The Ohio River Bridges – Section 3
Partial Cane Run Watershed Relocation

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100th Purdue Road School
Drainage Track
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Project Overview
Cane Run Watershed
Partial Watershed Relocation
Summary

Ohio River Bridges (ORB)

- "Increase cross-river mobility by improving safety, alleviating traffic congestion & connecting highways"[3]
- 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

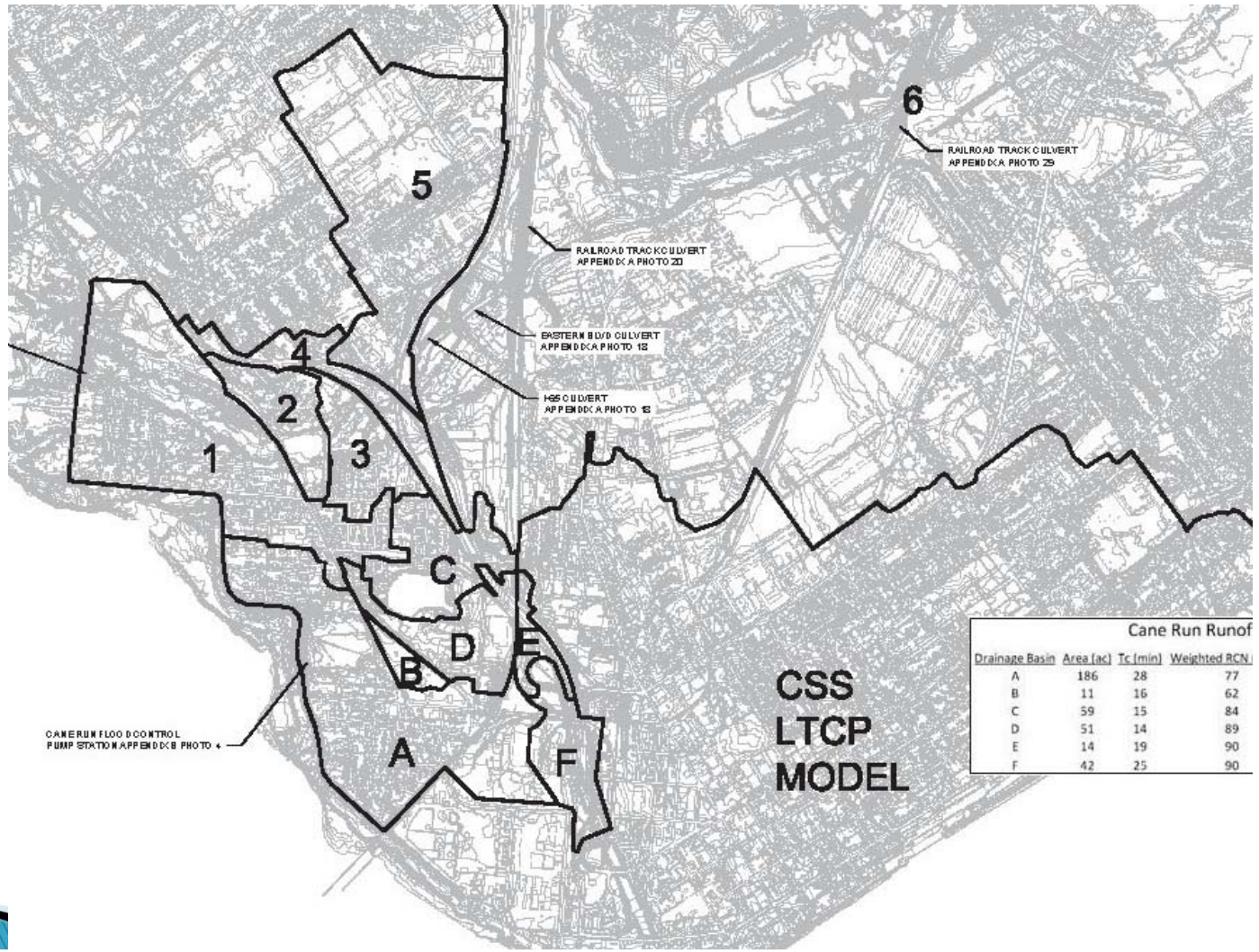
Section 3 Drainage Design History

- 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

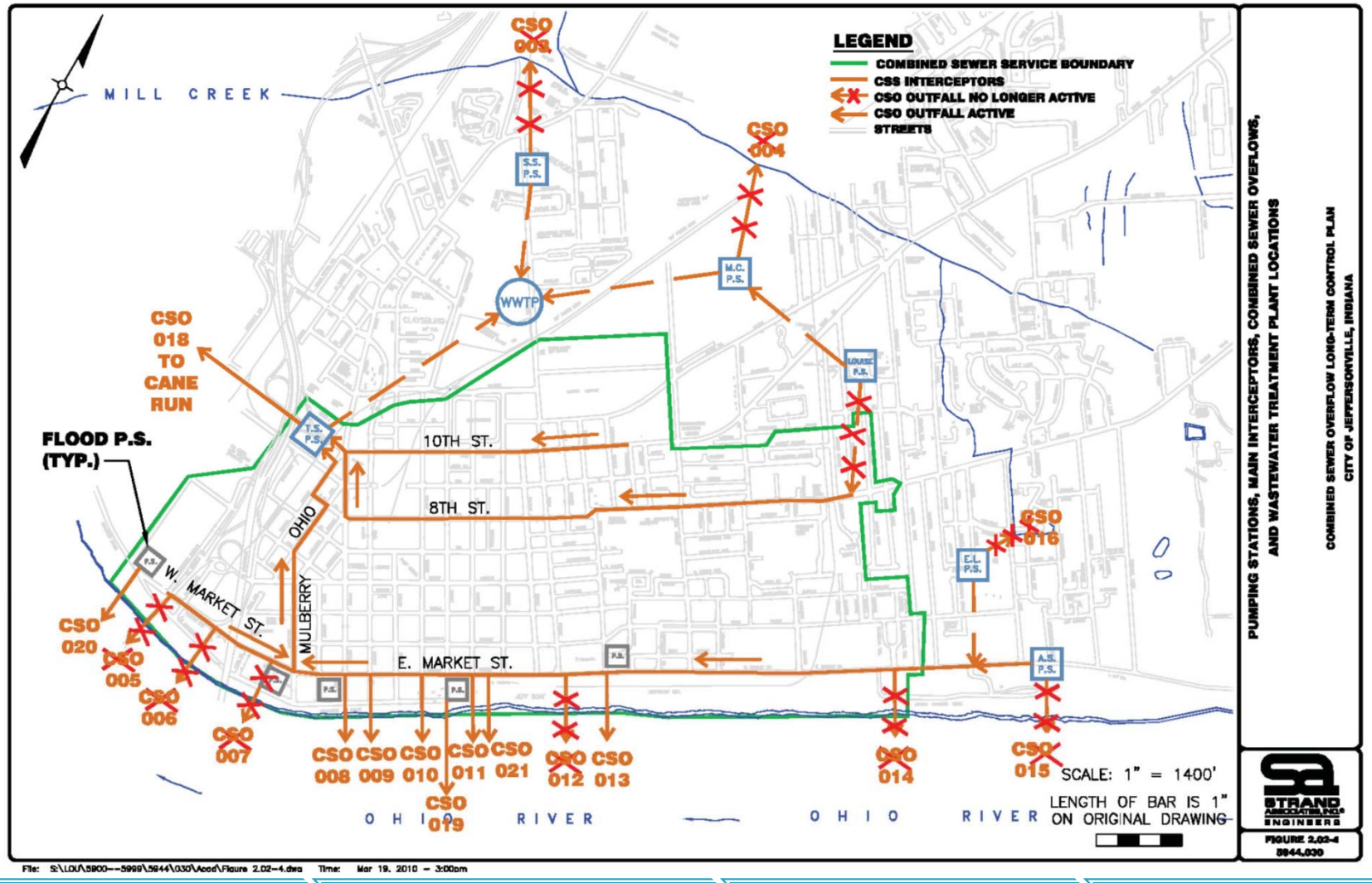
Exhibit from Strand Assoc. Study[5]



Cane Run Runoff

Drainage Basin	Area (ac)	Tc (min)	Weighted RCN
A	186	28	77
B	11	16	62
C	59	15	84
D	51	14	89
E	14	19	90
F	42	25	90

Exhibit from Strand Assoc. Study[6]

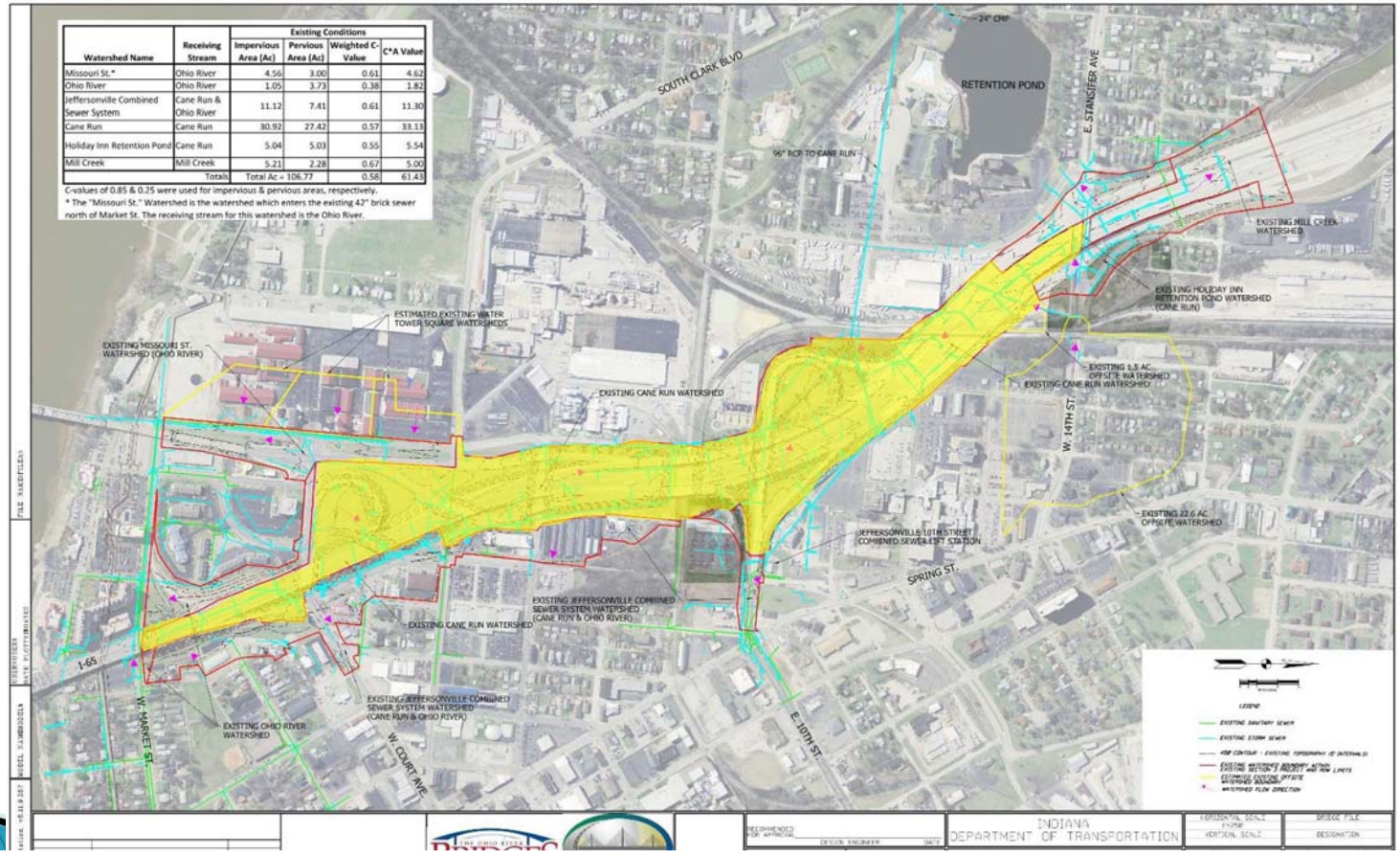


Cane Run Watershed[7]

- 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 ≈ 58 Ac
  - Additional runoff indirectly enters Cane Run

Cane Run Watershed

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



Watershed Name	Receiving Stream	Existing Conditions: Impervious Area (Ac)	Pervious Area (Ac)	Weighted C-Value	C*A Value
Missouri St.*	Ohio River	4.56	3.00	0.61	4.62
Ohio River	Ohio River	1.05	3.73	0.38	1.82
Jeffersonville Combined Sewer System	Cane Run & Ohio River	11.12	7.41	0.61	11.30
Cane Run	Cane Run	30.92	27.42	0.57	33.13
Holiday Inn Retention Pond	Cane Run	5.04	5.03	0.55	5.54
Mill Creek	Mill Creek	5.21	2.28	0.67	5.00
	Totals	Total Ac = 106.77		0.58	61.43

C-values of 0.85 & 0.25 were used for impervious & pervious areas, respectively.
* The "Missouri St." Watershed is the watershed which enters the existing 42" brick sewer north of Market St. The receiving stream for this watershed is the Ohio River.

Culverts within ROW[7]

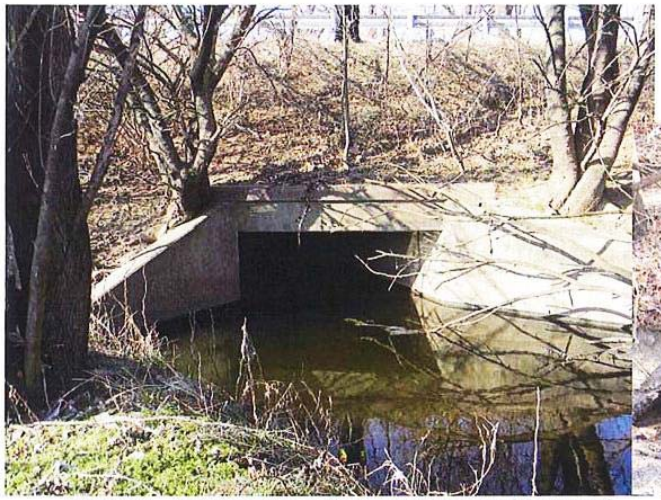


Figure 2 - Existing Ramp Culvert Entrance (East End)

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

Cane Run Flooding History[8]

- 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[9]

- Great Flood of 1937, Louisville, KY

Houses flipped in a Louisville neighborhood.

Location	January 1937 Rainfall
Louisville	19.2 in
Lexington	15.1 in
Bowling Green	20.7 in
Cincinnati	13.7 in
Evansville	14.8 in
Earlington, Kentucky	23.0 in

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

At midnight their worst fears were realized. The whistles began to blow, warning everyone to leave the city. Sirens at the fire stations screamed out into the night. The Branham family, and thousands of others were forced to flee for their lives.

– Personal memoir of Rev. Branham, Jeffersonville Resident

Widespread flooding at and around Churchhill Downs.

Inundation of western Louisville looking east toward downtown.

Cane Run Flooding History

- Floodwall Levee System

Google Earth Street View

Cane Run Flooding History[8]

- 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

2011 Indiana Design Manual[10]

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

Partial Watershed Relocation[5]

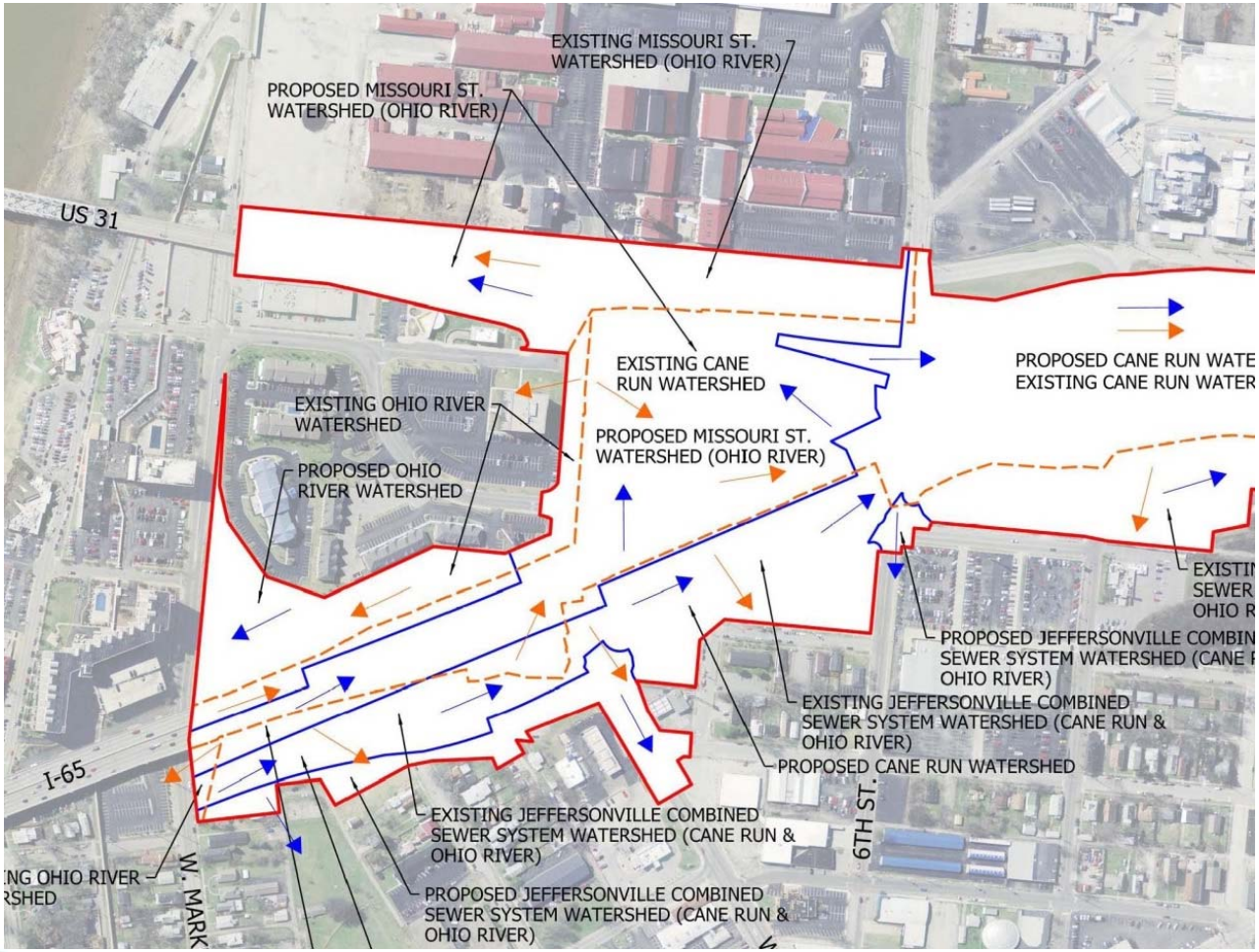
- Clarksville and Jeffersonville asked – no additional runoff be added to Cane Run
- Strand Assoc. – Cane Run watershed consultant:
  - Recommended not adding additional runoff to Cane Run, but instead, send as much runoff to the Woerner Avenue Flood Control Pump Station as possible
  - Flood Control 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[7]

- Identified watershed which could be relocated



Hydrodynamic Modeling

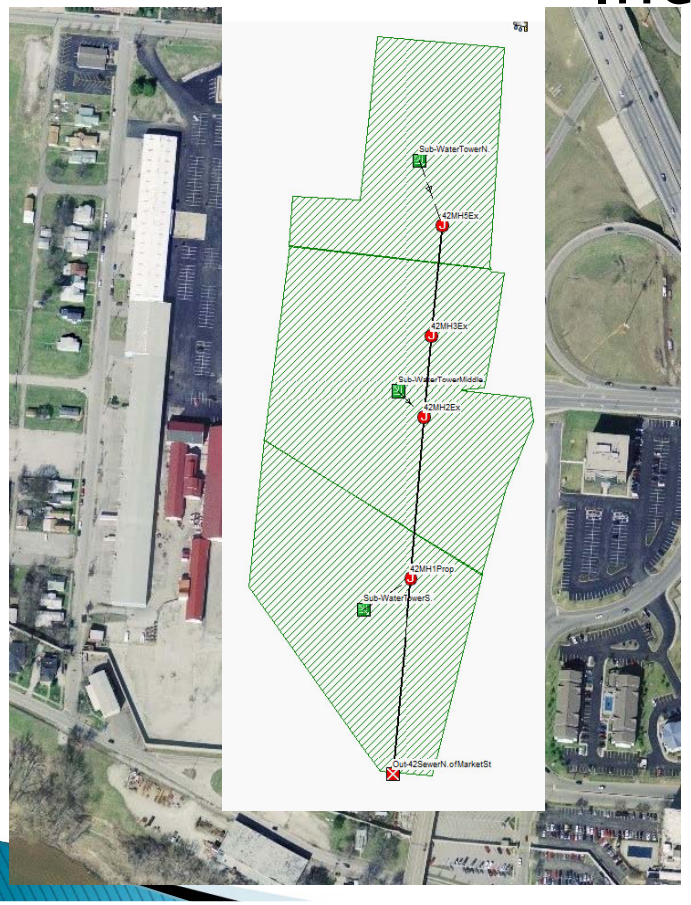
- DBT utilized Hydrodynamic Wave Routing
  - For trunk-line and detention pond analysis
  - Accounts for unsteady flow, pipe storage, backwater effects, momentum, time step
  - Solves full St. Venant equations
  - Huff curves (10%, 2%, 1%E.P. – 30Min to 24Hr duration)
- Exported line work from Microstation,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

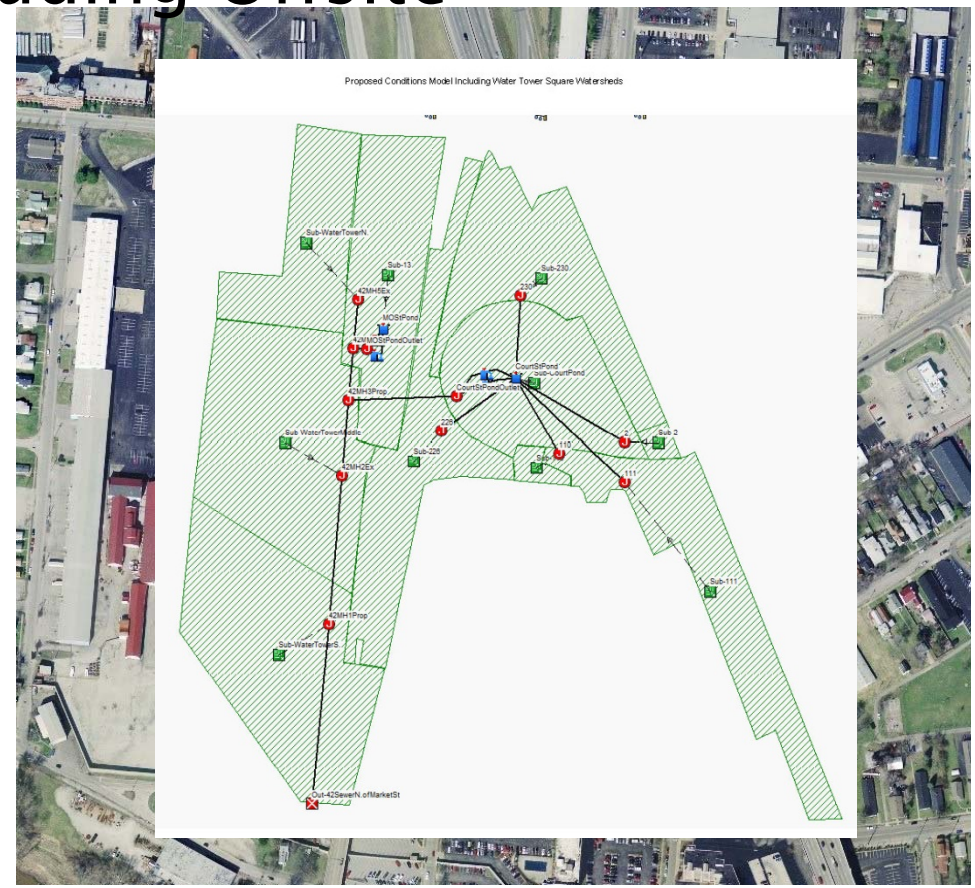
Hydrodynamic Modeling

- 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[7]

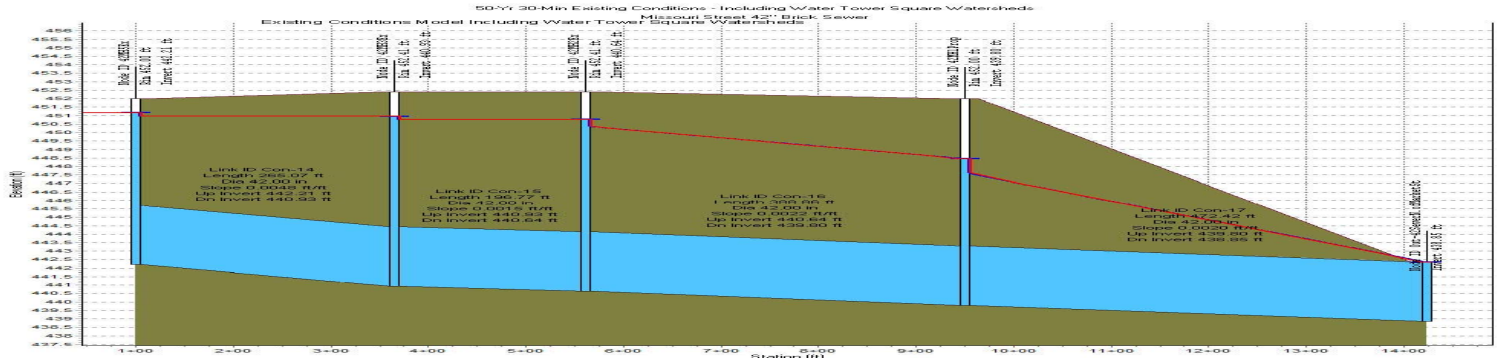
Existing MO St. Model | Proposed MO. St. Model Including Offsite



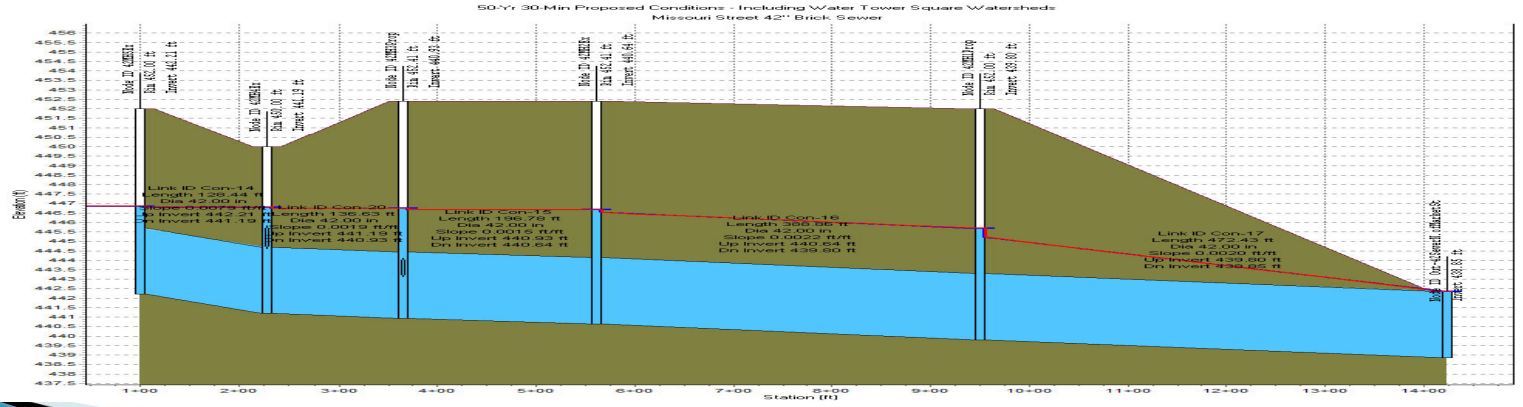


Hydrodynamic Modeling[7]

Existing MO St. Model – Including Offsite

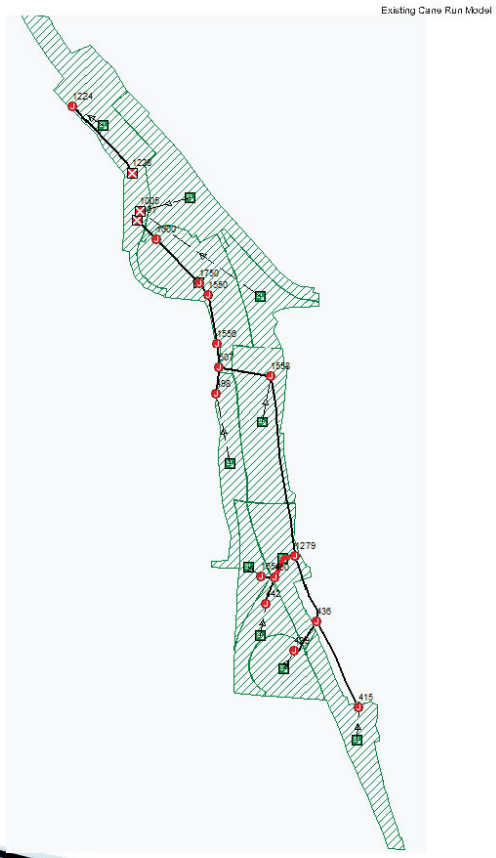


Proposed MO St. Model – Including Offsite



Hydrodynamic Modeling[7]

Existing Cane Run Model | Proposed Cane Run Model



Cane Run Models

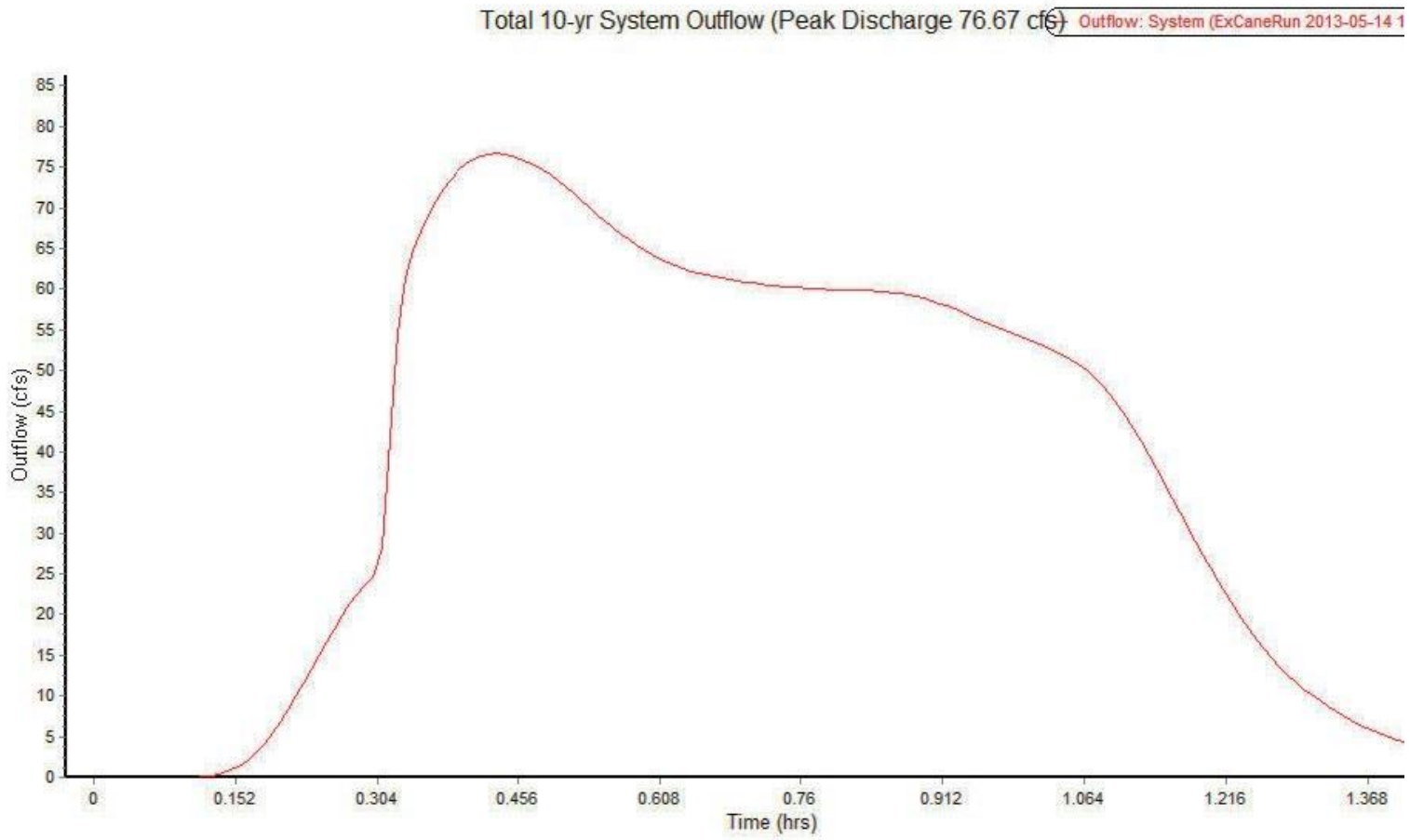
- Existing Model
  - 11 watersheds, 18 nodes, ≈1 mi. of links
  - Based on I-65 existing plans & survey
- Proposed Model
  - 10 watersheds, 16 nodes, ≈ 0.6 mi. of links
  - 2 Detention ponds
    - 6th St. Pond
    - 10th St. Pond

Proposed Detention Ponds[7]

- 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

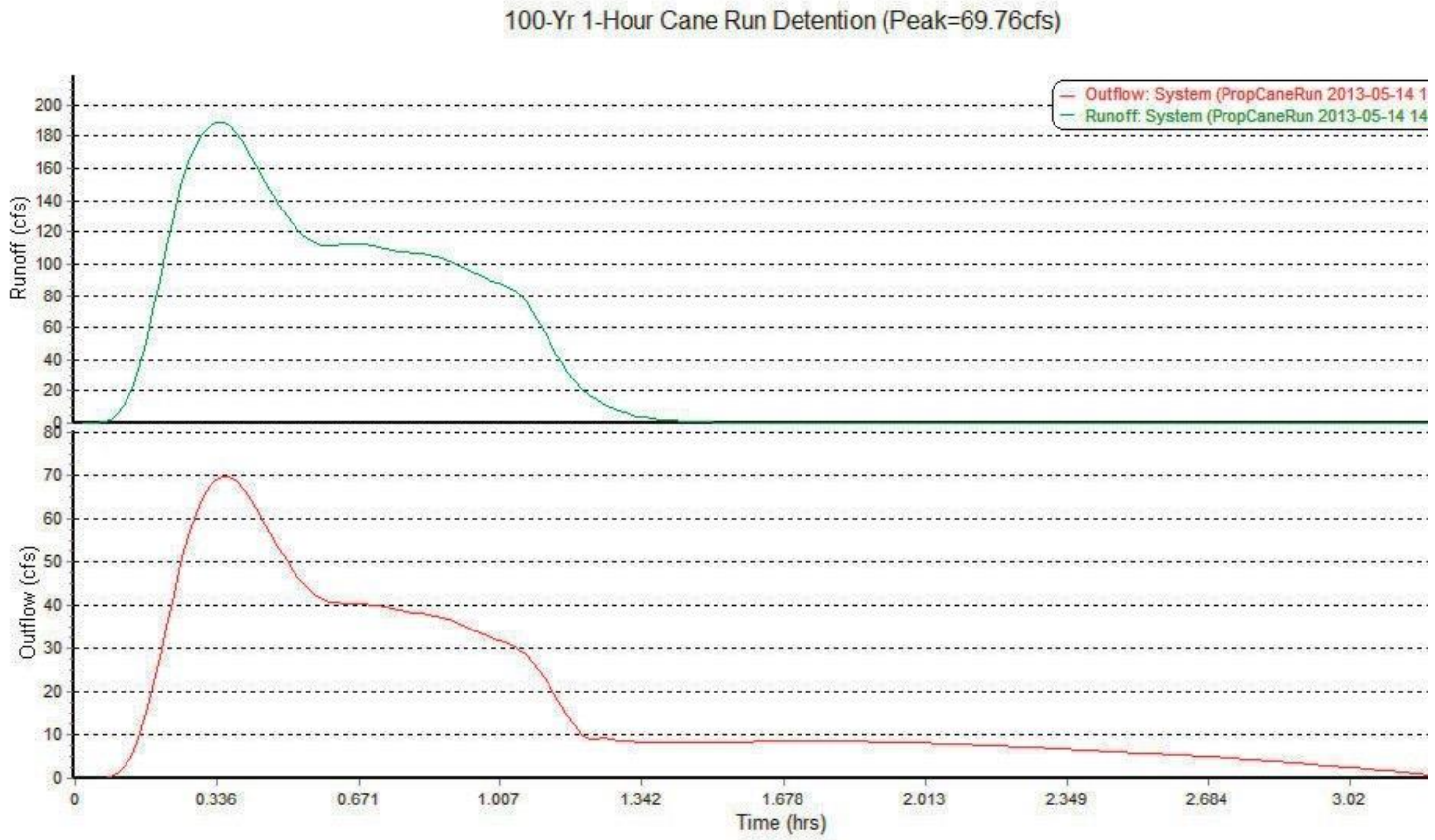
Hydrodynamic Modeling[7]

Existing Cane Run Discharge – within INDOT ROW



Hydrodynamic Modeling[7]

Proposed Cane Run Runoff and Discharge – within INDOT ROW



Impacts to MO St. Sewer[7]

- 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[7]

- 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

Summary

- The ORB project will "increase cross-river mobility by improving safety, alleviating traffic congestion & connecting highways"[3]
- 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

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