A New Integration of Modeling and Remote Sensing

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MSD’s Wet Weather Challenge

Cincinnati is among the top 5 CSO communities in US

772 cities in the United States with a combined sewer system

$3.4 Billion Wet Weather Program
Modeling Initiatives

- CFD Modeling to Generate Overflow Rating Curves
- Realtime River Intrusion Monitoring
Delta Avenue

Flooding 2016-17

CSO-469A
Flooding Possibly Due to MSD Weir
Overflow At 469A

8.5’ Overflow

4’ Underflow

8.5’ Inflow
Small Weir Wall

8.5’ Overflow
Overflow –
Discharge Coefficient (weir) = 3

Underflow –
Discharge Coefficient (orifice) = 0.85

- Inflow IE = 481.16
- Underflow pipe diameter = 4’
CFD Model
1. Recording level at a weir has potential problems
2. CFD provided an accurate assessment of the flow
3. Rating curve in SWM needed significant adjustment
4. Weir was not causing a backup
1. When does it overflow?

- **Overflow**: 8.5'
- **Inflow**: 8.5'
- **Underflow**: 4'

![Graph showing history probe elevations over time](image-url)
Where should the sensor be located?
If it is variable for a newly constructed level weir, what about this?
2. Accuracy of The CFD
February 23rd 2018 Storm Data

0 - 0.5’ @ 485 cfs
CFD Model
0 - 1.2’

485 cfs
3. Adjustment to the SWMM Model
Revised SWMM Model

Overflow Function

\[ f(h) = Q_{\text{over}} \]

Overflow Function CSO-469A

- PCSWMM - Tetra Tech
- PCSWMM - High Flow Calibration
- Flow3D
- PCSWMM - Literature Values

Q_{\text{overflow}} (cfs)

Elevation (ft.)

Flow3D Weir Height = 482.25

478 480 482 484 486 488 490 492 494 496
Overflow –
Entry Loss Coefficient = 0.15

• Inflow IE = 481.16
• Underflow pipe diameter = 4’

Underflow –
Entry Loss Coefficient = 0.2
Exit Loss Coefficient = 0.5
4. Flooding not due to Weir
River Intrusion

[Image of fish]

- CSO-002
- CSO-003
- CSO-004
- CSO-006
- CSO-007
- CSO-009
- CSO-010
- CSO-011
- CSO-012
- CSO-014
- CSO-015
- CSO-017
- CSO-018
- CSO-019
- CSO-021
- CSO-022
- CSO-023
- CSO-024
- CSO-179
- CSO-223
- CSO-402
- CSO-403
- CSO-404
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- CSO-406
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- CSO-430
- CSO-431
- CSO-433
- CSO-434
- CSO-435
- CSO-436
- CSO-444
- CSO-458
- CSO-461
- CSO-467
- CSO-468
- CSO-469
- CSO-472
- CSO-489
- CSO-528
- CSO-529
- CSO-530
- CSO-654
- CSO-666
River Intrusion

To Mill Creek

To Ohio River

Legend

CSO 006 and 469A
Dual Pressure Sensors

Pressure Sensor Cables

 Tubes to add water
Dual Pressure Sensors
Dual Pressure Sensors

Minor River Inflow Back over the Dam: Backflow working Properly
Dual Pressure Sensors

Minor River Inflow Back over the Dam: Backflow working Properly
Sawtooth from Barrier Dam

Each Pump is 700,000 gpm
Downstream of Dam

Elev. Of Dam

Upstream of Dam
### Conditions

<table>
<thead>
<tr>
<th>CSO 006</th>
<th>Elev. Of Dam</th>
<th>Downstream of Dam</th>
<th>Upstream of Dam</th>
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**Legend**

- CSO-006 / Downstream Level
- CSO-006 / Upstream Level
Some Future Actions

1. Realtime Modeling of Collection System
2. Playback Comparison of Calibration Alternatives