Minimizing Storm Water Runoff Impacts to Streams and Rivers through Targeted Flow Thresholds: 

*The Biological Relevance of Qcritical.*

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Matthew S. Wooten¹, Robert J. Hawley², Katherine R. MacMannis² and Elizabeth V. Fet¹

¹Sanitation District No. 1 Northern Kentucky (SD1), Fort Wright, KY,
²Sustainable Streams, LLC, Louisville, KY.
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!***
• 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)
Stability Index (Calibration Sites): $SI = -1.41 \ln(\text{Imp}) + 1.99$

$R^2 = 0.30$

$p = 0.03$

P<0.01
Baselines...(cont)

Community Structure Changes

urbanization
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 $Q_{\text{critical}}$

- 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
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)
(a) Pre-retrofit
2013-10-31
Peak intensity = 2.40 cm/h
Peak outflow = 0.17 m³/s

(b) Post-retrofit
2014-04-02
Peak intensity = 3.00 cm/h
Peak outflow = 0.15 m³/s

(c) Pre-retrofit
2013-12-05
Peak intensity = 2.40 cm/h
Peak outflow = 0.11 m³/s

(d) Post-retrofit
2013-06-04
Peak intensity = 6.60 cm/h
Peak outflow = 0.11 m³/s

Legend:
- Outflow
- Rainfall Intensity (at basin)
- Inflow (Pipes 1 & 2)
Hawley et al. (2017)
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
**Existing Conditions with existing detention**

$Q_s = 837$ tons

**Original Inline with existing detention**

$Q_s = 849$ tons

<table>
<thead>
<tr>
<th></th>
<th>Pre-Development</th>
<th>Existing Conditions (28 as is)</th>
<th>Original Inline Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flow (cfs)</td>
<td>412</td>
<td>596</td>
<td>502</td>
</tr>
<tr>
<td>Sediment (tons)</td>
<td>521</td>
<td><strong>837</strong></td>
<td><strong>849</strong></td>
</tr>
</tbody>
</table>
16 Retrofits and Alt. Storage \( Q_{s2} = 686 \text{ tons} \)

Optimized Inline \( Q_{s2} = 583 \text{ tons} \)

Revised Inline with U/S Plates \( Q_{s2} = 444 \text{ tons} \)
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?

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