Minimizing Storm Water Runoff Impacts to Streams and Rivers through Targeted Flow Thresholds:
The Biological Relevance of Qcritical.

Chicago Metropolitan Water Reclamation District Seminar Series

Stickney Water Reclamation Plant

Cicero, IL

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Sustainable Streams LLC

Science · Service · Solutions

Outline

- Background
- Monitoring
- Approach
- Results
- Application

Why do we manage storm water runoff ?

- **Historically—**
  - **Flood Control**
  - **Narrative**
  - **Presumptive Approach**
  - **“Design Storms”**
- **No Consideration**
  - **Water Quality**
  - **Channel Protection**
  - **Stream Integrity**
    - **Ecological**
    - **Hydrological**
    - **Geomorphological**

******Storm water runoff often considered one of the most serious threats to the integrity of our rivers and streams!***

Why?

- **Impacts of flow alteration well established**
  - **Changes to flow regime (Poff et al, 1997)**
  - **Urban Stream Syndrome (Walsh et al, 2005)**
  - **Stream Function Pyramid (Harman et al, 2012)**

Potential Barriers

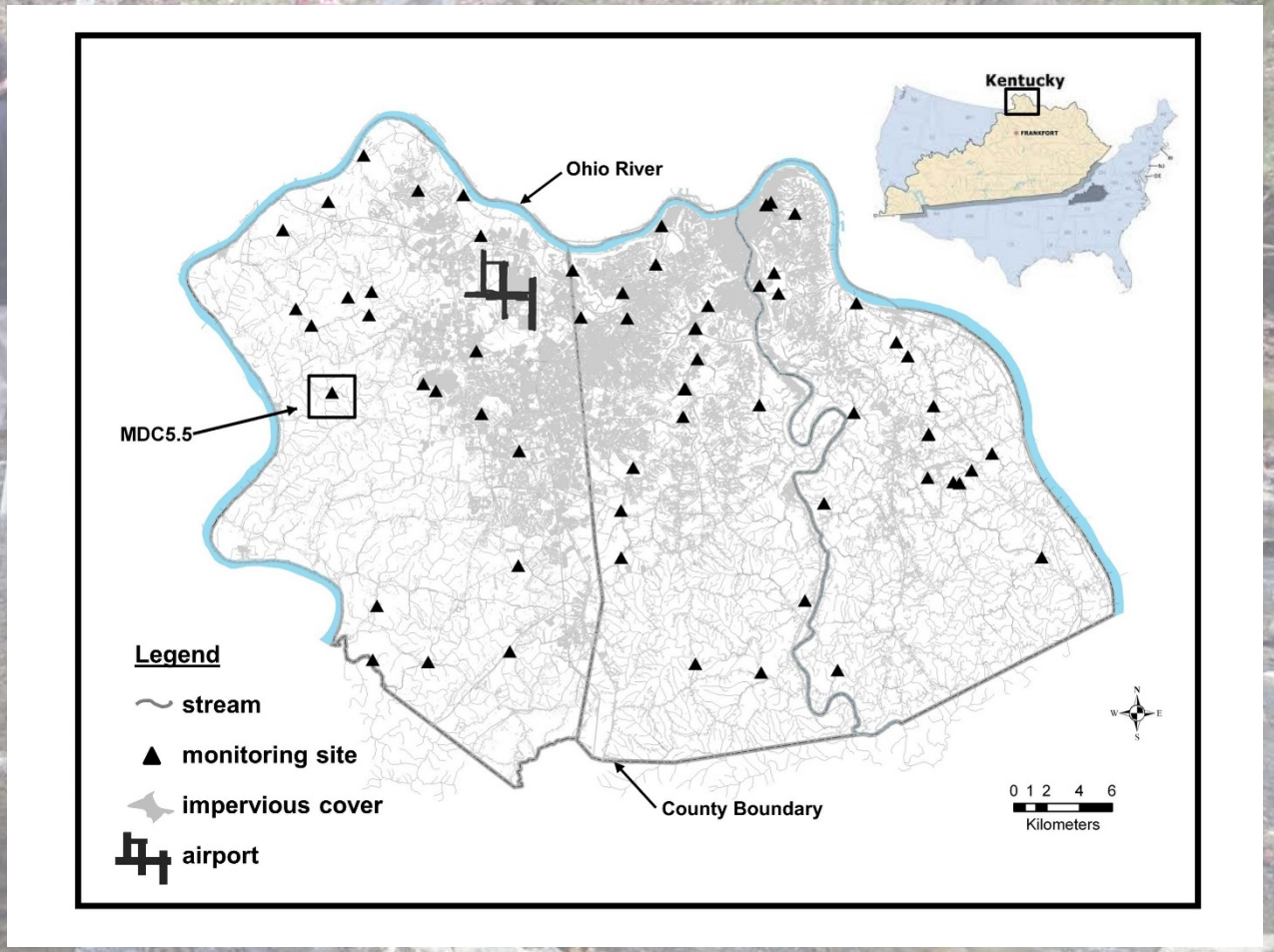
- Lack of Goals?
- Lack of Targets?
- Lack of Thresholds?
- Regional Variability?
- Lack of Baseline Condition?
- Other Complexities?
  - Social, financial, political……

Stream Assessment Program

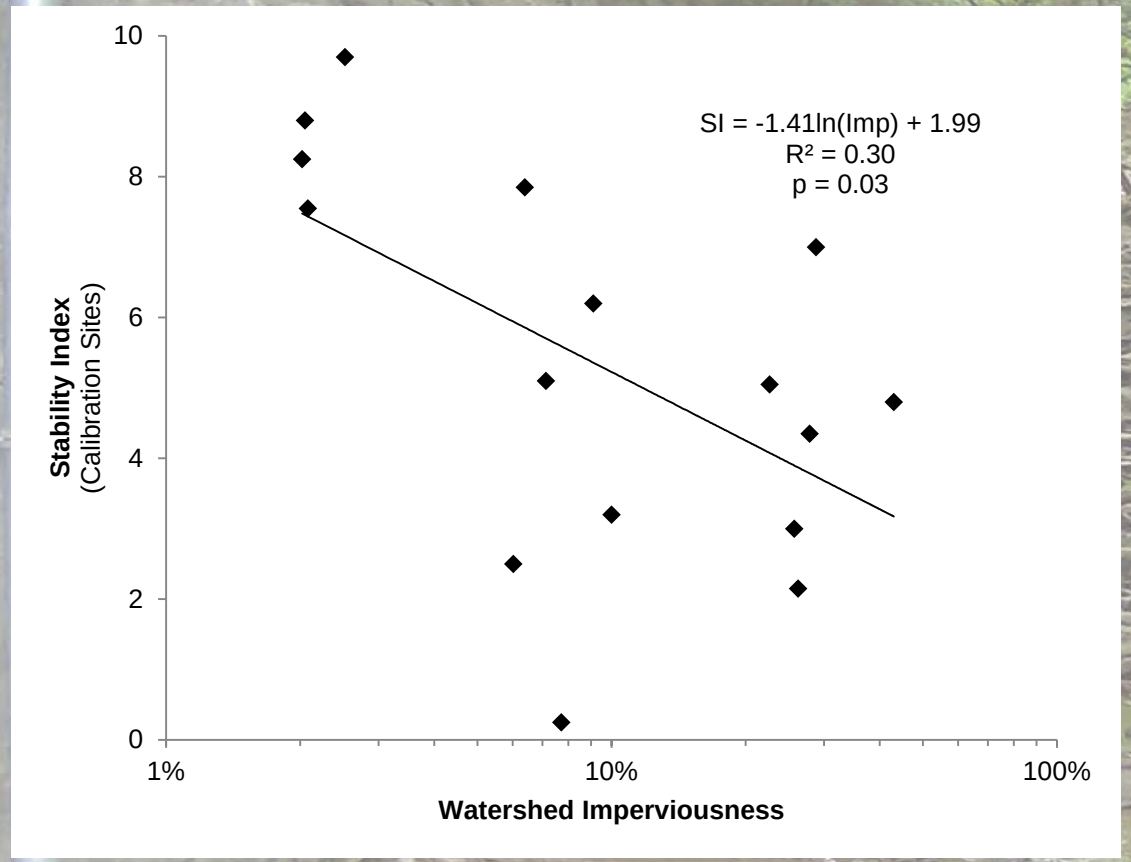
Storm Water Utility

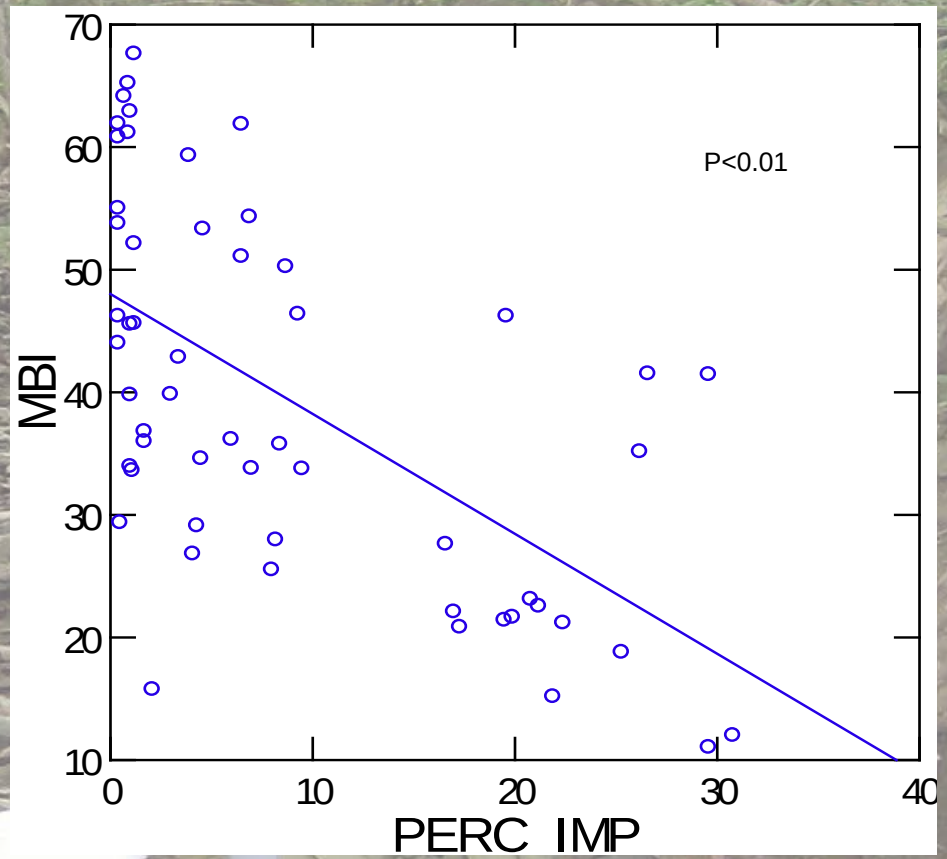
- 30 cities and 3 counties
- 223 square mile service area
- 400 miles of storm lines
- 30,000 structures

- ~75 sites:
  - Water Quality
  - Biology
  - Physical Habitat
  - Stream Stability (Hydromod)



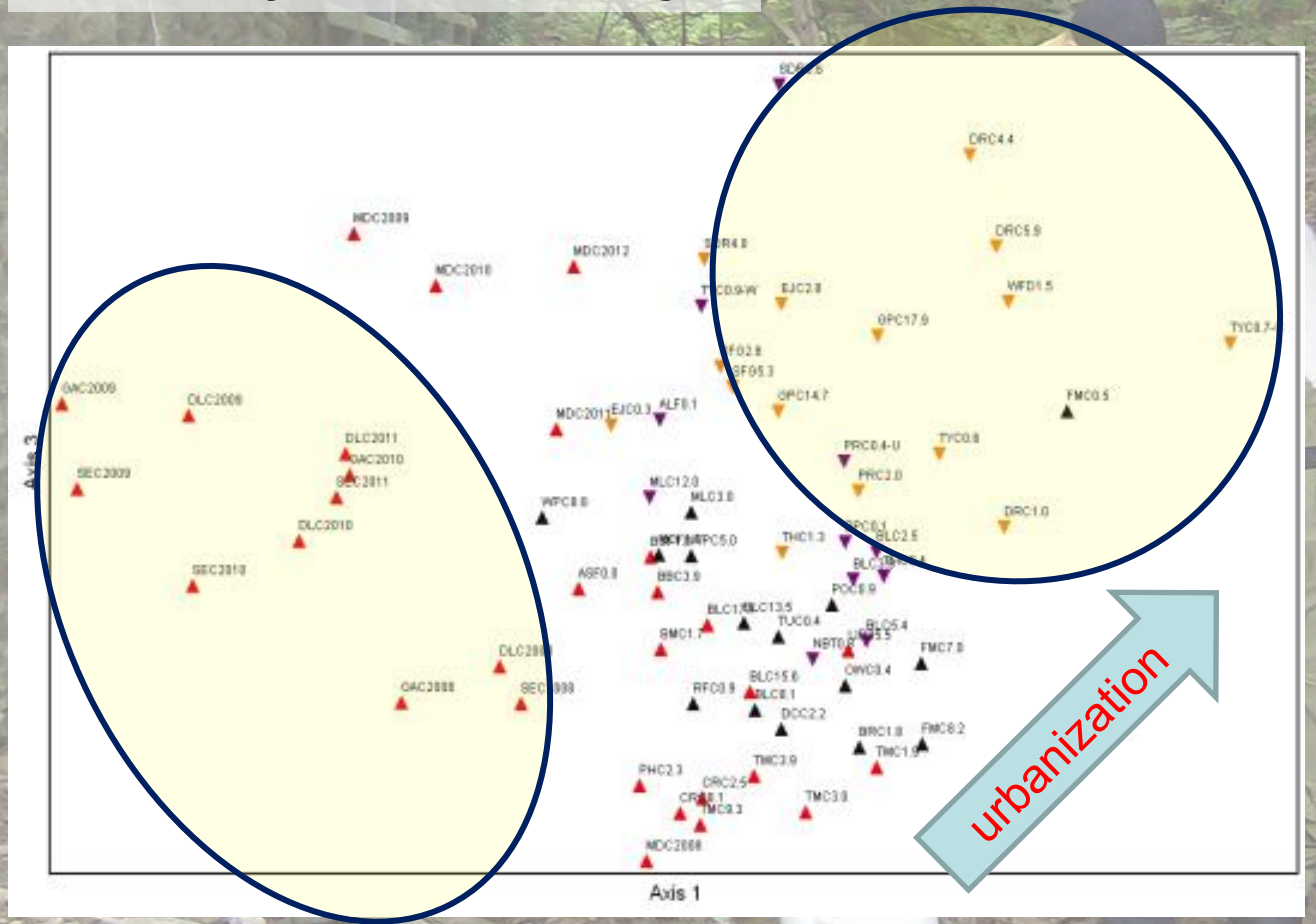
Baselines….


SI = -1.41ln(Imp) + 1.99
R² = 0.30
p = 0.03
Stability Index
(Calibration Sites)
10
8
6
4
2
0
1%
10%
100%
Watershed Imperviousness

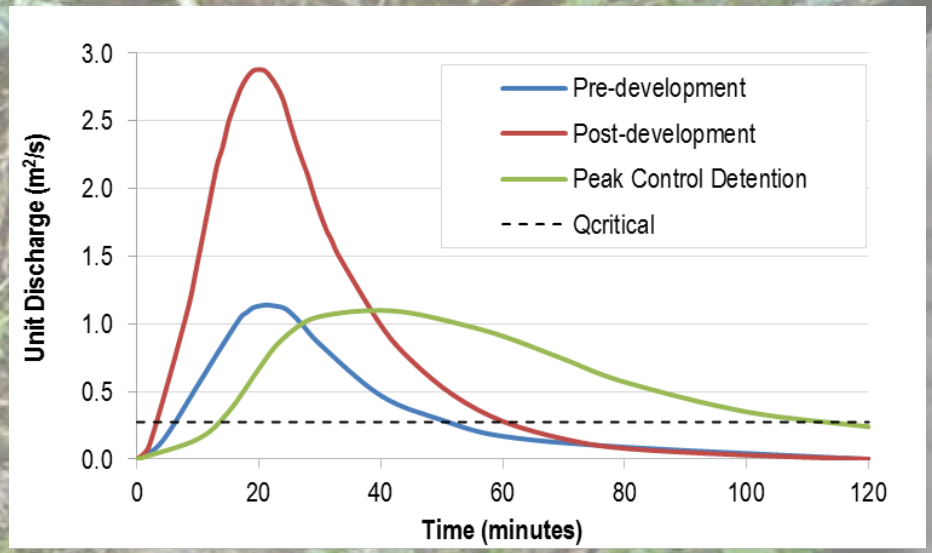

P<0.01
MBI
70
60
50
40
30
20
10
0
10
20
30
40
PERC_IMP

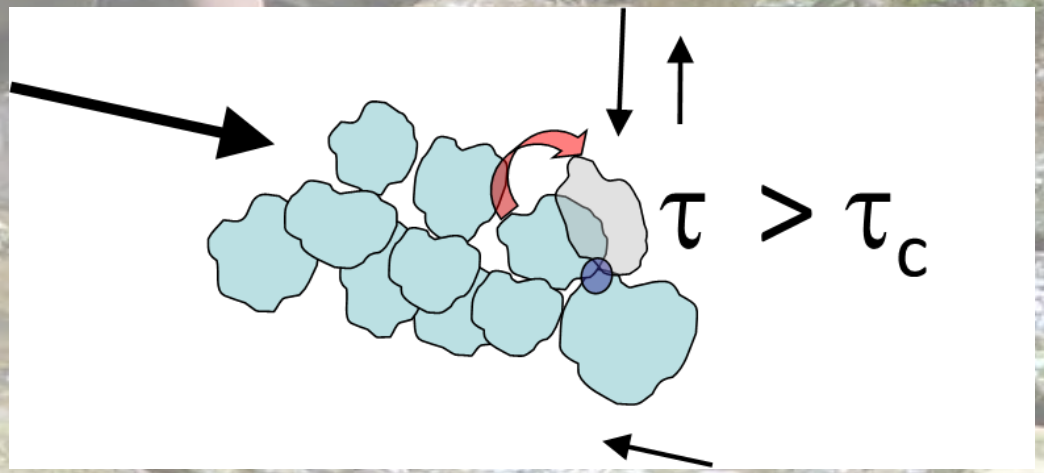
Baselines….(cont)

Community Structure Changes



Establish Thresholds



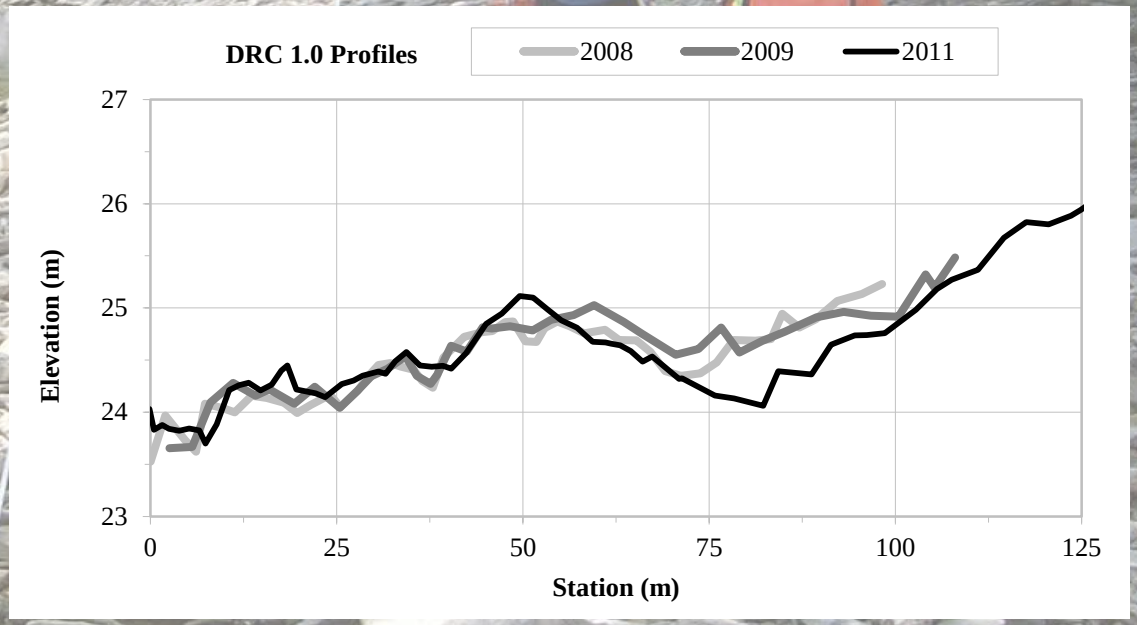


Critical Flow Concept

Analysis of the 2-yr, 2-hr storm from Fort Collins, CO by Bledsoe (2002), Journal of Water Resources Planning and Management

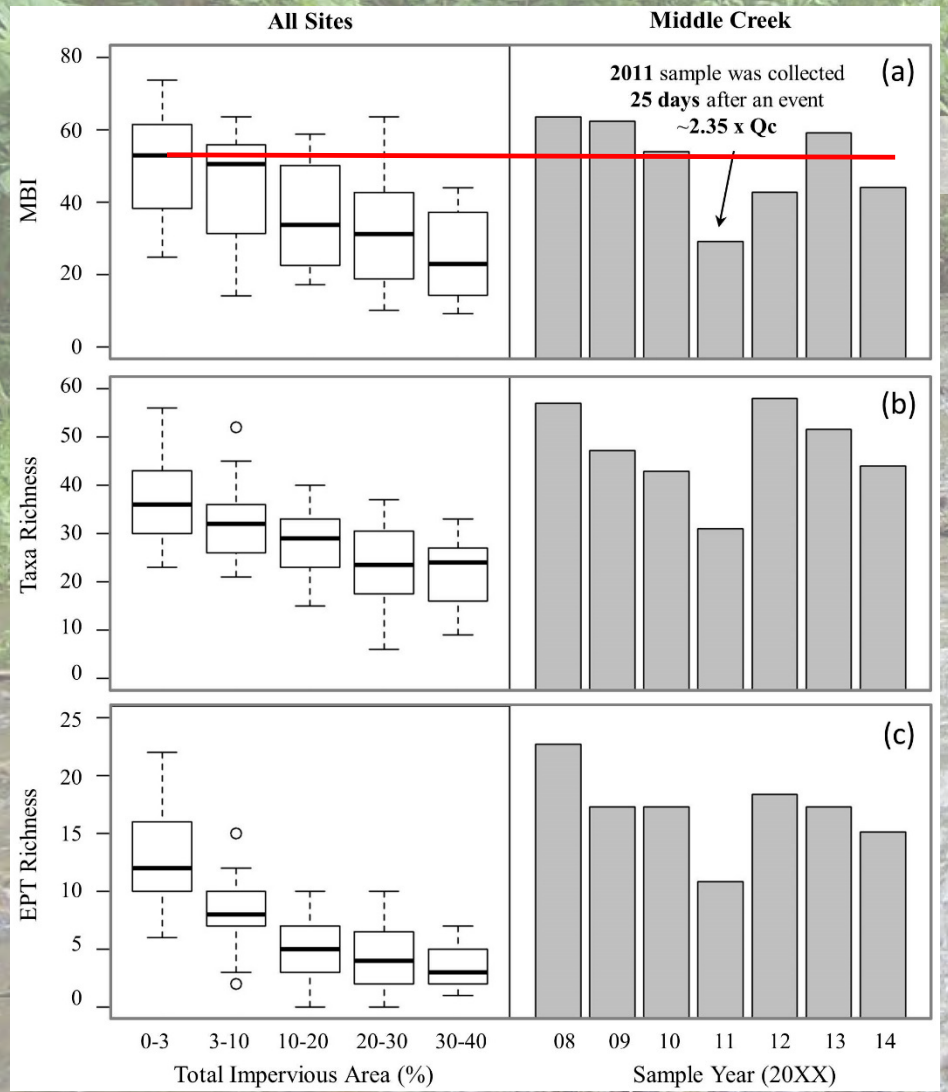
Establish Relevance

Shorter Riffles
Deeper and Longer Pools

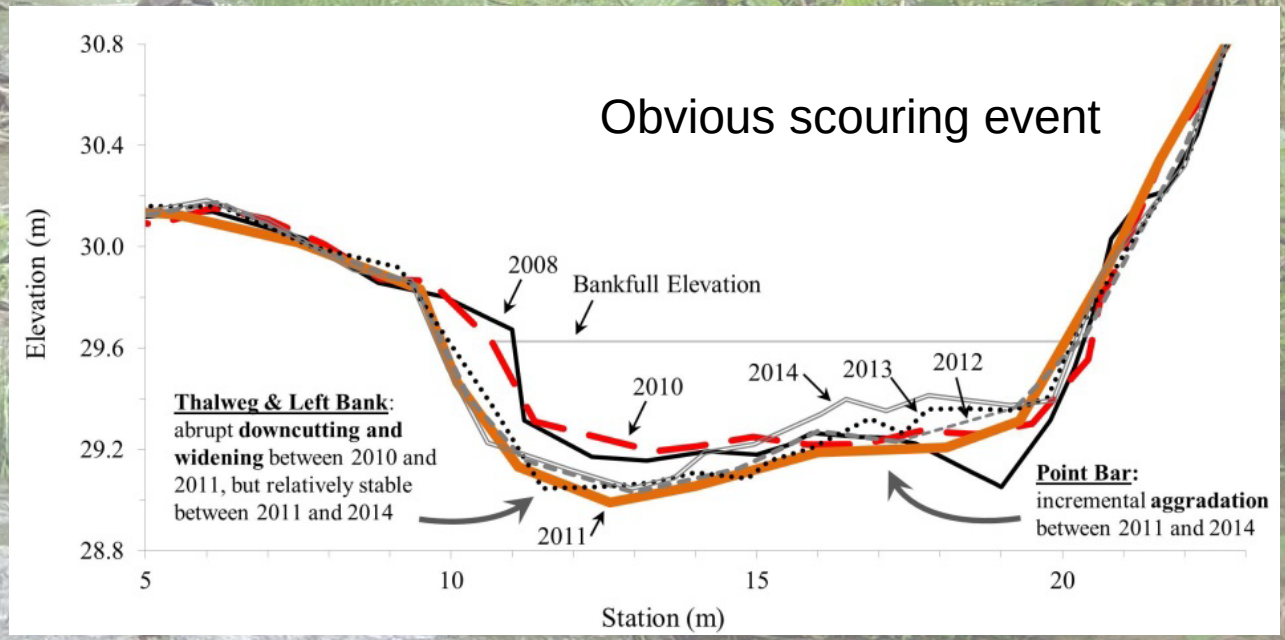


Hawley et al., Geomorphology, July 2013

Biological Relevance of $Q_{critical}$



-Impacts in index scores, EPT and overall richness

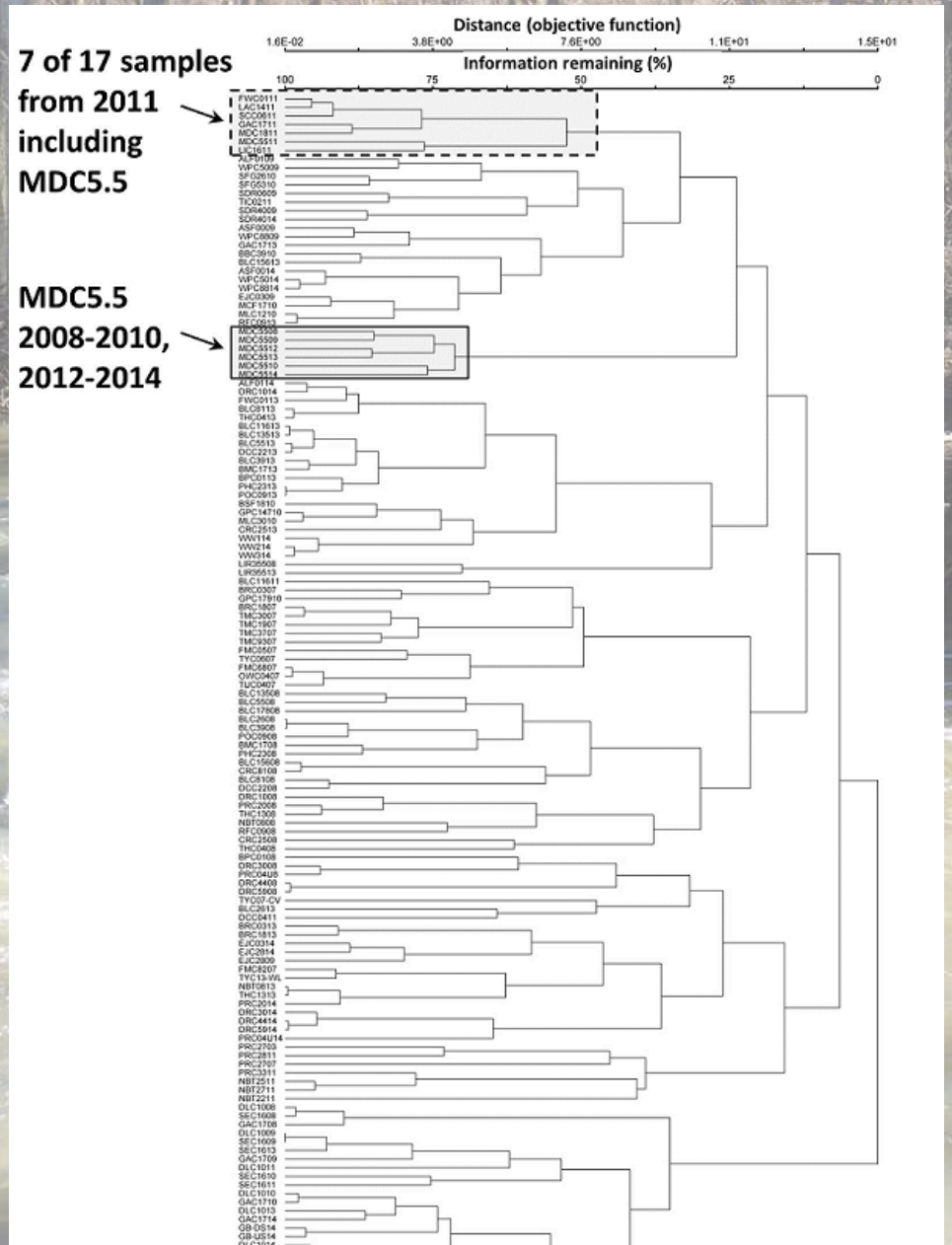


Adapted from Hawley et al. (2016)

Cluster Analysis

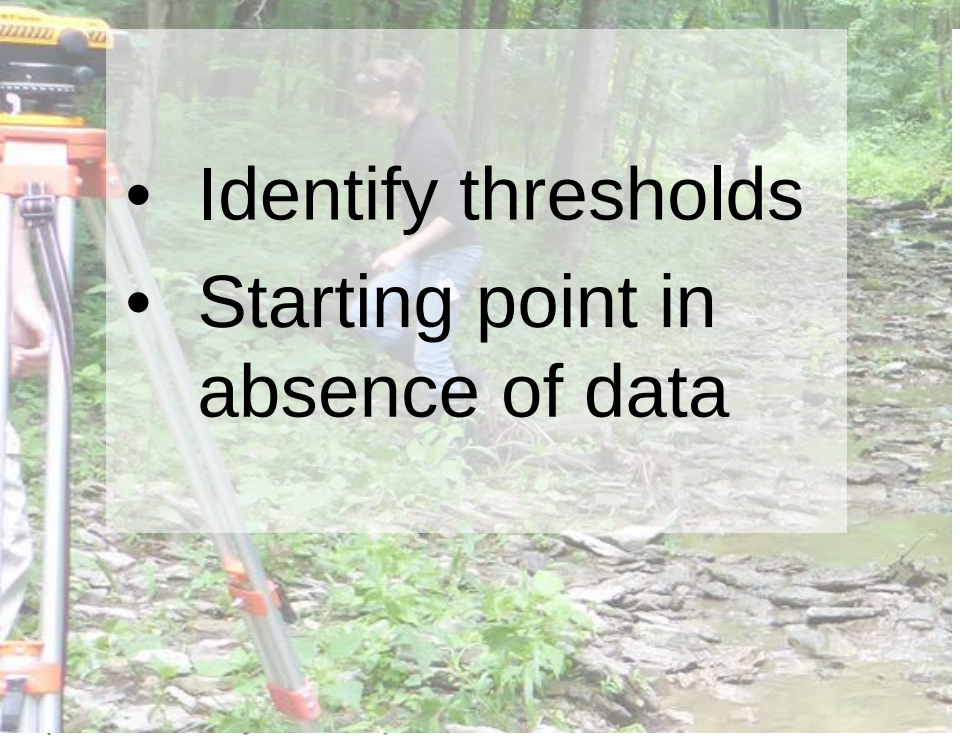
- Clear separation in MDC5.5 2011
- No node reconnection until 25% variability remaining

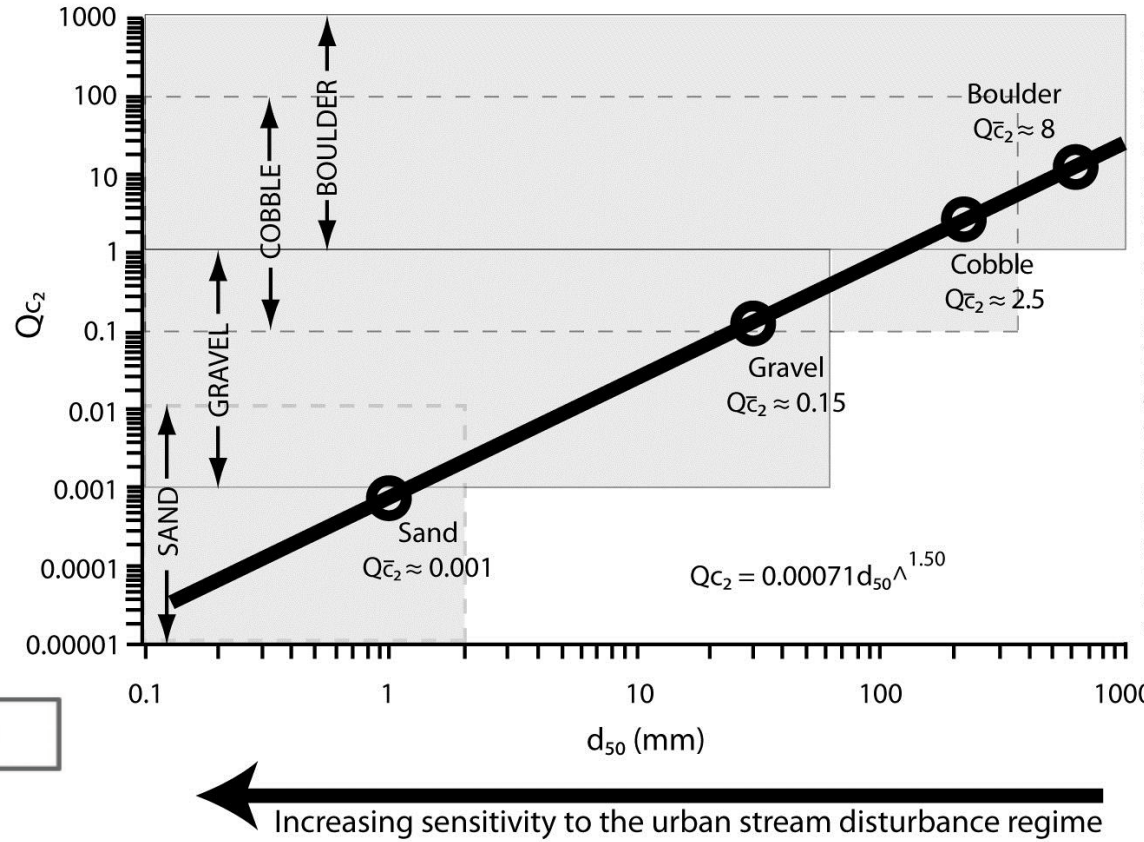
Adapted from Hawley et al. (2016)



Reducing Risk to Our Rivers- A Framework

- Identify thresholds
- Starting point in absence of data



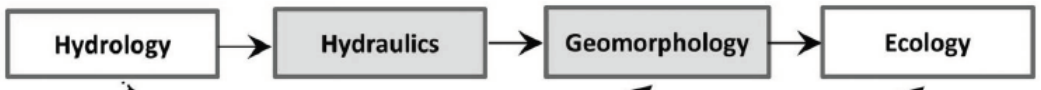


Boulder: Duration controls for larger events (≥2-y storm) are likely to be more important than conventional channel protection controls that focus on the 1-y storm and smaller.

Cobble: A threshold-type management approach could be efficacious. Effective discharge could be sub-bankfull to an overbank event.

Gravel: Broad range (Qc_2 0.001 - 1), typically sub-bankfull flows, warrants a geomorphic investigation of appropriate targets for the system. Management approaches may range from hydrologic mimicry of specific flow ranges to threshold-type approaches, which manage excess volume and releases to below the Q_c.

Sand: Hydrologic mimicry may be very important for channel stability. Effective discharge analyses may indicate that channel protection controls should focus on duration controls for relatively frequent flows (<< 1-y storm).



Hydrogeomorphic and **Ecohydrological goals** to preserve geomorphically and ecologically relevant aspects of the natural flow regime

Adatped from Hawley and Vietz (2016), Freshwater Science

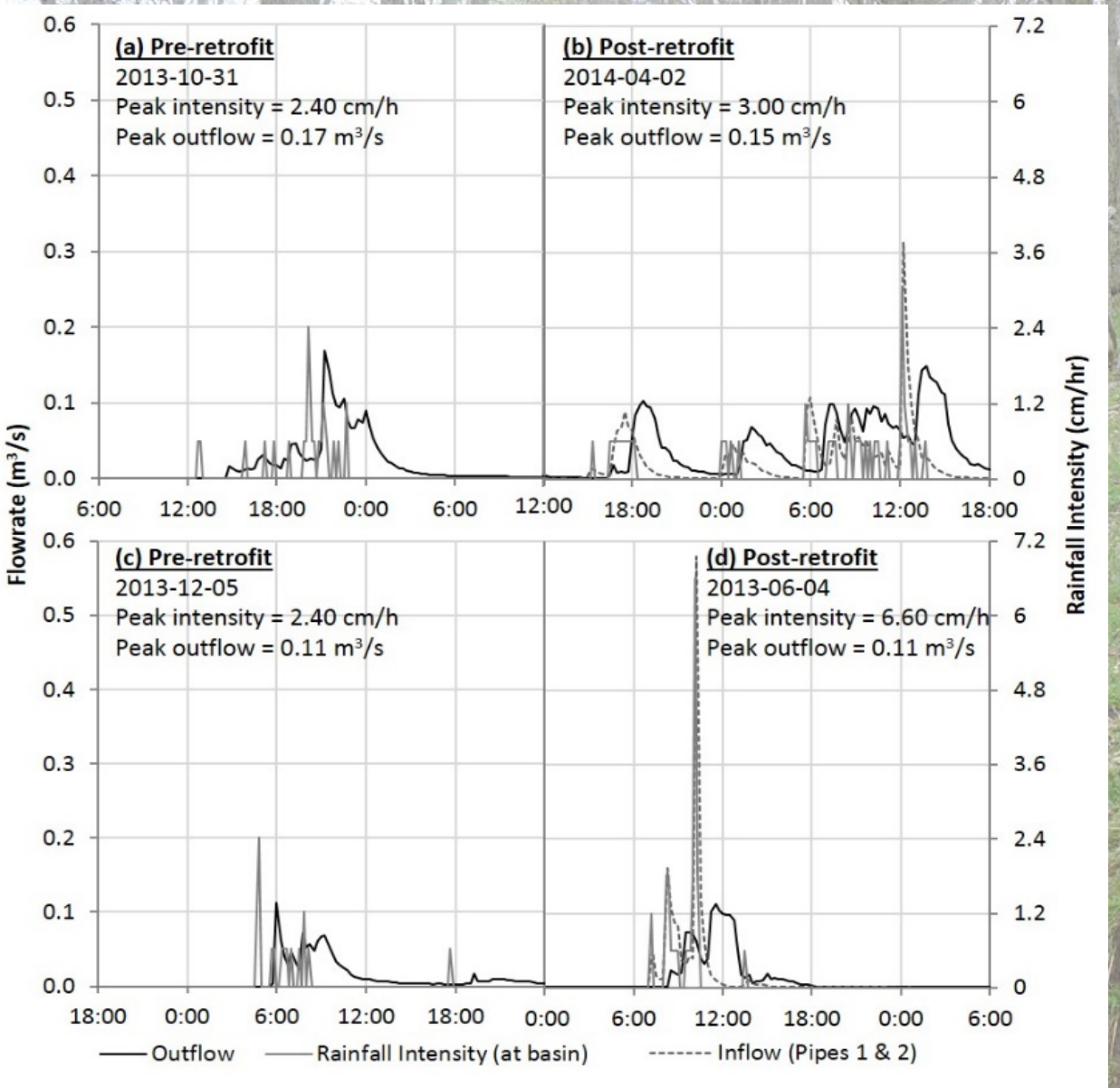
Implementation

- Pilot Project 1-“Detain H20”
  - Basin Retrofitting
  - P3-Toyota, SD1, USEPA, Boone County Conservation District
- Pilot Project 2-”Horse Branch”
  - Watershed Scale
  - Multiple optimizations
  - Municipalities

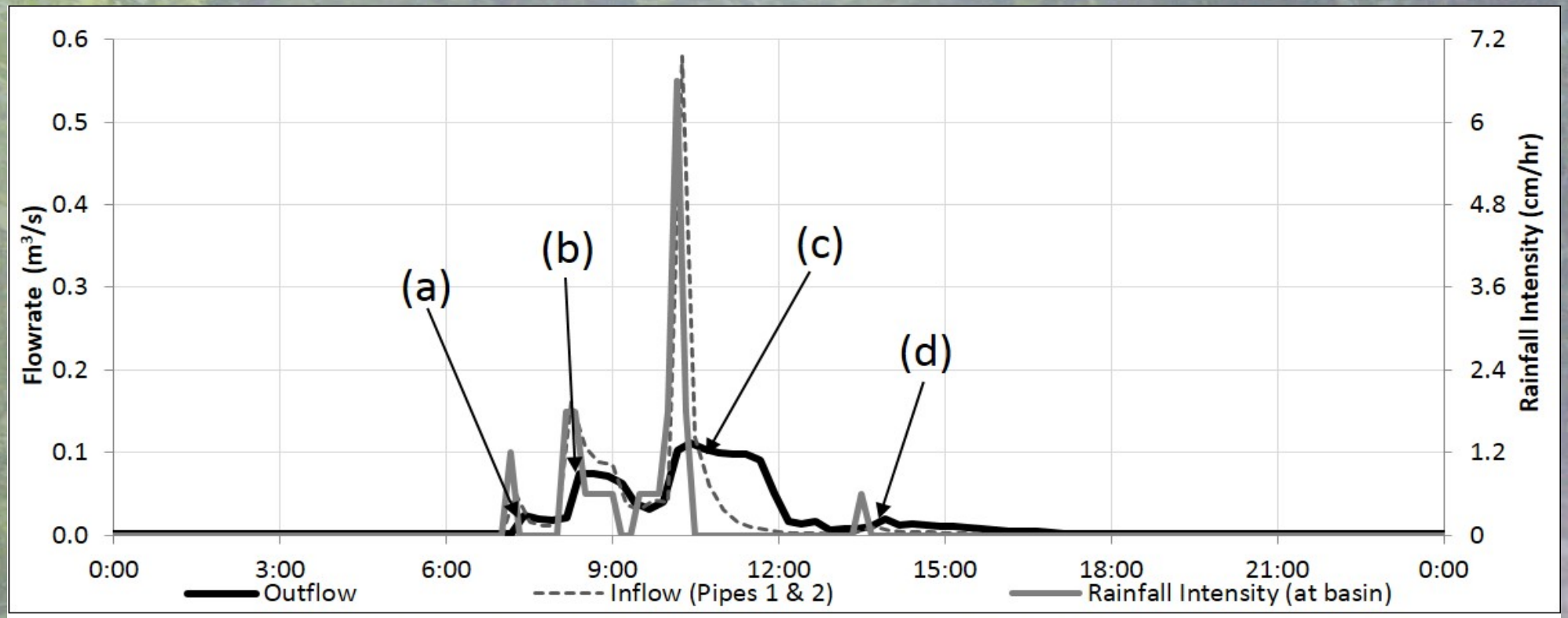
Detain H20

- Detention Basin Retrofit
- Passive
- ~25 acres DA
  - ~50% impervious
- Reduce erosive power
- Maintain flood control
- Pre-post flow monitoring
- Three in-stream monitoring stations

Hawley et al (2017)



Hawley et al (2017)



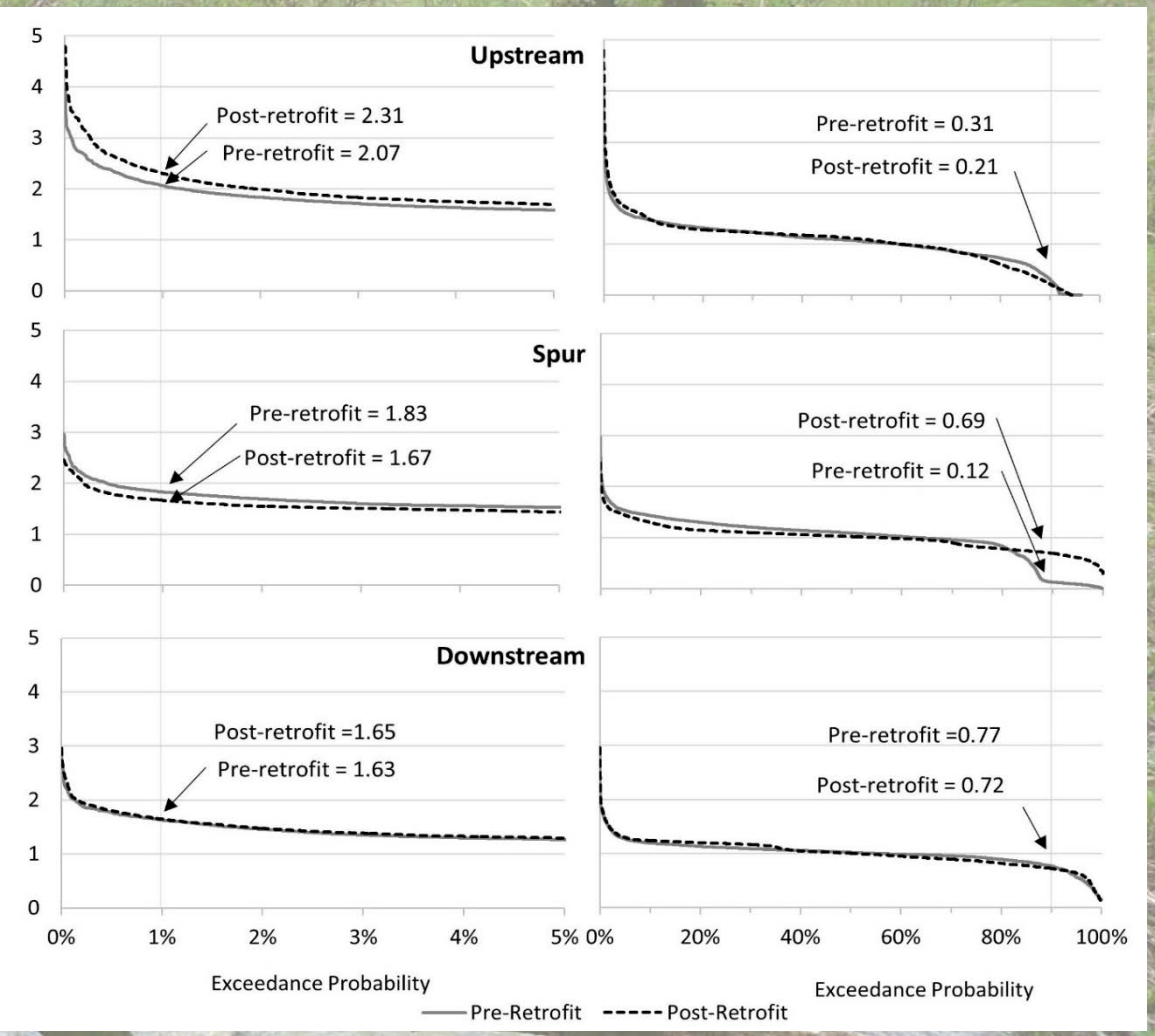
(a) 2014/06/04 – 7:54

(b) 2014/06/04 – 8:34

(c) 2014/06/04 – 10:45

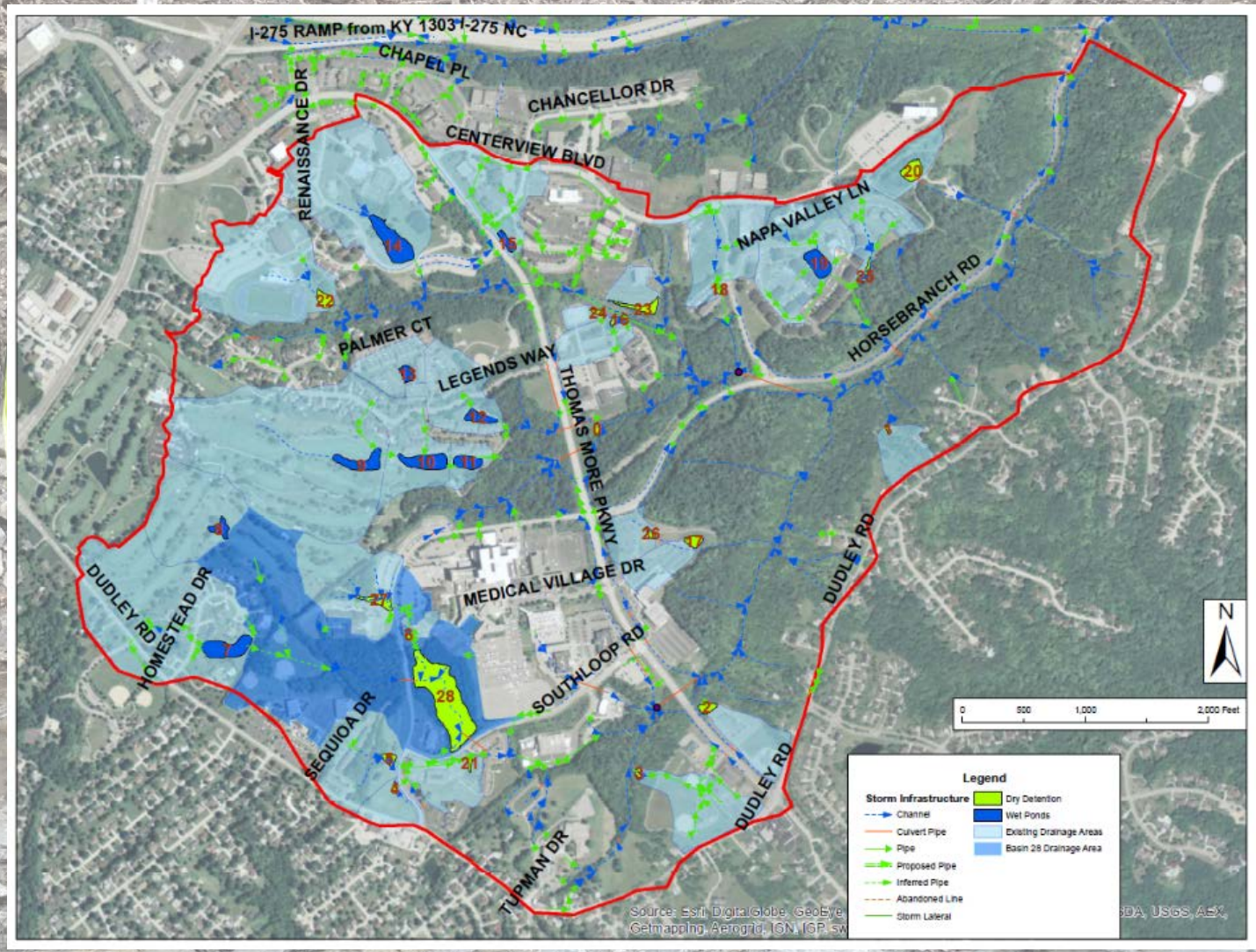
(d) 2014/06/04 – 14:07

Hawley et al (2017)

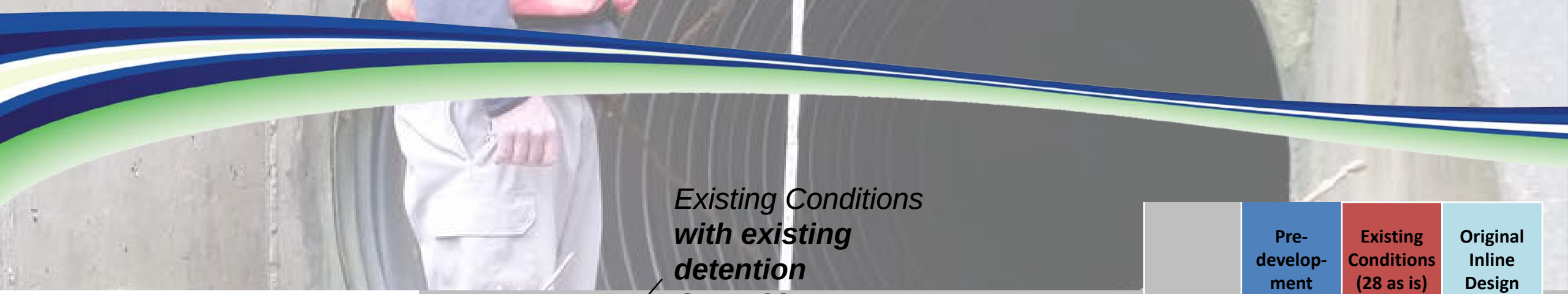

Upstream
Post-retrofit = 2.31
Pre-retrofit = 2.07
Pre-retrofit = 0.31
Post-retrofit = 0.21
Spur
Pre-retrofit = 1.83
Post-retrofit = 1.67
Post-retrofit = 0.69
Pre-retrofit = 0.12
Downstream
Post-retrofit =1.65
Pre-retrofit = 1.63
Pre-retrofit =0.77
Post-retrofit = 0.72
0%
1%
2%
3%
4%
5%
0%
20%
40%
60%
80%
100%
Exceedance Probability
Exceedance Probability
Pre-Retrofit
Post-Retrofit

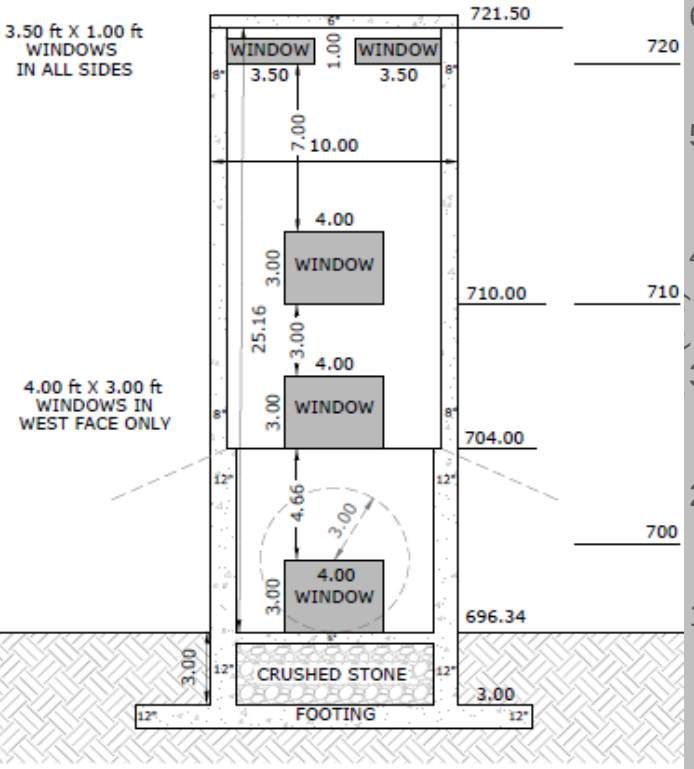
Horse Branch

- Watershed Based
  - >20% impervious
- Multiple concerns
  - Stream bank erosion
  - Stream incision
  - Transportation infrastructure
  - Utility infrastructure
  - Stream quality
- Multiple solutions
- Municipal cooperation



Stability Concerns



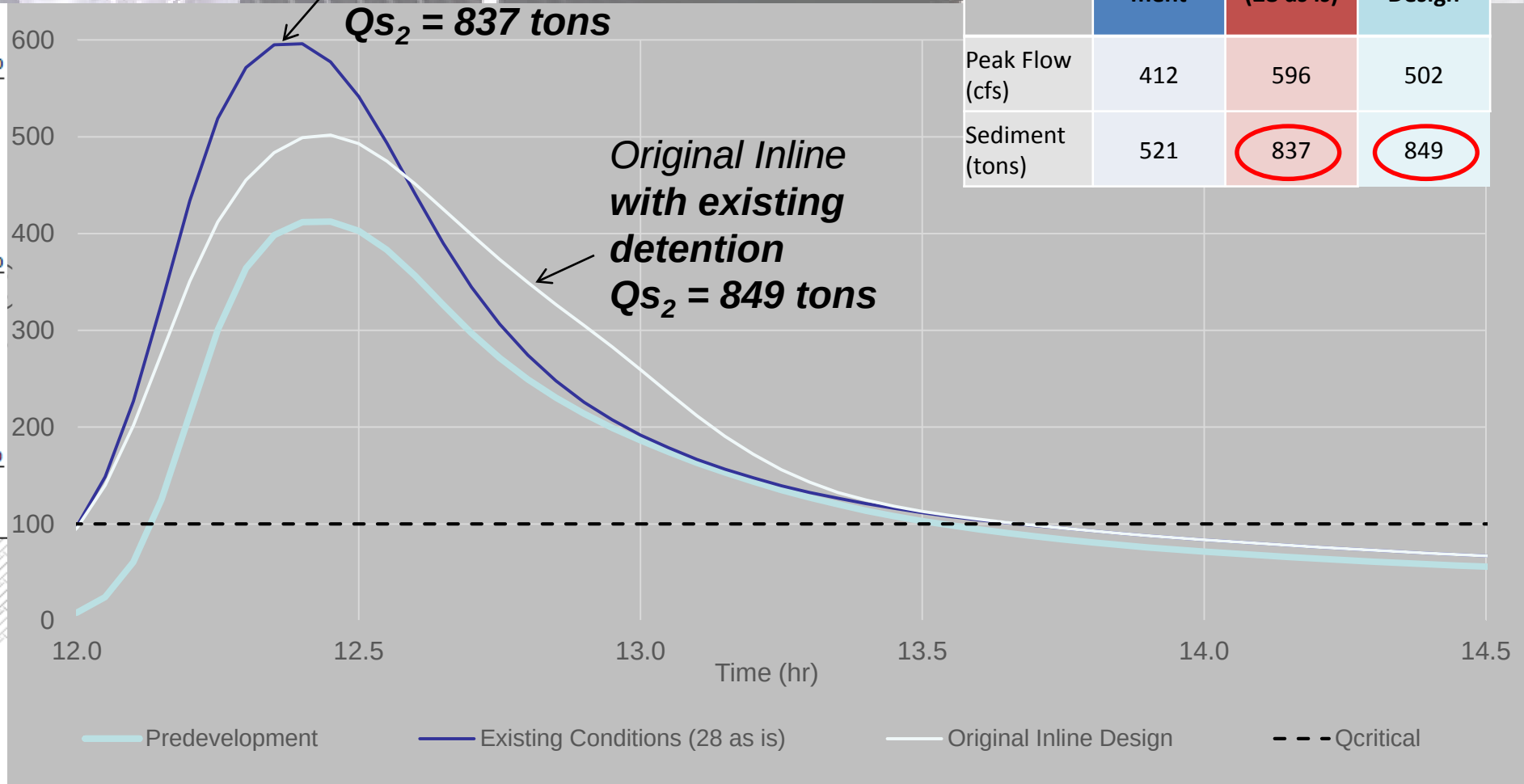


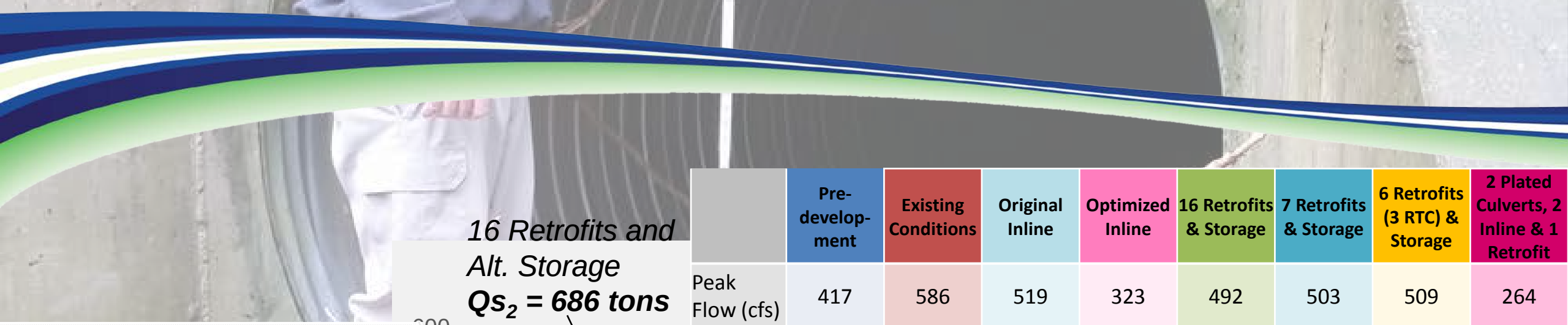
PROPOSED ALTERNATE 1
DRAINAGE STRUCTURE
SCALE: 1"= 4'

Existing Conditions ***with existing detention*** ***Qs_2 = 837 tons***

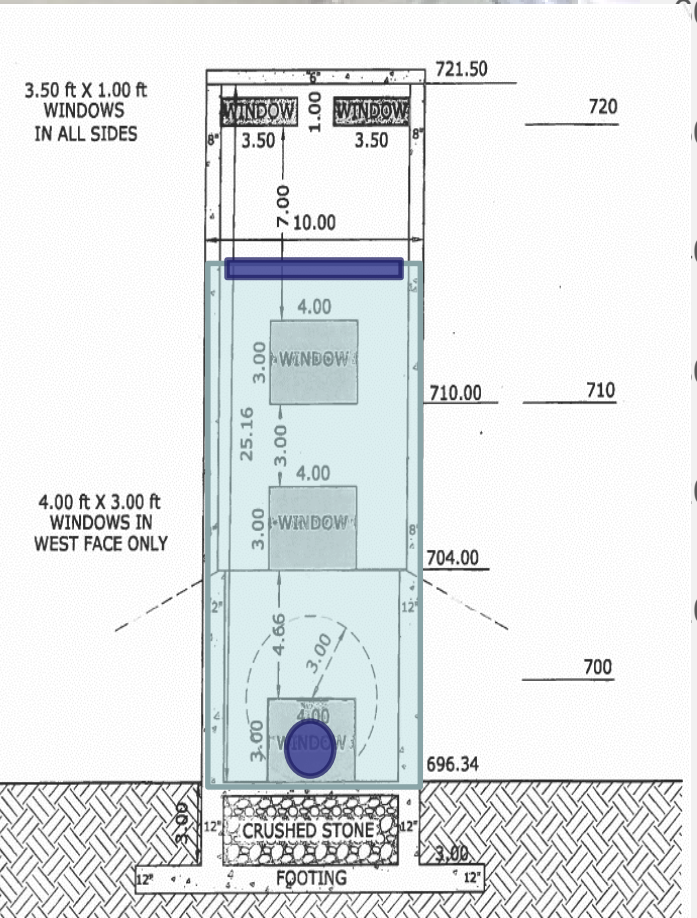
Original Inline ***with existing detention*** ***Qs_2 = 849 tons***

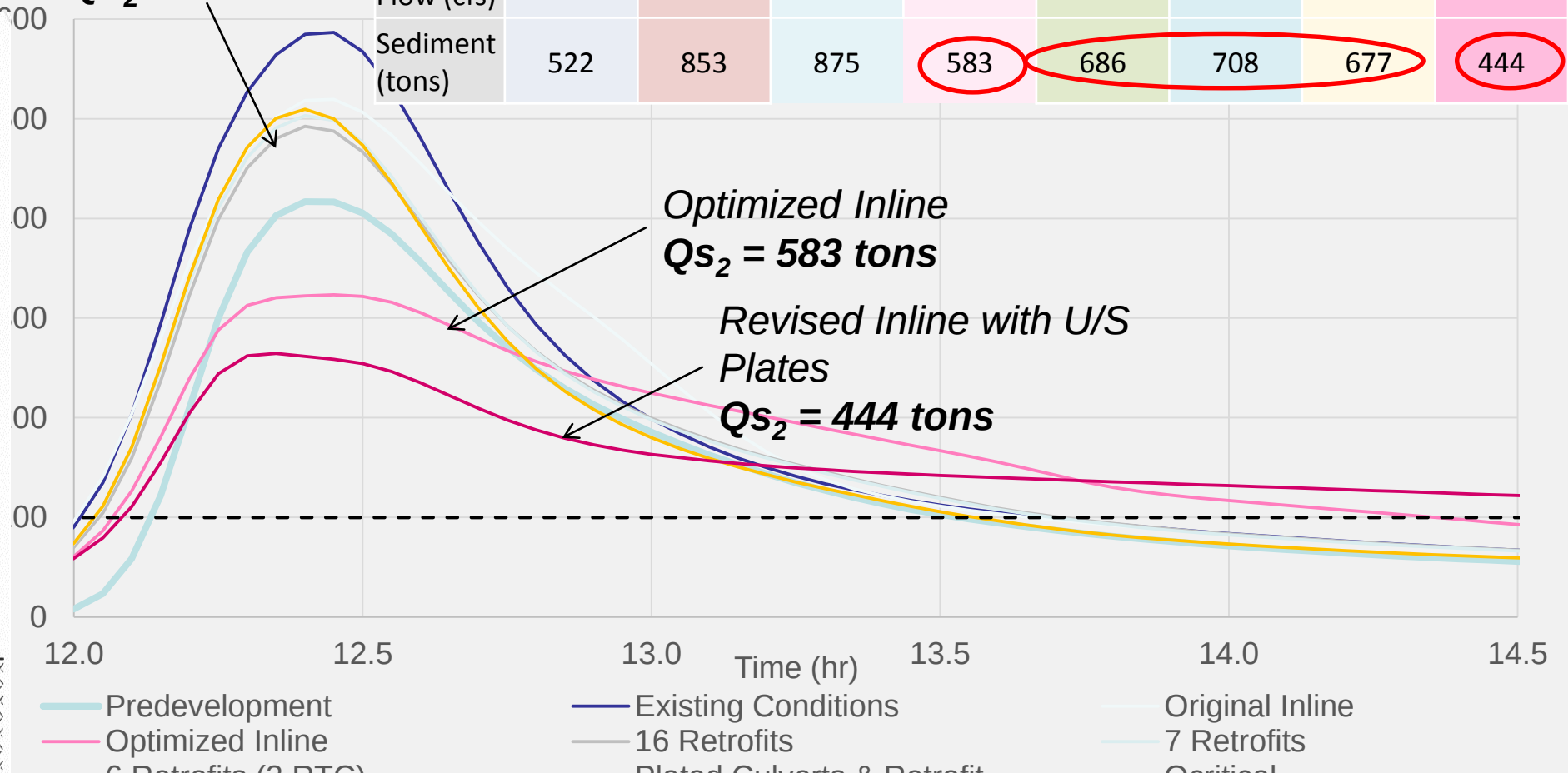
	Pre-develop-ment	Existing Conditions (28 as is)	Original Inline Design
Peak Flow (cfs)	412	596	502
Sediment (tons)	521	837	849





	Pre-development	Existing Conditions	Original Inline	Optimized Inline	16 Retrofits & Storage	7 Retrofits & Storage	6 Retrofits (3 RTC) & Storage	2 Plated Culverts, 2 Inline & 1 Retrofit
Peak Flow (cfs)	417	586	519	323	492	503	509	264
Sediment (tons)	522	853	875	583	686	708	677	444

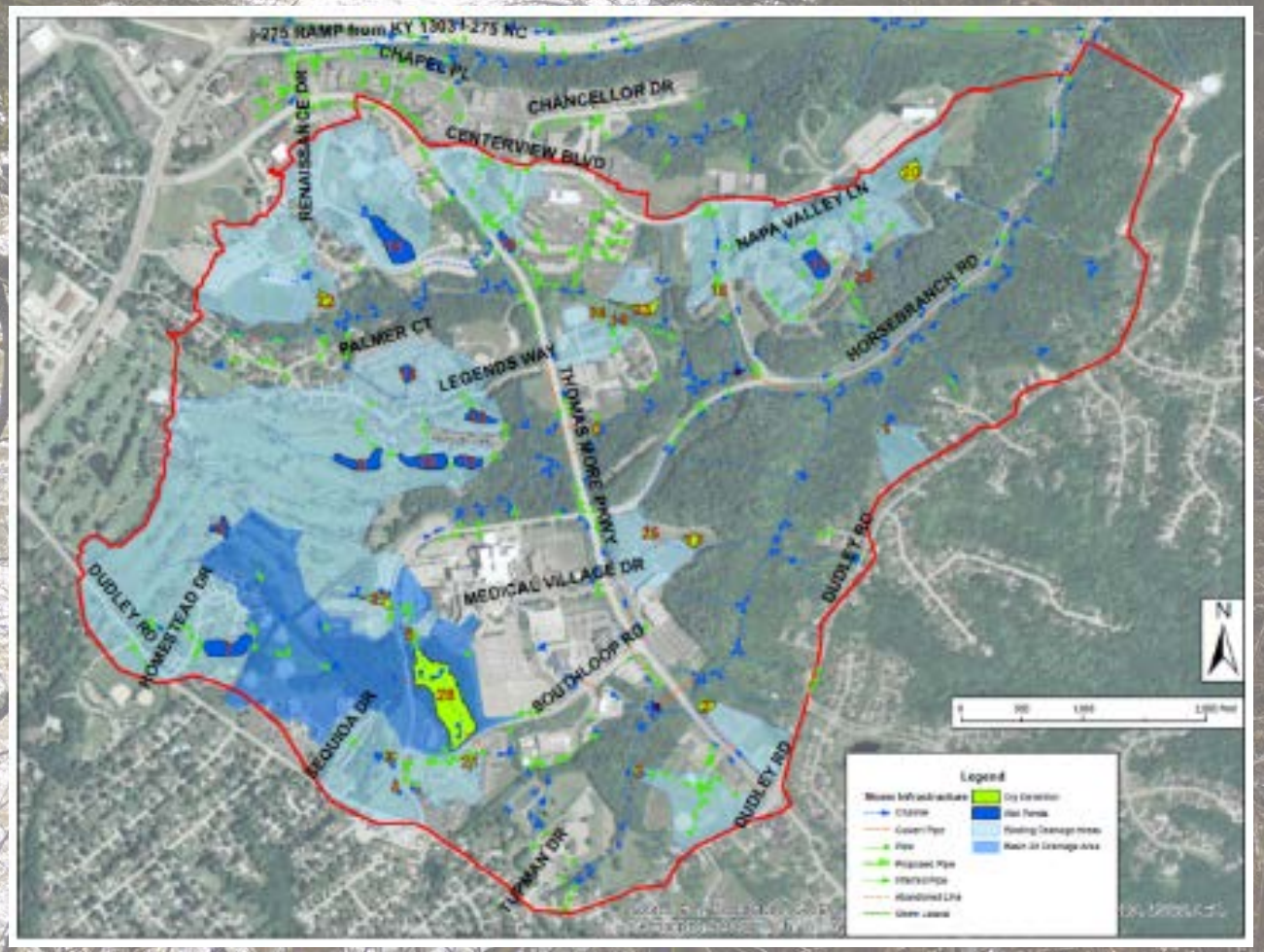




Success Monitoring

Opportunities for a Watershed Approach

- Improve physical, chemical, and biological integrity
- Stakeholder engagement, awareness, and participation
  - Cities, utilities, etc.
- Likelihood for in-stream success
  - relatively small watershed
  - only 20% impervious



Wrapping up

- Storm water runoff
  - Substantial threat
- Alters flow and disturbance regime
- Biologically relevant
- Protecting Streams and Rivers
  - “Low hanging fruit”

Thank you!

Discussion?

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I'm often asked why I do what I do, I simply grin, and show folks this photo…..