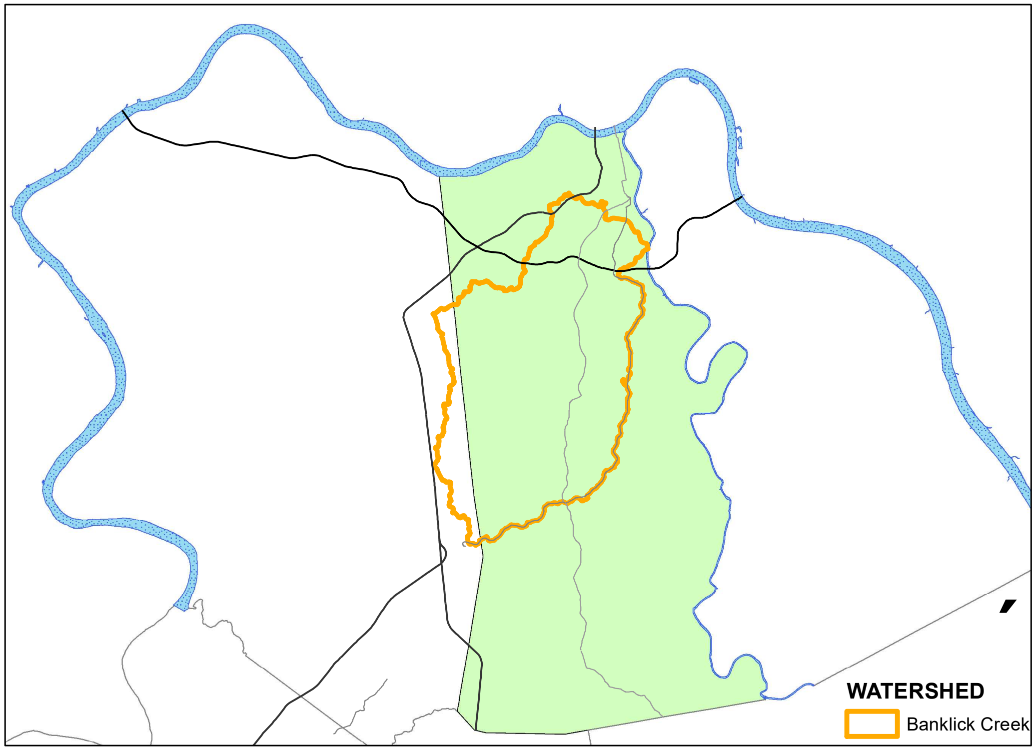
Basin Retrofits & Partnerships Banklick Watershed

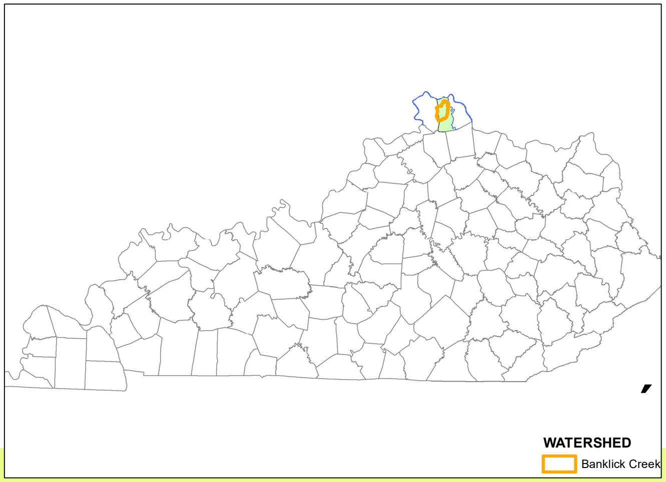
Kentucky Watershed Academy: Likely Partners

Nicole Clements
Watershed Coordinator
Banklick Watershed Council

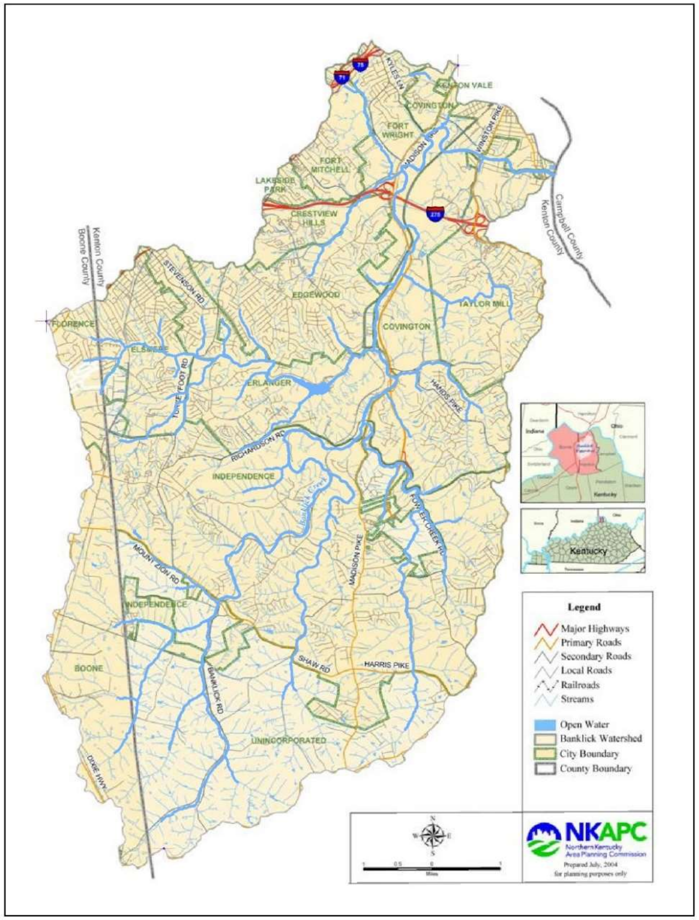
Banklick Watershed Council



- Formed in 2002
- Nonprofit, Volunteer Board
- Plan Developed in 2005
  - Revised 2010
  - 319(h) Funding



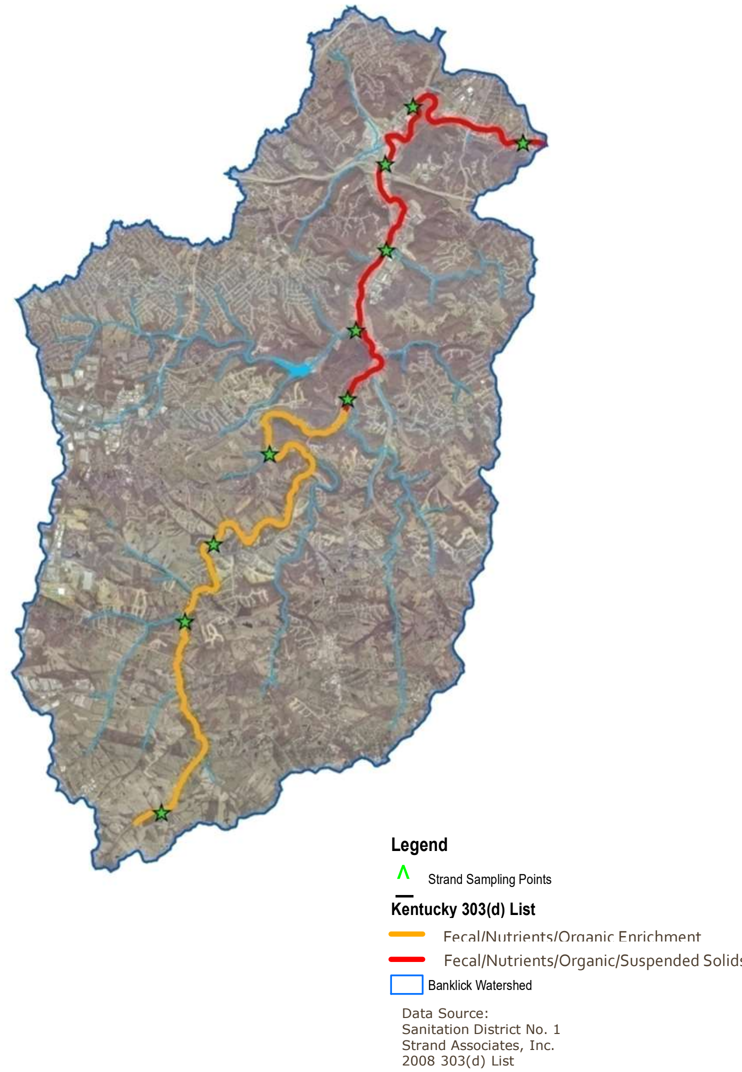
Banklick Watershed



- 58 square miles
- 19 miles long
- Agriculture in Headwaters, Highly Developed in Lower Reaches

Banklick Challenges

- Pollution
  - Fecal coliform, Nutrients, Organic, and Sediment
- Flooding
- Erosion & Stormwater Management



Channel Evolution From Land Use Changes

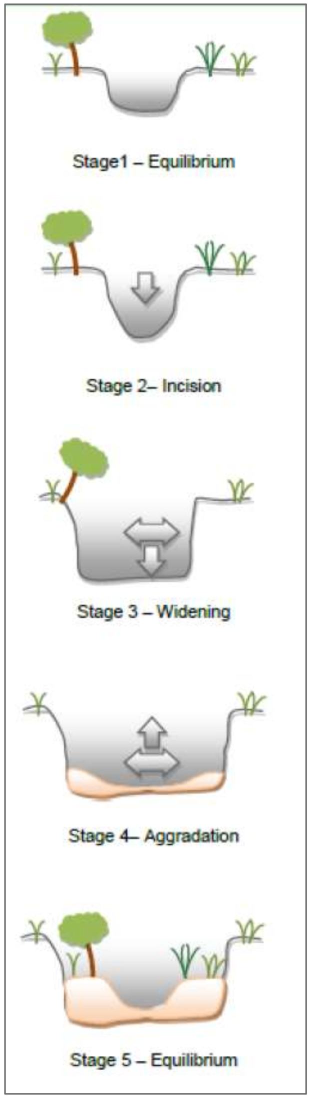
- Landuse Changes
  - More Runoff
  - Faster Runoff

  = Erosion of Streambank/bed

  = Instability of Channel

- Channel Evolution Model
  - Natural Process, as Streams 'Resize' and Erode to Adapt to Increased Flows
  - Consistent with NKY Steams

- Eroding, Evolving, Unstable Streams Problematic in Urban Areas



Channel Evolution Model

(Adapted from Schumm et al., and Hawley et al., 2020)

Runoff and Erosion Threatens Infrastructure

- Channel Incision & Widening Threatening Community Infrastructure
- Impacts to:
  - Roads, Bridges
  - Utilities (Gas Lines, Water, Sewers)
- Expensive, Recurring Repairs
  - KYTC – $3.1 Million in Damages in 2011
  - Dry Creek Watershed – $2.6 Million in Sewer Repairs over 7yrs.

* Pictures Courtesy SD1 of Northern Kentucky

Sanitation District No. 1 (SD1)

- Regional Wastewater/Stormwater (MS4) Utility
  - Boone, Kenton, Campbell Counties
- Recognized that Stream Erosion & Channel Instability
  - Risk To Infrastructure
  - Repairs Impacting Budget

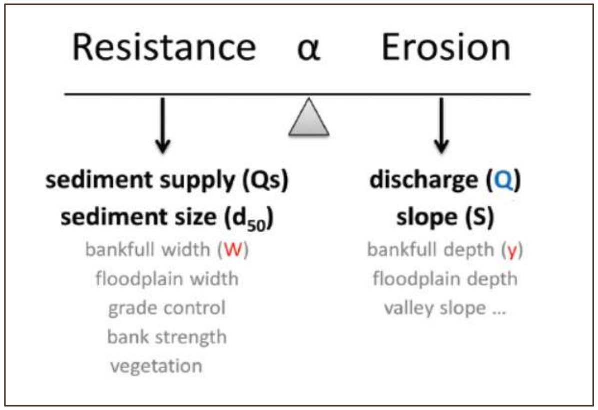
- SD1 Investigation & Research
  - Started in 2009
  - Lead by Matt Wooten (SD1 Aquatic Biologist)
  - Collected Hydrogeomorphic Data at 61 locations; 2x Annually
    - Channel Cross-sections, Longitudinal Profiles, Bed Material Composition
    - Tracked/Documented Erosion and Movement of Streams

- Conventional Urban Development was Altering Flow Regime in Creeks such that Hydromodification (Flashier Streams, Larger Flow) was the Cause of Excessive Stream Erosion and Overall Channel Instability

SD1 Research Findings

- Research Identified 'Critical Flow' Rate for NKY
  - Threshold at Which Streambed Mobilization Begins to Occur
  - 0.4 cfs per acre of Drainage Area

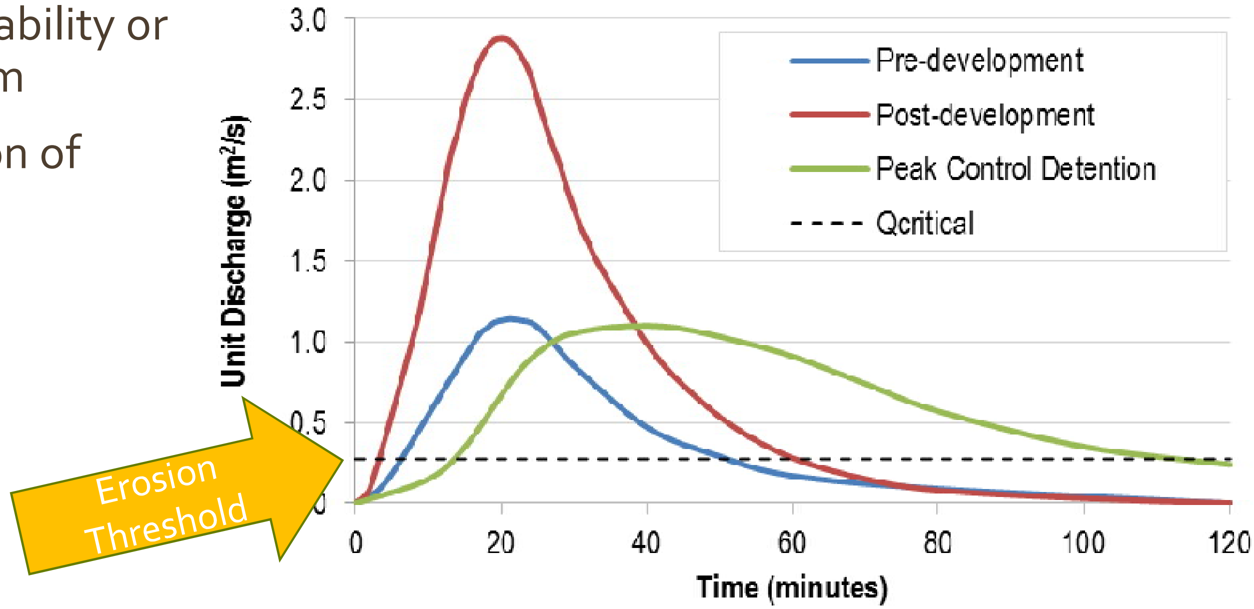
- SD1's Provided Basis for a Revised Approach to Stormwater Management
  - 2015 – New Basins Must Consider Erosion (Critical Flow)



Critical Flow Rate Considerations

Traditional Stormwater Controls

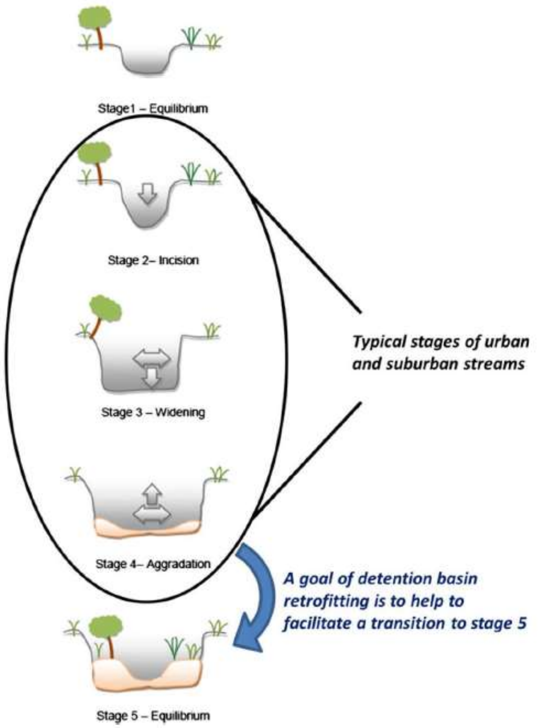
- Previously: Controls Peak Flow Rates for Large Storms to Minimize Downstream Flooding
- Does Not Address Channel Instability or Hydromodification Downstream
- Peak Control Elongates Duration of Erosive Flows



Detention Basin Retrofitting

Why Consider Basin Retrofitting?

- Retrofitting Goal:
  - More Natural Flow Regime
  - Facilitate Transition to Stage 5 (Equilibrium)



Adapted Channel Evolution Model
(Hawley et al., 2017)

2014 Pilot Project

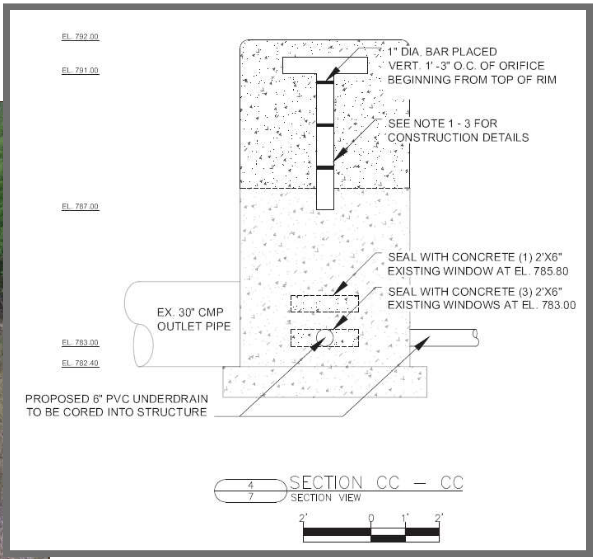
- How do We Retrofit Basins? What's Effective?
  - Completed Two Basin Retrofits Using Very Different Approaches

- #1) "Bioretention Retrofit"
  - Modify Outlet Control Structure
  - Excavation and Grading
  - Underdrains
  - Engineered Soils, Aggregate, Filter Fabric,
  - Native Plants

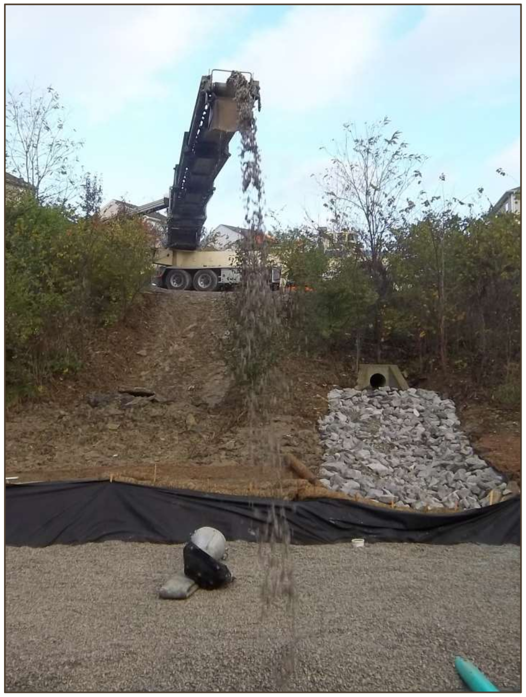
- #2) "Simplified Retrofit"
  - Modify Outlet Control Structure

Bioretention Retrofit
Before

- Residential Area (16 acre Drainage Area)



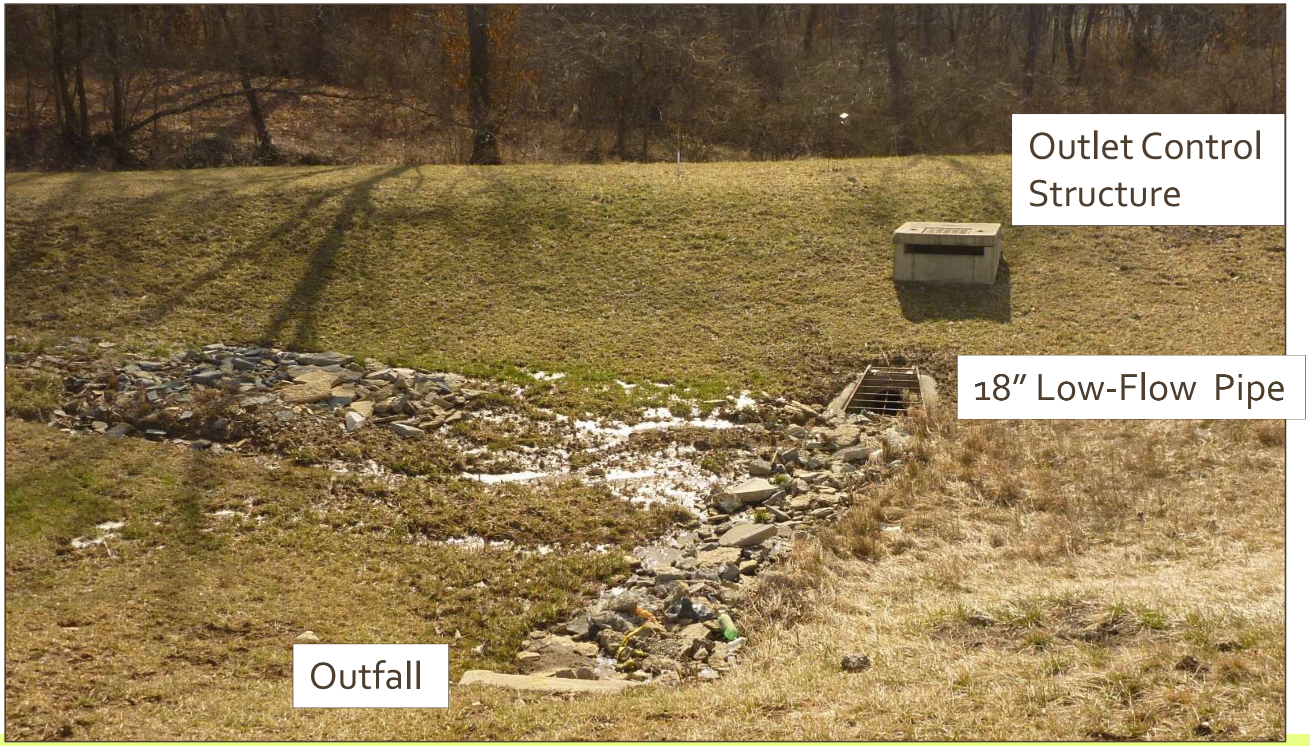
Bioretention Retrofit
During Construction



Bioretention Retrofit Completed – $72,000

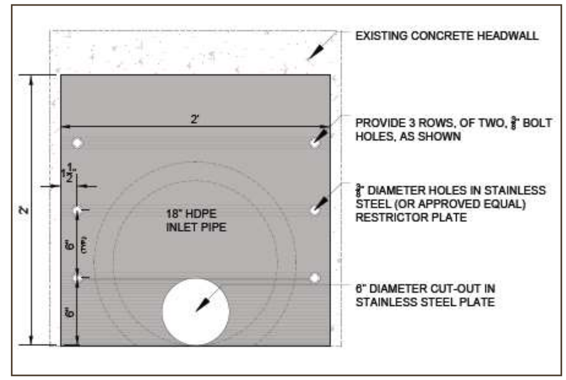
Simplified Retrofit
Before

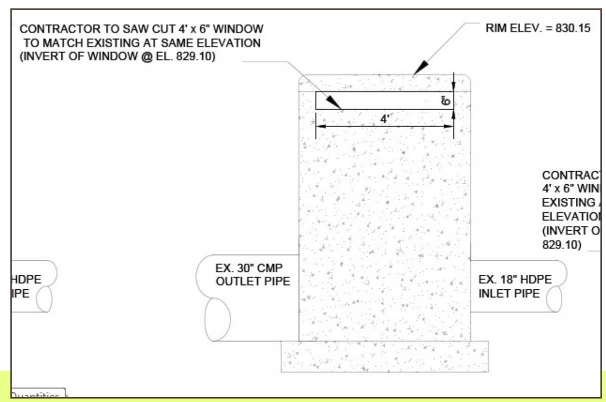
- Residential Subdivision – ~10 Acre Drainage Area



Simplified Retrofit

After - $4,000





Pilot Modeling Results

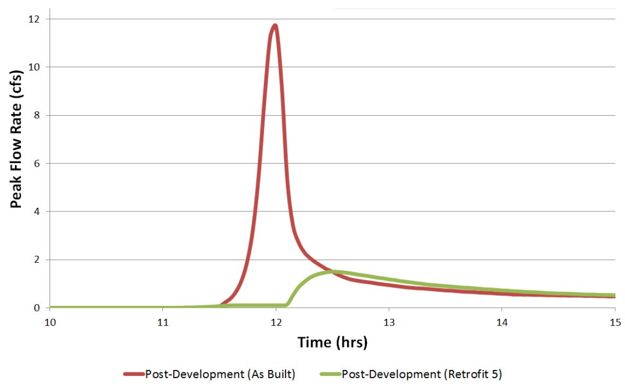
"Bioretention Retrofit"

- $72,000
- Flows (3-Month Event)

  Post-Development (As Built) = 11.71 cfs (+245%)

  Post-Development (Retrofit) = 2.47 cfs (-27%)
- Sediment Transport Model

Pre-developed	68 tons
Existing (w/detention)	398 tons (+407% or 330 tons)
Basin Retrofit	225 tons (+210%; 187 tons)



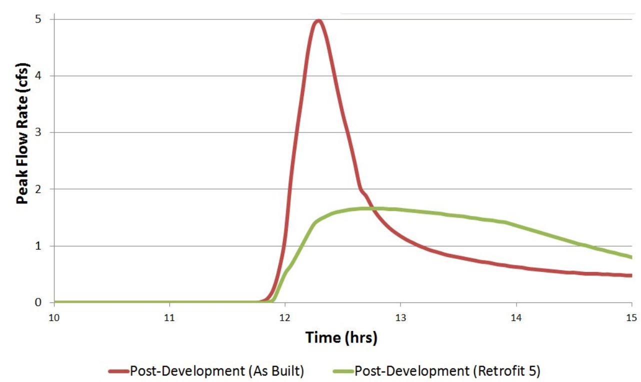
"Simplified Retrofit"

- $4,000
- Flows (3-Month Event)

  Post-Development (As Built) = 4.97 cfs (+4%)

  Post-Development (Retrofit) = 1.66 cfs (-65%)
- Sediment Transport Model

Pre-developed	516 tons
Existing (w/detention)	569 tons (+10% or 53 tons)
Basin Retrofit	340 tons (-34%; -176 tons)



Detention Basin Retrofit Pilot Approach Comparison

	Bioretention Retrofit	Basic Retrofit
Reduces Peak Flows for Small Storms	✓	✓
Provides Hydromodification Benefits (Reduced Bank Erosion)	✓	✓
Provides Volume Reductions	✓	
Provides Water Quality Treatment	✓	
Changed Aesthetics/Amenity	✓	
Cost Savings		✓

Moving Forward with Retrofitting

- Detention Basin Retrofits
  - Key "Tool in the Toolbox" for *Hydrologic Restoration* in Urban Areas
  - Sustainable Approach to Address Erosion & Sediment
  - Cost Effective Opportunity
  - ~165 Detention Basins in Banklick Watershed
- 9 completed
  - Design & Construction
  - $3,500 - $10,000 Depending on Complexity
  - "Batch" Projects (2 or 3 at a Time)
- Next Steps:
  - *SD1 Regional Opportunities Analysis*
    - Regional Needs
    - Strategic/Prioritized Implementation

(After)

"Low-Flow" Outlet at Basin Bottom (Before)

Lessons Learned

- Basin & Infrastructure Ownership
  - SD1 Easement vs. Private Ownership
  - Landowner Impacts - More Frequent Water in the Basin and Slower Release
  - Maintenance of Structure & Basin
- Not all Basins Qualify…
  - Some don't Have Excess Capacity
  - Some Weren't Constructed as Designed, or Meet Current Flood Control Standards
- Modeling Is Important
  - Basin Selection
  - Benefit:Cost
  - Define Goals: Channel Stability vs. Volume vs. Water Quality


(After)


"Overflow" Structure (Before)

Keys to Success:
Beneficial Partnerships

- Find Mutual Benefits
  - Sewer/MS4 = Infrastructure Risk Reduction
  - City, County, KYTC = Roadway/Bridge Protection
  - Property Owners = Property Loss & Erosion

- Approach to Partnership Building
  - Collaboration vs. Confrontation
  - Present Sound, Sustainable Solutions
  - Appeal to Fiscal Responsibility
  - Provide Value (Expertise, Time)
    - Experienced Team (Design & Construction)

Sustainable Streams LLC

STRAND ASSOCIATES

Questions?

- Special Thanks:
  - Matt Wooten, SD1
  - Bob Hawley, Sustainable Streams
  - Katie MacMannis, Sustainable Stream
  - Chris Rust, Strand Associates

- For more Information:

  Nicole Clements, Watershed Coordinator
  Banklick Watershed Council
  www.Banklick.org
  Admin@Banklick.org

1. Hawley, R.J., MacMannis, K.R., and M.S. Wooten. 2013. Bed Coarsening, Riffle Shortening, and Channel Enlargement in Urbanizing Watersheds, Northern Kentucky, USA. Geomorphology 201:111-126.
2. Hawley, R.J.; Wooten, M.S., MacMannis, K.R., and E.V. Fet. 2016. When do Macroinvertebrate Communities of Reference Streams Resemble Urban Streams? The Biological Relevance of Qcritical. Freshwater Science. 35(3):778-794.
3. Hawley, R.J., Goodrich, J.A., Korth, N.L., Rust, C.J., Fet, E.V., Frye, C., MacMannis, K.R., Wooten, M.S., Jacobs, M., Sinha, R. 2017. Detention Outlet Retrofit Improves the Functionality of Existing Detention Basins by Reducing Erosive Flows in Receiving Channels. Journal of the American Water Resources Association (JAWRA) 1-16.
4. Hawley, R.J.; MacMannis, K.R.; Wooten, M.S.; Fet, E.V., Korth, N.L. 2020. Suburban stream erosion rates in northern Kentucky Exceed reference channels by an order of magnitude and follow predictable trajectories of channel evolution. Geomorphology 352(106998.