SWAT-DEG and Channel Stability Assessment

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River Restoration

- $1 billion a year estimates since 1990
- most common goals: water quality enhancement, manage riparian zones, improve habitat, fish passage, bank stability
- More 1/3 US rivers are listed as impaired or polluted
- From Bernhardt et. al. Science (2005)

Effects Urbanization

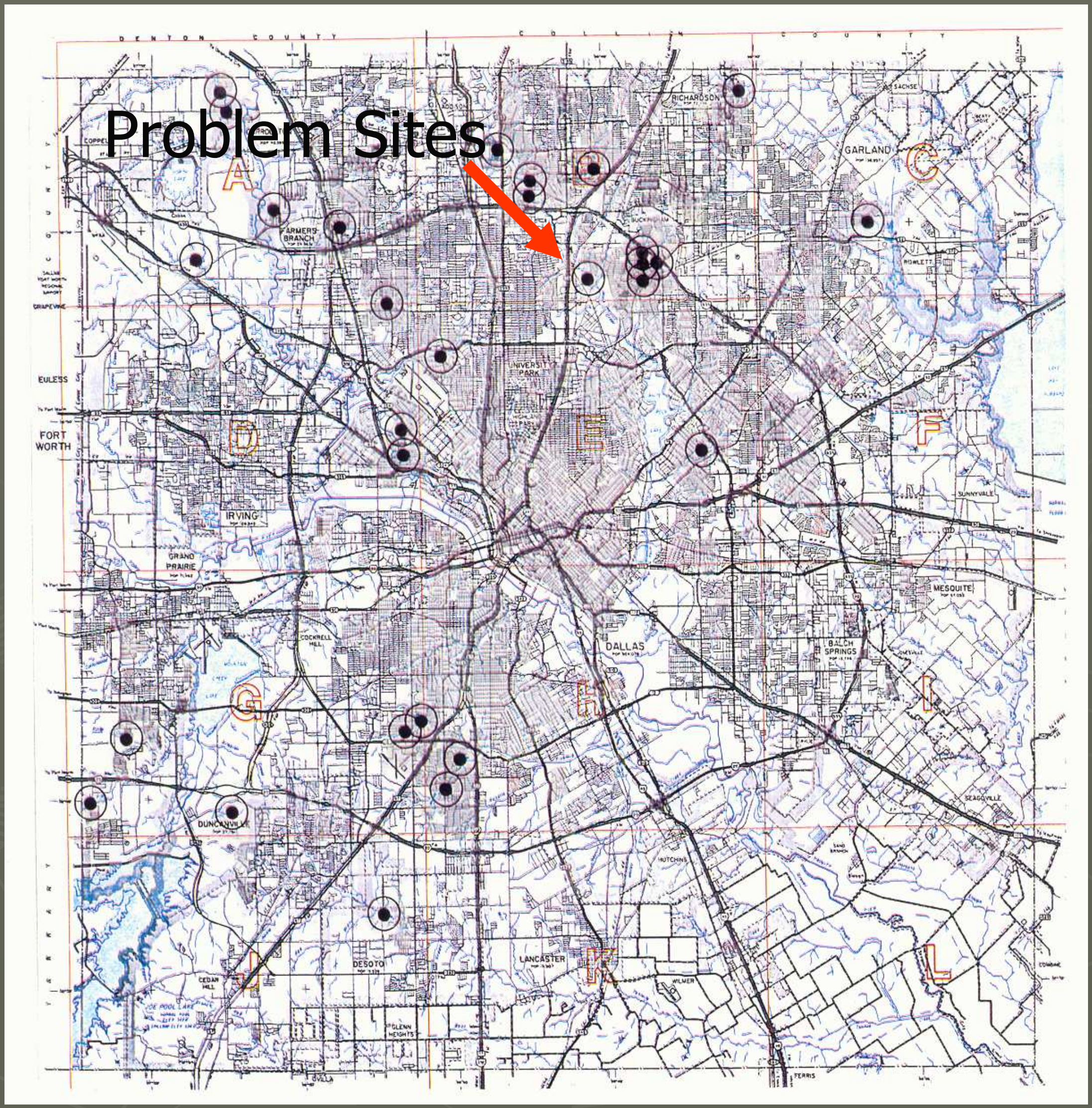
 

Population: 6 million

Growth: 140,000 yr (Suburbs rate 20-50%)

Single Family: 40,000 yr Multifamily: 10,000yr

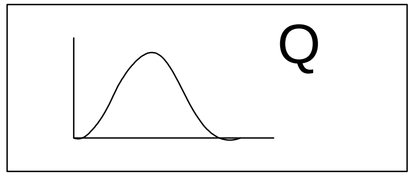
Streambank Problems: One Year

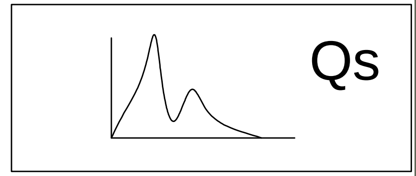


Reed and Associates

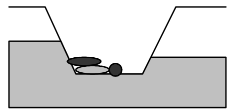
Variables in Channel Assessment

Driving

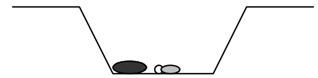




Boundary

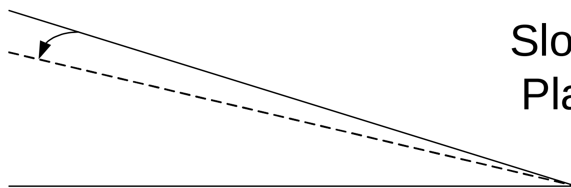


Threshold/
Rock

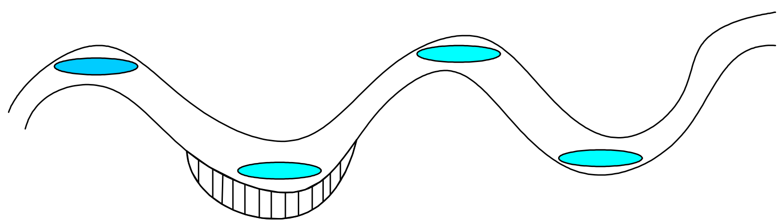


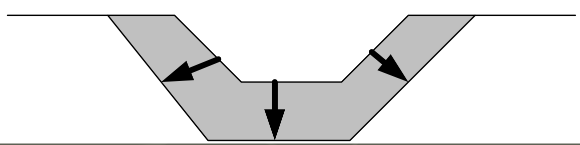
Alluvial

Channel Changes



Slope and
Planform





Lane’s Relationship

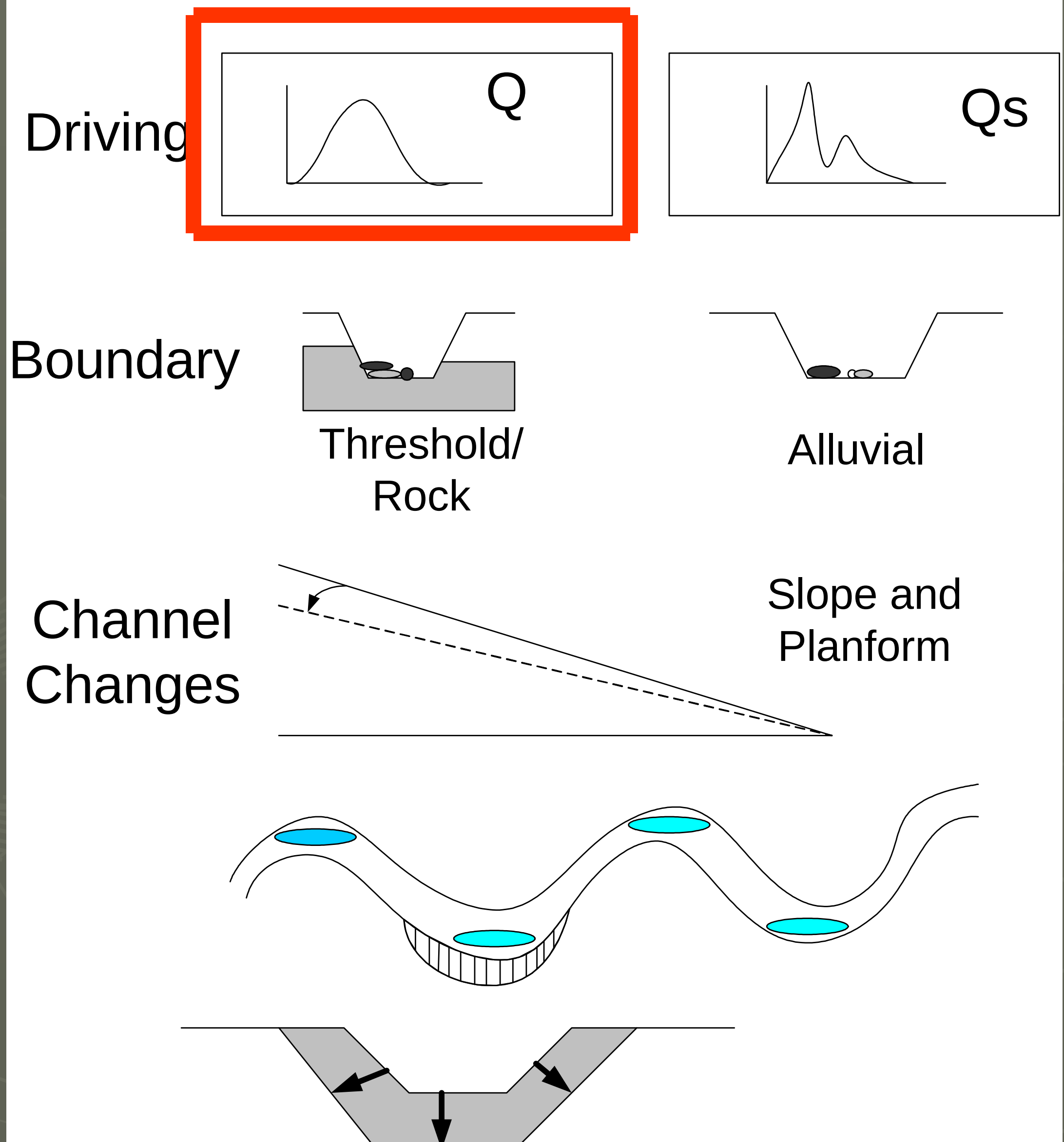
$$Q\ S \sim Q_s D_{50}$$

Questions for Stream Assessment

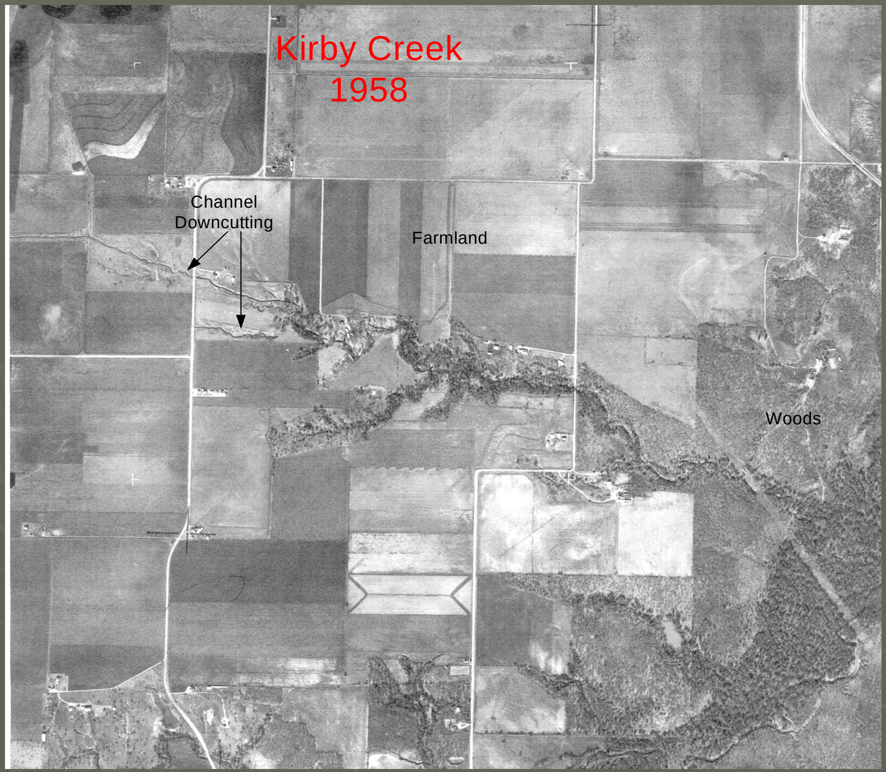
- Is the channel stable given landuse change?
- How much will the stream downcut? (Do I need drop structures?)
- How fast will it downcut (when need $$$)?
- What are stable channel dimensions: W,D,Rc (for repair and setbacks)

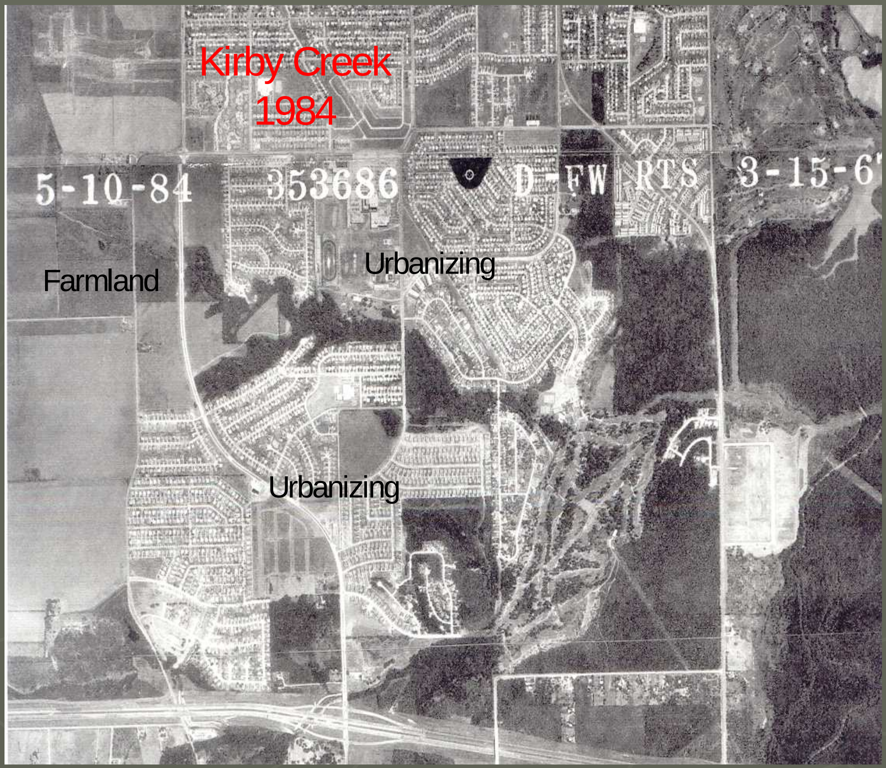

Bankfull
Active Channel
Scour
Bed
Material

Variables in Channel Assessment

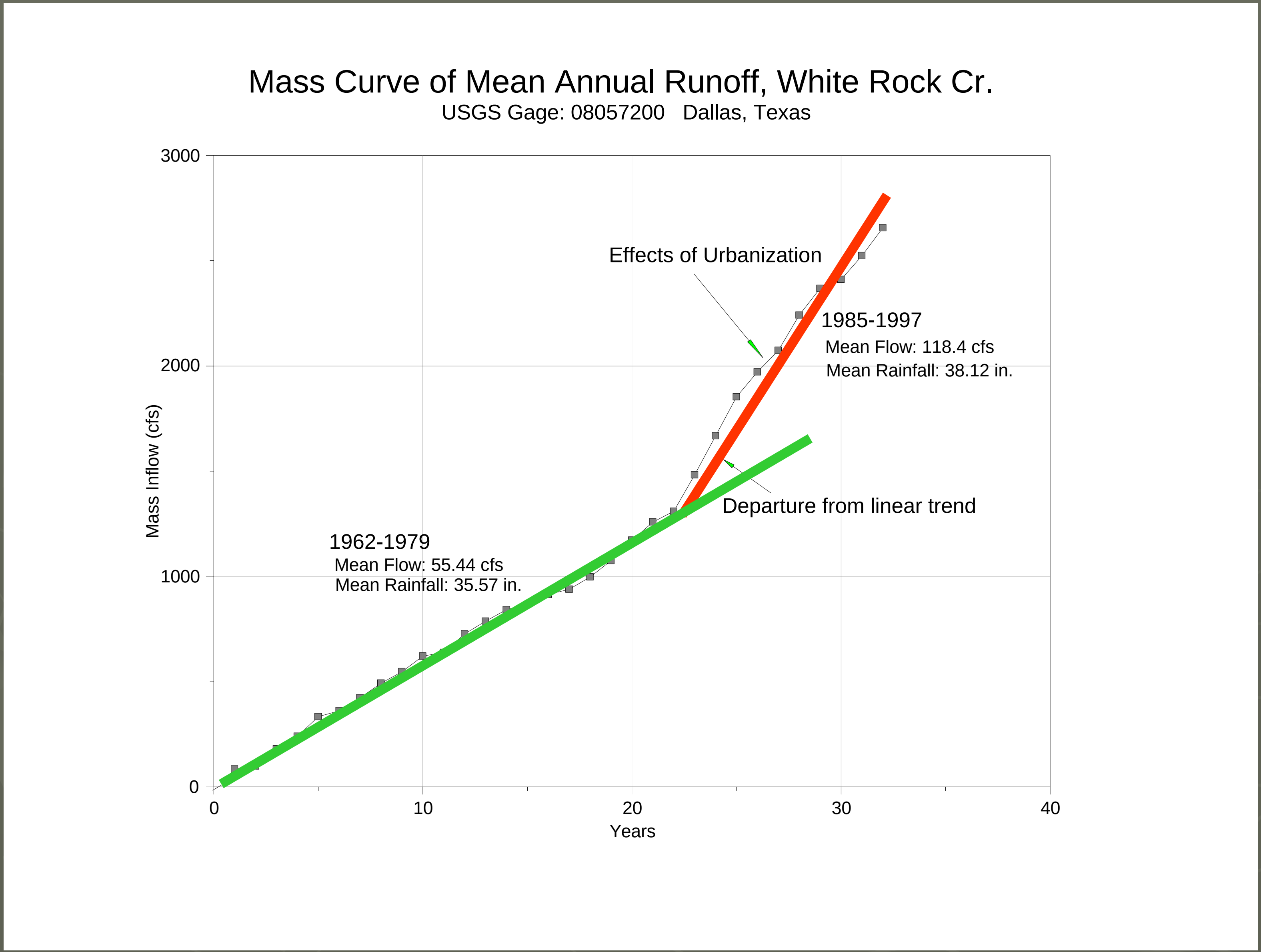


Urbanization





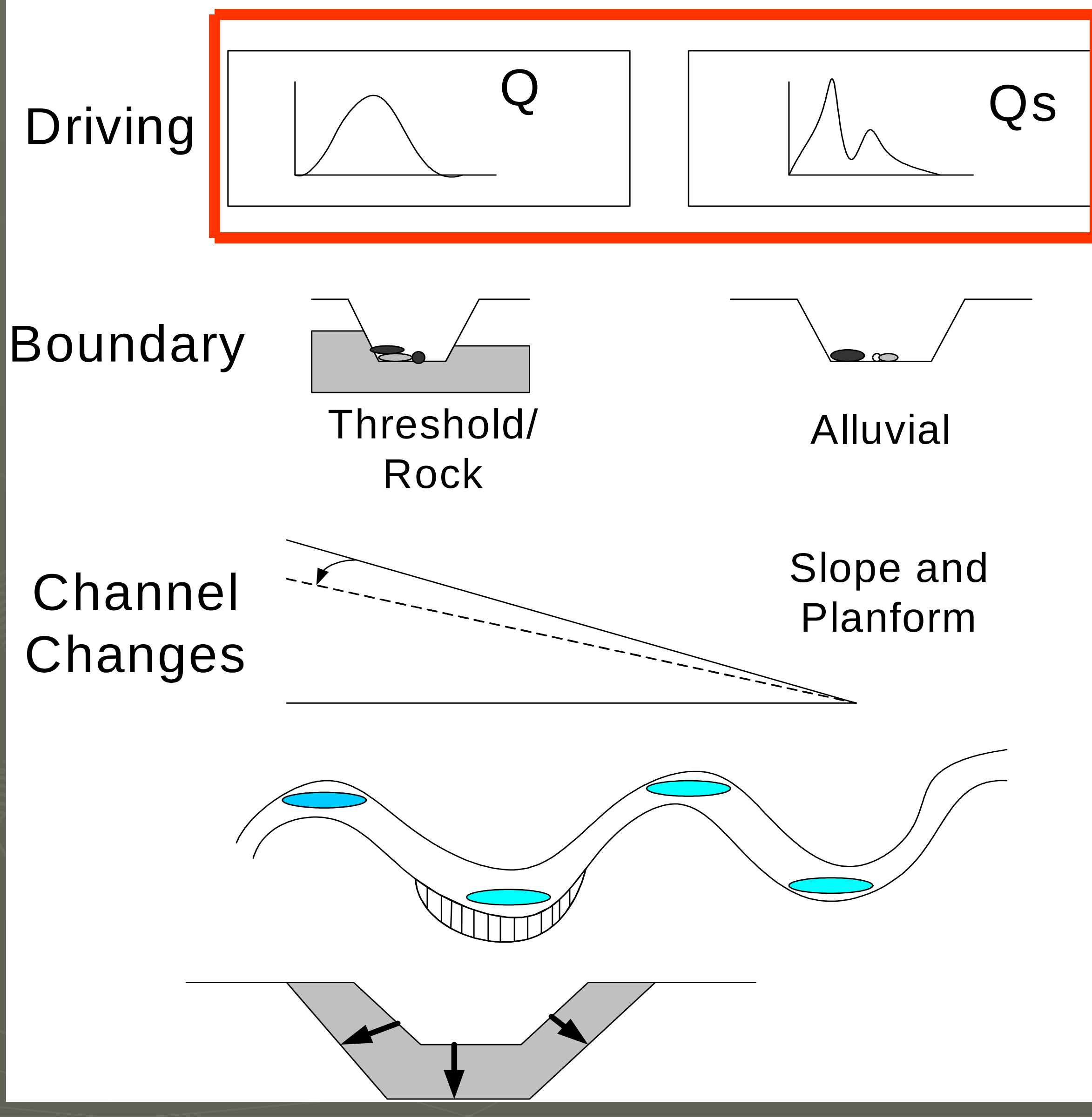
Urban Mass Curve



Peak Discharge

- When I% is increased 0-40% Q2>35%
- When I% increased 0-100% Q2>80%
- Peaks 1.2-1.4X undeveloped
- Annual Direct runoff 2X undeveloped

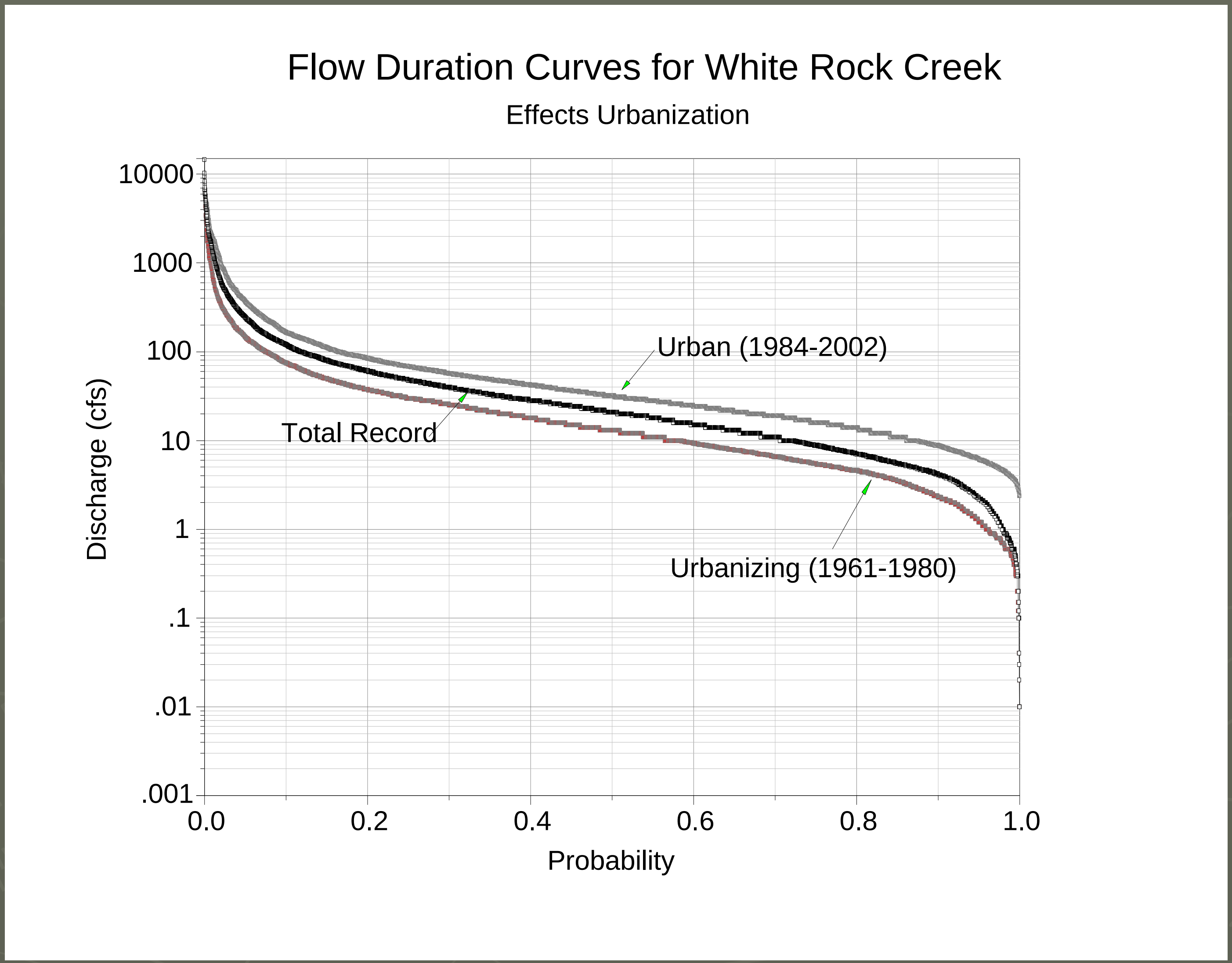
Variables in Channel Assessment



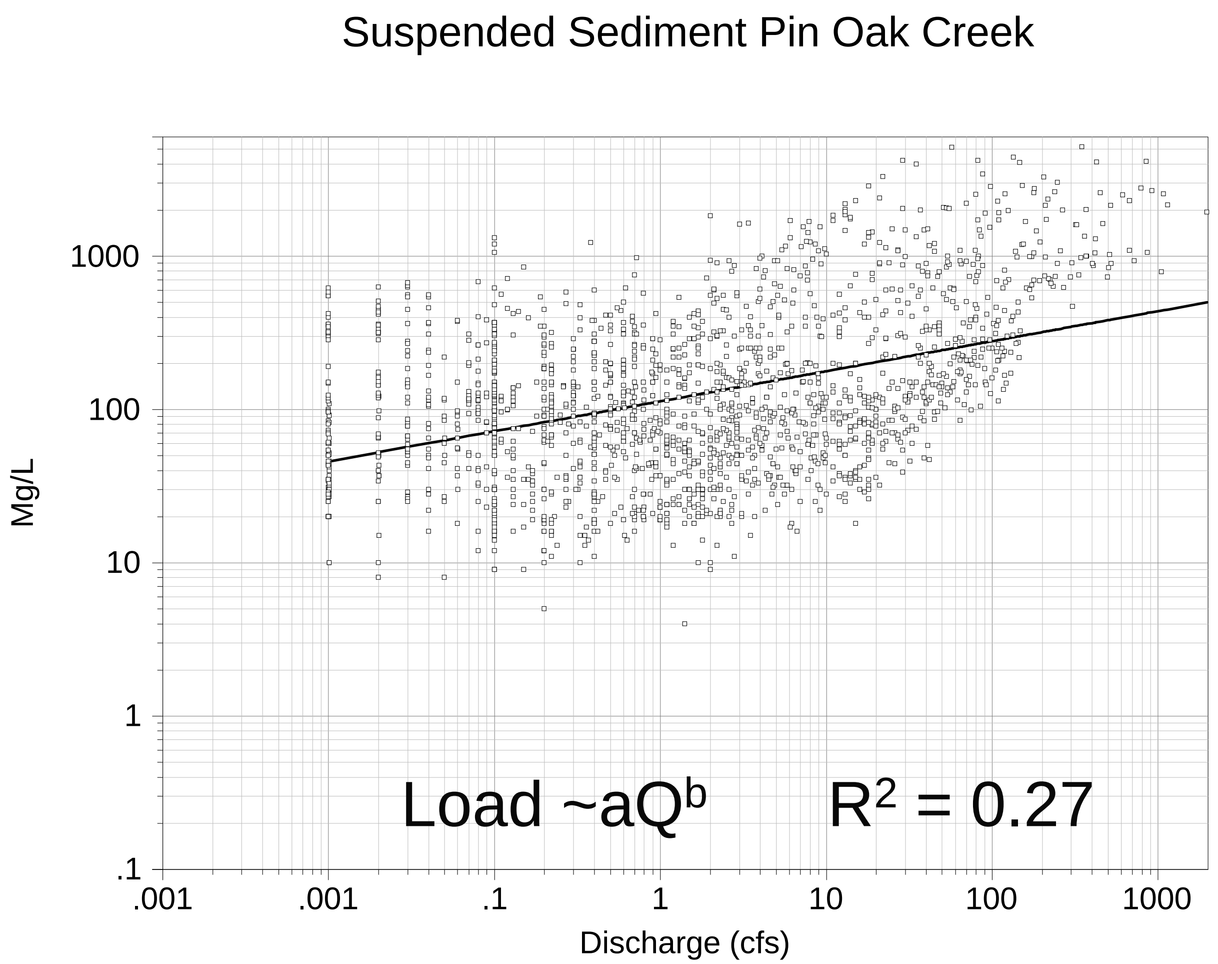
Effective Discharge

- Flow magnitude that transports greatest amount of sediment over time
- Used as preliminary guide for restoration design (Goodwin JHyd Eng. 2004)
- Problems: based on flow duration data
- Based on suspended or bed material data
- Where is the data?

Urbanizing Flow Durations

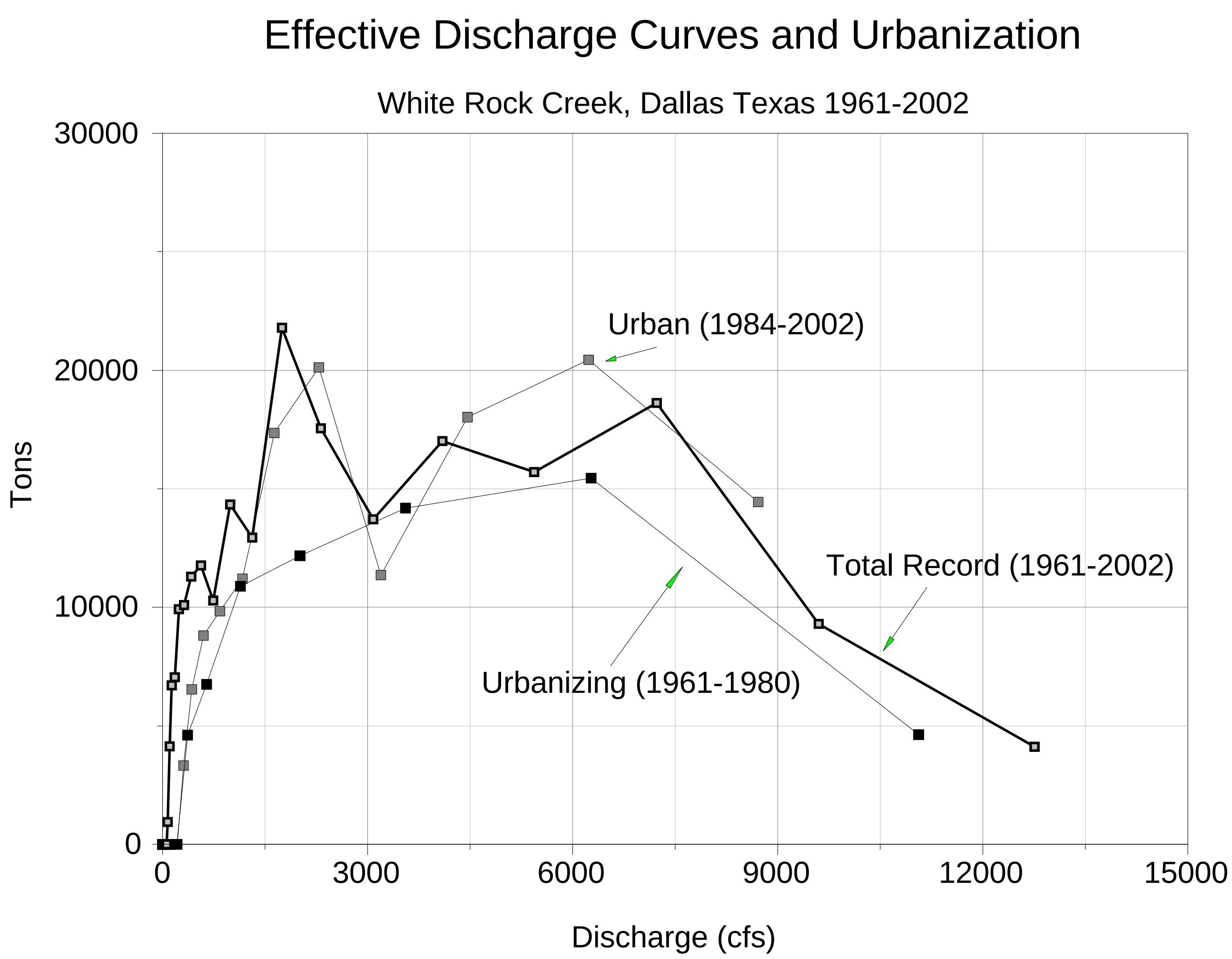


Sediment Data

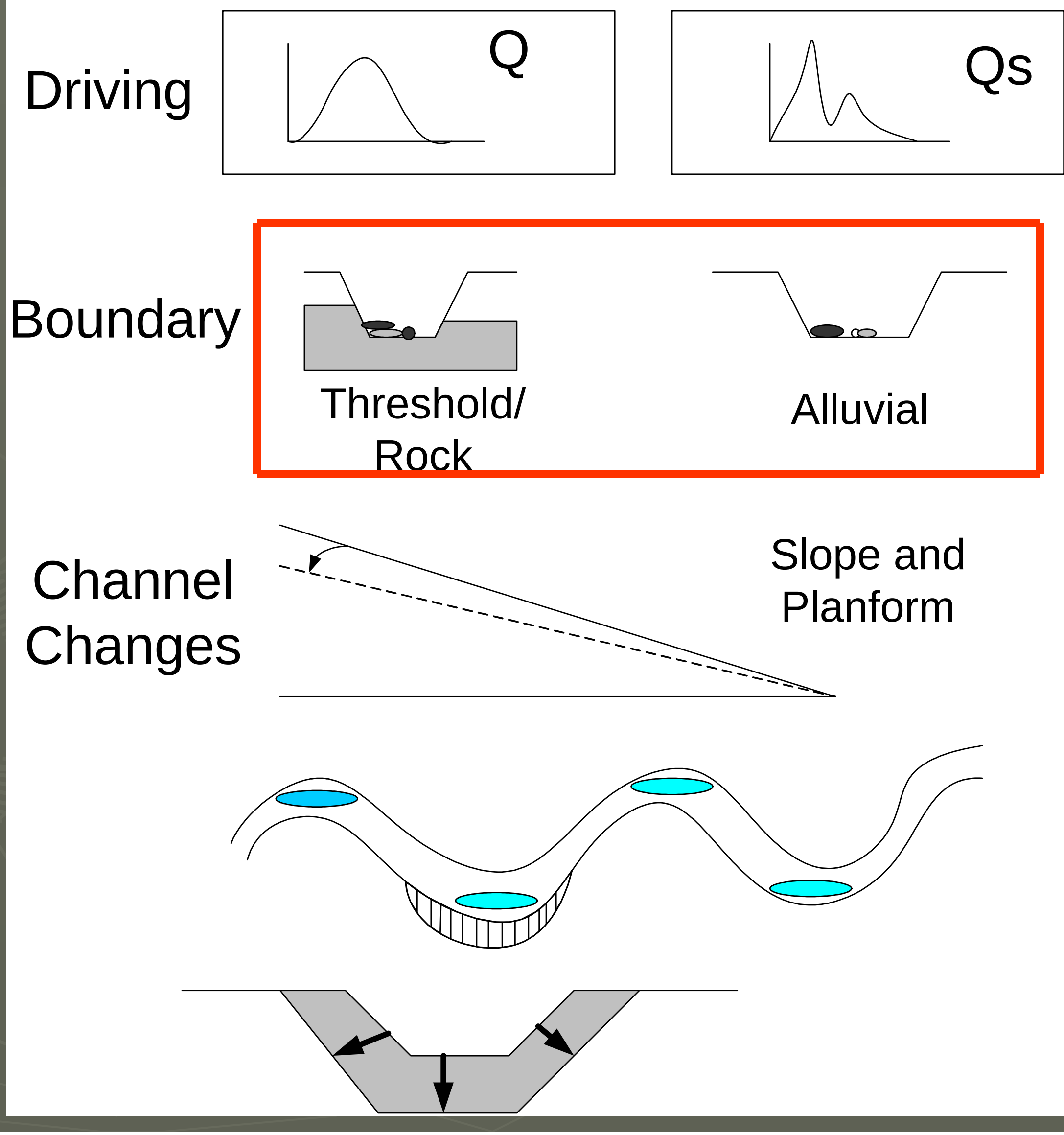


Few stations (n=6 Blacklands) and data scattered!

A Moving Target



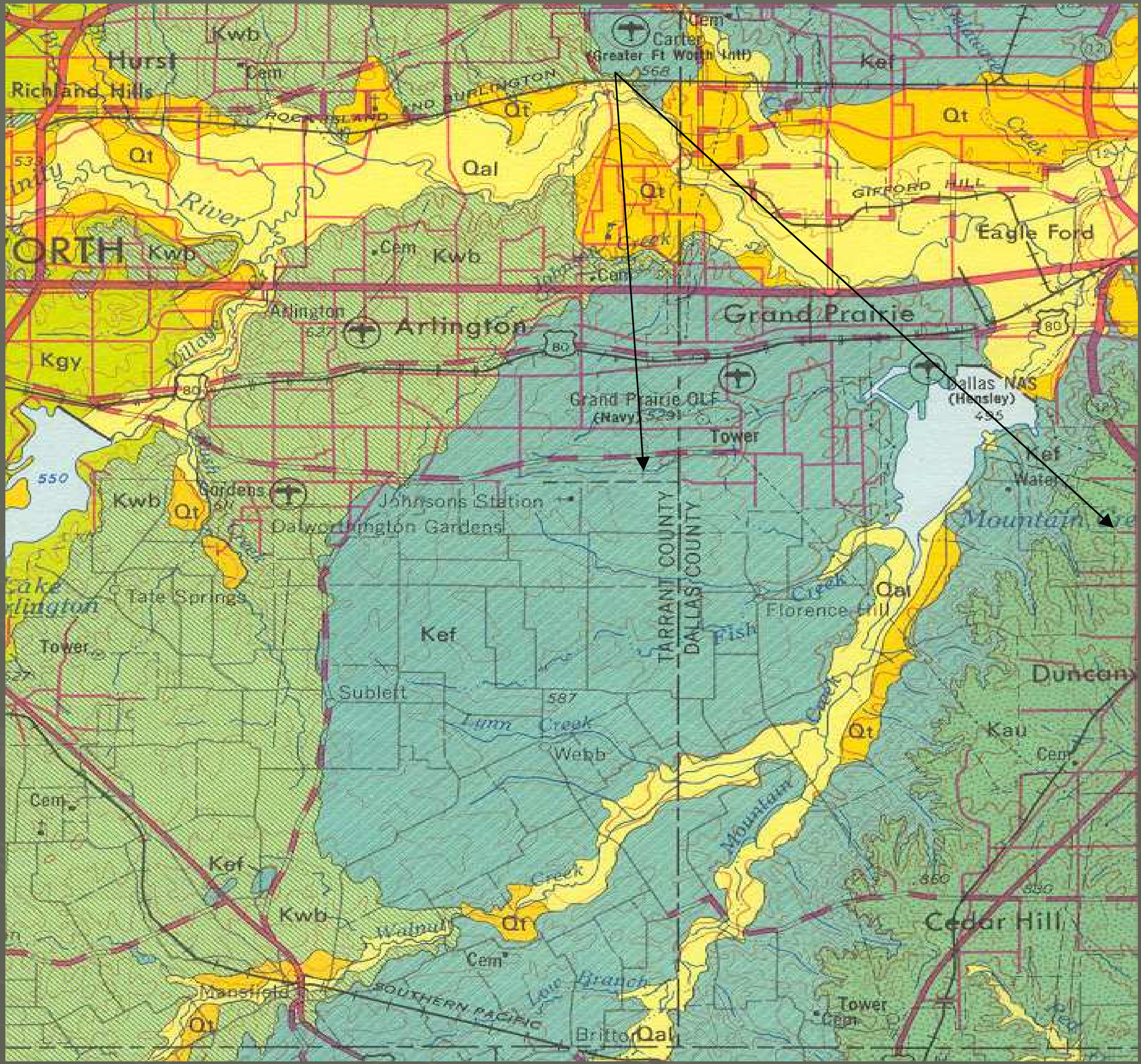
Variables in Channel Assessment



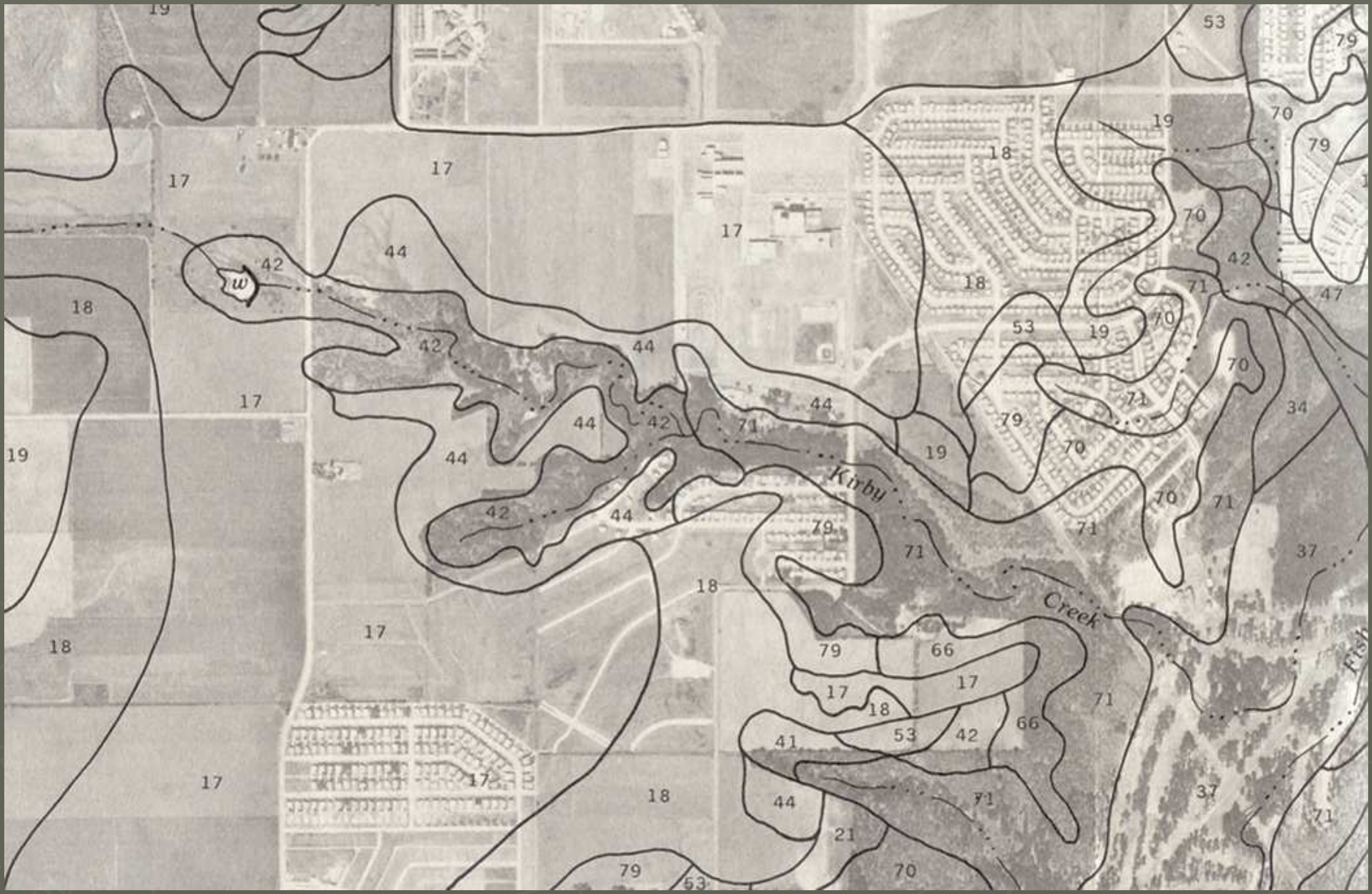
Physiographic Setting

- Province/EcoRegion: Blackland Prairie
- Rock Type: Shales and Limestones
- Soils: silty clays to clays
- Climatic Regime: Semi-Humid Monsoonal

Geology/Soils



Soils



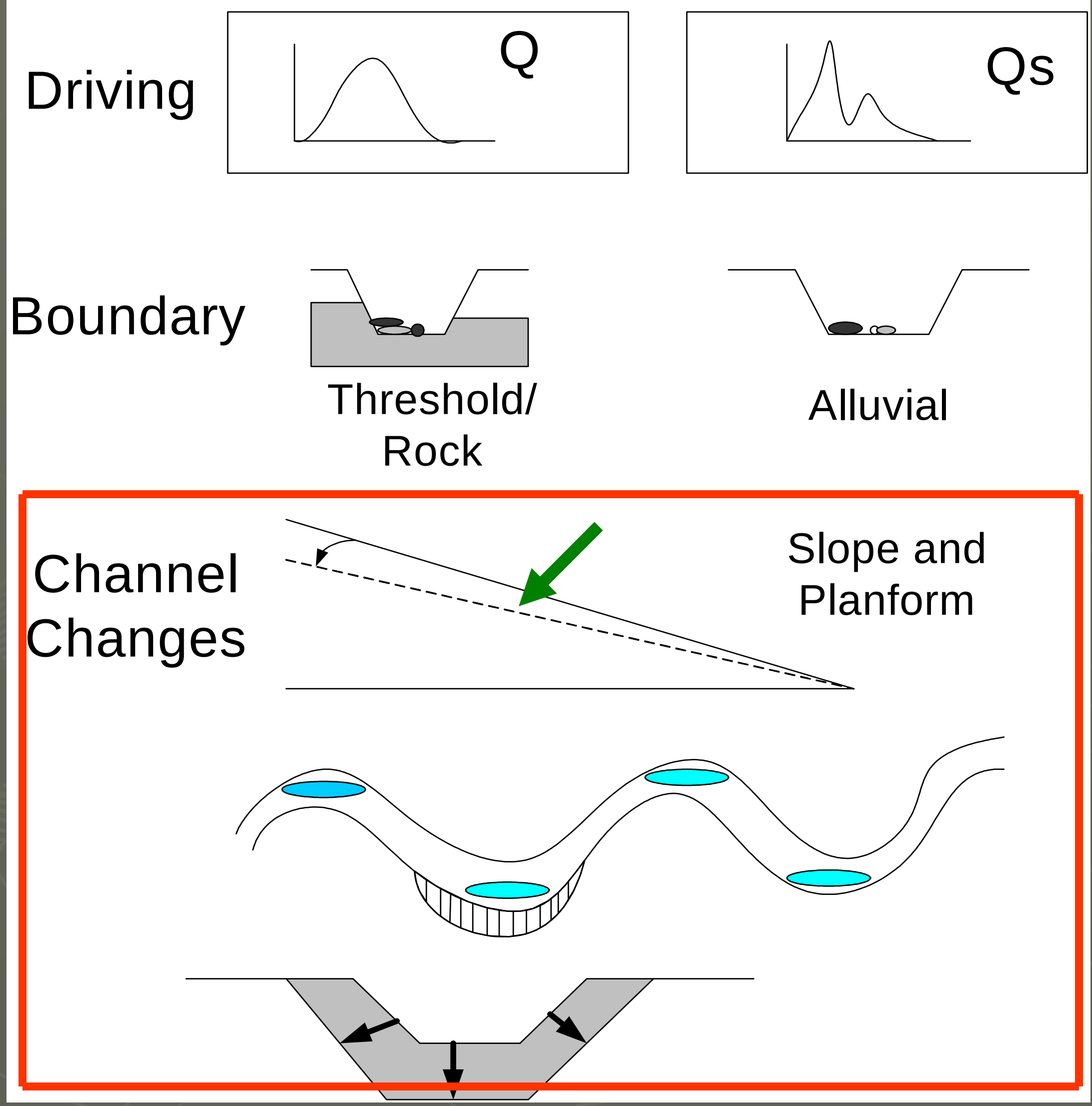
Grain Size, PI, Permeability, Hydrologic Group, AWC, Erodibility

Threshold Channels

Threshold Channels

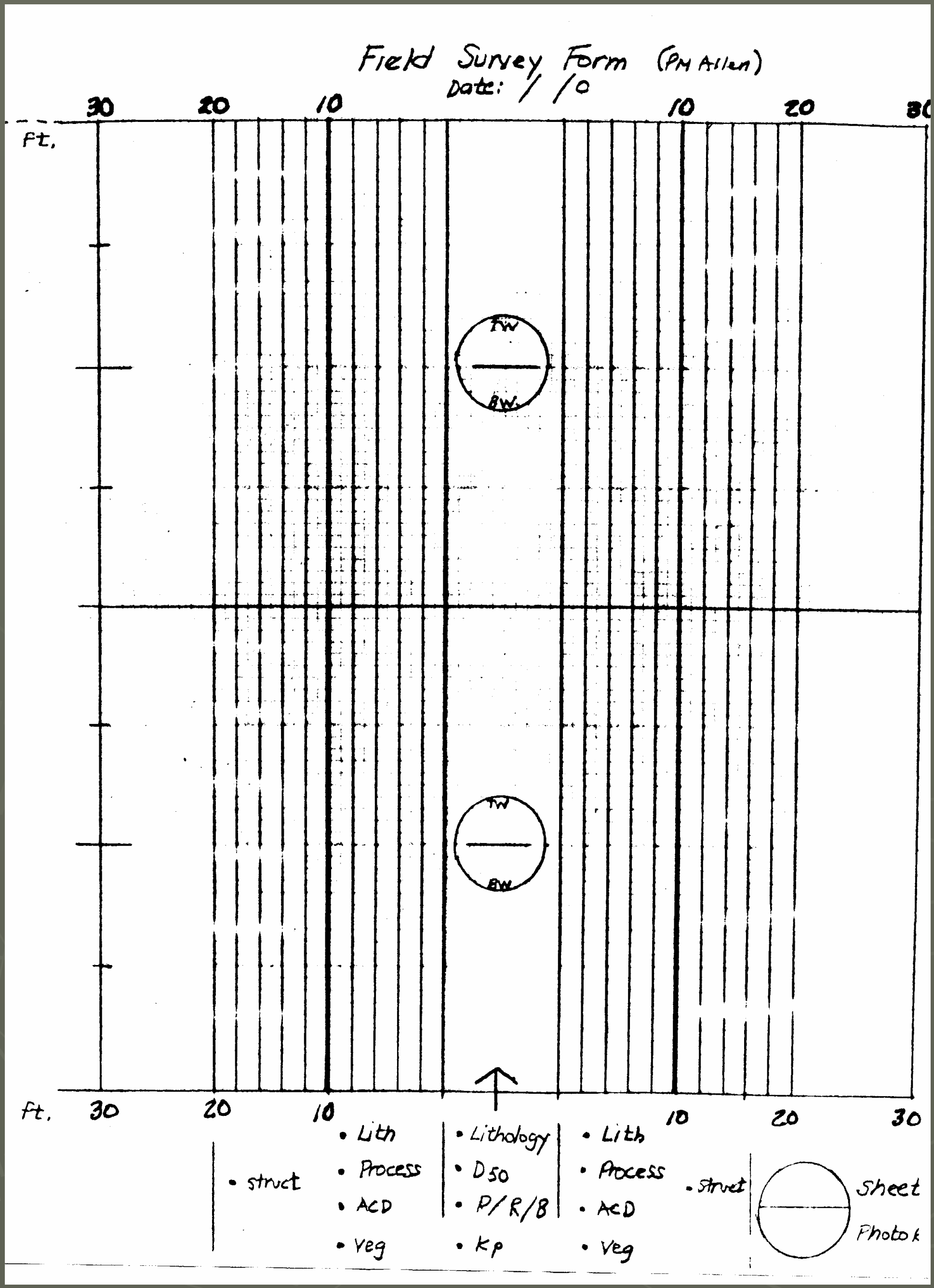
Stream Erosion Zones
Alluvial/Threshold Channels

Variables in Channel Assessment



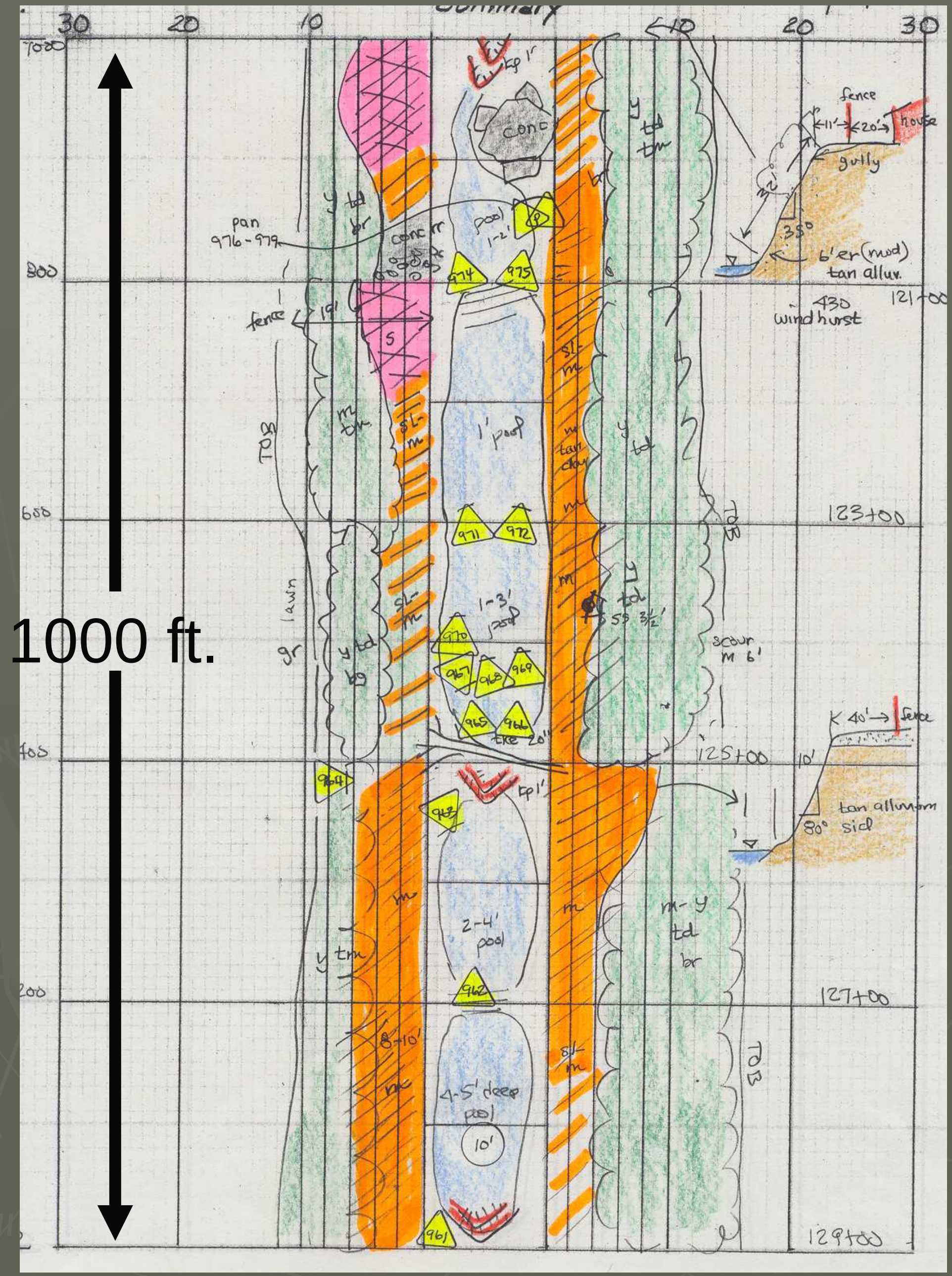
Field Survey

- Channel Survey by 200 foot Reach
- Photographs left/right banks
- Active Channel
- Bed-bank samples
- Pool/riffle and bed/bank processes



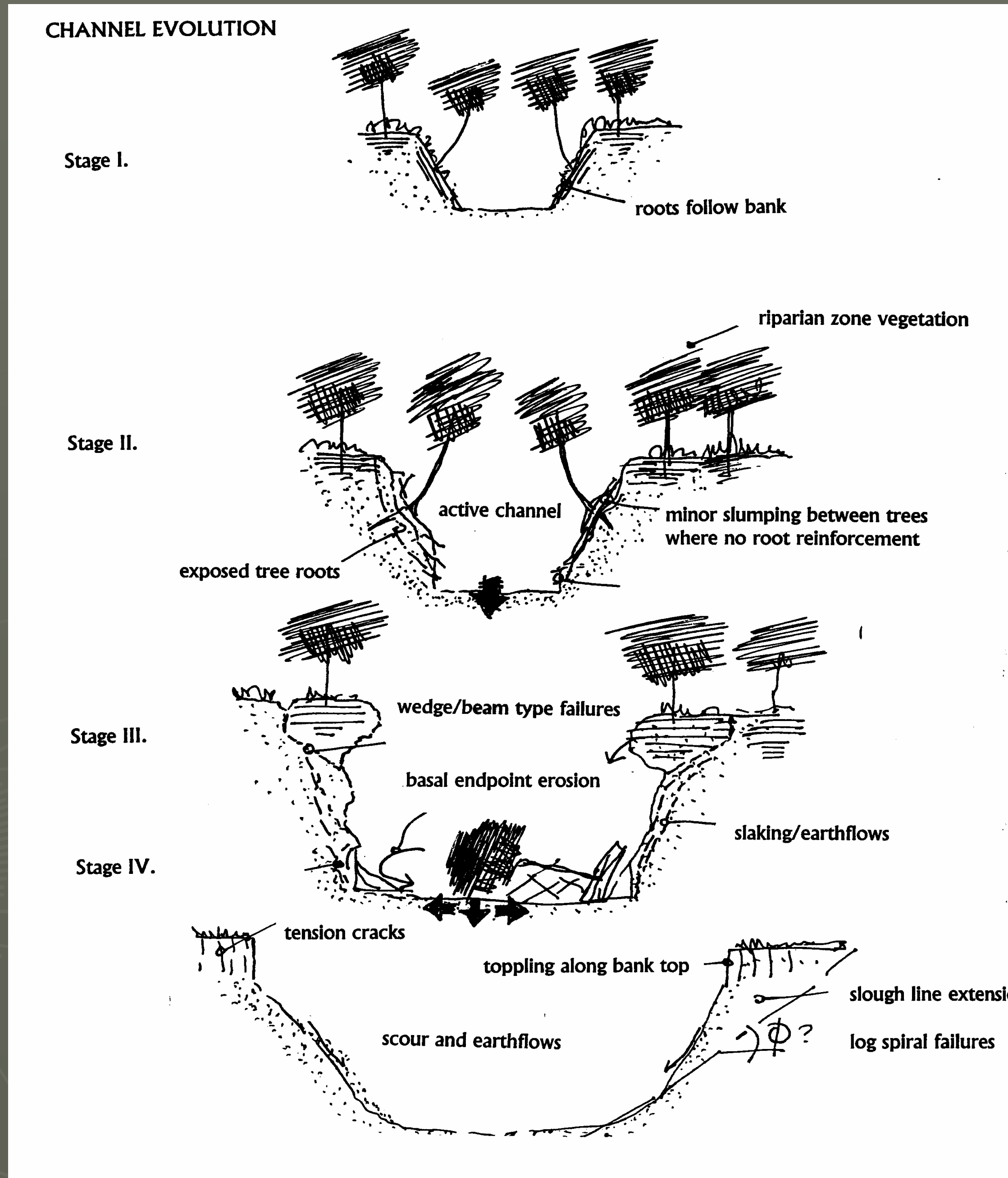
Field Survey Form

Example: Field Data Sheet



Channel Evolution Model

- Channels Evolve in 4-6 Stages
- Schumm, Harvey, Watson and Later Simon
- Equilibrium only after adjustments in channel slope, width, depth
- Typically proceeds upstream


CHANNEL EVOLUTION
Stage I.
roots follow bank
Stage II.
riparian zone vegetation
active channel
minor slumping between trees
where no root reinforcement
exposed tree roots
Stage III.
wedge/beam type failures
basal endpoint erosion
slaking/earthflows
Stage IV.
tension cracks
toppling along bank top
slough line extensio
scour and earthflows
log spiral failures

Phase II: Downcutting

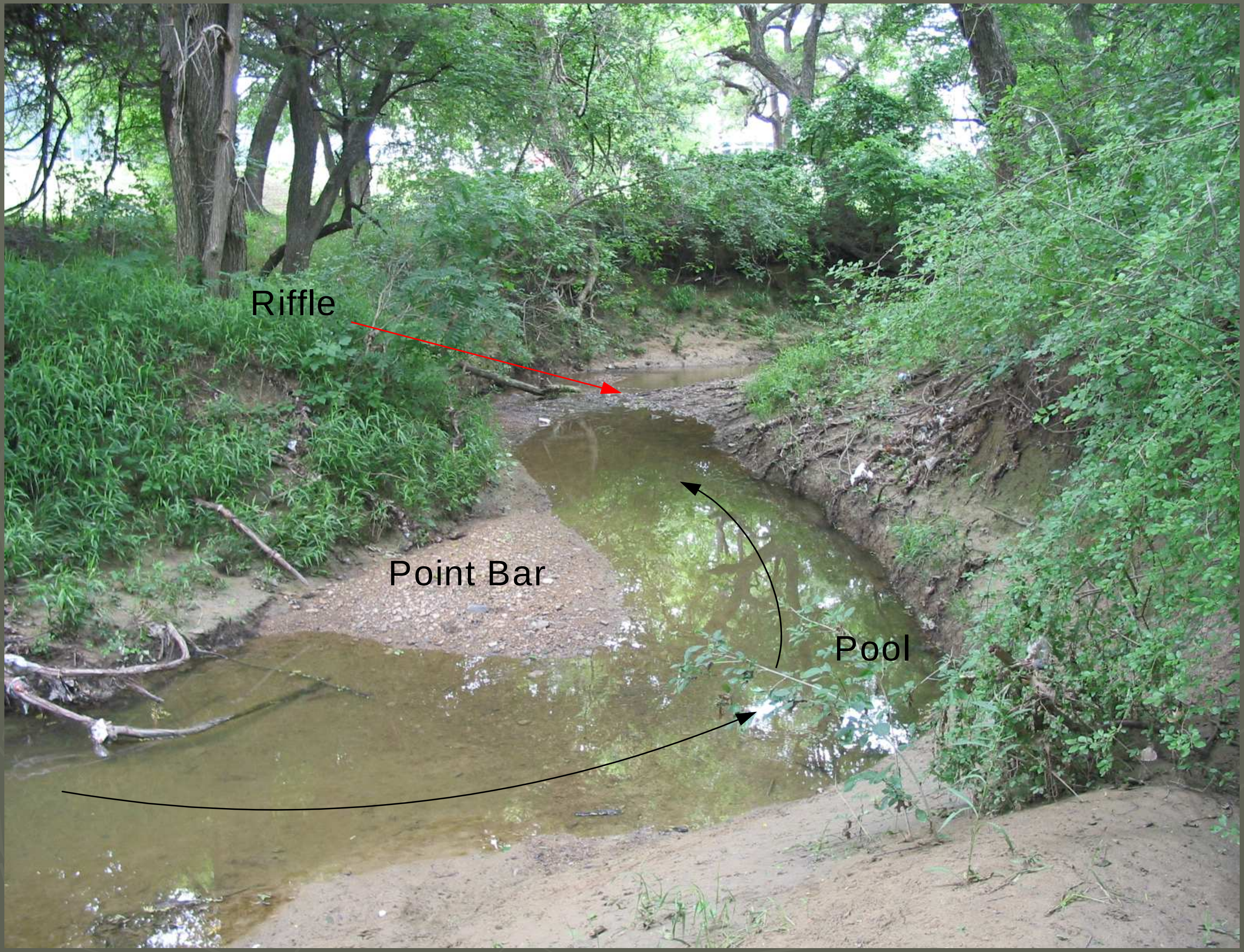
Phase II Knickpoint

Phase III Tree Loss/Widening

Phase III: Widening

Bank Failures: Slump Wedge

Phase IV:Stable



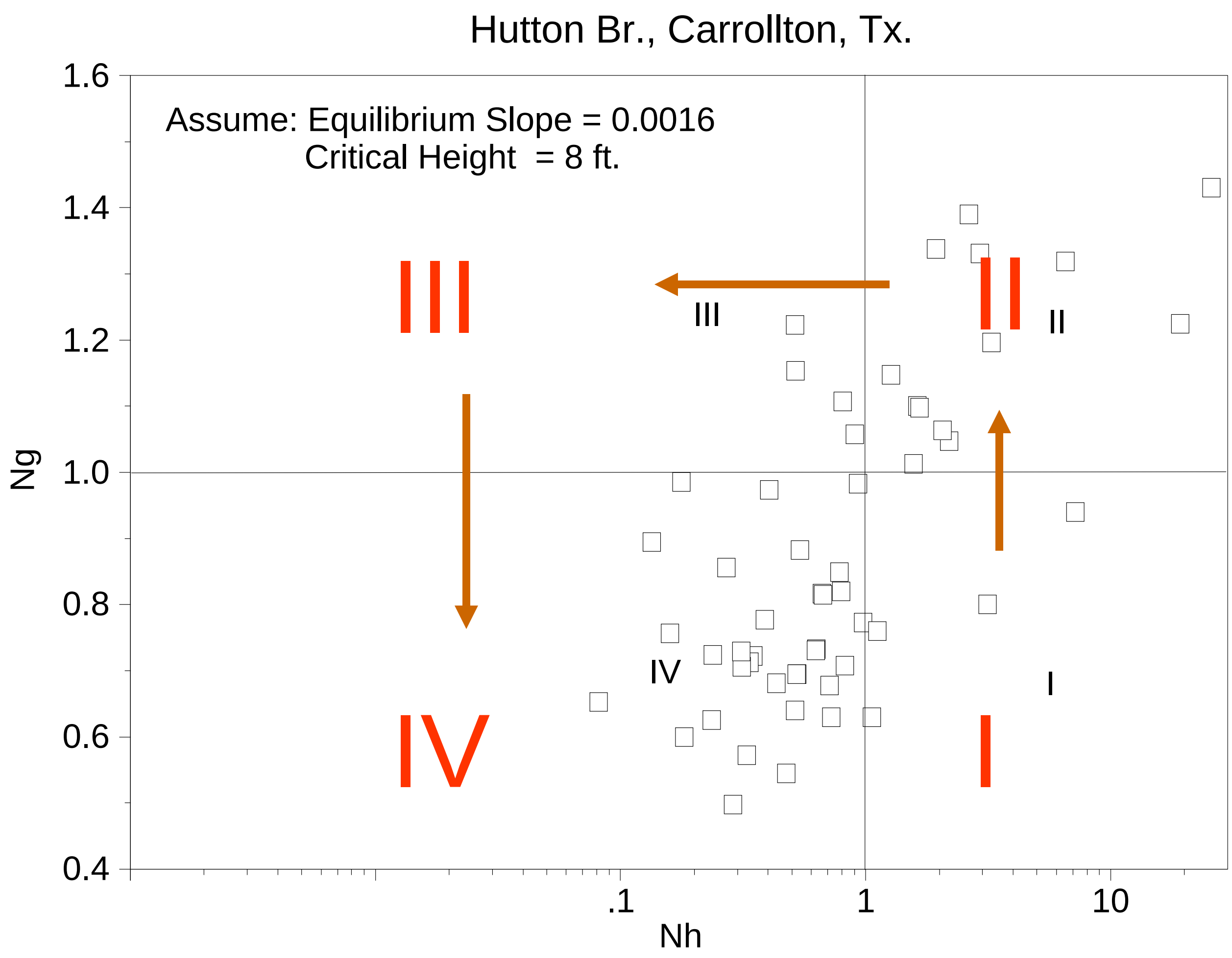
Analysis of Field Data

- What do I do with the Field Data?
- Harvey Watson and the CEM
- Or…whats next?

Watson Harvey Stability

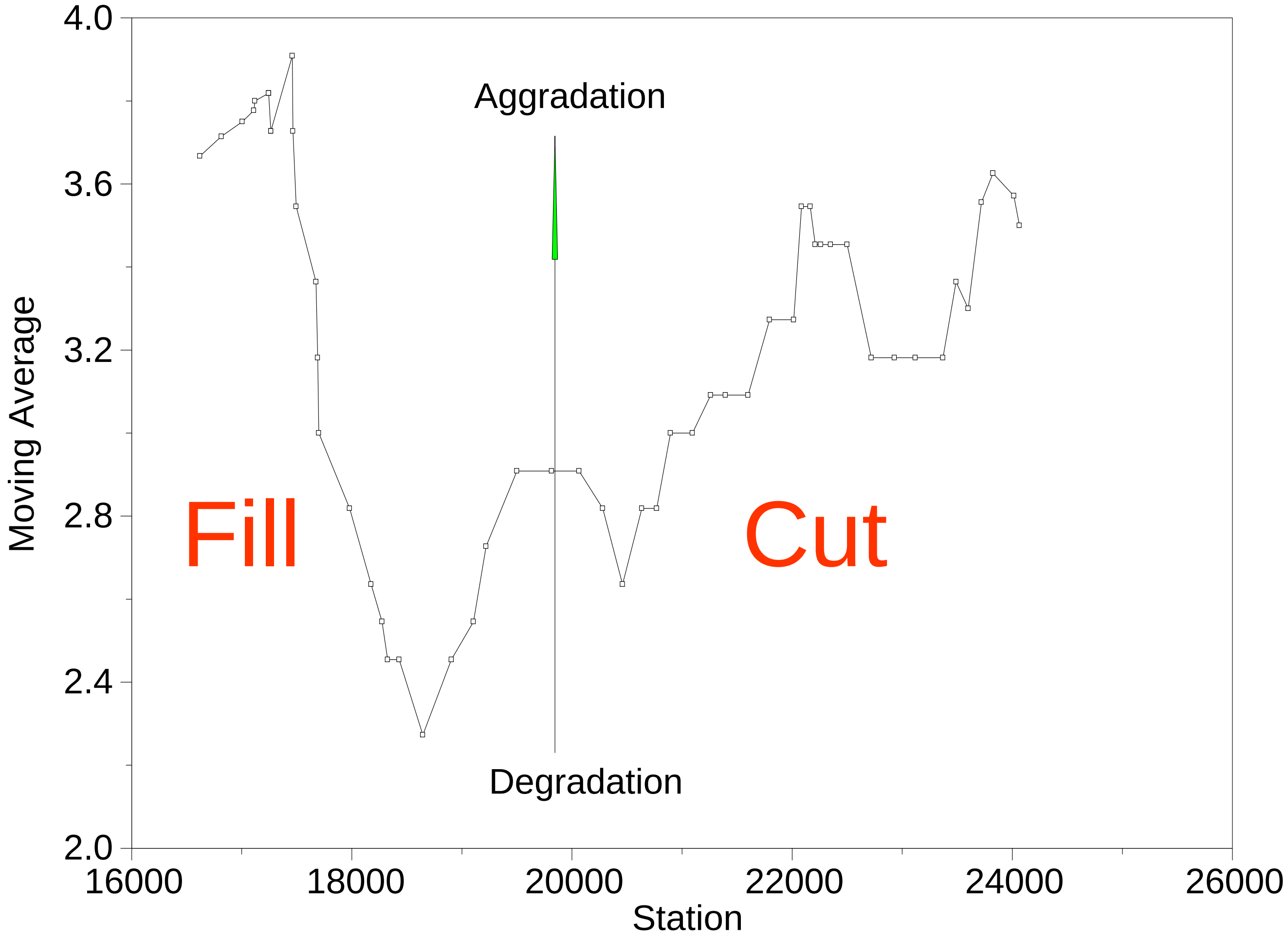
- Nh = Equilibrium slope/actual slope
- Ng=Actual Height/Critical Height
- I = Stable
- II= Degrading (Optimal for Grade Control)
- III = Aggrading and Failing Banks
- IV = Stable minor Aggradation

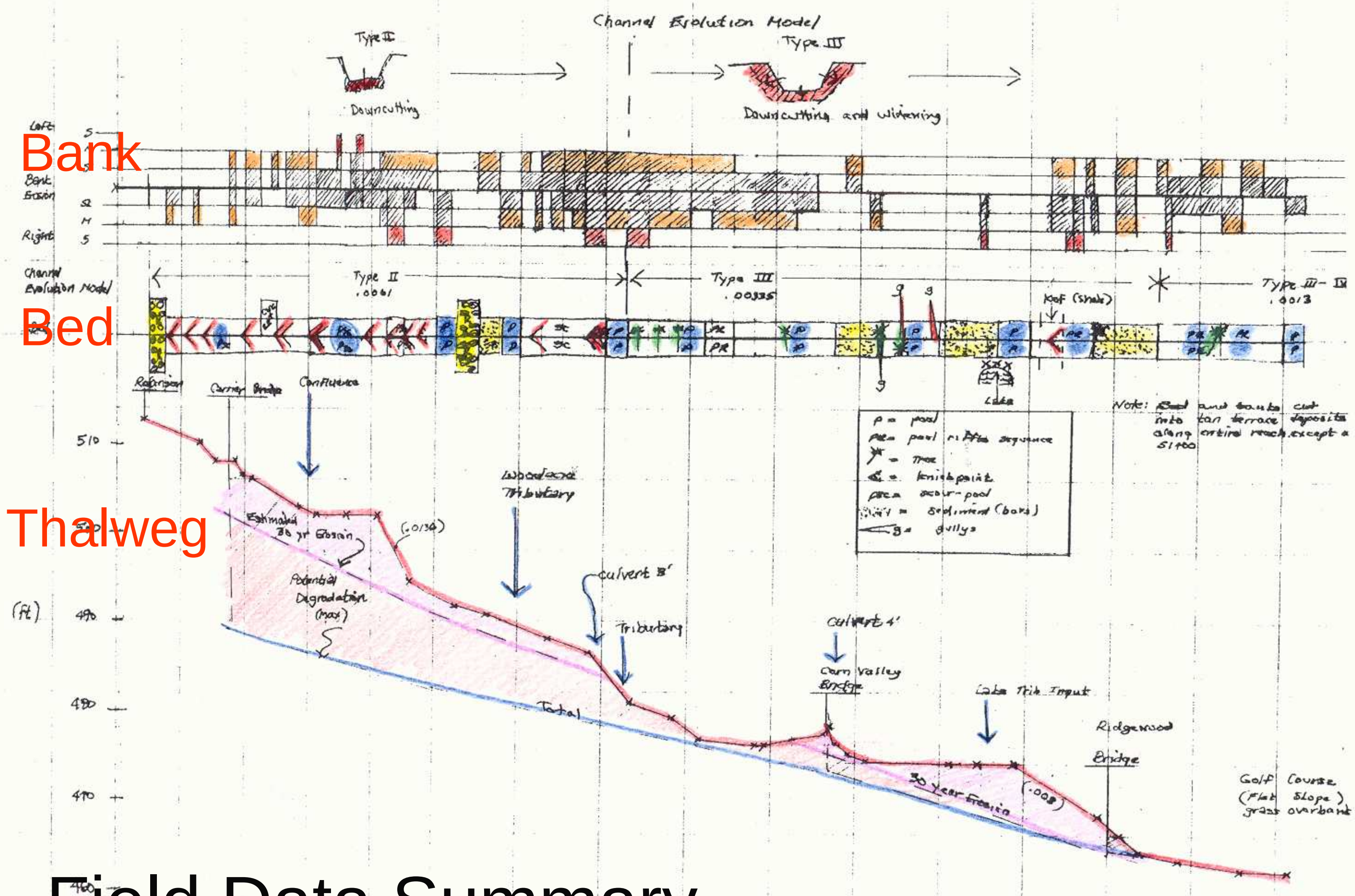
Watson/Harvey Analysis of Channel



Watson /Harvey Trendline Analysis

Hutton Br., Carrollton, Tx.





Field Data Summary

Downcutting Controls Channel Morphology

- How can we quantify Channel Evolution Model?