Nutrient Control Credits for Urban Streams

Integrating stream restoration and stormwater management

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Rod Lammers

Outline

- Background: urbanization, stream response, and nutrient loading
- CLEAN Center approach
- Big Dry Creek case study
- Conclusions

WHAT'S THE PROBLEM?

- Development is widespread

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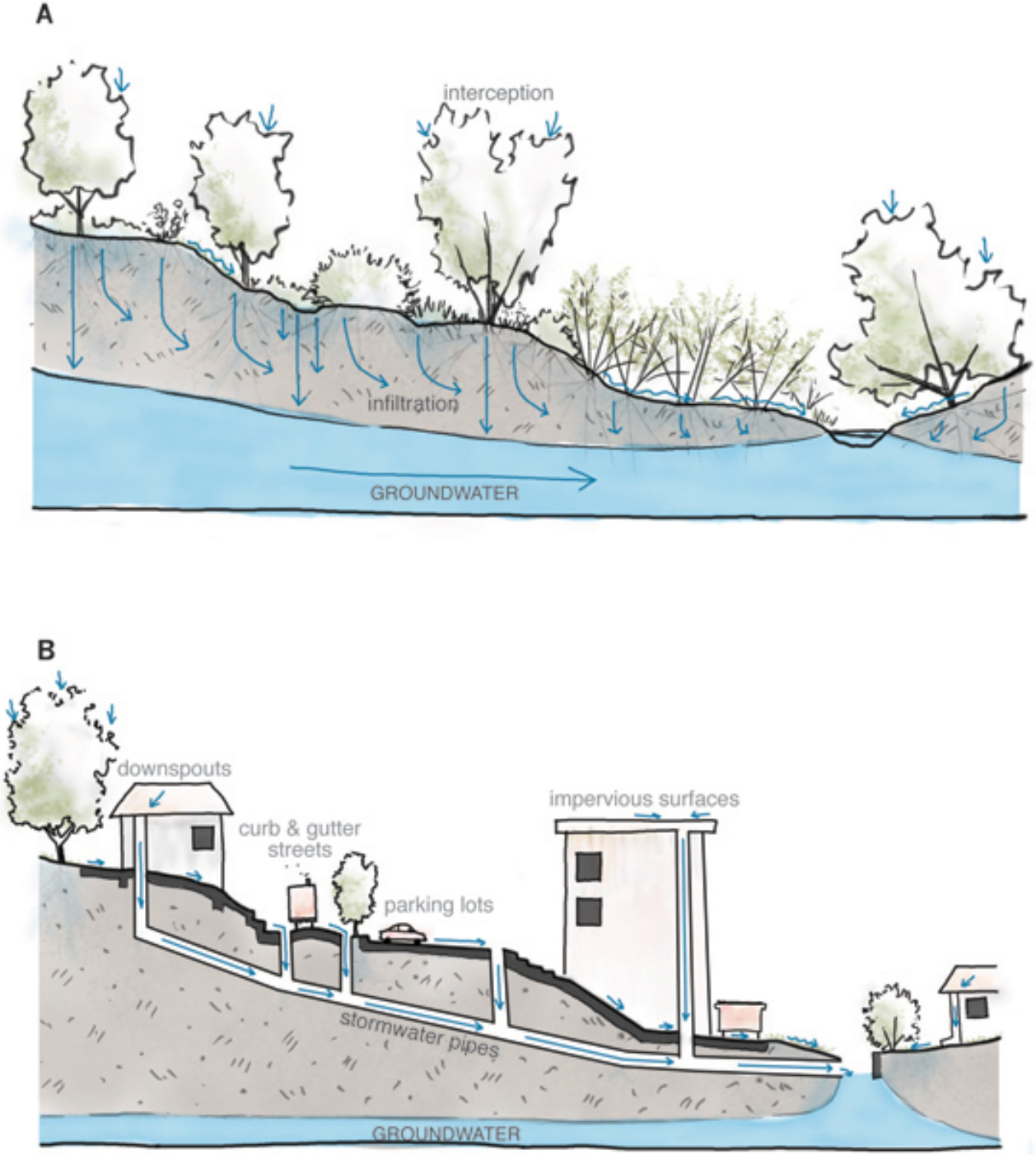
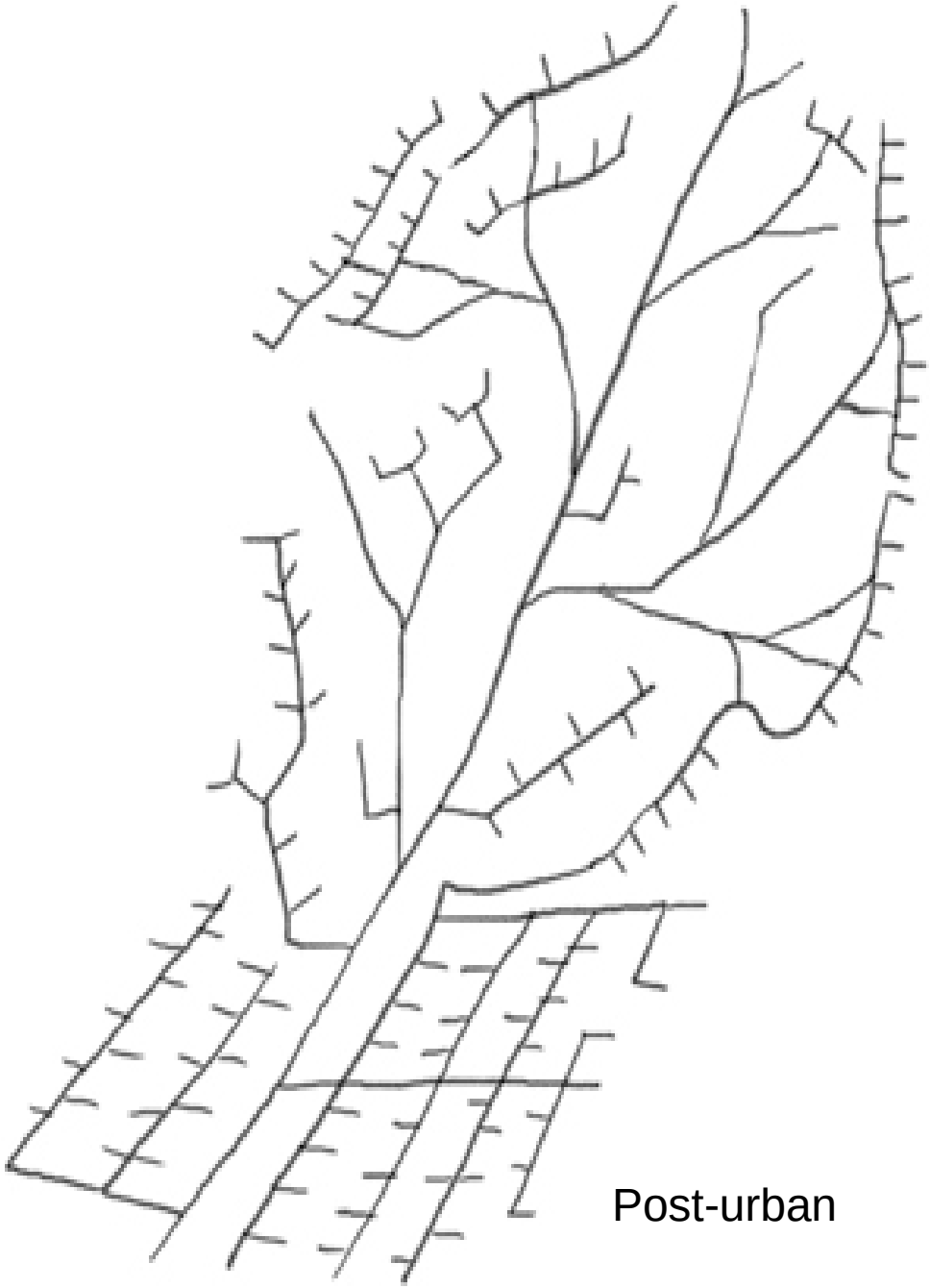
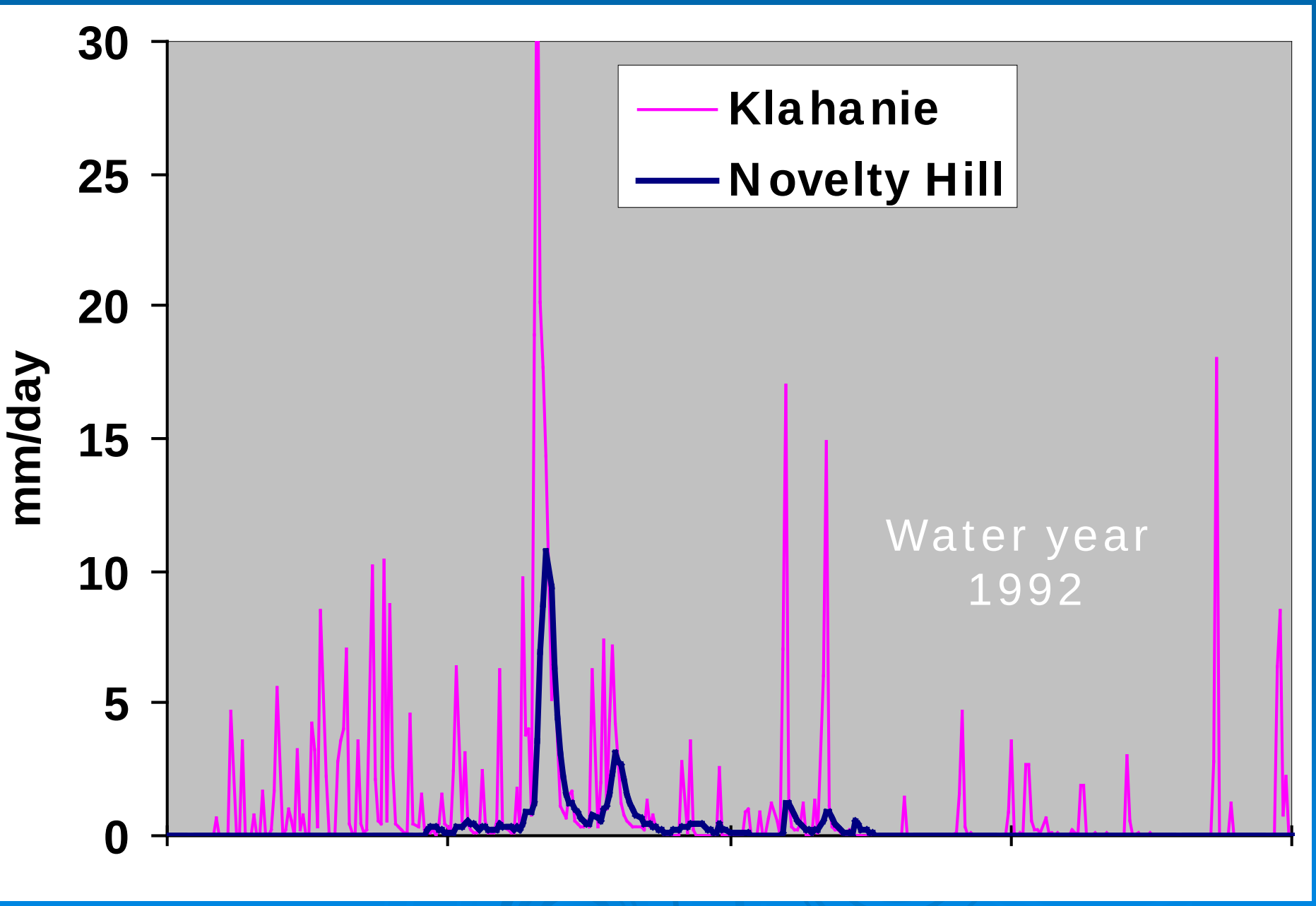
- Stormwater impacts are severe


A
interception
infiltration
GROUNDWATER
B
downspouts
curb & gutter
streets
parking lots
impervious surfaces
stormwater pipes
GROUNDWATER

Pre-urban



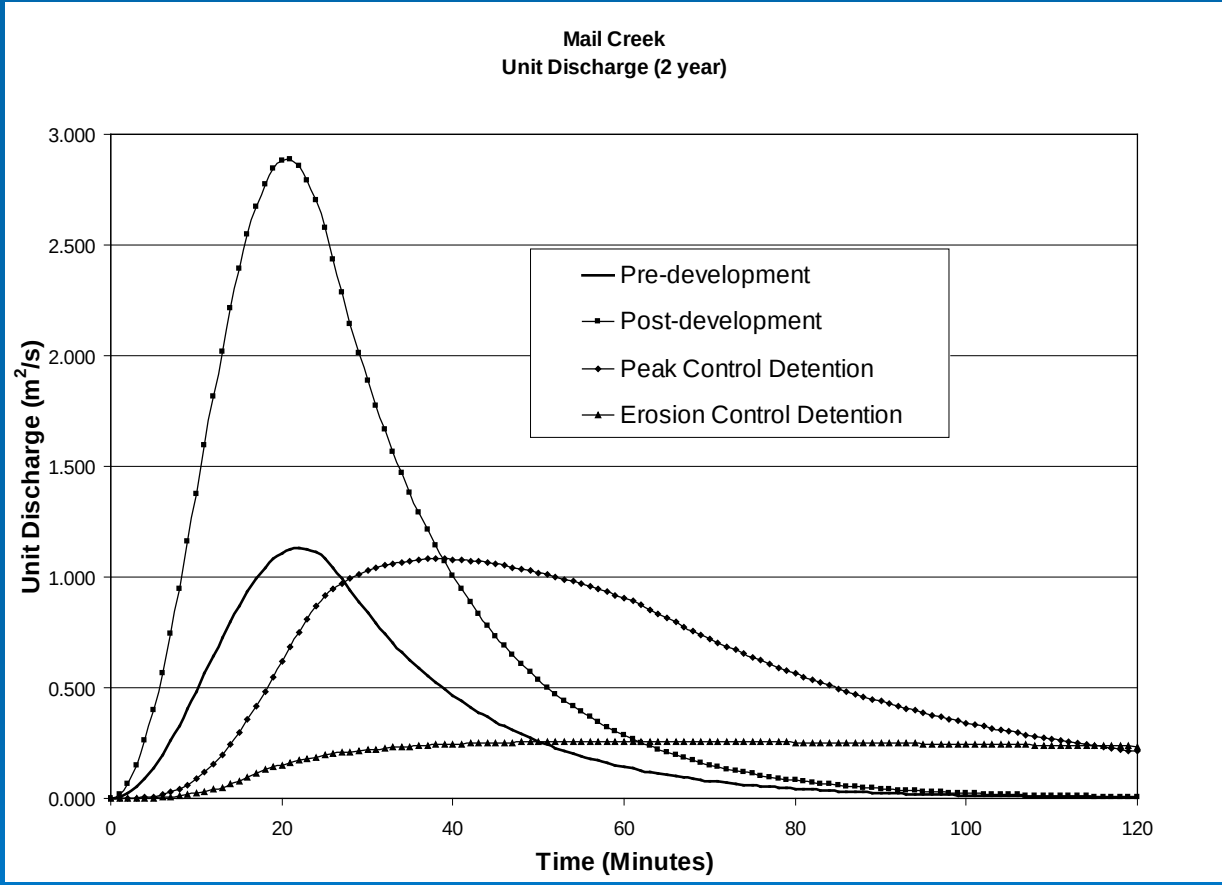
Post-urban

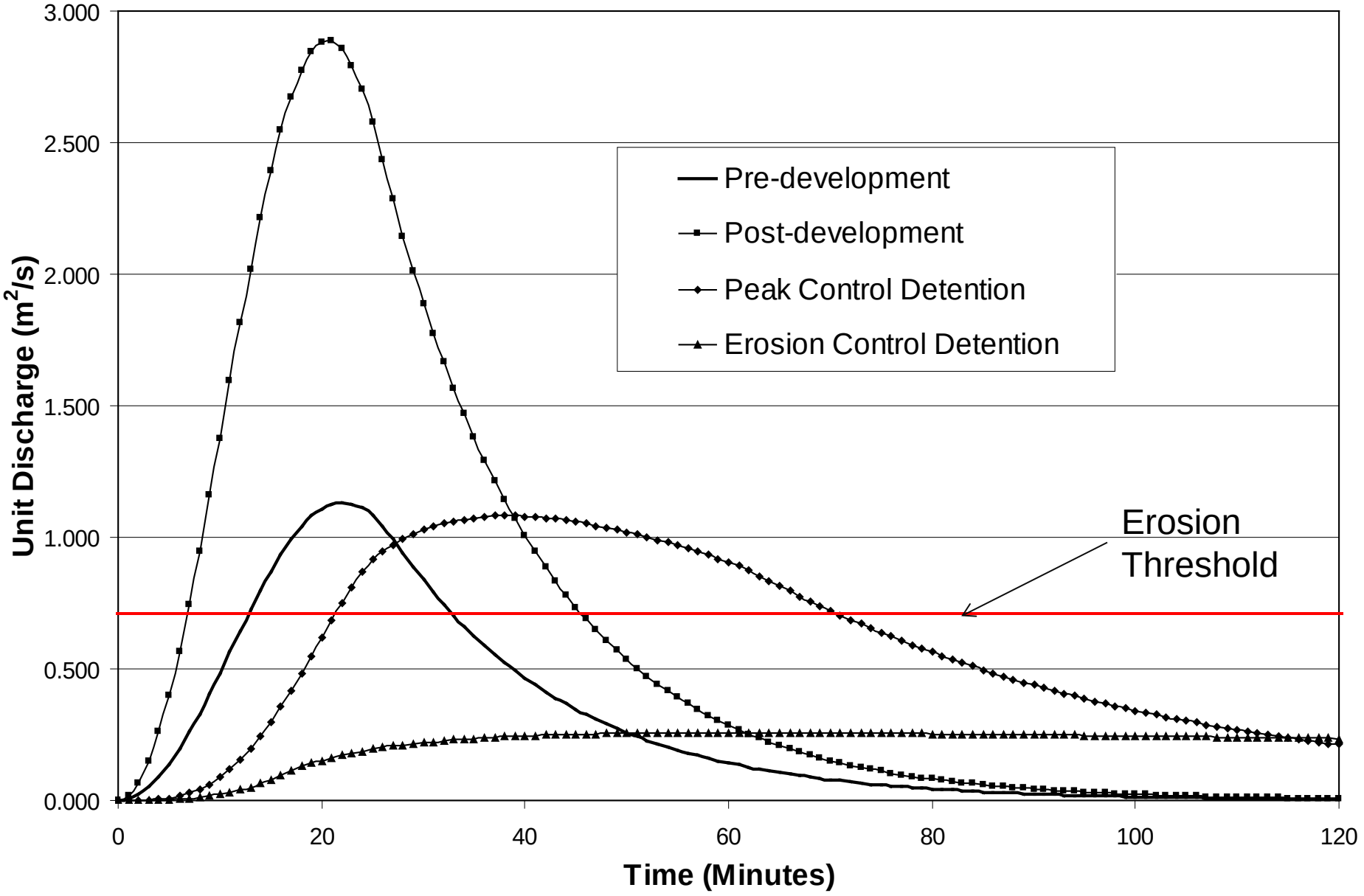


Data from Mark Wigmosta, Univ. of Washington and Derek Booth, Univ. of Cal. Santa Barbara

WHAT'S THE PROBLEM?

- Urbanization is widespread
- Stormwater impacts are severe
- Historic mitigation is often ineffective


Mail Creek
Unit Discharge (2 year)
Unit Discharge (m²/s)
3.000
2.500
2.000
1.500
1.000
0.500
0.000
0
20
40
60
80
100
120
Time (Minutes)
Pre-development
Post-development
Peak Control Detention
Erosion Control Detention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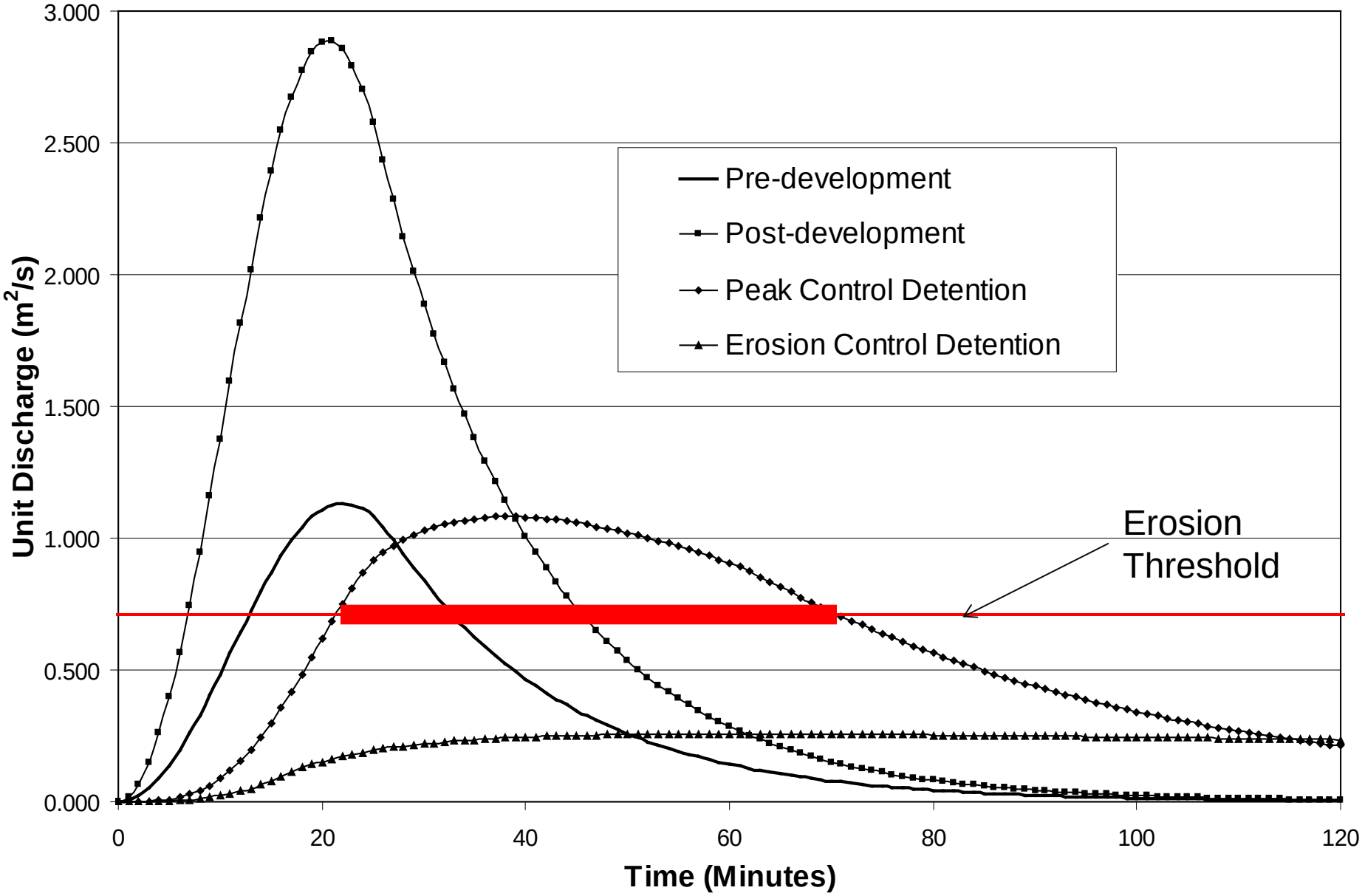
Erosion
Threshold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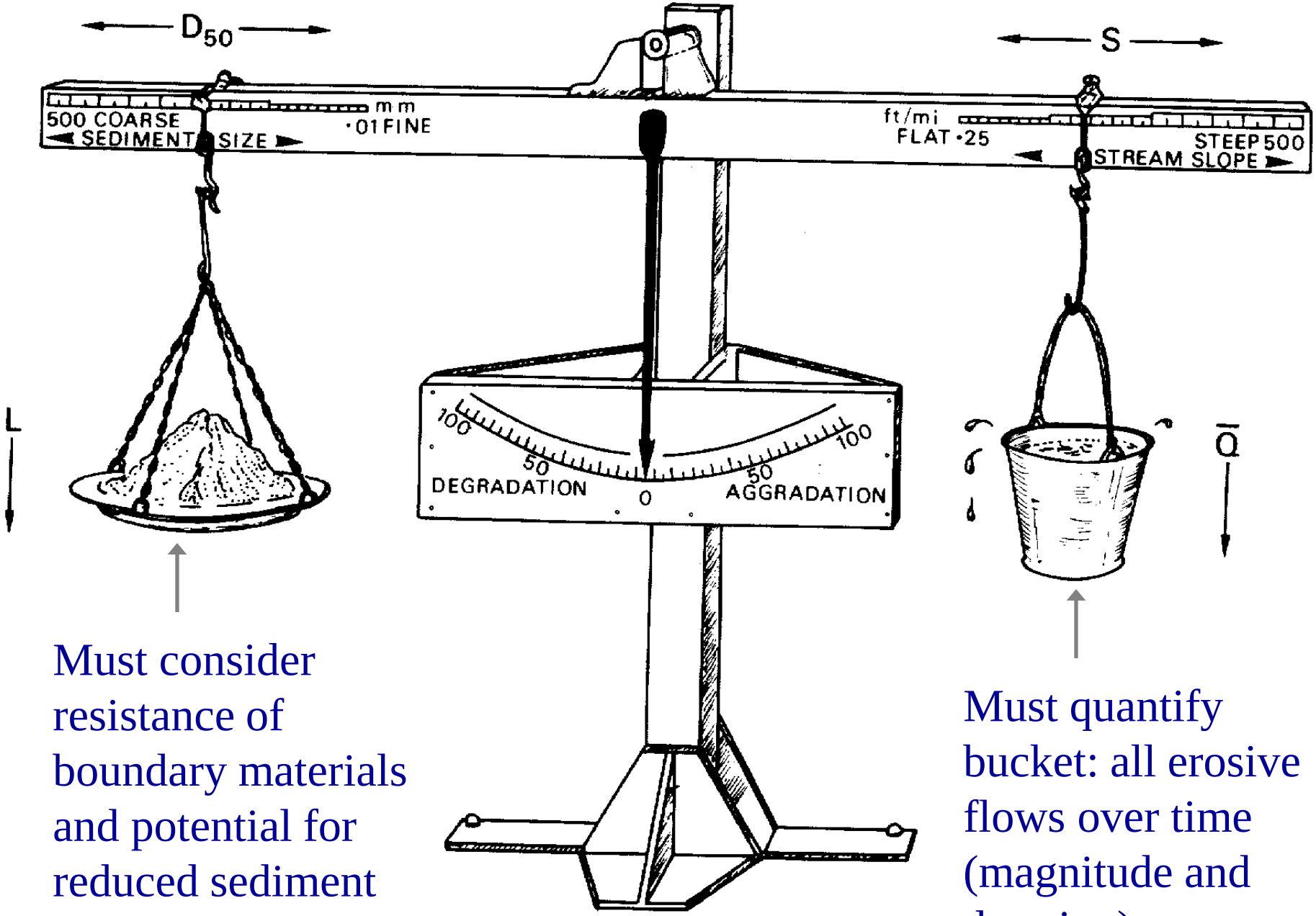
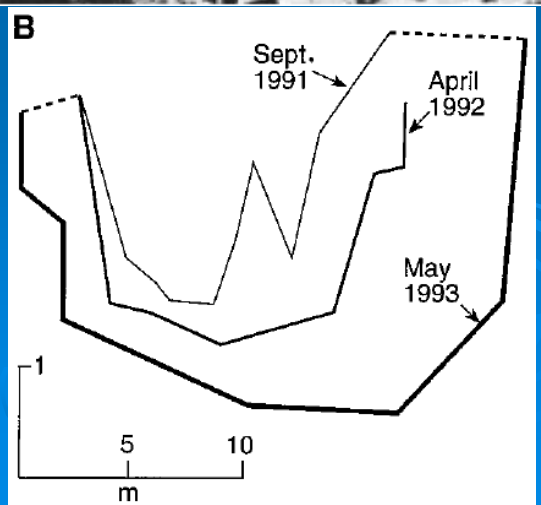


Must consider resistance of boundary materials and potential for reduced sediment supply over time

Must quantify bucket: all erosive flows over time (magnitude and duration)



Southern California

Trimble (1997)

North Denver Suburbs

Cottonwood Creek
South of Denver

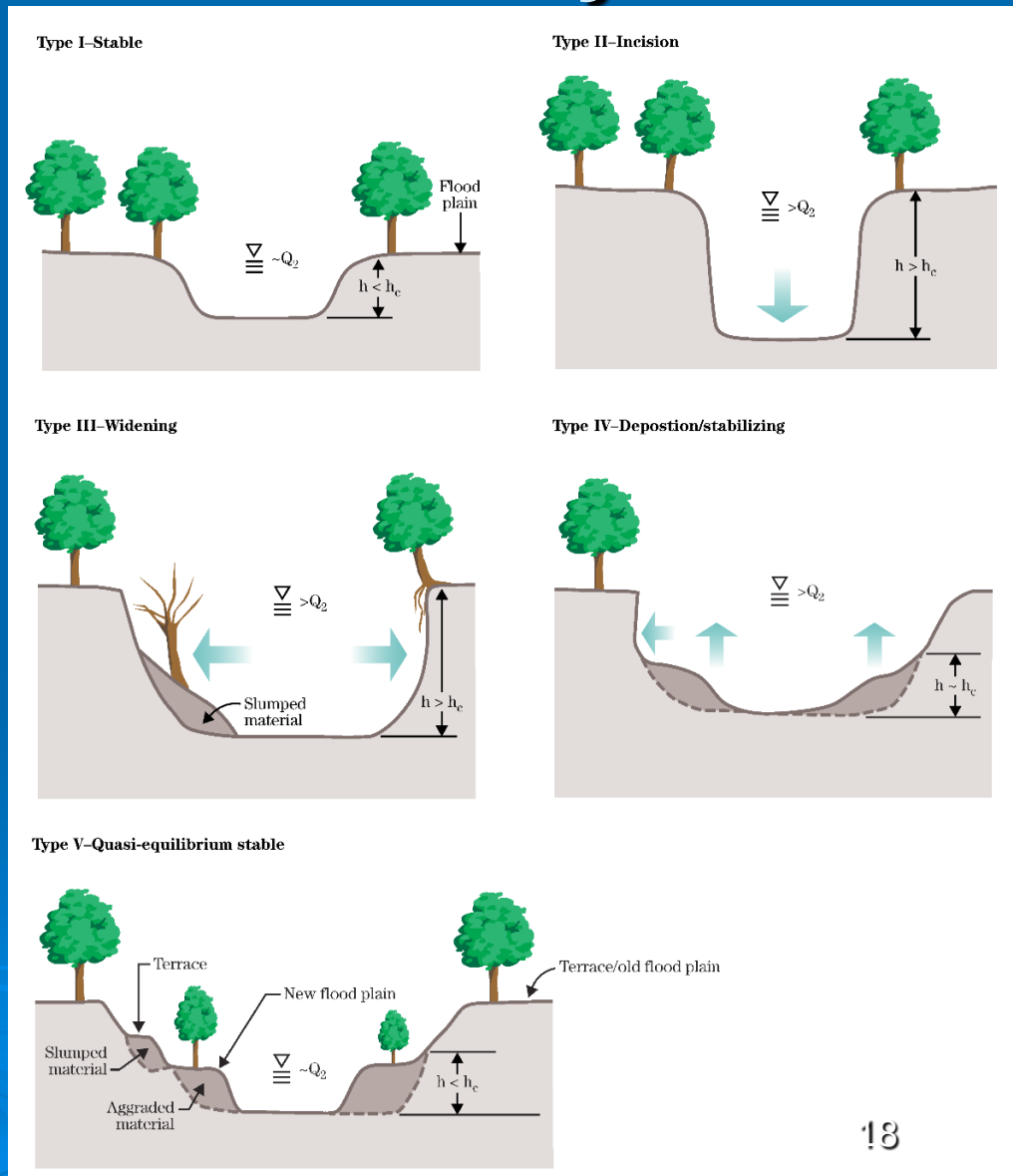
Fountain Creek

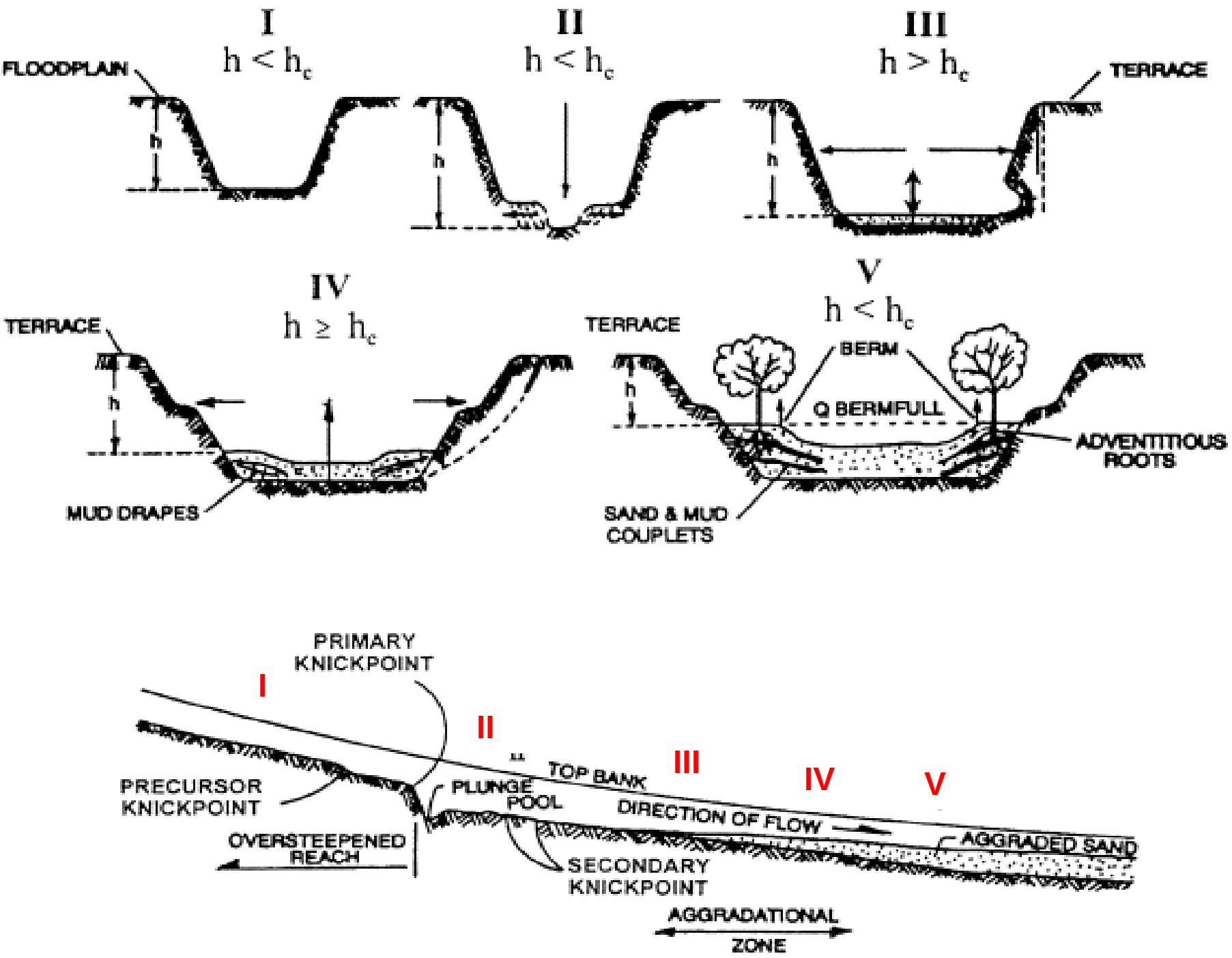
Woodland Park, CO

Big Dry Creek

Background Summary

- Channels respond to land use change
- Erosion introduces sediment-bound phosphorus
- Nitrate removal in riparian zones can be reduced




I
h < h_c
II
h < h_c
III
h > h_c
FLOODPLAIN
TERRACE
h
IV
h ≥ h_c
TERRACE
MUD DRAPES
V
h < h_c
TERRACE
BERM
Q BERMFULL
ADVENTITIOUS ROOTS
SAND & MUD COUPLETS
PRIMARY KNICKPOINT
I
II
III
IV
V
TOP BANK
PRECURSOR KNICKPOINT
PLUNGE POOL
DIRECTION OF FLOW
AGGRADED SAND
OVERSTEEPENED REACH
SECONDARY KNICKPOINT
AGGRADATIONAL ZONE

…is that a big number or a little number?

CLEAN Center Objectives

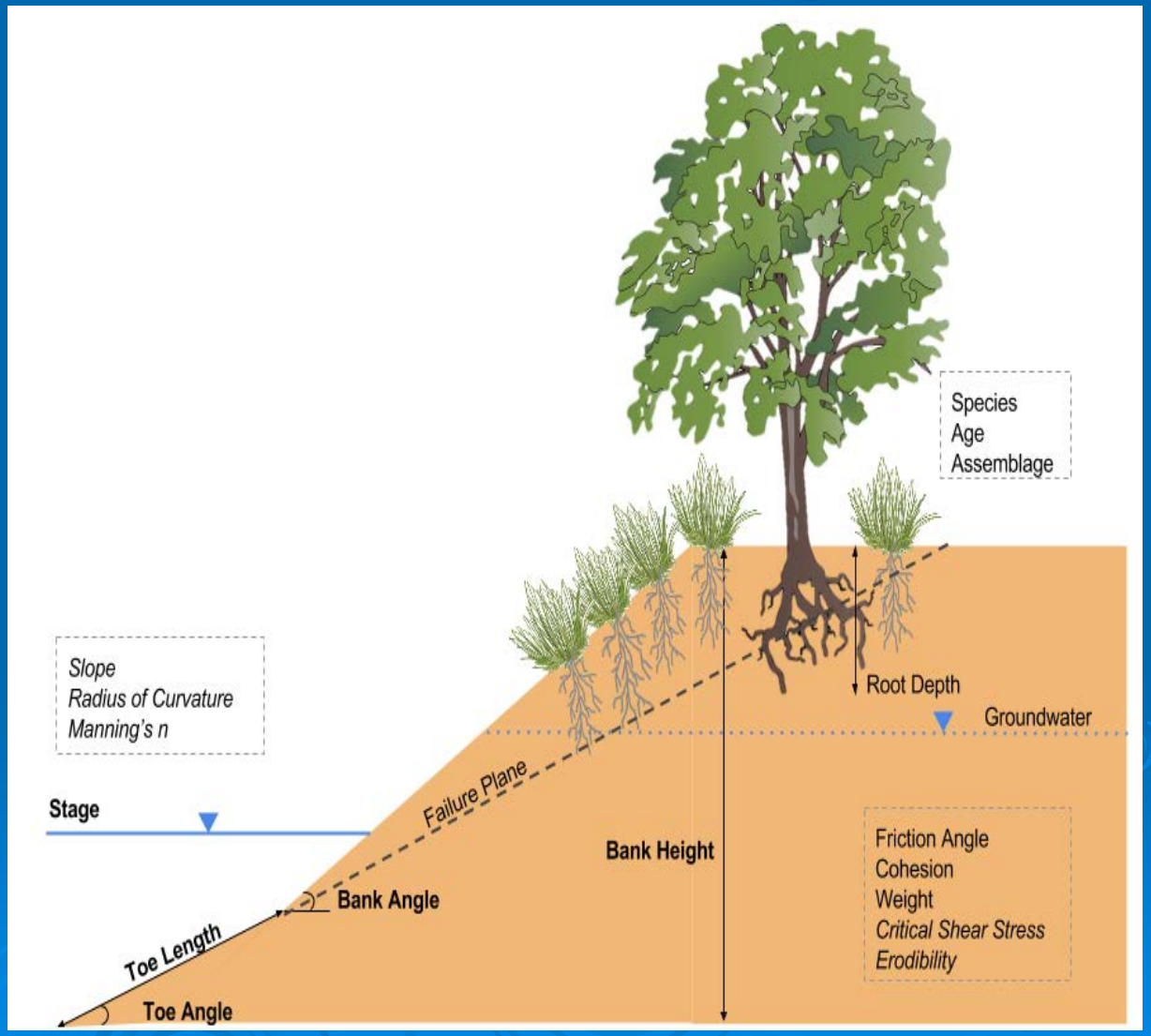
- Include effects of channel erosion in nutrient management strategies
  - Tools for managers to assess contributions of channels to nutrient loading
  - Estimate cost-effectiveness of various “restoration” strategies
  - Evaluate practices to reduce nutrient loading

CLEAN Tasks

1. Literature review
   - Channel evolution modeling
   - Stream restoration as a nutrient BMP
2. Tool development for estimating loading from channel evolution
3. Estimate restoration benefits
   - Primarily focused on phosphorus and channel erosion
4. Field testing of P models
   - Big Dry Creek, CO and Lick Creek, NC

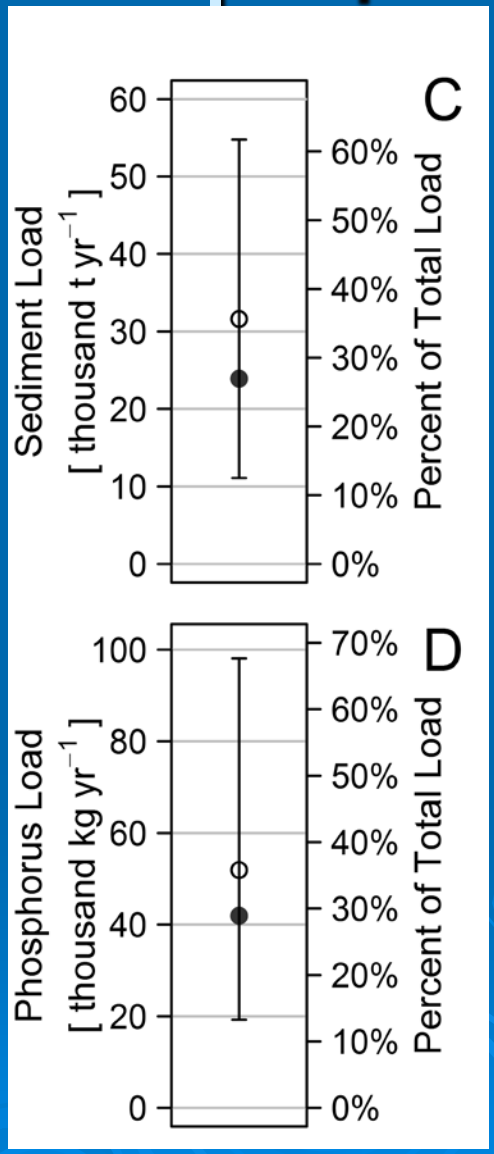
Bank erosion model analysis

- Bank Stability and Toe Erosion Model (BSTEM)
- Two erosion mechanisms



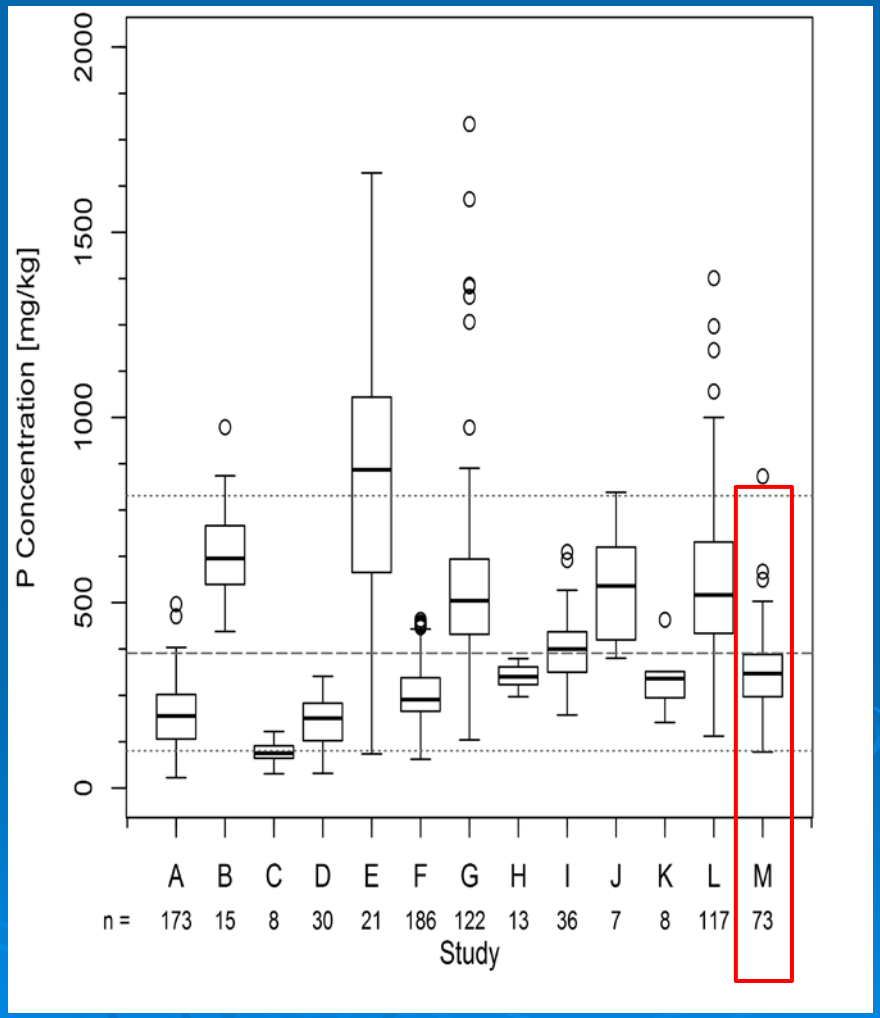
Bank erosion model

- Bank stability: height and cohesion
- Fluvial erosion: slope, height, and critical shear stress
- Significant uncertainty in model outputs



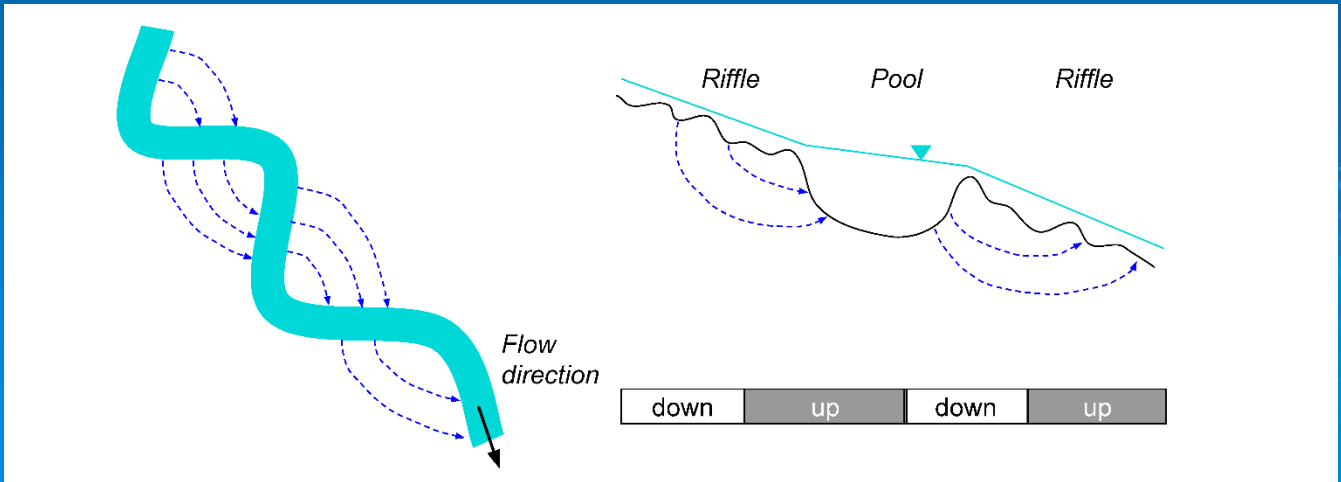
Stream restoration and nutrients

- Literature review to assess ability of stream restoration to reduce nutrient loading/increase processing
- Limited direct studies of restoration benefits
- Compiled data on bank phosphorus concentrations



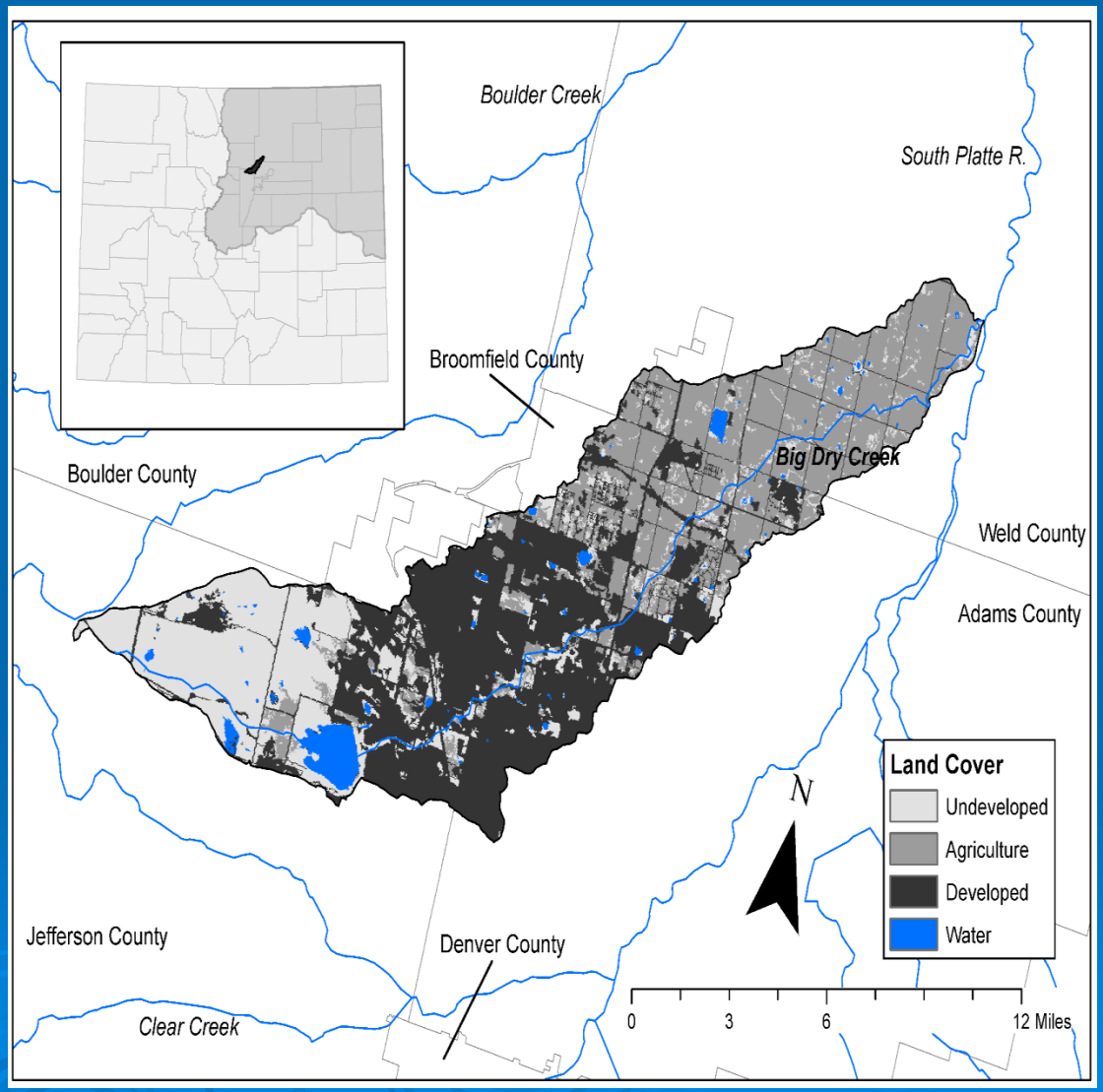
Literature Review – Candidate Practices for N & P Crediting

- Bed and bank stabilization
- Riparian buffers
- Instream enhancement
- Floodplain connection



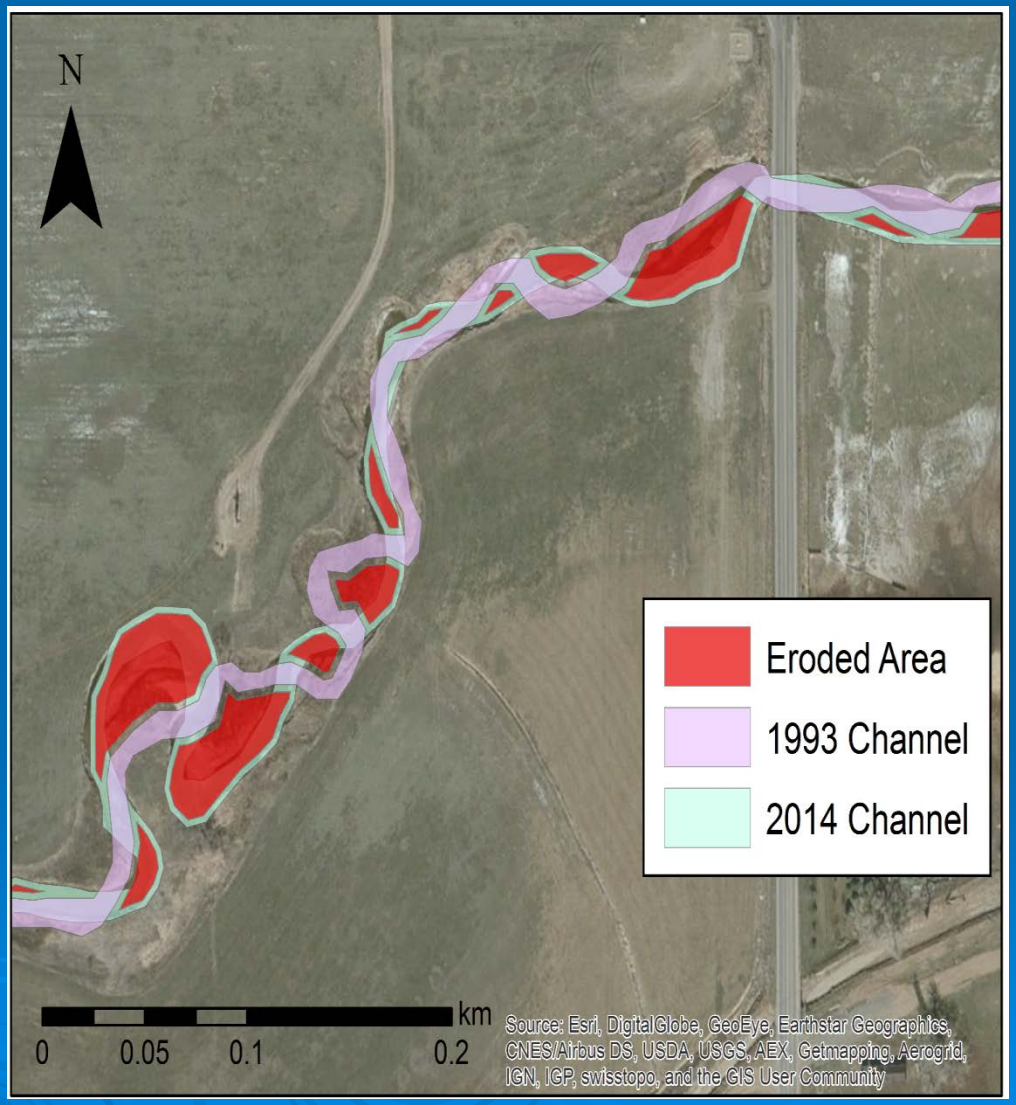
Big Dry Creek

- Desktop analysis
  - Channel change
  - Reach delineation
- Field data collection
  - Bank geometry
  - Bank P content



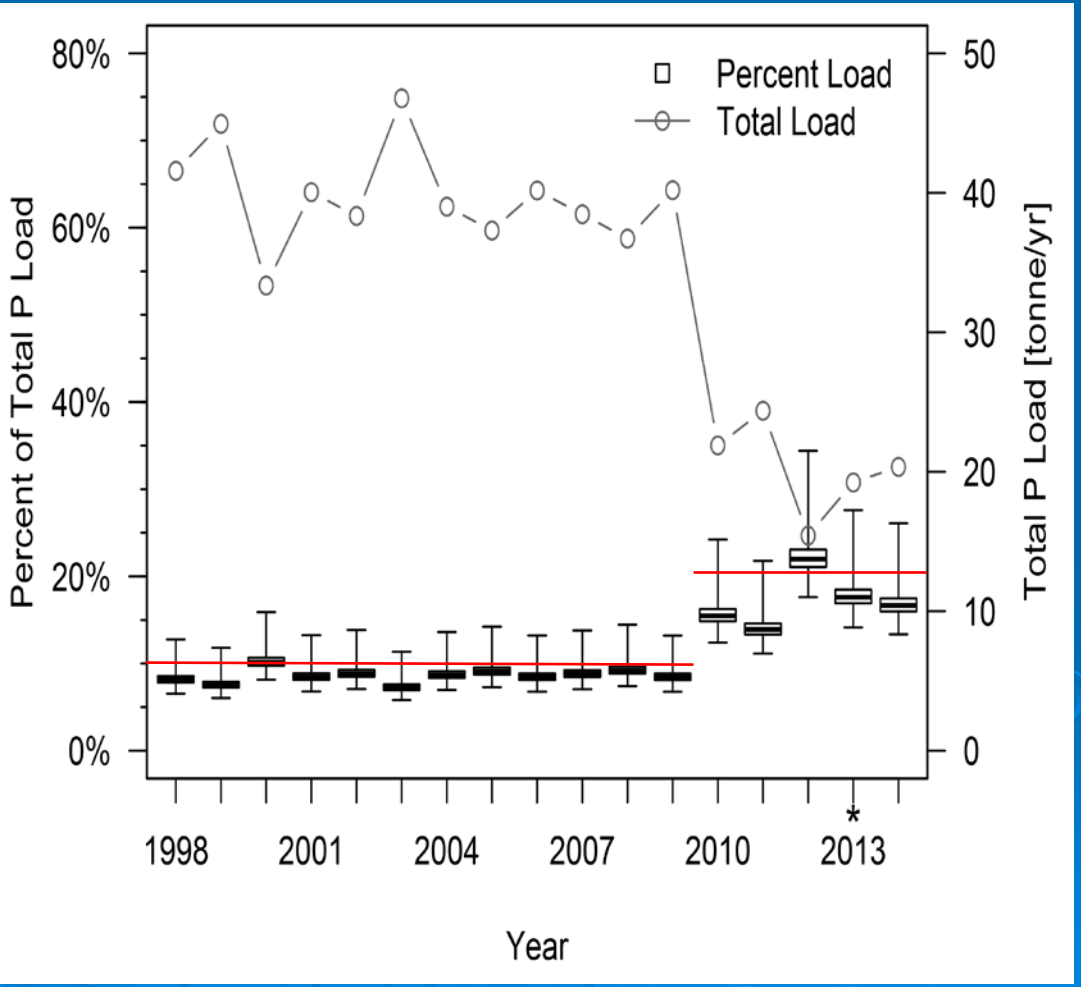
Preliminary results

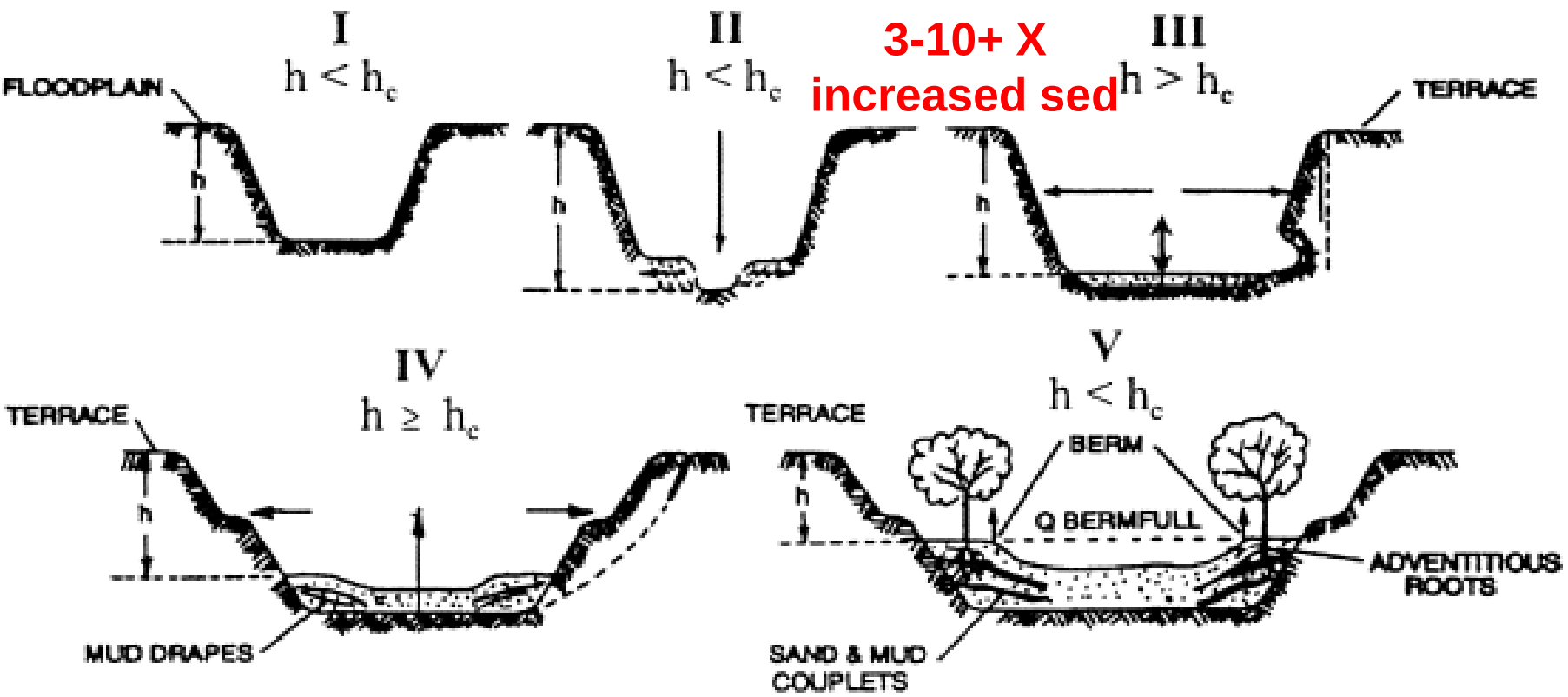
- Eroded area (satellite imagery)
- Bank heights (field)
- Soil bulk density (US Soil Survey)
- Bank P concentrations (field)



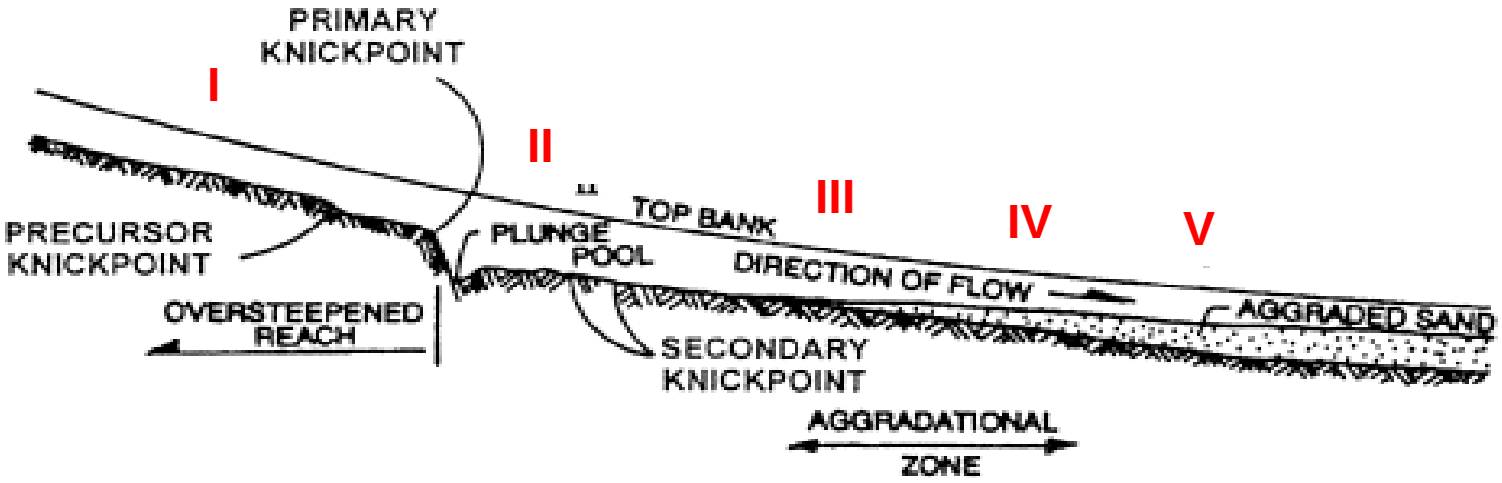
Preliminary results (cont.)

- Historically average of ~10% of total watershed P load
- Recently, contribution percentage may be higher
- Future of channel erosion uncertain





Sustaining benefits depends on future stormwater management



Big Dry Creek
Bank Stabilization Scenario

Big Dry Creek Bank Stabilization Scenario
Applied to ~30% of eroding channel length (3.6 mi)

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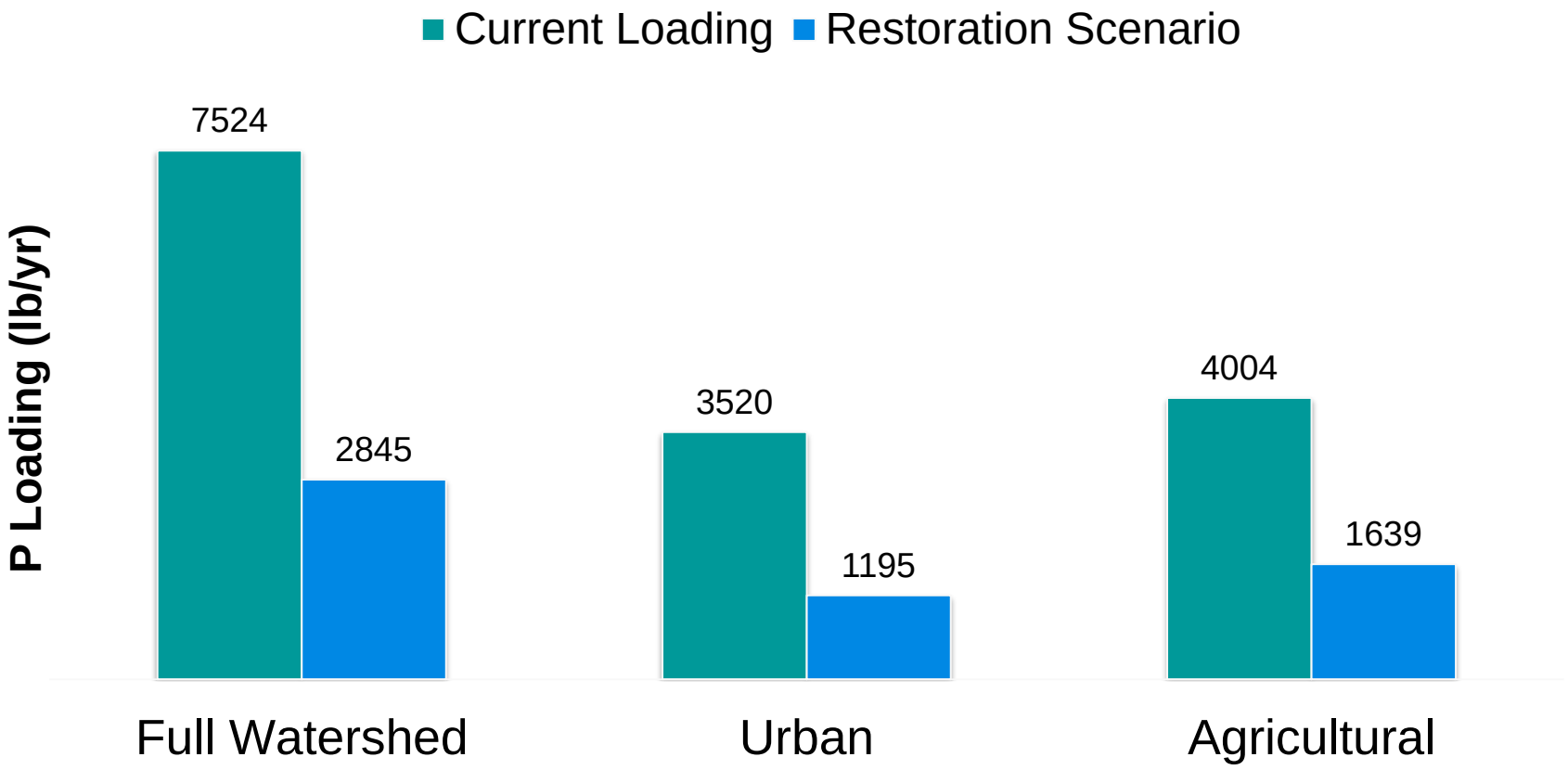

Future channel evolution and restoration effectiveness depends on stormwater mgmt.

Conclusions

- Nutrient loading from channel erosion can be a significant source that spans sectors
- CLEAN is developing practical tools for estimating loading from channels – answer the question “is it a big number?”
- Stream restoration practices can reduce N & P loading but empirical basis for evaluating credits not well developed

Conclusions (cont'd)

- Restoration must be integrated with "full spectrum" stormwater controls
- View streams not just as things in space but processes in time
- Account for potential downstream influence of changed sediment supply
- Potential co-benefits of restoration are many, and include health health

Collaboration and community engagement

- Working with stakeholders in CO and NC
- Coordinating CLEAN with WERF-funded effort to assess stream restoration as a nutrient BMP and provide guidance on nutrient crediting
- CSU, NC State, UGA linking channels and stormwater

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Urban River Parkways

An Essential Tool for Public Health

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July 2014

Center for
Occupational &
Enviromental
Health UCLA

Every 1 dollar spent on trails results in $3 direct medical benefit