The Willow Run Success Story: Integrated Planning and Green Infrastructure Solutions

Presenting:

MICHAEL WOOLUM, P.E., P.L.S.

Strand Associates, Inc.®
Agenda

- Sanitation District No. 1 Overview
- Regional Green Infrastructure Vision
- Case Study #1 – KYTC Detention Basin Retrofit
- Case Study #2 – Terraced Reforestation
- Case Study #3 – 12th Street Green Street
Sanitation District No. 1

- SD1 Service Area (146,640 acres)
- Combined Sewer System (6,036 acres)
- Boone, Kenton and Campbell Counties
Sanitation District No. 1

- Wastewater / Storm Water Utility
  - Special District established in 1946
  - Regional wastewater utility formed in 1994
  - Regional stormwater utility formed in 2003
  - Serves multiple local jurisdictions
    - Wastewater = 32 cities and 3 counties
    - Stormwater = 29 cities and 3 counties
  - Service Area
    - Wastewater = 187 square miles (CSS = 9.4 square miles)
    - Stormwater = 218 square miles
  - Infrastructure
    - 1,600 miles of sanitary sewers and 3 regional WWTPs
    - 450 miles of storm sewers and 15 flood pumping stations
Sanitation District No. 1

• Primary Water Quality Challenges
  • Sewer Overflows
    • CSOs ~ 1.7 billion gallons annually
    • SSOs > 100 million gallons annually
  • Stormwater Runoff
    • Urban and Rural
  • Stream Impairments ~ 200 miles
  • Stream Hydromodification
    • 6 mo. – 2 yr. (Q-critical)
Watershed Management Approach

• SD1 entered into a Consent Decree with U.S. EPA and Kentucky on April 18th 2007
  • First successfully negotiated consent decree based on an adaptive watershed management approach
• Requires SD1 to improve water quality, eliminate SSOs, and comply with the CSO Policy by 2025
• Approach allows SD1 to revise watershed plans every 5 years to “course correct”
• 18-36 permitted overflows/yr. based on receiving stream
Regional Green Infrastructure Vision

- Developed Green Infrastructure for each major basin (2009)
Regional Green Infrastructure Vision

- Green Infrastructure Program supports adaptive watershed management consent decree

Source: Sanitation District No. 1

Courtesy of: Strand Associates, Inc.
Willow Run Watershed

- Largest CSO in SD1’s system
  - 1,871 Acres
  - 485 MG CSO (approx. 33% of system total)
- Discharges to Ohio River
- Highly visible corridor
- Spans three cities (Covington, Park Hills, and Fort Wright)
- Historic Willow Run Creek
- Large transportation improvements pending: I-71/75 corridor

With Permission of: Sanitation District No. 1
Willow Run Watershed

**STRATEGIC SEPARATION with WATER QUALITY**
Offload natural drainage to proposed detention/water quality features and storm water conveyance.

**OFFLOADING**
Coordinate with future development projects to separate storm water from the combined system.

**DETENTION**
Incorporates new and retrofit designs to delay runoff from upper portion of watershed.

**DOWNSPOUT DISCONNECT**
Rooftop runoff directed to proposed detention/water quality features and storm conveyance.

**DRAINAGE IMPROVEMENTS**
Construction of new storm sewers reduces localized flooding.

**OPPORTUNITY BENEFITS**
Removal of 280 MG of CSO discharge
Approximately 58% reduction in overflow volume in a typical year.
Willow Run Watershed

Courtesy of: Strand Associates, Inc.® and Human Nature
Case Study #1 – KYTC Detention Basin Retrofit

- Detention basin drainage area = 110 acres
- Detention basin footprint = 2 acres
KYTC Detention Basin Retrofit

Map Data: Bing Maps
KYTC Detention Basin Retrofit Concept Plan

Courtesy of: Strand Associates, Inc.® and Human Nature
KYTC Detention Basin Retrofit Existing Outlet

- Multi-staged outlet control structure provided very minimal benefit for smaller design storms.
- Detention basin included excess storage capacity that was under utilized during most storm events.
KYTC Detention Basin Retrofit New Outlet Design
KYTC Detention Basin Retrofit Constructed Site Photos

Courtesy of: Strand Associates, Inc.
KYTC Detention Basin Retrofit Monitoring

50% - 75% Peak Flow Reduction

Peak Flow (gpm)

Rainfall (in)

Pre-Construction

Post-Construction

Courtesy of: Strand Associates, Inc.
KYTC Detention Basin Retrofit Monitoring

Peak Flow Rate Comparison - 0.41 Inch Rain Event

Peak (pre) = 2,090 gpm
Peak (post) = 442 gpm

Peak flow rate delayed by 18 hours

Flow (gpm)

Time (hrs)

Pre-Construction
Post-Construction

Courtesy of: Strand Associates, Inc.

Pre-Construction
Post-Construction
Constructed Site Photos

With Permission of: Sanitation District No. 1
Constructed Site Photos

With Permission of: Sanitation District No. 1
KYTC Detention Basin Retrofit Business Case

Existing Conditions
110 acre drainage area
2 acre existing basin

Monitored Benefits
23.2 MG CSO reduction annually

CIP Costs
$1.62 million (total)
$300,000 (retrofit only)
$0.07/gallon of CSO reduction
Case Study #2 – Terraced Reforestation

Map Data: Google

Courtesy of: Strand Associates, Inc.®
Terraced Reforestation Project Partners

- Public Agencies
  - Sanitation District No. 1 of Northern Kentucky (SD1)
  - Kentucky Transportation Cabinet
  - City of Covington

- Design Team
  - Strand Associates, Inc.®
  - Thelen Associates, Inc.
  - Human Nature, Inc.
  - Integrated Engineering (formerly Riegler Engineering)
Terraced Reforestation Concept Plans

- 20-acre Drainage Area

Source: Human Nature
Terraced Reforestation Concept Plans

Courtesy of: Strand Associates, Inc.® and Human Nature

I-75 Terraced Reforestation

6 MILLION GALLONS OF STORM WATER RUNOFF INTERCEPTED ANNUALLY
Terraced Reforestation Concept Plans

- Infiltration rate of in situ soils = 0.012 in./hr.
- < 1-2 in./hr. requires underdrain system.
Terraced Reforestation Concept Plans

- Geotechnical considerations
  - Slope stability as a result of detaining water and infiltration into in situ soils
  - Low permeability of in situ shale fill
  - Pockets of rubble fill from old interstate construction/demolition

Source: Thelen Associates
Terraced Reforestation Design

- Captured 2 point source inflows
Terraced Reforestation Construction

Courtesy of: Strand Associates, Inc.®
Terraced Reforestation Construction Lessons Learned

Source: Thelen Associates

Courtesy of: Strand Associates, Inc.
Terraces extend over 120 feet in vertical relief
Constructed Site Photos

- Interconnected terraces
  reduced outflow
Constructed Site Photos

With Permission of: Sanitation District No. 1
Constructed Site Photos

With Permission of: Sanitation District No. 1
Long-term reforestation objective provides added benefits
Constructed Site Photos
Constructed Site Photos

2010

2012

2014

With Permission of: Sanitation District No. 1
Long-Term Maintenance

With Permission of: Sanitation District No. 1
Long-Term Maintenance

With Permission of: Sanitation District No. 1
Long-Term Maintenance

• $4,000-5,000/yr. annual maintenance cost
Performance Monitoring and Business Case

- BMP performance and CSO volume reduction, monitoring and modeling
  - Pre-Construction vs. Post-Construction analysis

**Preliminary Monitoring Results**
- 5.6 MG CSO reduction annually

**Project Cost**
- $1,283,000
- $0.23 / gallon

*Courtesy of: Strand Associates, Inc.*
2014 ACEC National Honor Award

Seeing the Forest Through the TREES

Each year, 6 million gallons of storm water runoff generated by a massive tributary caused an estimated 4.2 million gallons of contaminated sewage overflow (CSO) to the Ohio River. The Southern District No. 1 (SD1) in Northern Kentucky is under a Consent Decree to address CSOs, with an emphasis on use of sustainable infrastructure solutions. This tributary seemed like an impractical location for the use of green storm water controls—over 120 feet of elevation change, poorly drained clay soils, and the risks associated with geotechnical instability were major obstacles.

Our Team developed a truly innovative concept plan and design to construct a terraced reforestation system on the tributary to manage storm water runoff using a series of large terraced berms. The project included 13 terraced berms having a total length of 4.740 linear feet. Within each berm, a 6-foot deep stabilization system was constructed including a grading zone, engineered vegetation soil, and understory to capture and slowly release, storm water runoff without causing turbulence instability. The berms and surrounding areas were planted with 300 trees and 8 acres of native seeding.

Constructed in the right-of-way of Interstate 71/75, the most highly trafficked corridor in the region, the magnitude and visibility of the terraced reforestation project provides a sustainable gateway into the Northern Kentucky region. The project serves as a national model of how storm water can be managed sustainably and cost-effectively, even in challenging conditions, to provide flow attenuation and volume reduction resulting in downstream CSO abatement.

TERRACED REFORESTATION FOR SUSTAINABLE CSO CONTROL, COVINGTON, KY

Honors Award

Terraced Reforestation for Sustainable CSO Control, Covington, KY

Strand Associates, Inc. - Cincinnati, OH

Courtesy of: Strand Associates, Inc.®

Source: ACEC-National, award banquet program, 2014
Case Study #3 – 12th Street Green Street

- Drainage area of approximately 1 acre (street runoff)
- Bioretention planter boxes, bioswale, and rain garden
- KYTC facilitated enhancement initiative
Constructed Site Photos

2011 – Before

2012 – After
Constructed Site Photos

Courtesy of: Strand Associates, Inc.
12th Street Green Street Business Case

Modeled Benefits
300,000 gallon CSO reduction annually

CIP Cost
$80,700
$0.27/gallon of CSO reduction

Courtesy of: Strand Associates, Inc.
Willow Run Watershed

Courtesy of: Strand Associates, Inc.® and Human Nature
Questions?

Michael Woolum, P.E., P.L.S.
Strand Associates, Inc.®
(859) 225-8500
Mike.Woolum@strand.com