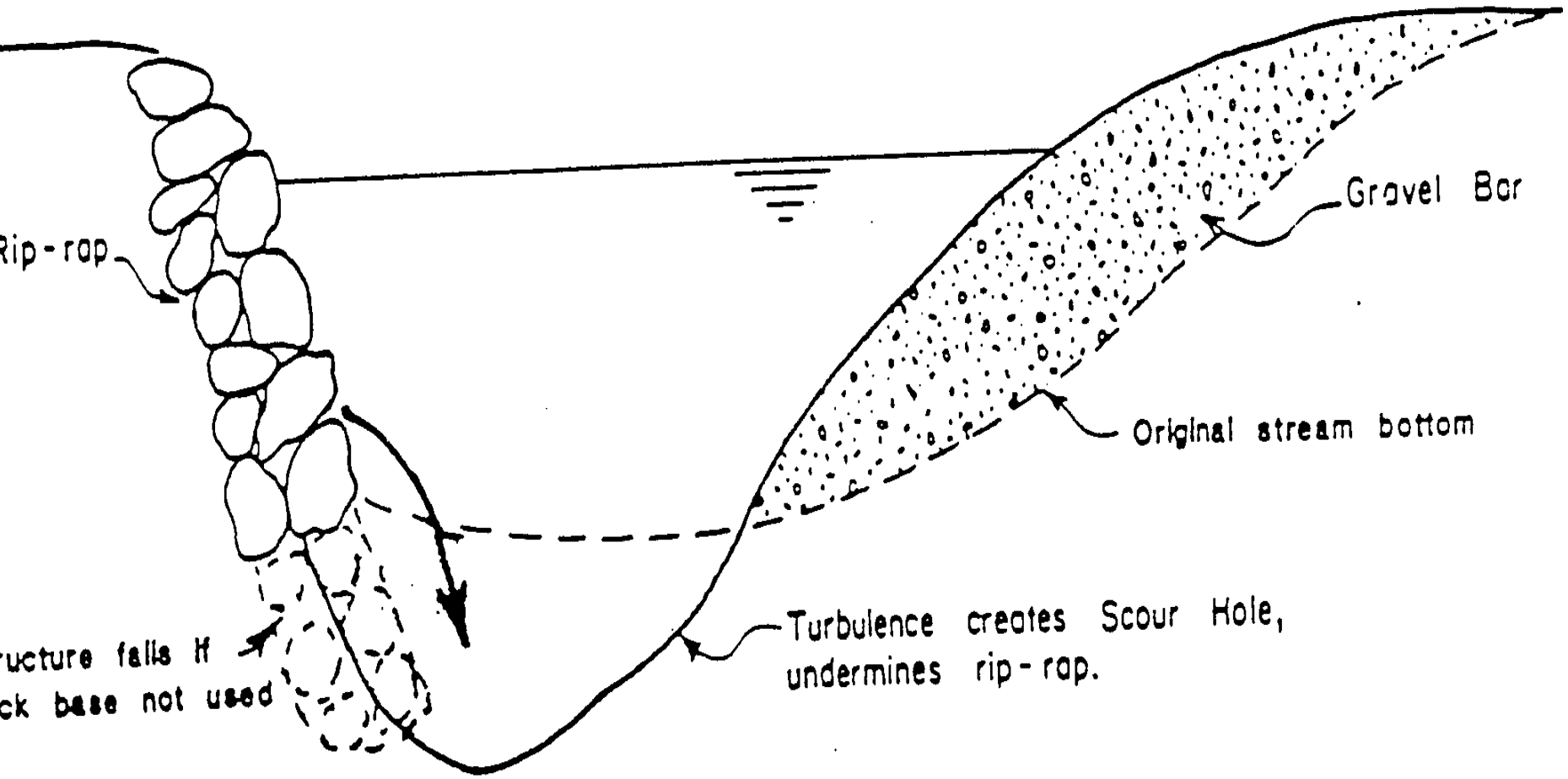
Materials used must be able to adjust

Nothing seems to work better than loose stone!

TYPICAL RIP–RAP BEHAVIOR



IMPACT ON THREAD



CROSS SECTION

Lesson #4

- A stable grade is ALWAYS required

Lesson #5

- Vegetation is secondary

Vegetation will stabilize the streambanks when and <u>only when</u> the stream is near a state of equilibrium.

Nature will plant vegetation on a stable slope

Wayne's Vegetative Rules

- Does nothing for bed degradation!
- Vegetation alone does not provide the "hard toe" needed to control excessive lateral migration
- Bio-degradable materials are "short-term fixes" for toe protection
- Natural vegetation will establish if toe is protected or velocities are slowed

Lesson # 6

- Bio-degradable material is not a long term solution

Coir Roll after 5 yr.

Lesson #7

- It Doesn’t have to be pretty!

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Lesson #8

- Geometry is Important

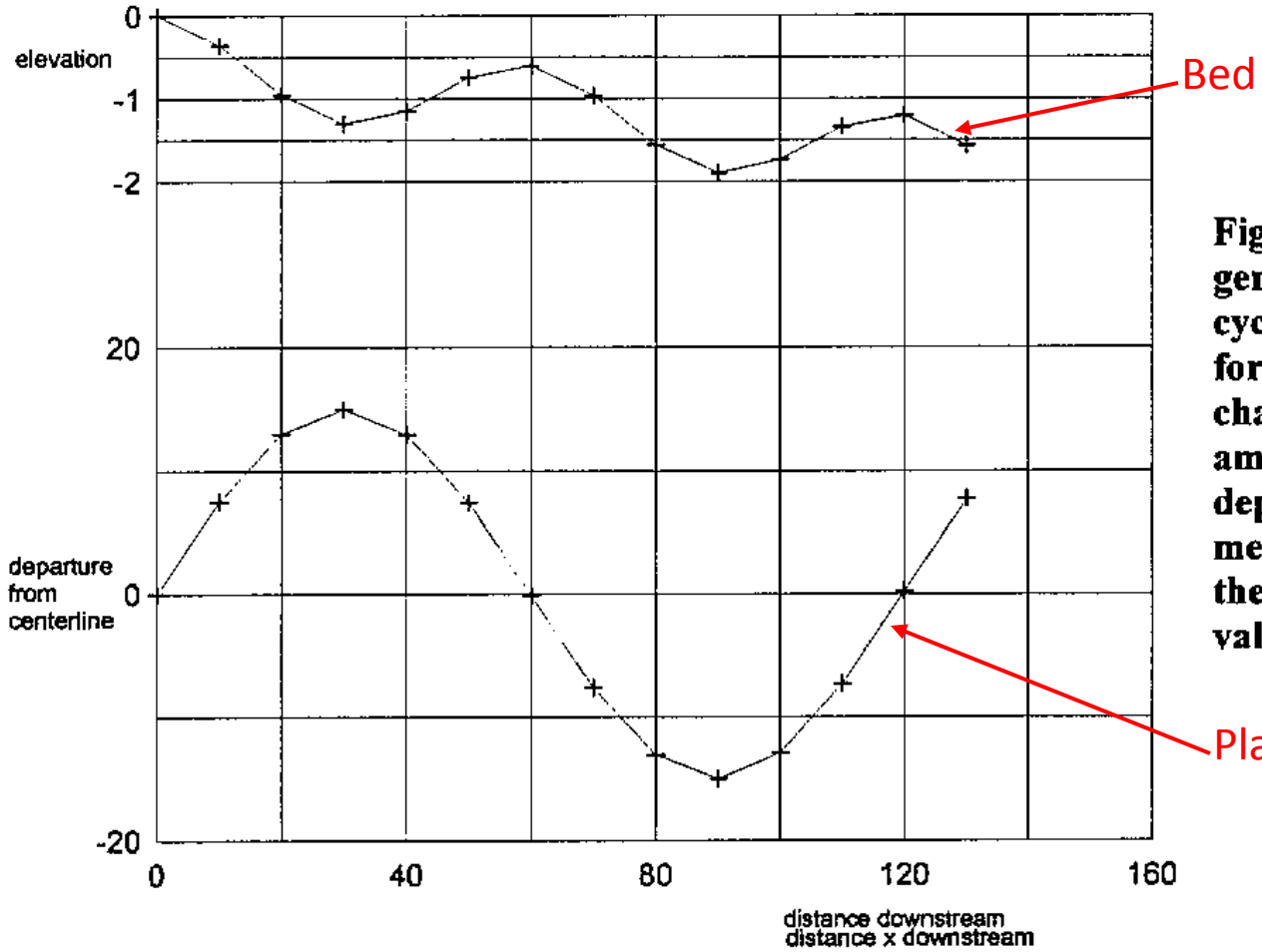


Figure 1.12: Sine waves generated as a profile (2 cycles) and a plan (1 cycle) for a theoretical 10 m wide channel with a meander amplitude of 30 m and a pool depth of 1 m. The 120 m meander is measured along the axis of a 1% gradient valley.

How many uniform channel beds are constructed?

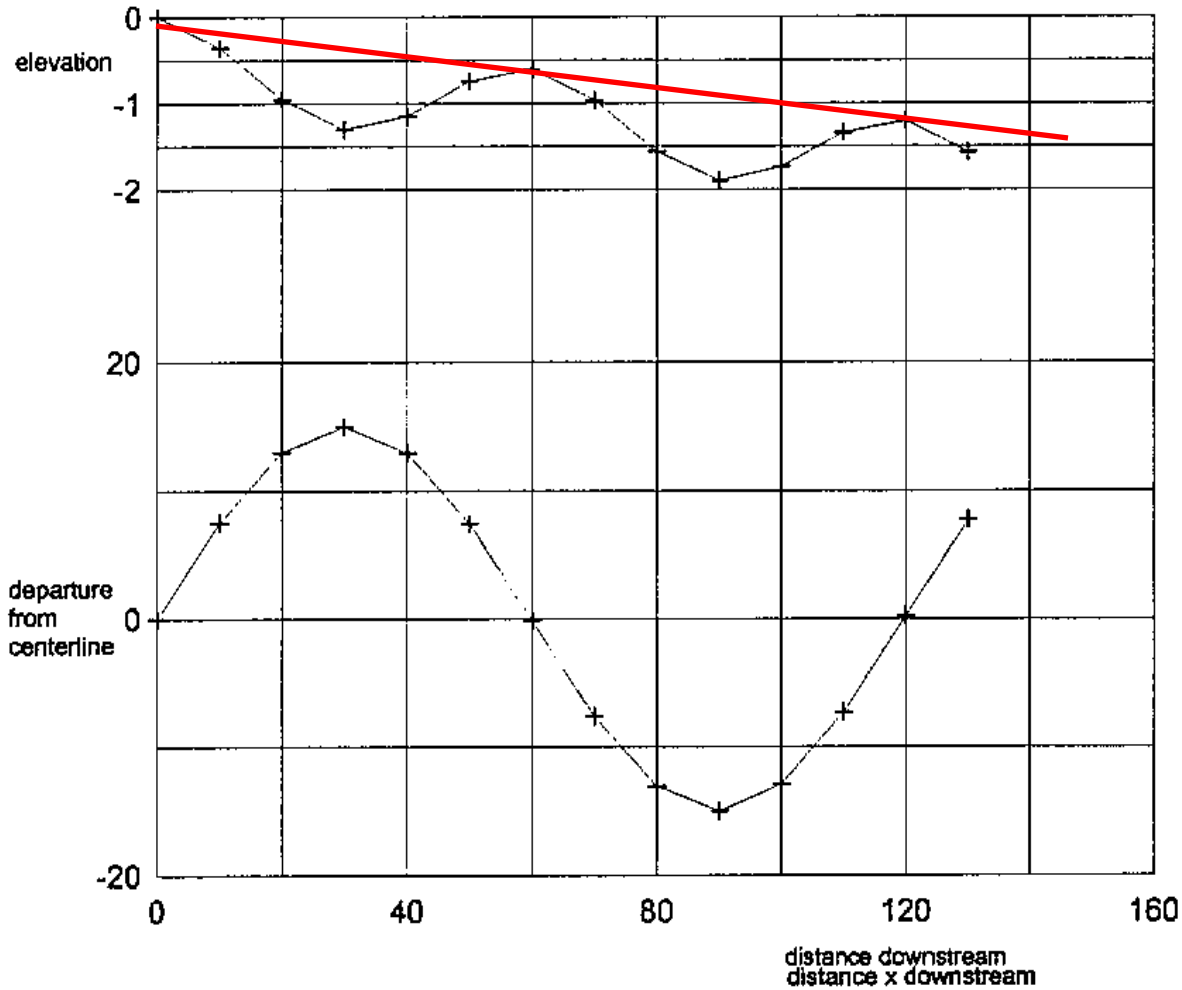


Figure 1.12: Sine waves generated as a profile (2 cycles) and a plan (1 cycle) for a theoretical 10 m wide channel with a meander amplitude of 30 m and a pool depth of 1 m. The 120 m meander is measured along the axis of a 1% gradient valley.

Radius of Curvature

- Ave radius = 2.3 times bankfull width (Leopold)
- 2.3 is the optimum for hydraulic efficiency
- Range generally from 1.6 to 4.5 times bankfull width (natural streams)
- 1.8 is the suggested minimum to attempt stabilization!

Radius >1.8 BFW
Bankfull Width

Lesson #10

- Geotechnical Problems must be addressed

Unconsolidated materials are special cases

Two Warnings!!

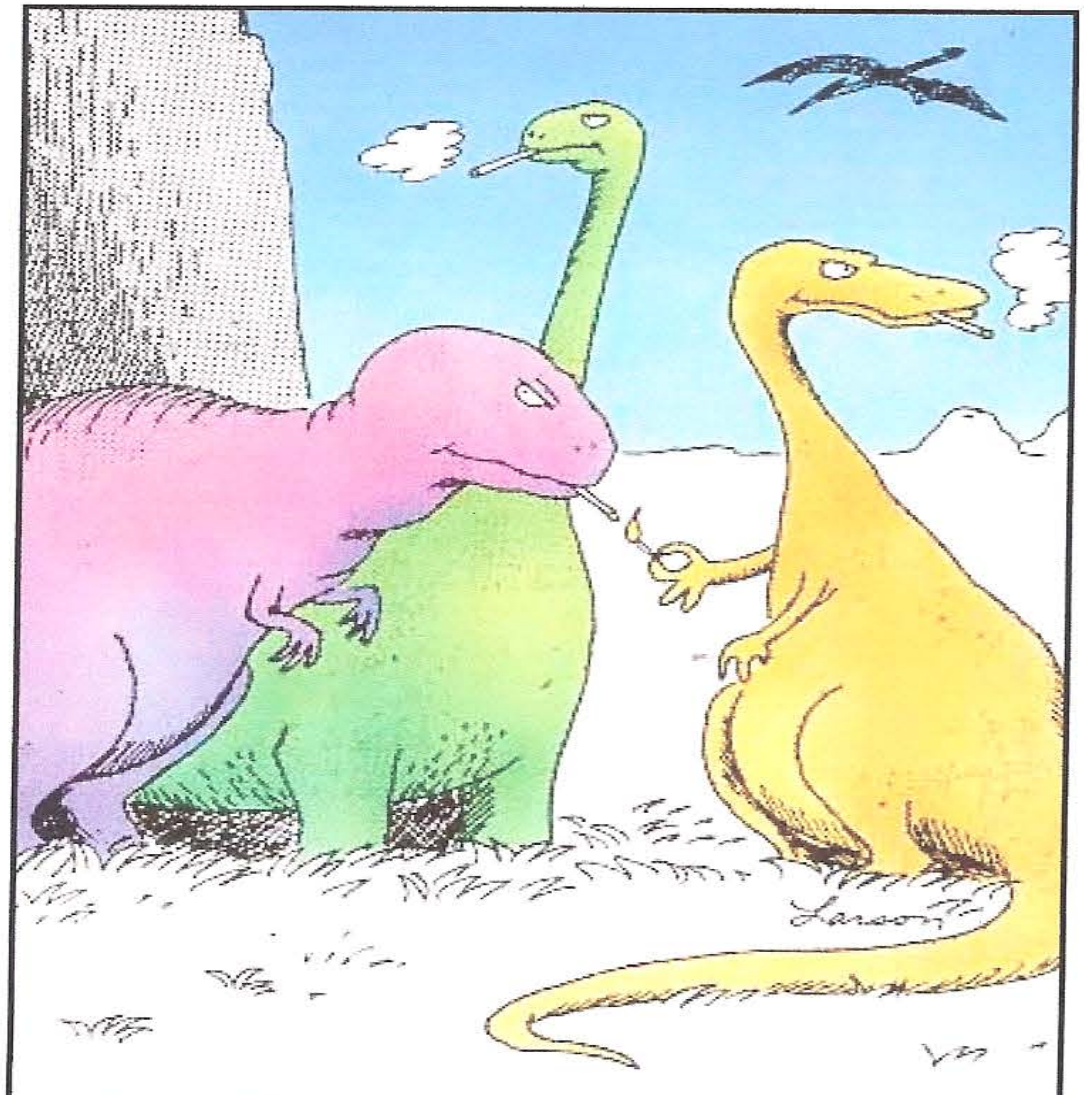
First Warning

- Principles --I.e. increasing cover, decreasing velocity at the water-bank interface, reducing shear stress, increasing resistance to erosion, etc. are transferable
- Techniques--I.e. a-jacks, vegetation, bendway weirs, stream barbs, etc. may NOT be transferable

Second Warning

- Lack of experience may result in over simplification of causes of bank failure.
- Causes and effects of changes are inter-related and complex.
- Experienced observers are generally more cautious about making initial judgements.
- Always look for the real problem!

The real reason dinosaurs became extinct



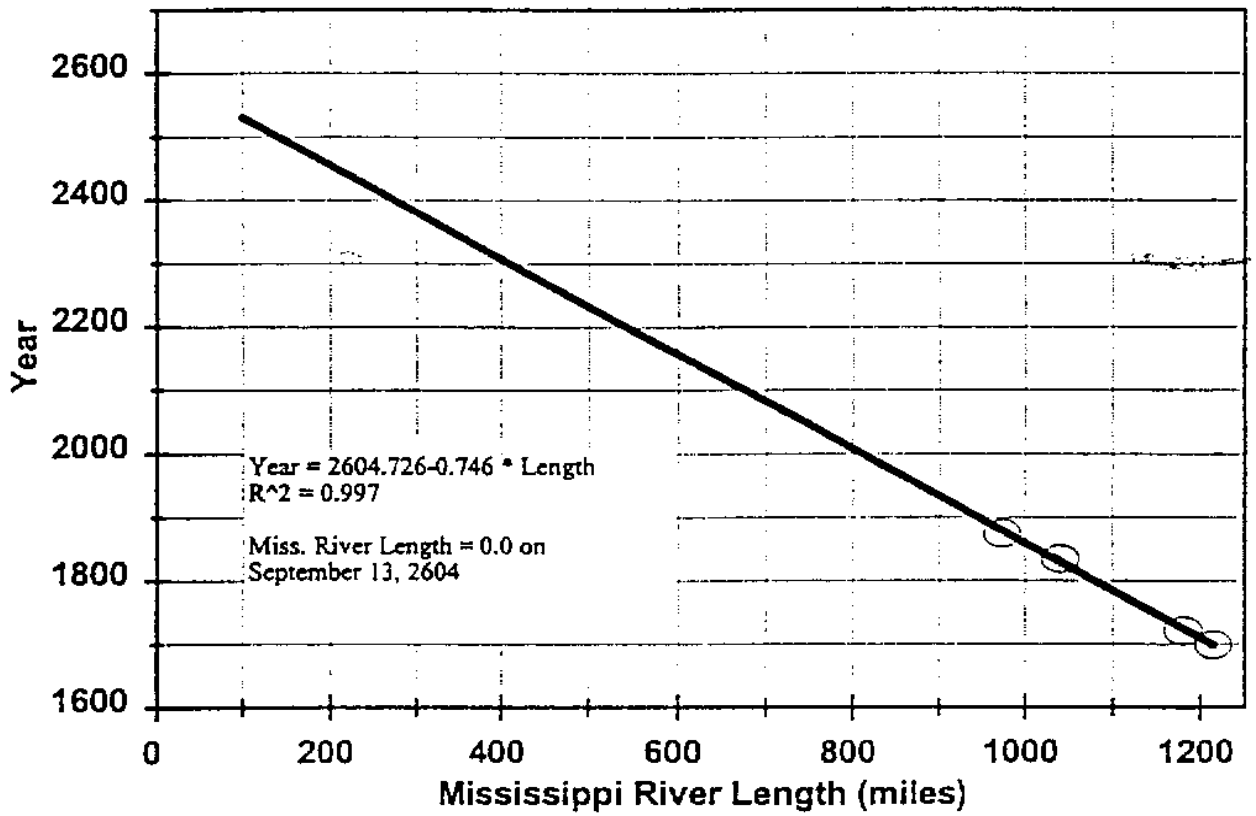


Figure 2-8. Empirical relationship predicting the eventual length of the Mississippi River

2 Rules to Follow

THERE ARE *NO* *COOKBOOK* SOLUTIONS!

Every stream will have unique characteristics

The Designer must be on site during construction!

Streams are dynamic—they change

Five Secrets to Success

- **Spend the time you need to understand the problem?**
- **Know where Nature wants to take the stream?**
- **Work within your limits! (experience)**
- **Be prepared to do maintenance.**
- **Learn from your Mistakes!**

Quarry Stone

Objections

- Old Fashioned
- Not Natural looking
- Moves too easily
- Requires maintenance
- Requires large equipment to handle
- Not suited for vertical walls

Advantages

- Works well
- Looks better over time
- Adjusts to stream changes
- Easy to add more stone
- Usually less expensive

Stream Stabilization Techniques using Stone

- 4 Major Structural Practices Used
- (one or a combination will work)
  ==========
- Rock Riffle Grade Control Structures (stage II or III)
- Stone Toe Protection (stage III or IV)
- Bendway Weirs (stage IV)
- Stream Barbs (stage IV)

Rock Riffle Grade Control Structures (stage II/ III streams)

- **Stabilize the Bed**
- **Creates Riffle/Pool Sequence**
- **Dissipates Energy**
- **Aerates Water**
- **Permit Fish Passage**
- **Aesthetically Attractive**

Stone Toe Protection (stage III or IV streams)

- Protects the very base of the bank
- Provides “hard” Structure to Resist High Velocity
- Protects Area Below Waterline Where Vegetation Will Not Establish
- Creates Level Bench Where Vegetation Will Establish

Bendway Weirs (stage IV streams)

- Low Upstream Angled Rock Sills to Direct Water Away From Eroding Bank
- Moves Deep Part of Channel Away From Eroding Bank
- Creates Deeper Pools Near Stream Ends of Weirs

Stream Barbs (stage IV streams)

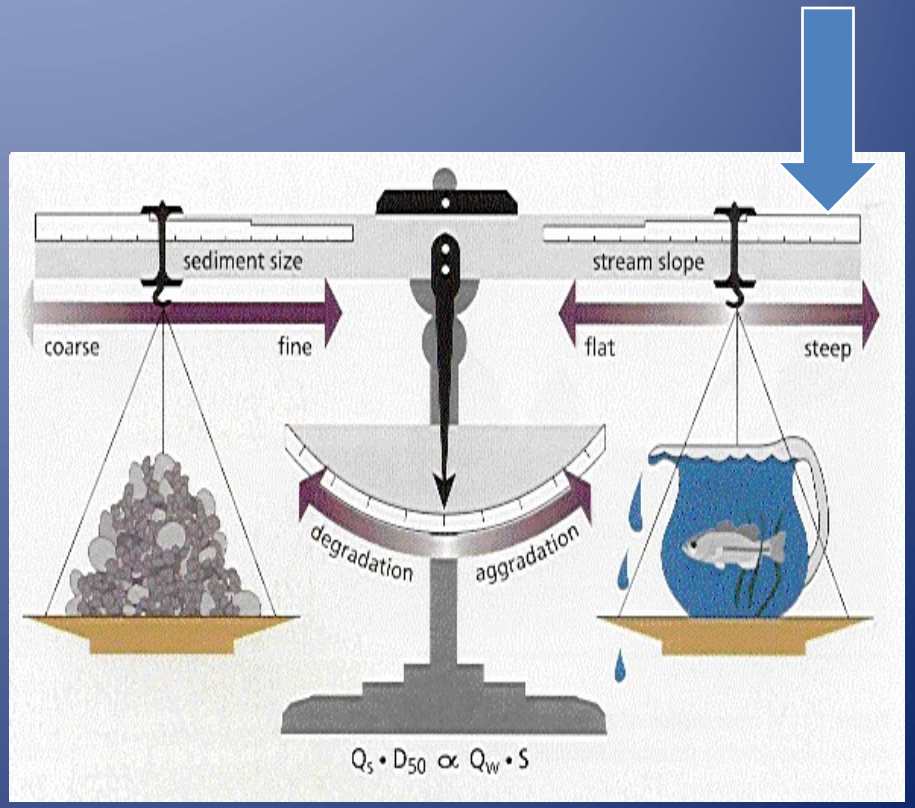
- “Hydraulic Stream Brake”
- Differ From Bendway Weirs
- ---taller
- ---sloped crest
- ---tighter upstream angle
- ---wider spacing

Extremely Important!!
LANE'S BALANCE

- Streams constantly adjust to changing conditions
- Intensified Land use (agriculture or urban) <u>WILL</u> change the flow characteristics of a stream—therefore adjustments will occur!!!
- Increased Runoff
- Increased flow frequency/duration
- Sediment hungry water in fully developed urban areas

Results of Human Activity on Stream dynamics

- Increased Runoff
- Increased Stream Slope
- Reduced Floodplain Width



IMPORTANT!!

- The Channel Evolution Model in essence says:
- If the channel is incised—it MUST erode its banks to form a new lower floodplain (at bankfull Q) before returning to equilibrium
- We can raise the flowline to re-connect with the floodplain or we can direct the floodplain development to the right or left.
- WE CAN’T STOP THE CEM PROCESS!!

03/11/2008

The End