Science-Based Vegetative Designs Using Engineering Specifications

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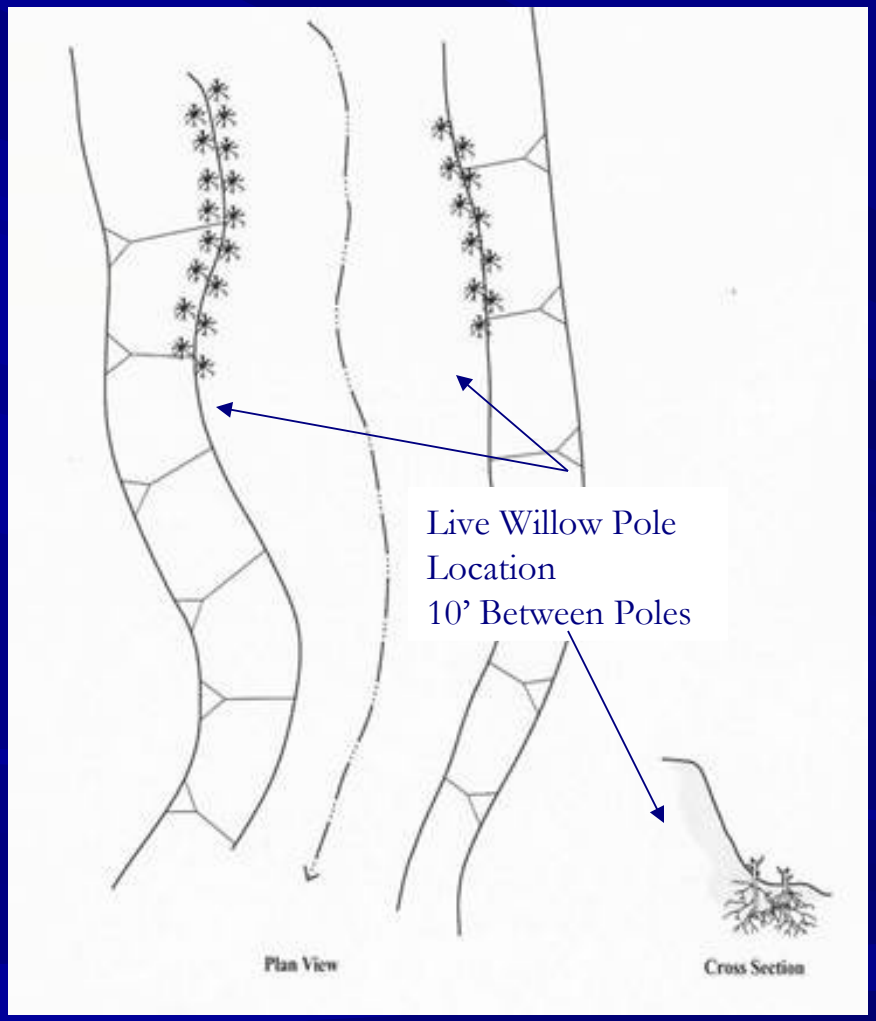
Outline

- Introduction
- Methodology
- Examples
  - Soil Parameters
  - Hydraulics
  - Planting Plans/Vegetative Parameters
- Results

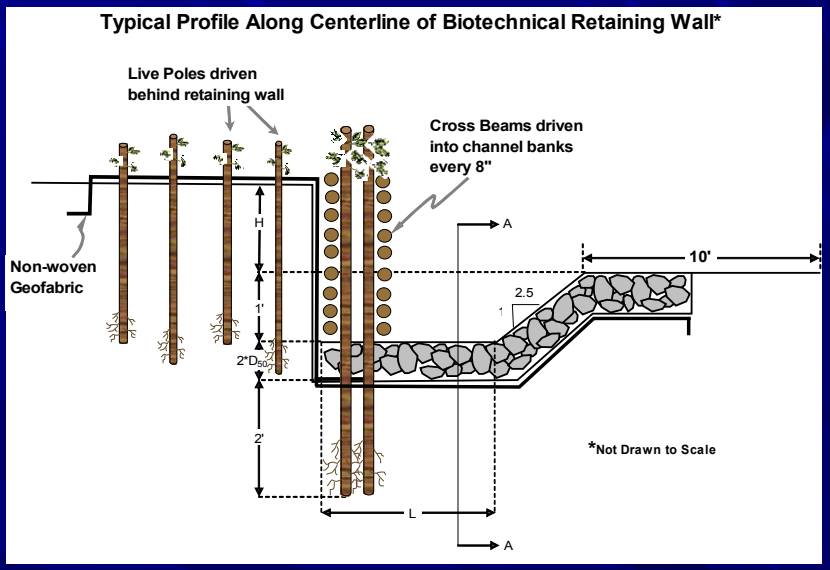
Science-Based Bio- and Bio-Technical Engineering

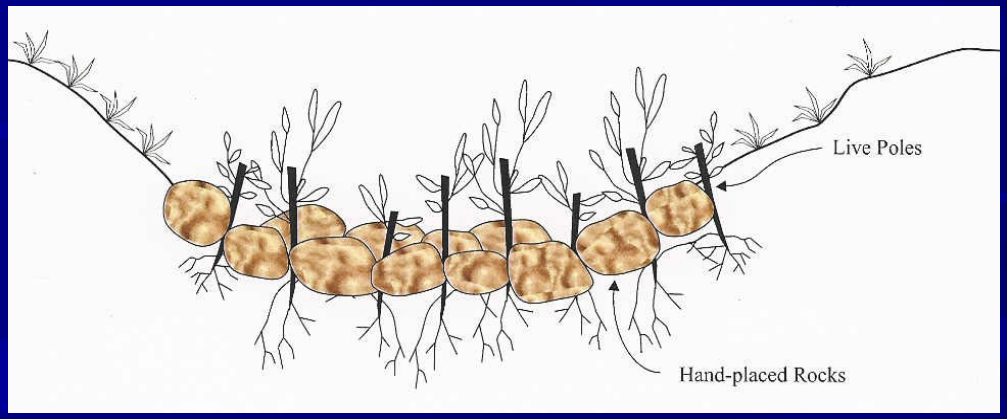
- Bioengineering – “soft” design incorporating only vegetation
- Bio-technical engineering – “medium” design incorporating man-made structures with vegetation
- “Hard” engineering – only man-made structures

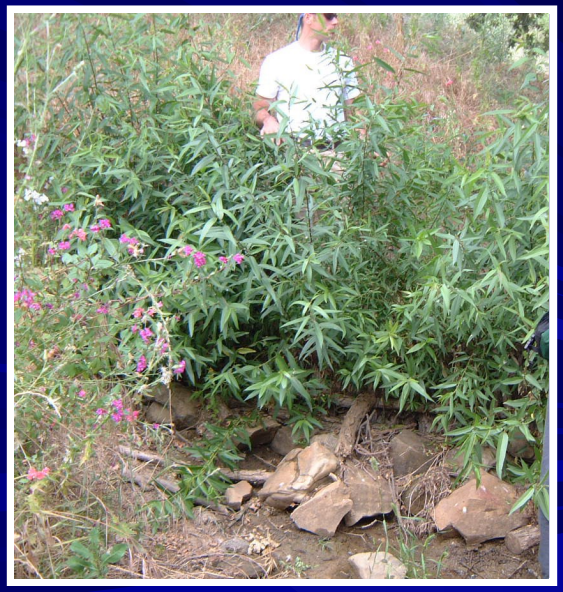
Bioengineering



Bio-technical Engineering







Science-Based Bio- and Bio-Technical Engineering

- Combine Geomorphology (i.e. the *Science*) with *Engineering* Practices
- Conduct geomorphic assessment
- Use your experience in known system
- Allows confidence in an unknown system
- Calculate EROSION THRESHOLD
- Specify root-bulb dimensions for planting plans

Bioengineering?

Bioengineering?

Erodibility Index Method (EIM)

(Annandale 1995)

$$K_h = M_s * K_b * K_d * J_s$$

- K_h units of stream power (kW/m^2)
- Calculate river's stream power (kW/m^2):
  P_a = Velocity * shear stress
  $P_a = 7.853\rho(\tau_w/\rho)^{(1.5)}$ (Annandale 2006)
- Kh > P_a, no erosion

Testing

- Based on 137 field observations (empirical equation)
- Physical Model at CSU – reticulated blocks for dam foundation erosion
- Physical Model at CSU – silt-sized particles in reservoir
- Field Installations – willow-wattle check dam, bed and bank protection

Erodibility Index Method (EIM)

(Annandale 1995)

$$K_h = M_s * K_b * K_d * J_s$$

KEY PARAMETERS FOR GRANULAR SOILS:

- Ms: consistency + geologic pick (Very loose, Crumbles very easily when scraped with geologic pick = 0.02)
- Kb: D_{50}
- Kd: friction angle (32^0 for quartz sand)
- Js = 1

Method

- Calculate Erosion Threshold
- Calculate Stream Power
- Compare
  - Define Necessary Root-Bulb Dimensions

OR

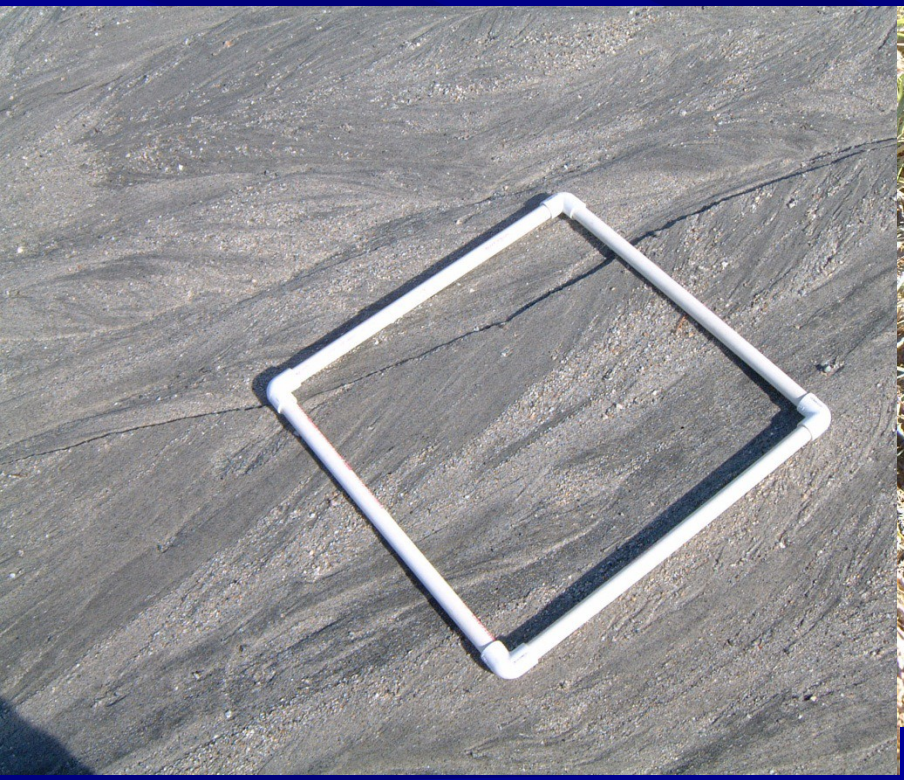
  - Define Bio-Technical Engineering

OR

  - Define Hard Engineering

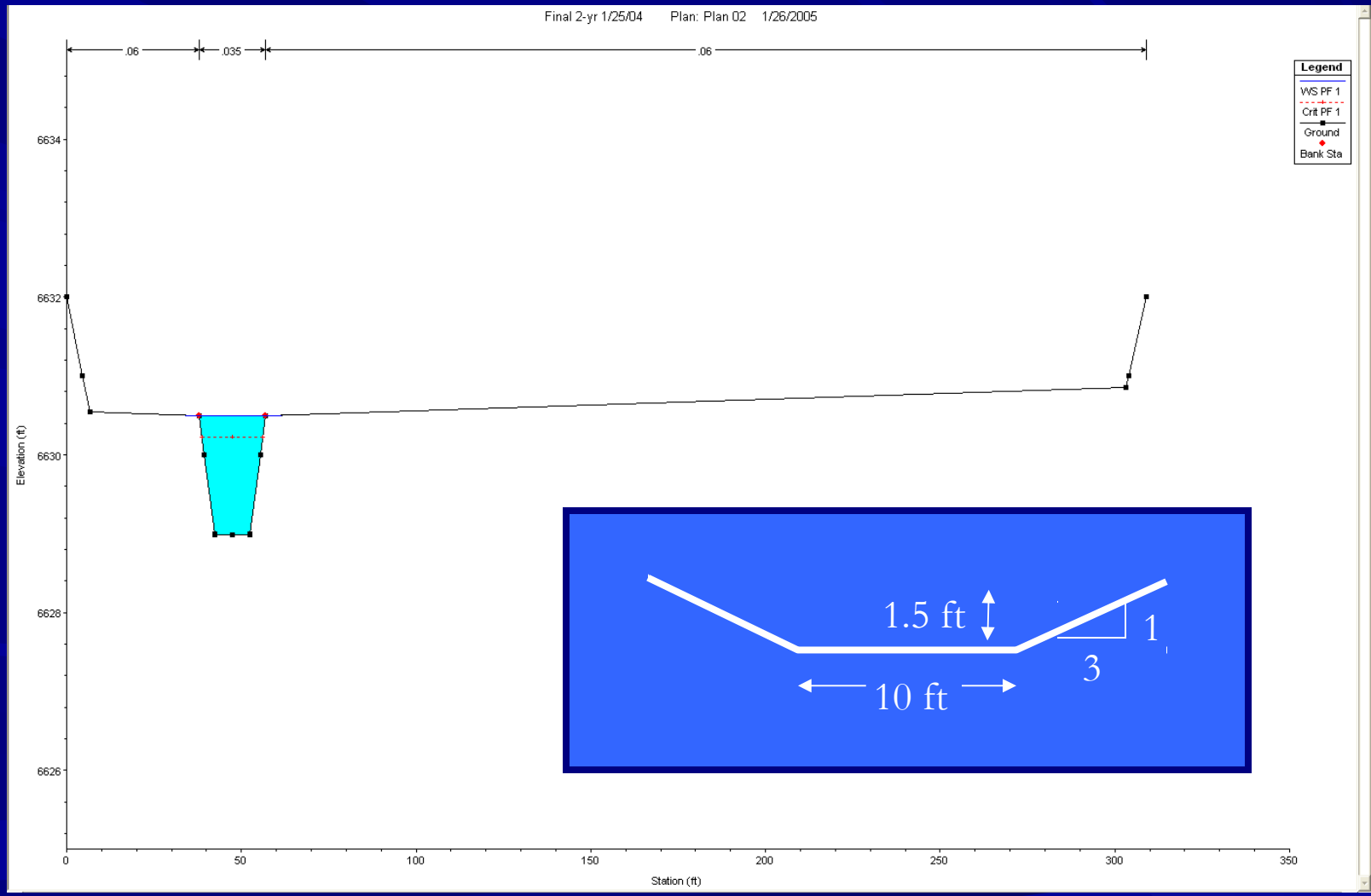
Calculate Erosion Threshold

$$K_h = M_s * K_b * K_d * J_s$$

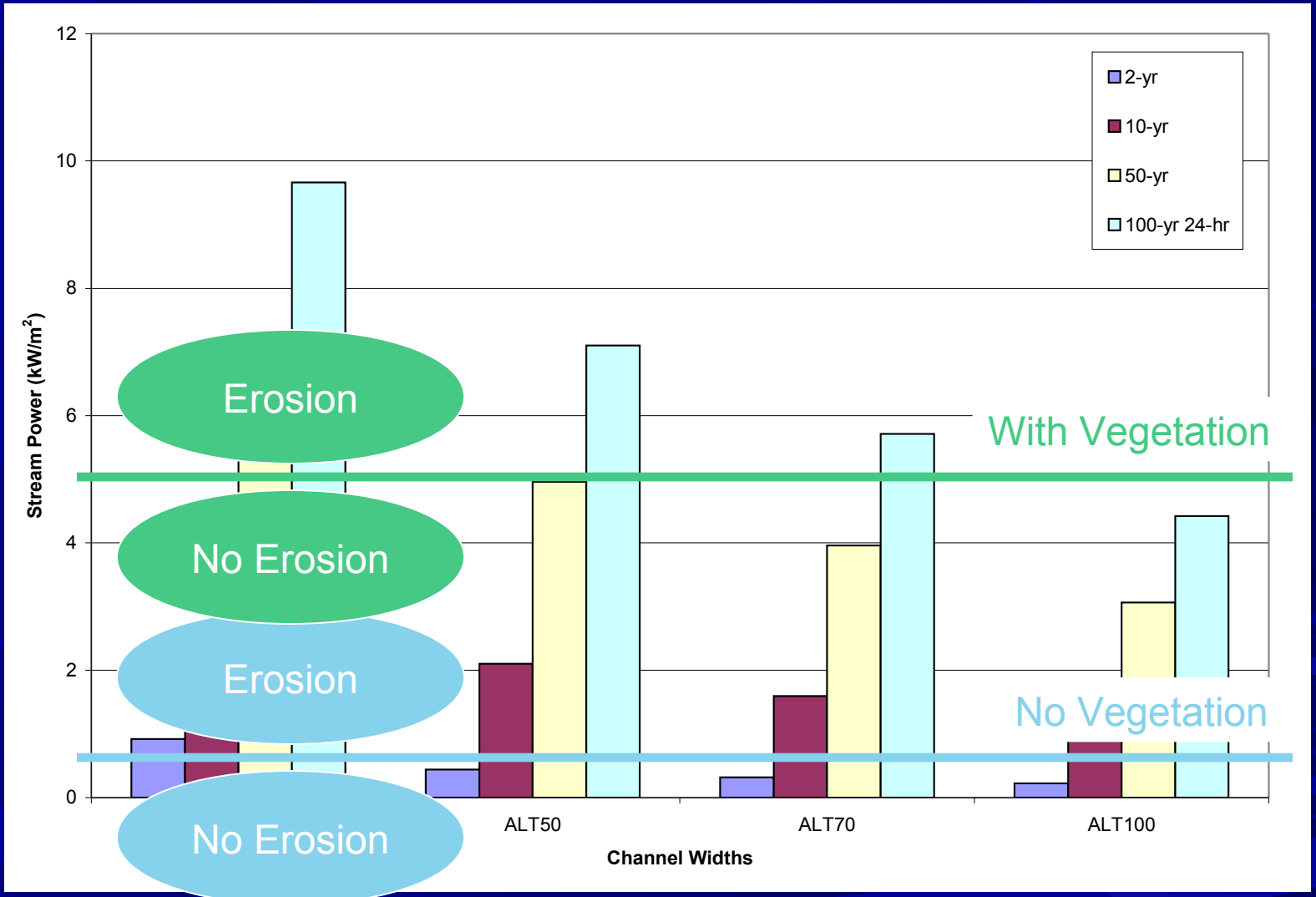


Must be fibrous root system

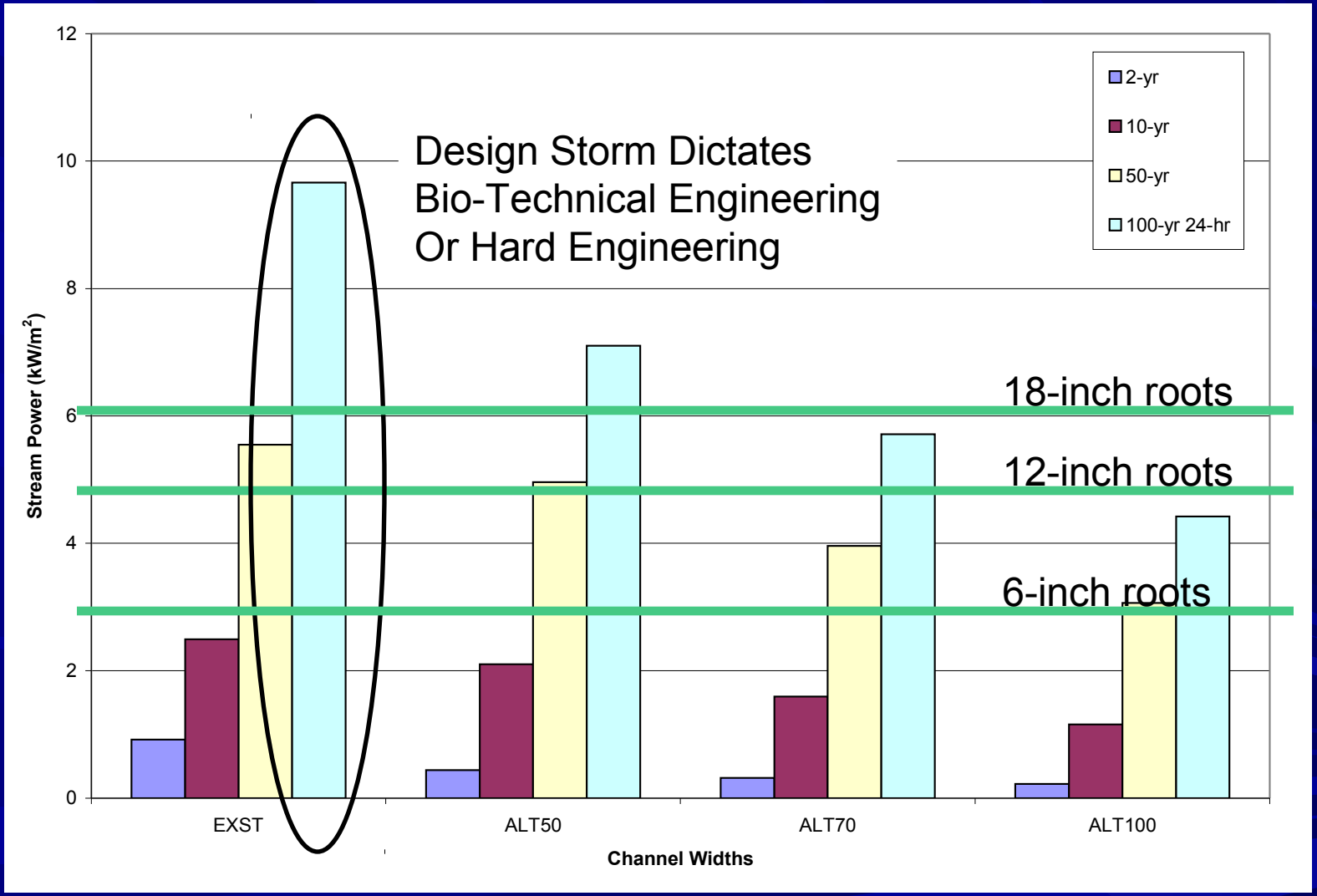
Calculate Stream Power



Compare


12
10
8
6
4
2
0
Stream Power (kW/m^2)
2-yr
10-yr
50-yr
100-yr 24-hr
Erosion
With Vegetation
No Erosion
Erosion
No Vegetation
No Erosion
ALT50
ALT70
ALT100
Channel Widths

Define Root Bulb



Application for Bio-Technical Engineering

$$K_h = M_s * K_b * K_d * J_s$$

Example Design Application for Bioengineering

Table 2. Erosion Criteria for Wattle Check Dam Design

Unit Flow	Slope	Material				
		Very Soft Clay	Soft Clay	Firm Clay	Stiff Clay	6" riprap
q=2 cfs/ft	0.2%					
	0.6%					
	1.0%					
	1.5%					
	2.0%	erosion				
	2.5%	erosion				
	3.0%	erosion	erosion			
q=4 cfs/ft	0.2%					
	0.6%					
	1.0%	erosion				
	1.5%	erosion	erosion			
	2.0%	erosion	erosion	erosion		
	2.5%	erosion	erosion	erosion	erosion	
	3.0%	erosion	erosion	erosion	erosion	
q=6 cfs/ft	0.2%					
	0.6%					
	1.0%	erosion	erosion			
	1.5%	erosion	erosion	erosion		
	2.0%	erosion	erosion	erosion	erosion	
	2.5%	erosion	erosion	erosion	erosion	
	3.0%	erosion	erosion	erosion	erosion	
q=8 cfs/ft	0.2%					
	0.6%	erosion				
	1.0%	erosion	erosion	erosion		
	1.5%	erosion	erosion	erosion	erosion	
	2.0%	erosion	erosion	erosion	erosion	
	2.5%	erosion	erosion	erosion	erosion	
	3.0%	erosion	erosion	erosion	erosion	
q=10 cfs/ft	0.2%					
	0.6%	erosion	erosion			
	1.0%	erosion	erosion	erosion	erosion	
	1.5%	erosion	erosion	erosion	erosion	
	2.0%	erosion	erosion	erosion	erosion	
	2.5%	erosion	erosion	erosion	erosion	
	3.0%	erosion	erosion	erosion	erosion	

Key: erosion; no erosion