Ohio River Bridges (ORB)

- “Increase cross-river mobility by improving safety, alleviating traffic congestion & connecting highways”
- 2011 Project Overview Video
Section 3

- Walsh Design Build Team – Section 3 Roles
  - Walsh Construction – Oversight & Management
  - Jacobs Engineering – Oversight & Management
  - Milestone Contractors – Construction
  - RW Armstrong (CHA) – Design

- ~$183 Mil. – construction & design
- 1.3 Miles of I-65 widening
- US-31 reconstruction
- 20+ bridges
- 20+ ramps
Section 3
Section 3 Drainage Design History

- **Jan. 2012 – Scoping/Preliminary Design**
  - Jansen & Spans Engineering

- **Summer 2012 – Bid Design**
  - Jacobs + Matt Gavelek of RW Armstrong (CHA)

- **2013 – Final Design**
  - RWA with Jacobs oversight
  - Section 3 Drainage Lead
    - Paul Myers of RW Armstrong/CHA
  - RWA/CHA design team ≈ 4 engineers + 1 CAD
  - Matt Gavelek of RW Armstrong/CHA
    - Hydrodynamic modeling, trunkline sizing, detention sizing, hydraulic reports, etc
Section 3 Drainage Design History

- Scoping/Preliminary Design
  - Identified importance of Cane Run & provided options

- Bid Design
  - Selected one option – detention to Cane Run

- Final Design
  - Finalized design
  - Added partial watershed re-route based on feed-back from local authorities
Cane Run Watershed

- Discharges to Ohio River
- Cane Run—low spot in Jeffersonville & Clarksville
  - Behind Ohio River floodwall/levee system
- Mostly urban
  - Also includes large combined sewer system
    - Total drainage area is complicated due to differing performance per rain event
- Strand Assoc. performed CSO LTCP & Mill Creek and Cane Run watershed analysis
  - Estimated non–combined sewer watershed = 363 Ac
  - Combined sewer “watershed” is complicated
Exhibit from Strand Assoc. Study

Project Overview
Cane Run Watershed
Partial Watershed Relocation
Summary
At time of ORB design, included Jeffersonville Wastewater Treatment Plant effluent
  ◦ Jeffersonville plans to send effluent to Mill Creek instead of Cane Run in future
Cane Run – main outlet of Section 3
Section 3 – ROW
  ◦ Approx. Total 107 Ac
  ◦ Existing direct drainage area to Cane Run \(\approx 58\) Ac
  ◦ Additional runoff indirectly enters Cane Run
Cane Run Watershed

- Existing direct Cane Run drainage area within project ROW (shown in yellow)
Culverts within ROW

Figure 2 - Existing Ramp Culvert Entrance (East End)

Figure 3 – Existing Ramp Culvert Exit (West End)

Figure 4 - Existing I-65/US-31 Culvert Entrance (West End)

Figure 5 – Channel Between Culverts
Downstream of project

- Earthen Levee
- 84" R.C.P. & Flag Gate
- 96" R.C.P.
- 96" R.C.P.
- Cane Run Lift Station
- 8'x6' R.C. Culvert
- 10th St. Lift Station

Project Overview  Cane Run Watershed  Partial Watershed Relocation  Summary
Cane Run Flooding History

- Dependent upon the Ohio River
- Major Ohio River Flood events:
  - 1832, 47, 67, 83, 84; 1913, 37, 48, 64, 97
- 1937 worst, estimated as >500-Yr flood
  - FIS states, “The 1937 flood on the Ohio River was the greatest and most destructive flood in the history of the Town of Clarksville. On January 27, 1937, the river crested at an elevation of 458.1 (NAVD)…Flood damage ran into the millions of dollars.”
  - I-65 at Cane Run is at elev. 440 (NAVD)
Cane Run Flooding History

Great Flood of 1913 – Jeffersonville, IN

Courtesy of Indiana Historical Society
Cane Run Flooding History

- Great Flood of 1937, Louisville, KY

<table>
<thead>
<tr>
<th>Location</th>
<th>January 1937 Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Louisville</td>
<td>19.2 in</td>
</tr>
<tr>
<td>Lexington</td>
<td>16.1 in</td>
</tr>
<tr>
<td>Bowling Green</td>
<td>20.7 in</td>
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<tr>
<td>Cincinnati</td>
<td>19.7 in</td>
</tr>
<tr>
<td>Evansville</td>
<td>14.8 in</td>
</tr>
<tr>
<td>Earlinton, Kentucky</td>
<td>23.0 in</td>
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</tbody>
</table>

Horses caught in branches of a tree several weeks after flood crest.

Widespread flooding at and around Churchill Downs.

Inundation of western Louisville looking east toward downtown.

Houses flipped in a Louisville neighborhood.

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Project Overview  Cane Run Watershed  Partial Watershed Relocation  Summary
Cane Run Flooding History

- Floodwall Levee System

Google Earth Street View
Floodwall – Levee System
- Completed 1949
- Protects 4,190Ac
- Protects 3’ above 1937 Flood Event
- 5.1 miles of earthen levee
- 1.8 miles of concrete floodwall
- 10 pump stations
Cane Run Flooding History

- Extreme flood event April 2011
  - Flood wall activated
  - Cane Run pumps could not keep up
  - Brought in many pumps to drain Cane Run
  - Holiday Inn & residential properties were partially flooded
- Pumps at Ohio River Levee are undersized
- Local municipalities plan to upgrade Cane Run pumps at Ohio River levee
- Currently, Jeffersonville city council voted no
Cane Run Flooding History

- Cane Run receives runoff from Jeffersonville & Clarksville. INDOT’s ROW is in the middle.
- Cane Run was completely open, but development enclosed 4/10 of a mile with 96” RCP
- Multiple parties complicates responsibility
- Given flooding history & situation, the Design-Build Team took extra consideration
INDOT’s IDM non-comprehensive legal discussion:

“The following generalizations can be made for drainage liability:”

- “1. A goal in highway–drainage design should be to perpetuate natural drainage as practical.”
- “2. The courts look with disfavor upon infliction of injury or damage that can be reasonably be avoided by a prudent designer, including where some alteration in flow is legally permissible.”
- “3. The laws relating to the liability of government entities are undergoing radical change, with a trend toward increased government liability.”
Considerations

- Perpetuating natural drainage would have perpetuated the existing flooding problems.
- Due to levee system, volume must also be considered.
- DBT pro-actively pursued discussions with local municipal authorities.
Clarksville and Jeffersonville asked – no additional runoff be added to Cane Run

Strand Assoc. – Cane Run watershed consultant:
  ◦ Recommended not adding additional runoff to Cane Run, but instead, send as much runoff to the Woerner Avenue Flood Control Pump Station as possible
  ◦ Flood Control District Superintendent agreed

Existing Corps’ Lift Station capacities:
  ◦ Cane Run ≈ 30cfs, active
  ◦ Woerner Ave ≈ 100cfs, rarely active
Partial Watershed Relocation

- Flood Control District Superintendent suggested sending the south portion of flow to a 42” separated previous combined sewer – Missouri St
- Jeffersonville looked at sewer & DBT tv’d the line
  - Found the brick sewer to be in good condition
- DBT investigated partial watershed relocation
Partial Watershed Relocation

- Identified watershed which could be relocated
Hydrodynamic Modeling

- DBT utilized Hydrodynamic Wave Routing
  - For trunk-line and detention pond analysis
  - Accounts for unsteady flow, pipe storage, backwater effects, momentum, time step
  - Solves full St. Venant equations
  - Huff curves (10%, 2%, 1%E.P. – 30Min to 24Hr duration)
- Exported line work from Microstation, built model with StormNet
  - StormNet software purchased by AutoCAD Civil 3D, now called Storm & Sanitary Analysis
Hydrodynamic Modeling

- Built 6 models
  - Existing Missouri St. – Within ROW
  - Proposed Missouri St. – Within ROW
  - Existing Missouri St. – Including Offsite
  - Proposed Missouri St. – Including Offsite
  - Existing Cane Run – Within ROW
  - Proposed Cane Run – Within ROW
Hydrodynamic Modeling
Existing MO St. Model | Proposed MO. St. Model Including Offsite
Hydrodynamic Modeling

Existing MO St. Model – Including Offsite

Proposed MO St. Model – Including Offsite
Hydrodynamic Modeling

Existing Cane Run Model | Proposed Cane Run Model
Cane Run Models

- **Existing Model**
  - 11 watersheds, 18 nodes, ≈1 mi. of links
  - Based on I–65 existing plans & survey

- **Proposed Model**
  - 10 watersheds, 16 nodes, ≈ 0.6 mi. of links
  - 2 Detention ponds
    - 6th St. Pond
    - 10th St. Pond
Proposed Detention Ponds

- **6th St. Detention Pond**
  - 15” Orifice + emergency overflow
  - 2% E.P. 1–Hr. peak inflow = 30cfs
  - 2% E.P. 1–Hr. peak outflow = 14cfs

- **10th St. Detention Pond**
  - 18” for low flow channel/standing water
  - 18” Orifice + emergency overflow
  - 2% E.P. 1–Hr. peak inflow = 79cfs
  - 2% E.P. 1–Hr. peak outflow = 8cfs

- **Combined 2% E.P. 1–Hr. Storage = 5.5Ac–ft**
Hydrodynamic Modeling

Existing Cane Run Discharge – within INDOT ROW
Hydrodynamic Modeling

Proposed Cane Run Runoff and Discharge – within INDOT ROW
Impacts to MO St. Sewer

- Additional ≈ 13.5Ac to Missouri St. sewer
- Provided two detention ponds to Missouri St sewer
- Court St. Loop detention pond is very large
  - Peak discharge ≈ 2.5 cfs
- Resulted in peak discharge improvement to MO St. sewer from INDOT ROW
  - Existing 10%E.P. peak discharge ≈ 20.7 cfs
  - Proposed 2%E.P. peak discharge ≈ 17.0 cfs
Impacts to Cane Run

- Resulting Cane Run watershed within INDOT ROW:
  - Total acreage
    - Existing ≈ 58.3
    - Proposed ≈ 59.9
  - Total Cw*Ac
    - Existing ≈ 33.1
    - Proposed ≈ 37.1

- Resulting Peak discharge to Cane Run from INDOT ROW:
  - Existing 10%E.P. ≈ 76cfs
  - Proposed 2%E.P. ≈ 60cfs
The ORB project will “increase cross-river mobility by improving safety, alleviating traffic congestion & connecting highways”.

Section 3 is located in a complex hydraulic scenario:
- Flood-wall/levee system
- Combined sewers
- Urban runoff

Previously flooded regions demand extra design consideration.
Summary

- Local authorities are an excellent resource
- Peak discharge may be main design criteria, but keep an open eye for other considerations
  - Cane Run’s levee system required volume consideration
- Consider hydrodynamic wave routing for complex situations
Win–Win Solutions DO Exist

- Local communities satisfied
  - Town of Clarksville accepted
  - City of Jeffersonville accepted
  - Jeffersonville – Clarksville Flood Control District accepted

- Approval granted from Army Corps of Engineers, INDOT & KYTC

- DBT Satisfied
  - Lowered construction cost
  - Stayed on schedule
  - Minimized contribution to Cane Run flooding problems
  - Met all design criteria, plus additional volume criteria
THANK YOU
Sources