Turning Monitoring Data into Watershed Priorities

National Water Quality Monitoring Conference
Cincinnati, OH

Mindy Scott, SD1
Carrie Turner, LimnoTech
May 1, 2014
Outline

- Background
- Data Collection
- Data Analysis
- Benefits
SD1 Background

**Wastewater Utility**
- Consolidated sanitary/combined sewers under SD1 in 1995
- 35 jurisdictions (32 cities and 3 counties)
- 176 square mile service area
- 1700 miles of sewer, 142 PS & 11 WWTPs

**Storm Water Utility**
- Formed regional utility in 2003
- Began transfer of ownership and maintenance of infrastructure in 2009
- 32 MS4 Phase II Co-permittees (29 cities and 3 counties)
- 218 square mile service area
- 435 miles of sewer and 31,000 structures
SD1 Primary Challenges

- **Combined Sewer Overflows**
  - 95 CSO Locations
  - 1.9 Billion Gallons Annually

- **Sanitary Sewer Overflows**
  - 179 SSO Locations
  - 240 Million Gallons Annually

- **Storm Water Runoff (MS4 & NPS)**
  - Hydromodification
  - Flooding

- **Impaired Waters**
  - Primary Pollutants of Concern (Bacteria, Solids & Nutrients)
Note: The segments of the Ohio River adjacent to the Cincinnati/Northern Kentucky area are listed as impaired from the Fourmile Creek confluence (Campbell County) downstream to the Big Bone Creek confluence (Boone County).
Consent Decree

• Signed April 18, 2007
• Requires SD1 to develop plans to address CSOs and SSOs by basin (overall goal to improve water quality)
• Unique – First CD to use watershed-based approach
Consent Decree Challenges

• How to prioritize controls and projects?
  – Large geographical area (590 sq. mi)
• What watersheds need improvement and for what parameters?
  – 6 of 16 watersheds had no water quality data
  – Need to consider both recreation and aquatic life
• Need for tools and models to manage and synthesize information across study area
Monitoring Program

• Perform water quality, biological, hydromodification and habitat surveys to assess stream conditions or “health”

• Conduct monitoring activities during 5-year rotating cycles
  – NKY watersheds, 590 miles² at approximately 75 sites
  – Ohio River, 90 stream miles at approximately 25 sites

• Used 4 study basins from Consent Decree consisting of 16 major watersheds to manage data collection efforts
Water Quality Monitoring

- Base Flow (dry weather conditions)
- Event-based (wet weather conditions)
Biological Monitoring

- Habitat Assessments
- Fish Population
- Macroinvertebrate Population
Hydromodification

- Cross-section & Profile Surveys
- Pebble Counts
Continuous Monitoring Program

- USGS Cooperative Agreement
- 13 Stations
- Real-time (15 minute) flow and water quality measurements

---

### National Water Information System: Web Interface

#### USGS Water Resources

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station name</th>
<th>Date/Time</th>
<th>Gage height, feet</th>
<th>Discharge, cfs</th>
<th>Precipitation in inches during the previous 24 hours</th>
<th>Temperature, water, deg C</th>
<th>Dissolved oxygen, mg/L</th>
<th>Percent of saturation</th>
<th>Data Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>03280100</td>
<td>ELLIANS CREEK @ ELLIANS CREEK RD NR HEBRON, KY</td>
<td>11/10 08:00</td>
<td>1.51</td>
<td>1.2</td>
<td>10.5</td>
<td>10.5</td>
<td>95</td>
<td>6.6</td>
<td>624</td>
</tr>
<tr>
<td>03282001</td>
<td>WIGLER CREEK AT WIGLER ROAD NEAR BURLINGTON, KY</td>
<td>11/10 08:45</td>
<td>1.23</td>
<td>4.5</td>
<td>10.1</td>
<td>10.7</td>
<td>96</td>
<td>7.2</td>
<td>583</td>
</tr>
<tr>
<td>03277075</td>
<td>GUN POWDER CR AT CAMP ERNST RD NR UNION, KY</td>
<td>11/10 09:00</td>
<td>1.02</td>
<td>13.0</td>
<td>11.0</td>
<td>9.8</td>
<td>91</td>
<td>6.3</td>
<td>616</td>
</tr>
<tr>
<td>03277130</td>
<td>MUD CRICK AT HWY 42 NR BEAVERLICK, KY</td>
<td>11/10 08:45</td>
<td>1.23</td>
<td>8.2</td>
<td>10.4</td>
<td>10.8</td>
<td>--</td>
<td>8.1</td>
<td>398</td>
</tr>
<tr>
<td><strong>Boone County</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03280140</td>
<td>TAYLOR CREEK AT DONNERMEYER DRIVE AT BELLEVUE, KY</td>
<td>11/10 08:30</td>
<td>1.20</td>
<td>0.50</td>
<td>11.3</td>
<td>8.5</td>
<td>79</td>
<td>7.1</td>
<td>1,160</td>
</tr>
<tr>
<td>03282044</td>
<td>TWELVE MILE CREEK AT HIGHWAY 1997 NR ALEXANDRIA, KY</td>
<td>11/10 08:45</td>
<td>1.73</td>
<td>10.0</td>
<td>11.3</td>
<td>8.5</td>
<td>79</td>
<td>7.1</td>
<td>1,160</td>
</tr>
<tr>
<td>03280772</td>
<td>FOUR MILE CREEK AT POPULAR RIDGE RD NR ALEXANDRIA, KY</td>
<td>11/10 09:00</td>
<td>1.22</td>
<td>0.56</td>
<td>11.3</td>
<td>8.5</td>
<td>79</td>
<td>7.1</td>
<td>1,160</td>
</tr>
<tr>
<td>03254520</td>
<td>ELK RIVER AT HWY 536 NEAR ALEXANDRIA, KY</td>
<td>11/10 08:30</td>
<td>8.75</td>
<td>--</td>
<td>10.9</td>
<td>11.2</td>
<td>103</td>
<td>8.0</td>
<td>324</td>
</tr>
<tr>
<td>03254695</td>
<td>TWELVE MILE CREEK AT HWY 9 AT COVINGTON, KY</td>
<td>11/10 08:30</td>
<td>1.64</td>
<td>--</td>
<td>10.2</td>
<td>9.7</td>
<td>87</td>
<td>8.8</td>
<td>963</td>
</tr>
<tr>
<td><strong>Campbell County</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03254480</td>
<td>CROUSSE CREEK AT HWY 17 NR PINE, KY</td>
<td>11/10 08:45</td>
<td>2.73</td>
<td>1.5</td>
<td>10.2</td>
<td>9.5</td>
<td>86</td>
<td>8.1</td>
<td>669</td>
</tr>
<tr>
<td>03254330</td>
<td>BALKIRE CREEK @ HIGHWAY 1829 NR ERLANGER, KY</td>
<td>11/10 09:00</td>
<td>3.65</td>
<td>12.0</td>
<td>10.2</td>
<td>9.5</td>
<td>86</td>
<td>8.1</td>
<td>669</td>
</tr>
<tr>
<td>03254015</td>
<td>PLEASANT RUN CREEK AT OAK STREET NEAR LUDLOW, KY</td>
<td>11/10 08:30</td>
<td>1.18</td>
<td>1.6</td>
<td>10.4</td>
<td>8.6</td>
<td>78</td>
<td>7.3</td>
<td>978</td>
</tr>
<tr>
<td>03260073</td>
<td>DRY CREEK AT SEWAGE PLANT NEAR ERLANGER, KY</td>
<td>11/10 08:30</td>
<td>1.35</td>
<td>1.5</td>
<td>10.4</td>
<td>8.6</td>
<td>78</td>
<td>7.3</td>
<td>978</td>
</tr>
</tbody>
</table>

**Kenton County**

Data status codes:
- -- Parameter not determined
Data Management

• Lots of water quality data
  – Over 3,000 samples
  – 12 - 20 parameters
  – Nearly 40,000 results

• Data management strategy
  – Organization
  – Centralized
  – Readily accessible
Data Management Framework

- **Master Database**
  - (Survey, Location, Agency Info)

- **Water Quality Database**
  - (Samples, Parameters, Data, QA/QC)

- **Biological/Habitat Database**
  - (Samples, Taxonomy, Metrics, Indices, Data)

- **Continuous Monitoring Database**
  - (Data by Date/Location)

- **Source Database**
  - (Samples, Parameters, Data, QA/QC)

- **Hydrologic Database**
  - (Flow data by date/location)

- **Meteorological Database**
  - (Rain and climate data by date/location)
What Did We Want to Learn from WQ Data?

• What parameters are most important in each watershed?
• What watersheds are most impacted by pollutants?
• What is the relative importance of dry and wet weather pollutant sources in each watershed?
• Are there correlations between watershed characteristics and in-stream water quality conditions?
Water Quality Monitoring Results
A Tale of Two Watersheds

Taylor Creek

Banklick Creek
Comparisons Across Watersheds (Total Phosphorus)
Fecal coliform Box-and-Whisker Plots
Comparison to WQ Standards (Fecal coliform)

Percent of Samples Exceeding Single Sample Maximum Fecal Coliform Water Quality Standard (400 cfu/100 ml)

- **Base Flow**
- **Wet Weather**
• High bacteria levels in dry and wet weather
• Wet weather sources important
• Non-SD1 sources also important
Comparisons Within Watersheds (TSS)

Total Suspended Solids (mg/L)

- MLC12.0
- MLC3.0
- MCF1.7
- BBC3.9
- BSF1.8

- TYC0.6
- TYC1.6-UNT0.4
- TYC0.9-WLC1.3
- TYC0.7-CVR0.2

- Dry
- Wet 1
- Wet 2
- Wet 3
- Wet 4
Major Findings

• Bacteria is a pollutant of concern in nearly all watersheds
  – In some watersheds, the highest levels were measured upstream of CSO and SSO inputs
• Nutrient levels vary a lot between and within watersheds
• Very few DO, pH or metals values exceeded water quality standards in any watershed
• Wet weather sources impact all watersheds
  – Watersheds most impacted by wet weather tend to have more imperviousness and more development
  – Bacteria, solids and phosphorus showed largest response to rainfall
  – Pollutant loads roughly correlate to storm size for most parameters
• Dry weather sources also important in some watersheds
Challenges

• Sites becoming unavailable due to construction or other access issues
• Field instrumentation
• Making the “go/no go” decision for wet weather
• Sampling representative conditions
Sampling Representative Conditions

- Not too wet, not too dry
Planning Tools

- Stream Condition Index
- Watershed Assessment Tool
- Watershed/Water Quality Models
Integrated Plan Implementation Strategy

SSO Solution

Cost-effective I/I Removal & BMP Activities

Monitor Effectiveness

Design Additional Gray to Achieve LOC

CSO Solution

Implement Green Infrastructure

Monitor Effectiveness

Design Additional Gray to Achieve LOC
Benefits of Sampling Program

• Confirmed anecdotal information about watersheds
  – Taylor Creek most impacted
• Increased understanding about stressors and conditions across all watersheds
• Used to develop analysis tools and inform detailed water quality models
• Establishes baseline to quantify improvements from control projects
• Communicate conditions to public and other stakeholders
• Confirmed the adaptive approach of the Consent Decree
  – Multiple pollutant sources warrant integrated plan to improve WQ
Questions?

Mindy Scott
SD1
mscott@sd1.org
(859) 578-6743

Carrie Turner
LimnoTech
cturner@limno.com
(734) 332-1200

Acknowledgements
Jim Gibson (SD1)
Matt Wooten (SD1)
Craig Frye (SD1)