ARCADIS Design & Consultancy for natural and built assets

PEAK FLOW MANAGEMENT

Hazem Gheith, PhD, PE
Vice President,
Collection Systems CoP Leader, Arcadis

TACWA, Flower mound, Texas, May 17, 2019

Health and Safety Moment

Sewage overflow to receiving waters is a health hazard.

We should recognize and read alert signs along trails and rivers and take proper protection, especially during and following a storm event.

ARCADIS Design & Consultancy for natural and built assets

Outline

- Sources of Unintended Peak Flows
- Deficiencies and Level of Service
- Peak Flow Prediction - Modeling
- Mitigation Approaches
- Integrated Plan Programs

Sources of Unintended Peak Flows – Sanitary Collection Systems

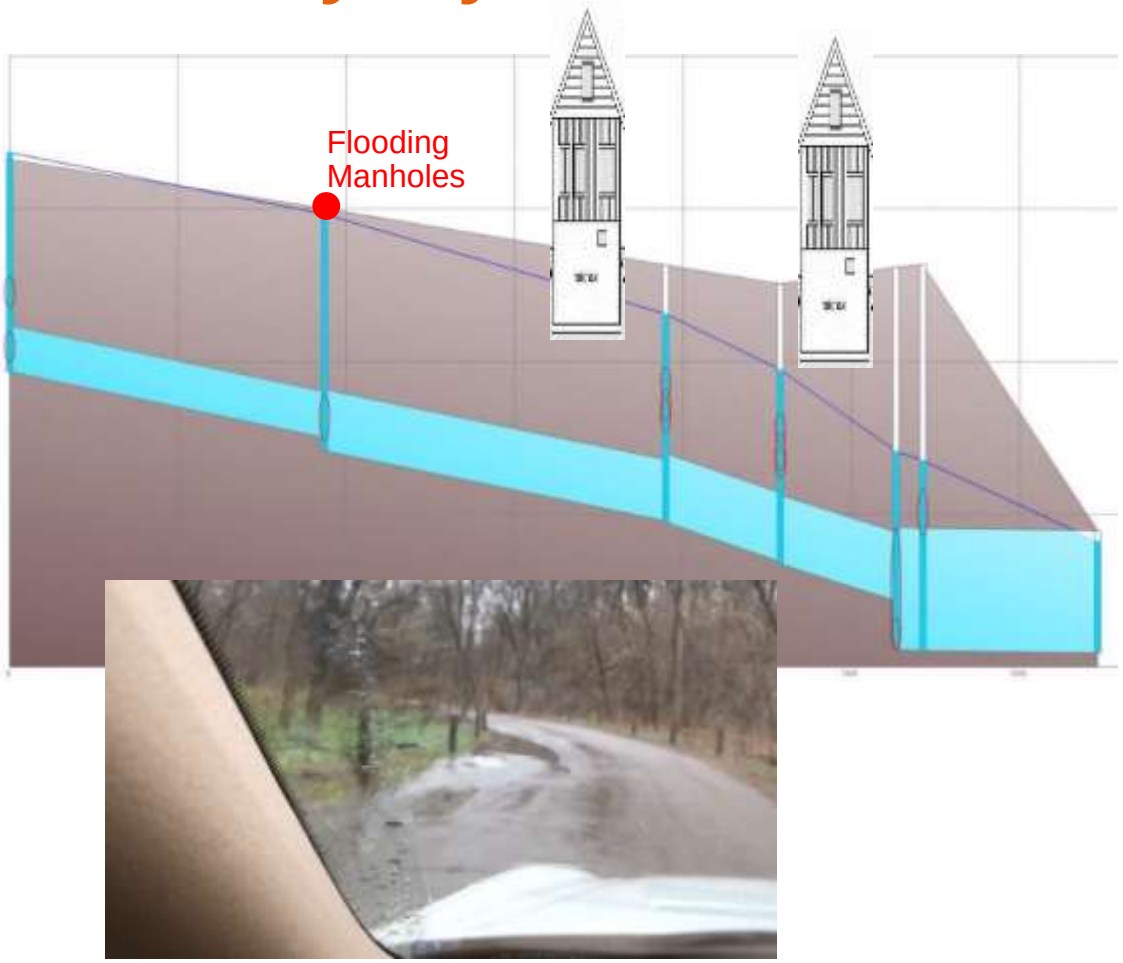
- New service areas (septic area, expand facility planning area)
- Rezoning and redevelopment
- Increased water usage by industries/commercial facilities
- Inflow and Infiltration as a result of aging sewers

Outline

- Sources of Unintended Peak Flow
- Deficiencies and Level of Service
- Peak Flow Prediction - Modeling
- Mitigation Approaches
- Integrated Plan Programs

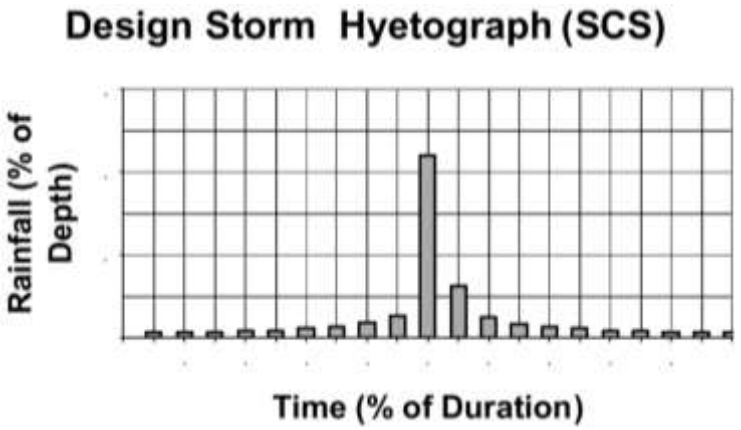
Deficiencies in Sanitary Systems

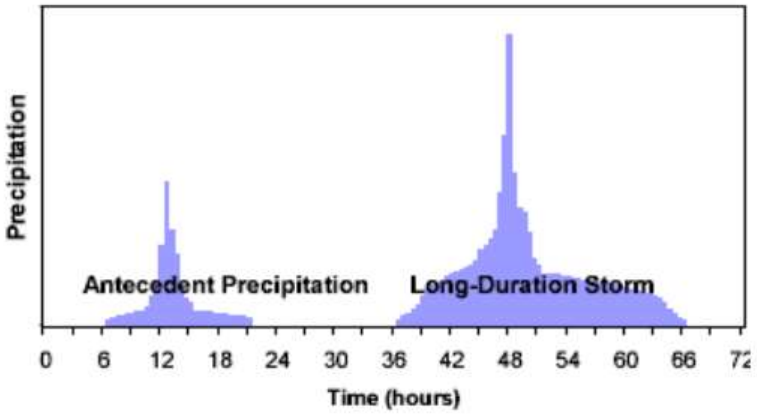
- Surcharged Pipes
- Flooding Manholes
- Backups into Basements
- SSO to Water Bodies
- Exceeding Treatment Capacities



Peak Flow Control Objectives

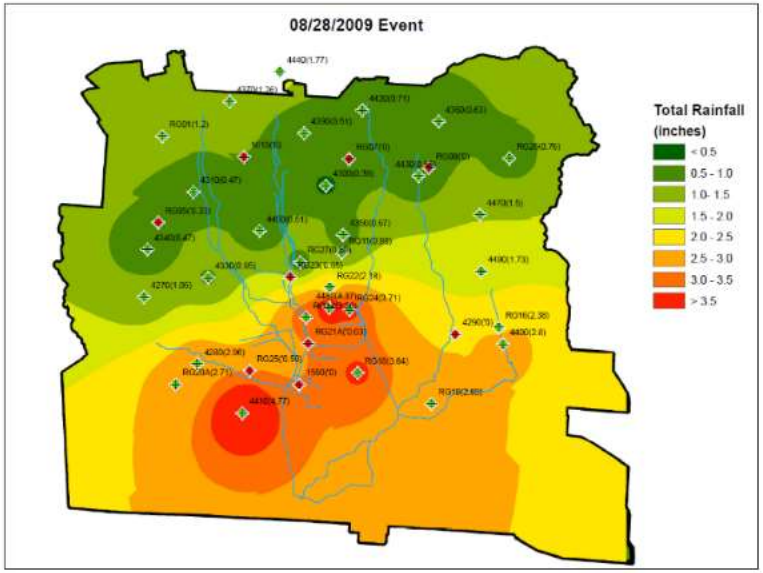
- Control deficiencies up to a peak flow frequency
- Flow frequency can be based on synthetic design storm recurrence frequency
  - Requires information on duration, temporal distribution, antecedent moisture condition, spatial distribution

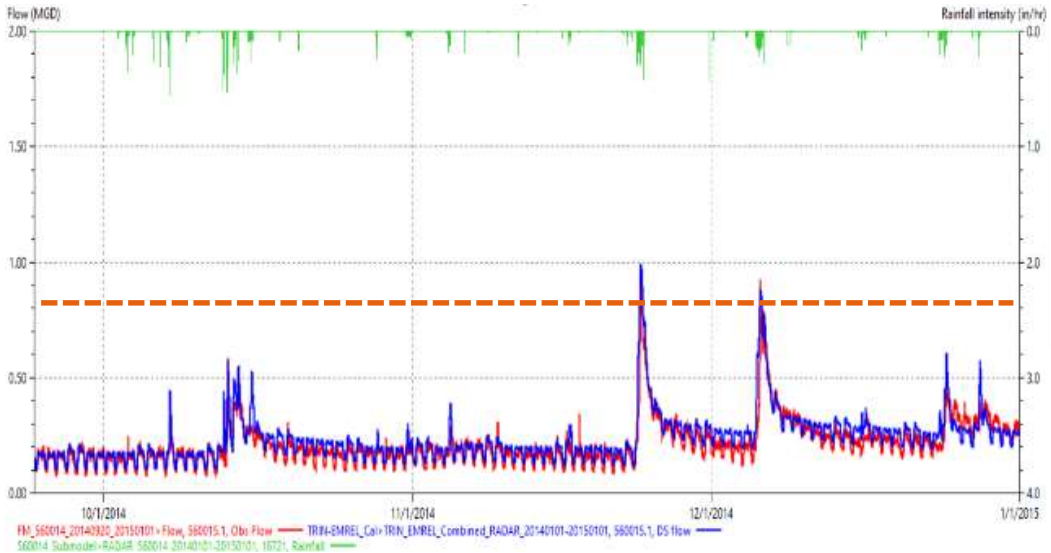




Rainfall Spatial Distribution

- A better flow frequency prediction can be calculated using long-term historical metrological condition
  - Requires long-term rainfall data
  - Requires H/H model

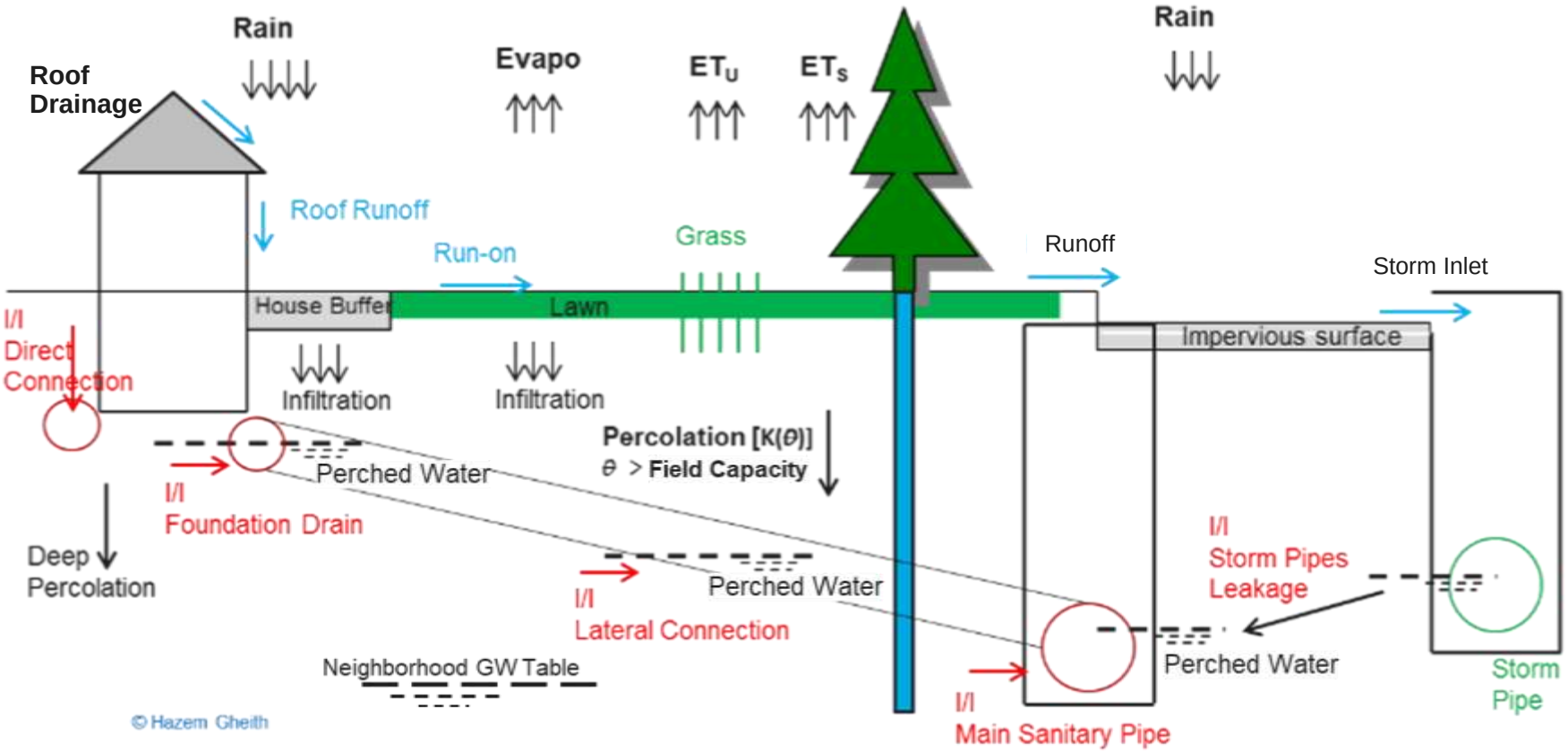




Outline

- Sources of Unintended Peak Flow
- Deficiencies and Level of Service
- Peak Flow Prediction - Modeling
- Mitigation Approaches
- Integrated Plan Programs

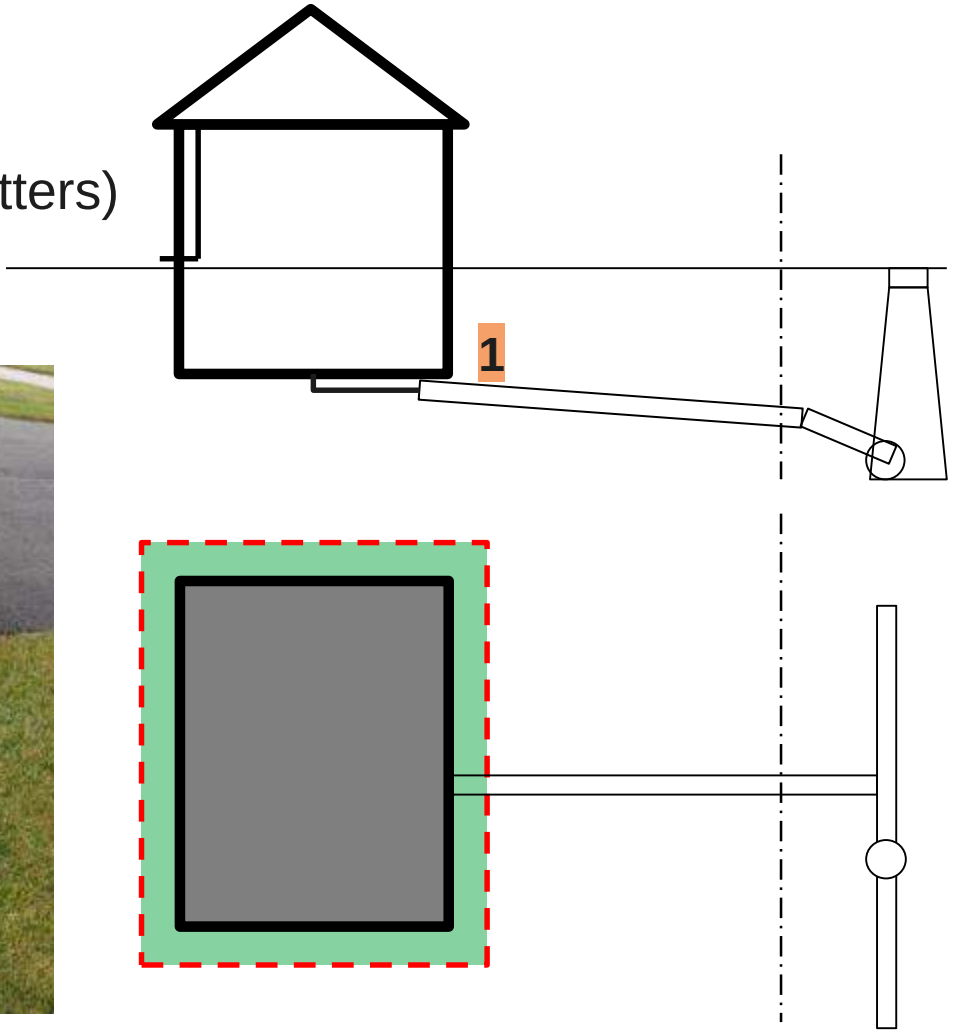
Peak Flow Prediction – Flow Sources



1. Foundation

Runoff areas:

- Roof top (splashing or bad gutters)
- Buffer area around the house

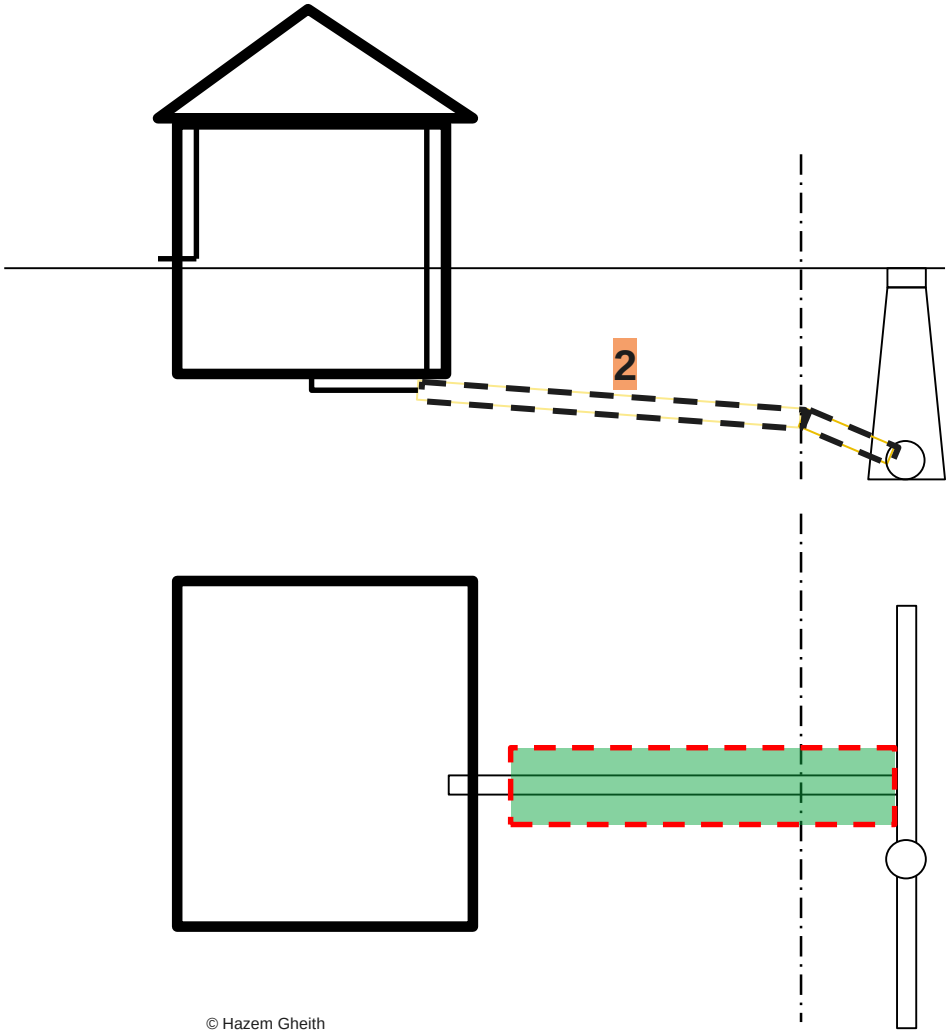


© Hazem Gheith

2. Lateral Pipes

Runoff area:

- Buffer area above the lateral pipe

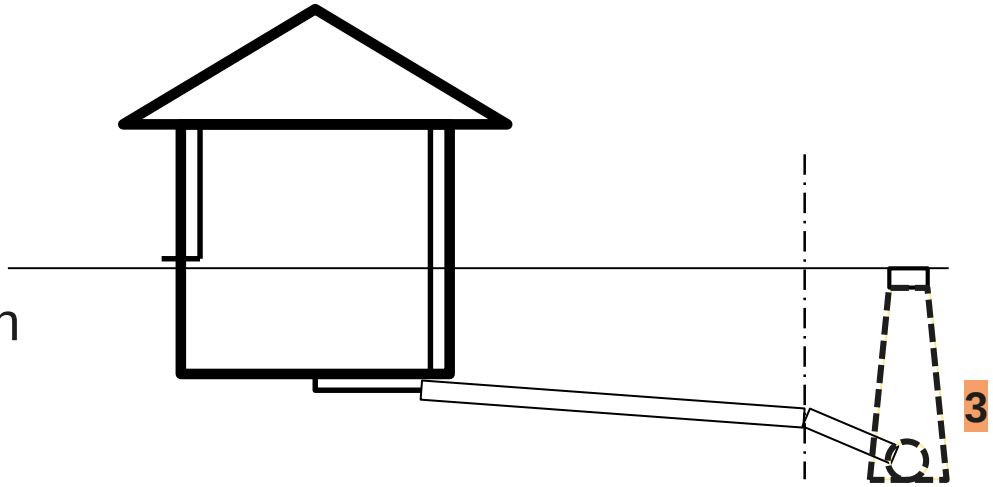


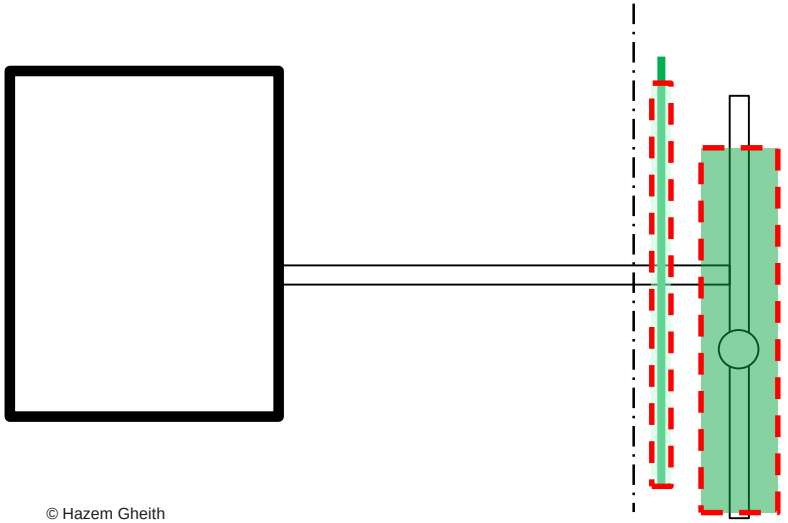
© Hazem Gheith

3. Sewer Mains

Runoff area:

- Buffer area above the sewer (under pervious surface)
- Co-location with storm trench

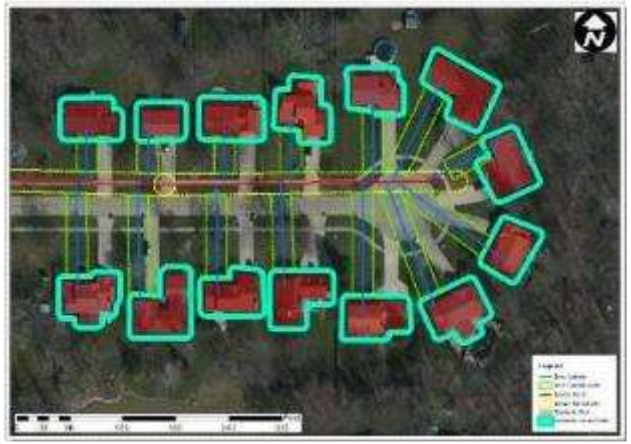




© Hazem Gheith

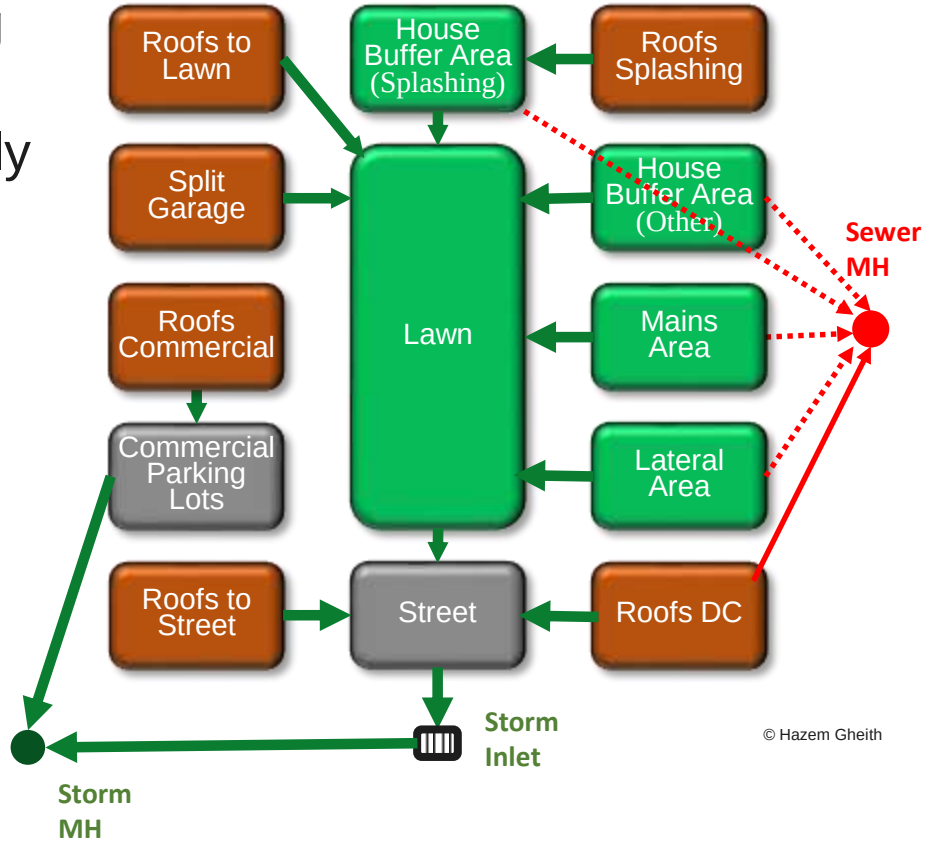
Surface Hydrologic Features

- Impervious: Roofs, parking lots, streets, alleys and drive ways
- Pervious: manmade trenches and non-disturbed areas



Integrated Model Platform

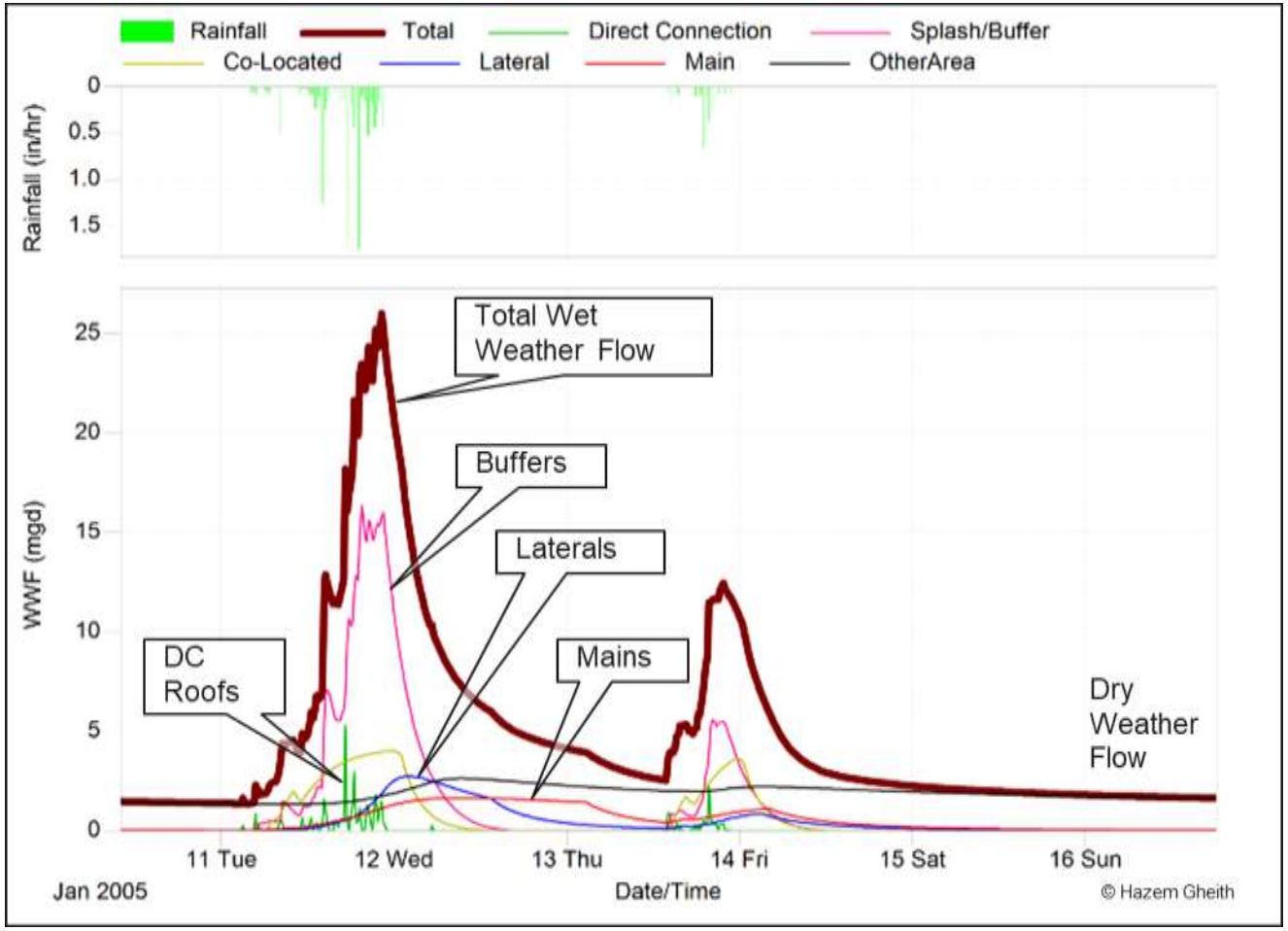
- One platform for understanding surface and subsurface flows
- Hydrologic features are uniquely represented
- Suitable for Integrated Plan planning
- Suitable for studying both separate and combined flow systems



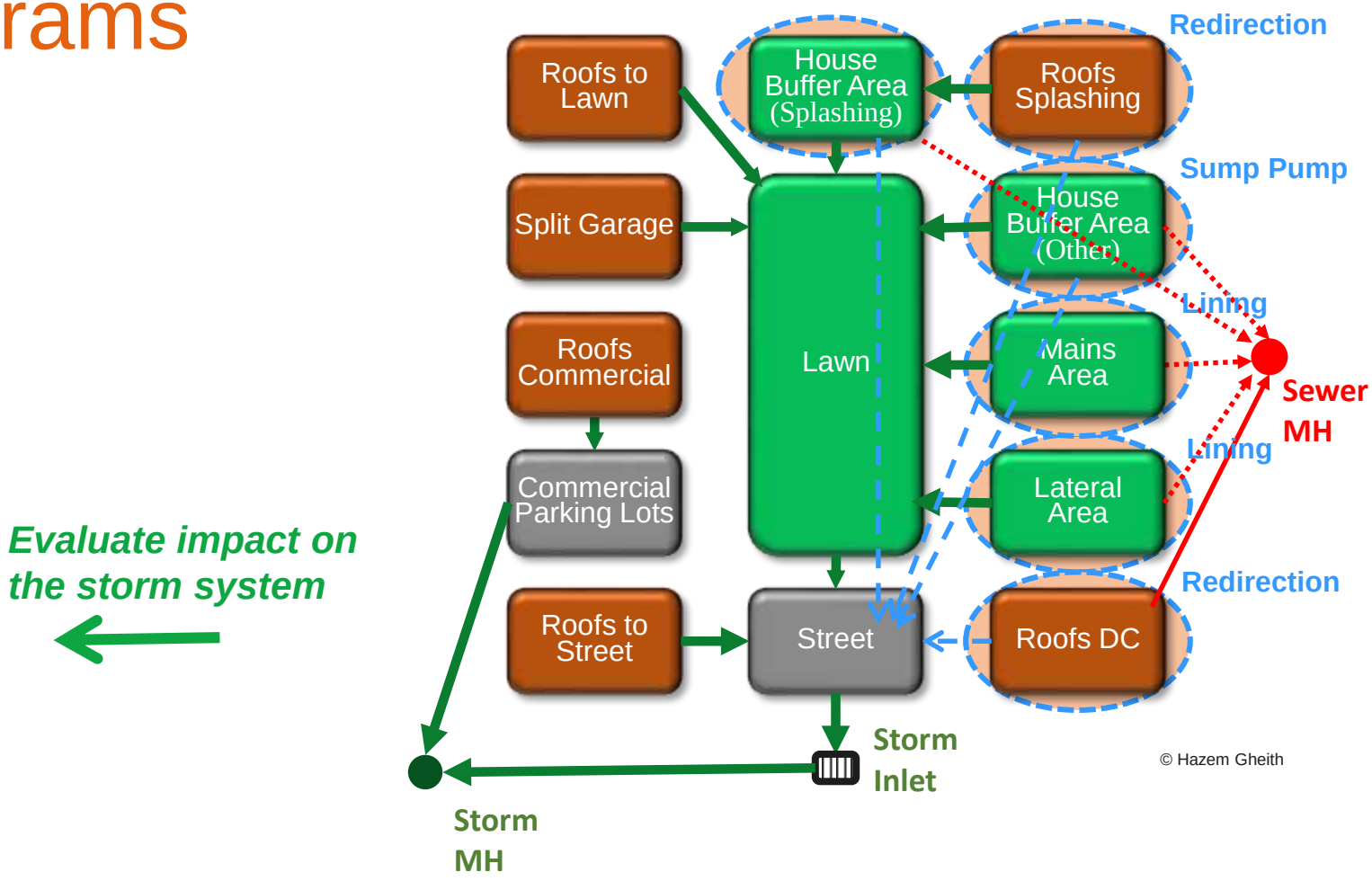
Mitigation Approaches - Source Control

Quantifying each I/I source:

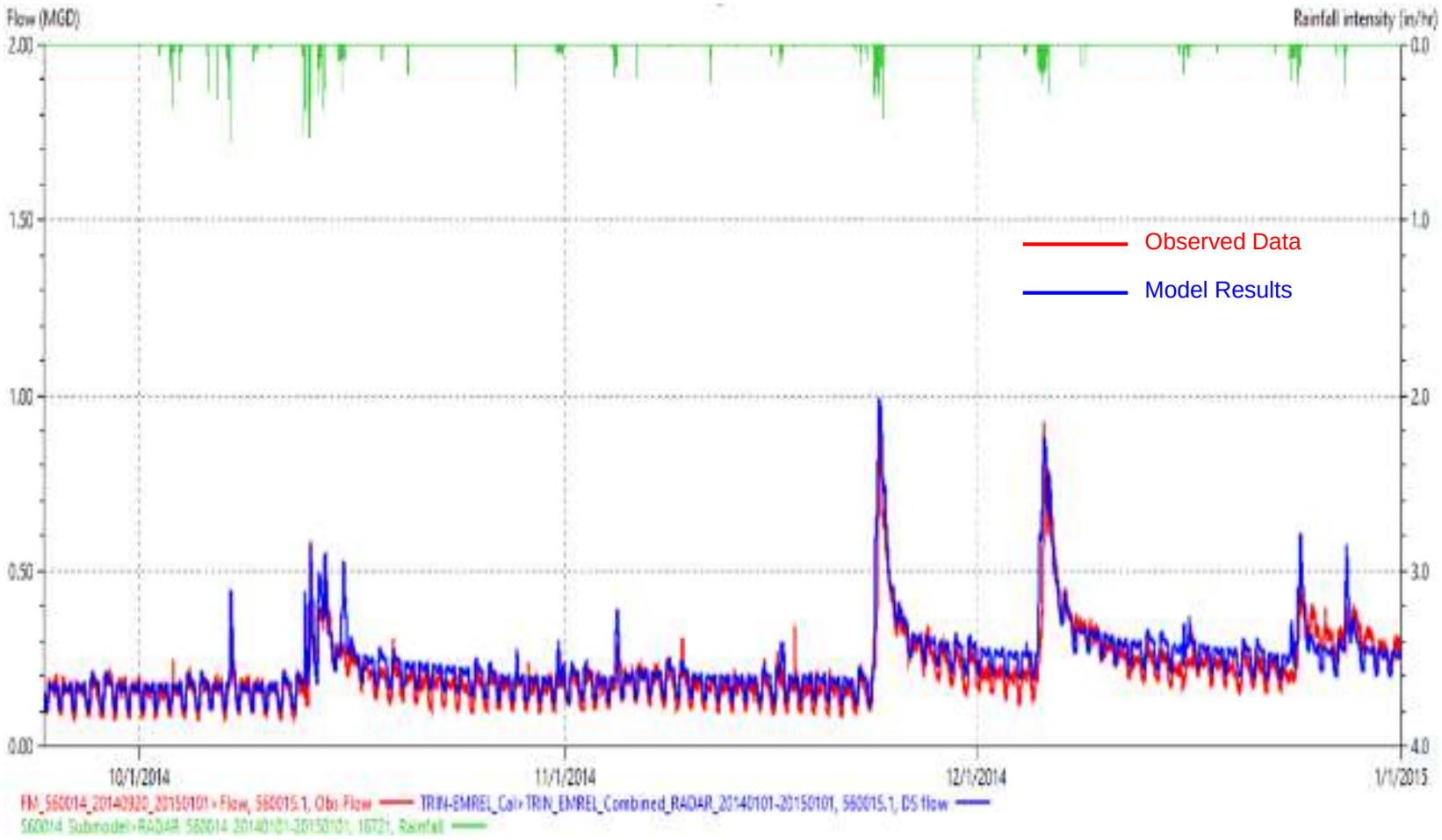
- Directly Connected Roofs
- House Buffer Area
- Storm Co-location
- Lateral Sewers
- Main Sewers



Planning Educated I/I Mitigation Programs



Peak Flow Prediction Example – IN



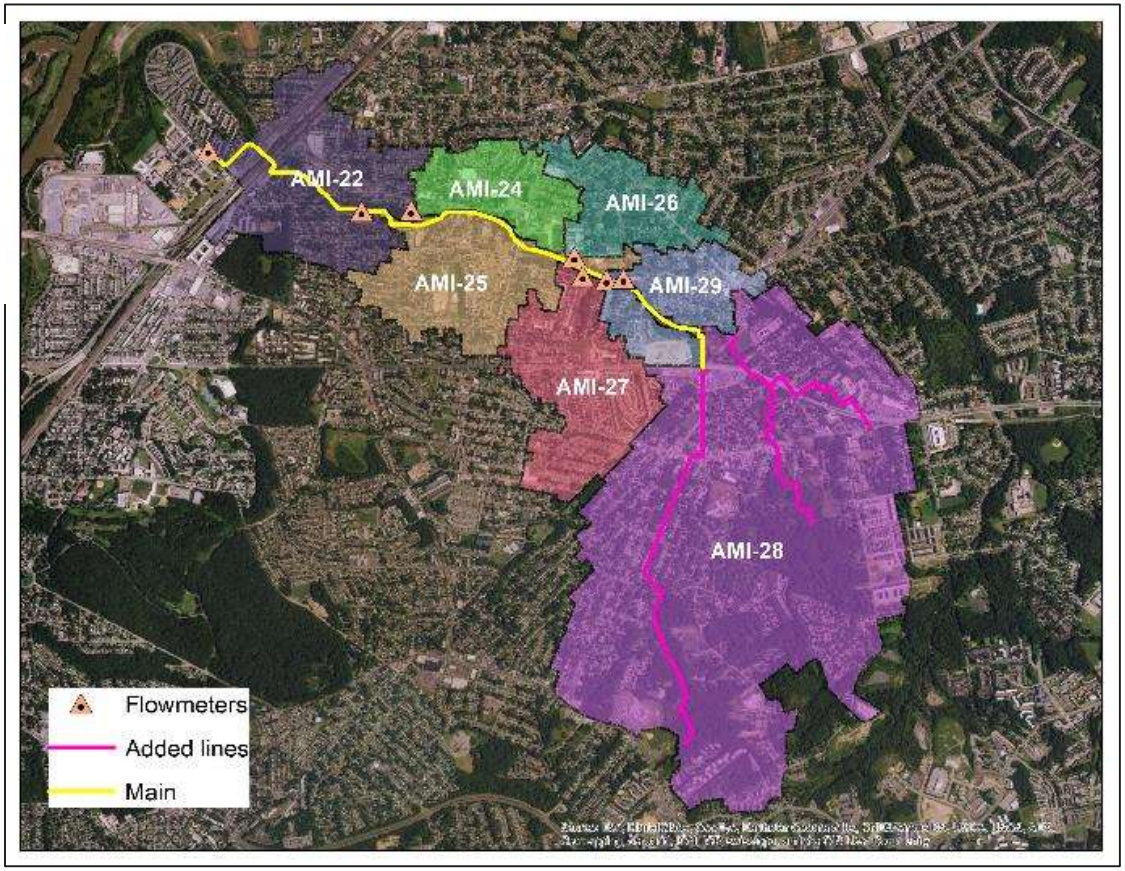
Outline

- Sources of Unintended Peak Flow
- Deficiencies and Level of Service
- Peak Flow Prediction - Modeling
- Mitigation Approaches
  - Source Control (I/I Reduction)
  - Capital Improvements
- Integrated Plan Programs

ARCADIS Design & Consultancy for natural and built assets

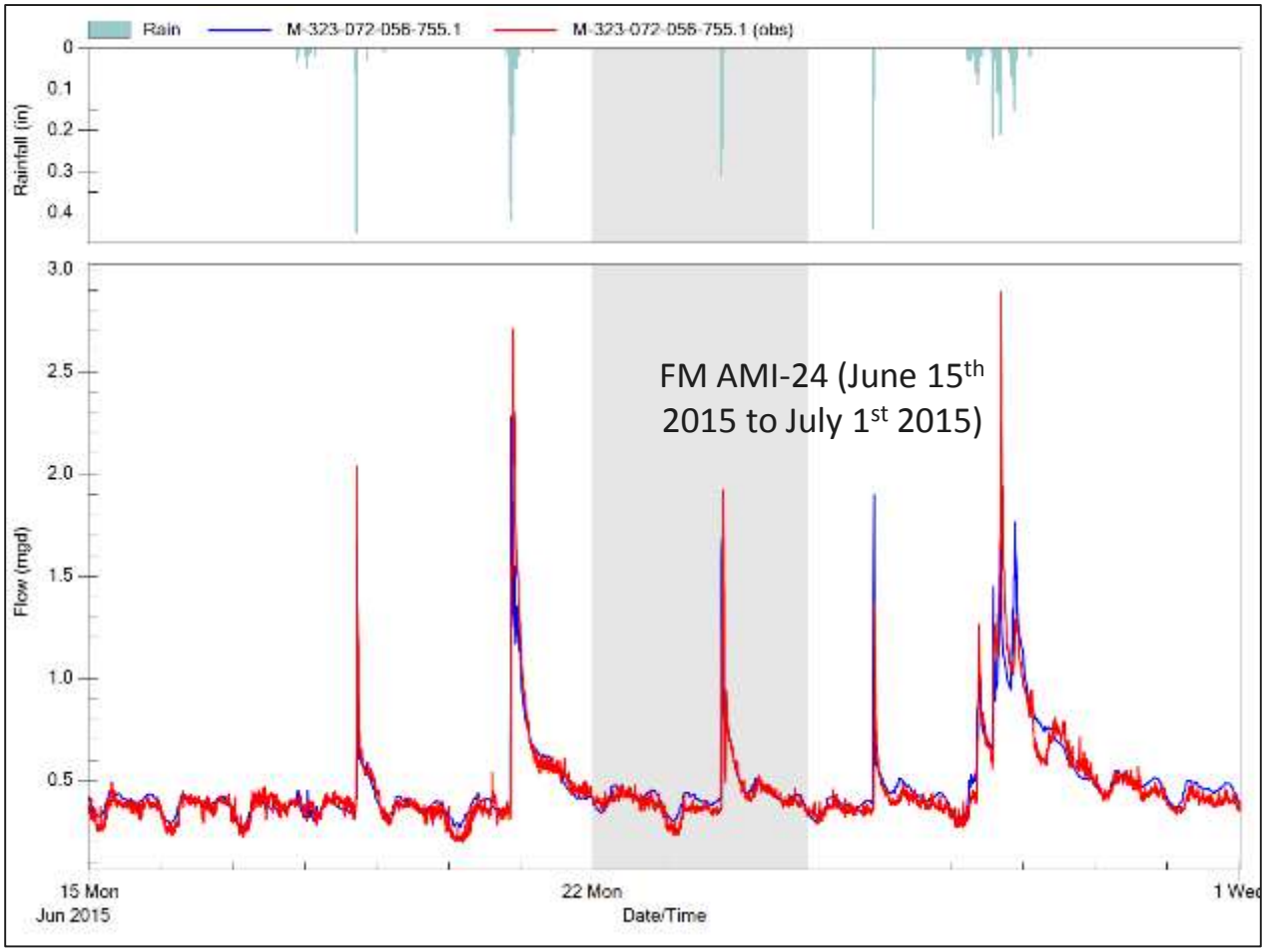
DC Water – Source Control Program

- 2,141 ac – high I/I
- Planning mains and laterals lining
- Prioritize field activities



ARCADIS Design & Consultancy for natural and built assets

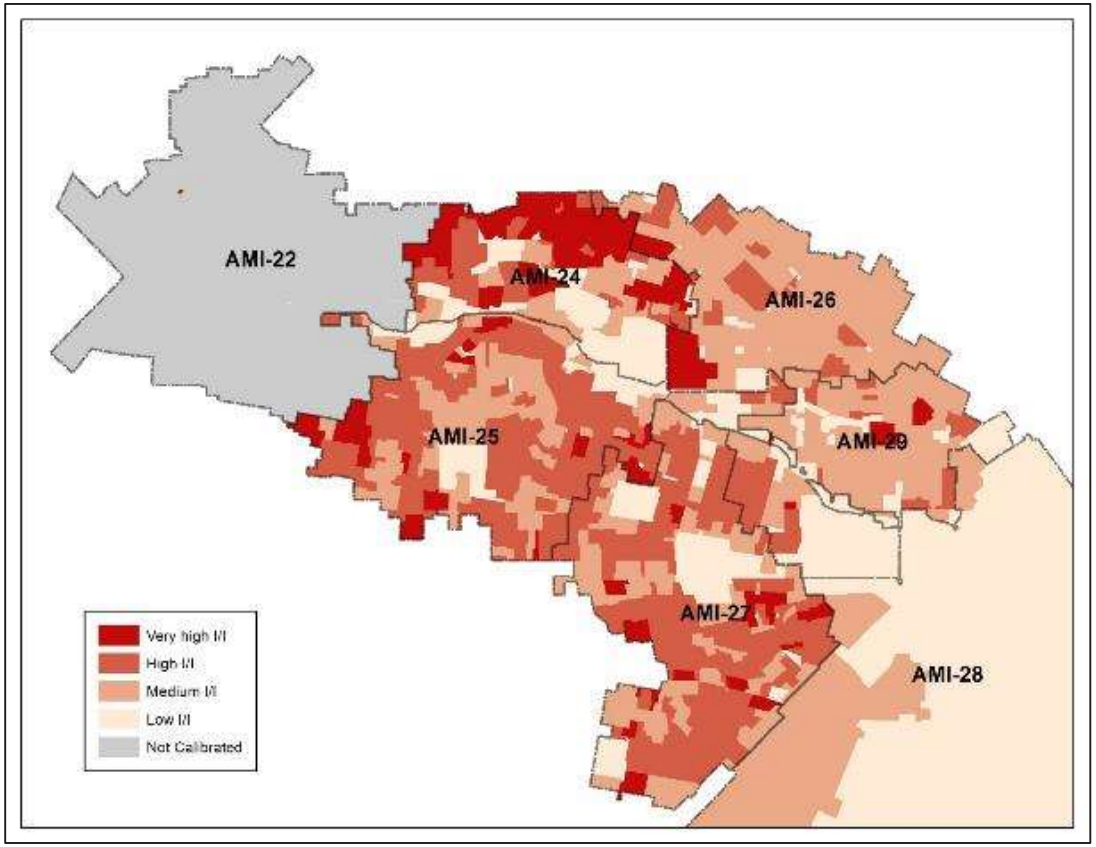
DC Water – Model Calibration



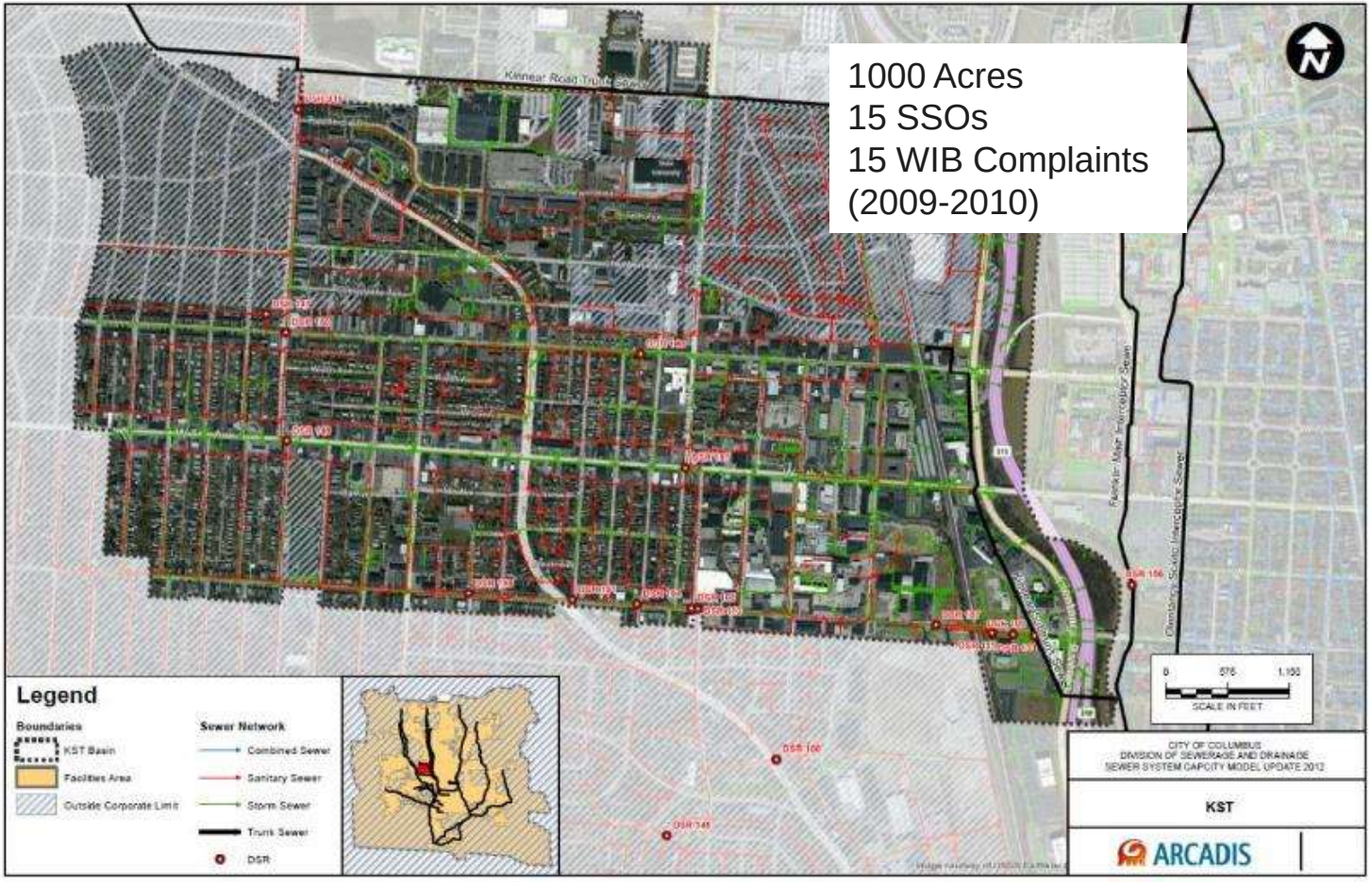
DC Water – Source Control Program

Thematic map showing focus areas ~ 400 acres

1Y-24Hr storm followed by 5Y-24Hr storm

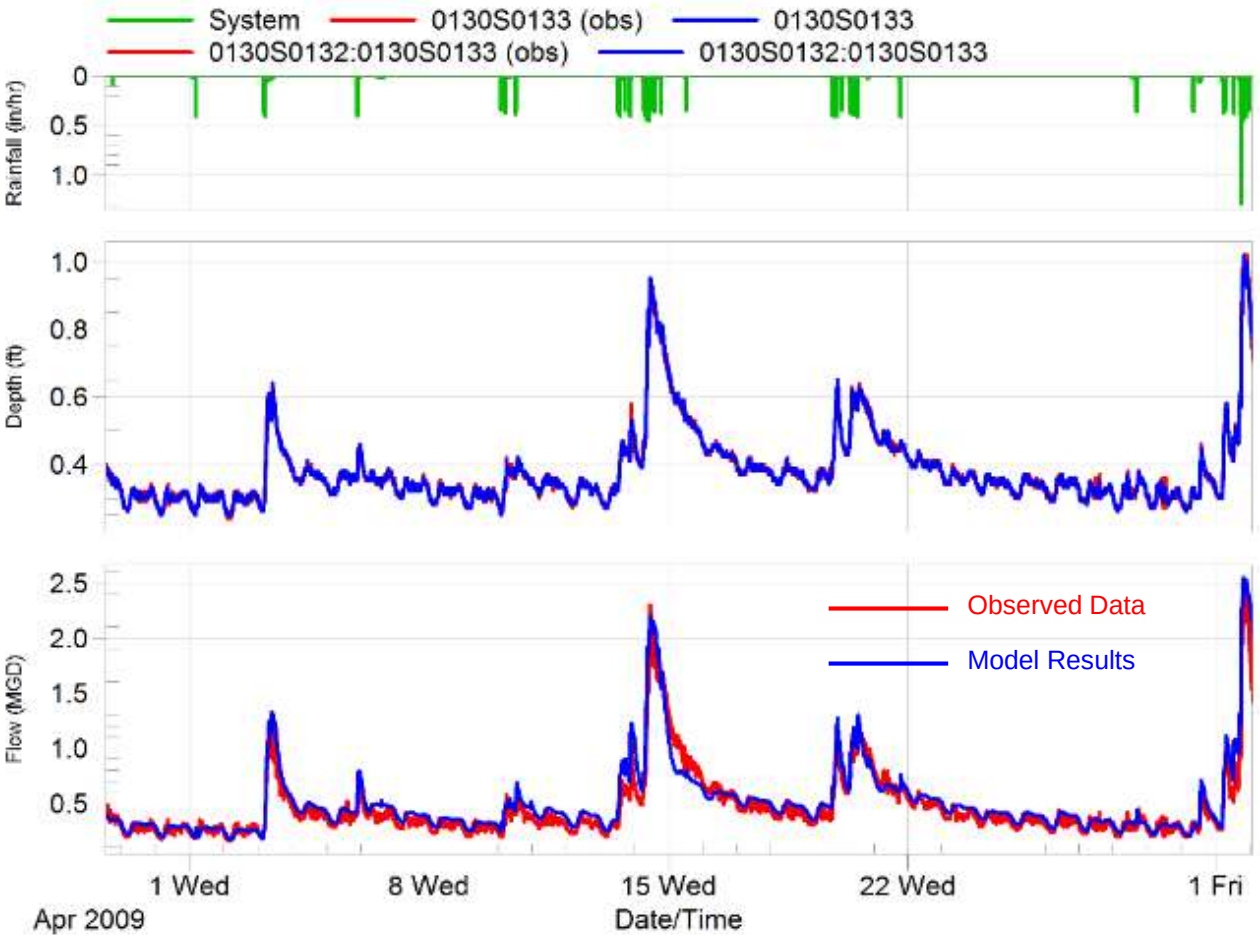


Columbus – OH W 5th I/I Mitigation



ARCADIS Design & Consultancy for natural and built assets

Columbus – OH Model Calibration



ARCADIS Design & Consultancy for natural and built assets

W 5th Basin I/I Sources Condition

Sources	Peak Flow Percentage (1/12/2005)	Flow Volume Percentage (12/01/2004-02/01/2005)
Roofs, Direct Connection	6%	1%
Roofs, Splash	34%	14%
Buffer Area Around Houses	30%	29%
Col-Located Storm	15%	17%
Lateral Pipes	9%	18%
Main Sewers	6%	21%

ARCADIS Design & Consultancy for natural and built assets

Columbus-OH Integrated Plan

Mitigation Analysis

10-Year LOS Historical Storm

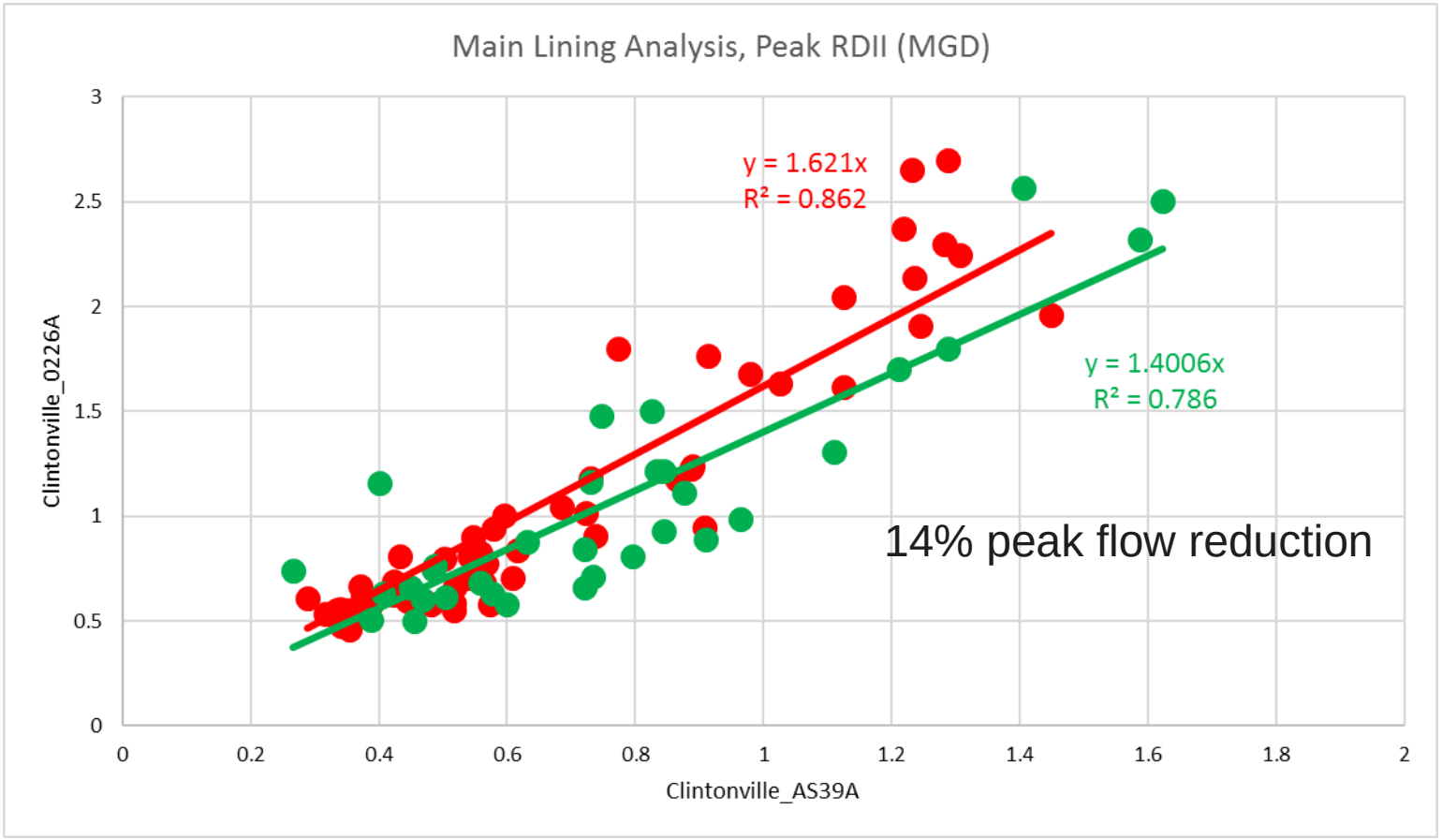
Scenarios	Number of Active SSOs	Total Overflow Volume (MG)	Peak Overflow (MGD)
Existing	10	5.14	8.5
Disconnect Direct Connection Roofs	10	4.38	5.9
Redirect 50% Splashing Roof drainage	6	2.65	5.7
Laterals Lining (all the way to the 4”x 6”)	9	1.9	6.4
Main Sewers Lining	9	2.82	7.8
Storm Sump Pump	1	0.91	1.5
Disconnect Direct Connected Roofs + Lateral Lining + Main Lining	7	0.61	3.4
Disconnect Direct Connected Roofs + Redirect 50% of Splashing Roofs + Lateral Lining + Main Lining	0	0	0

Mains Pilot Lining

Control Basin Comparison Approach

- Control Basin: AS_39A
- Improvements Basin: Clintonville_0226A

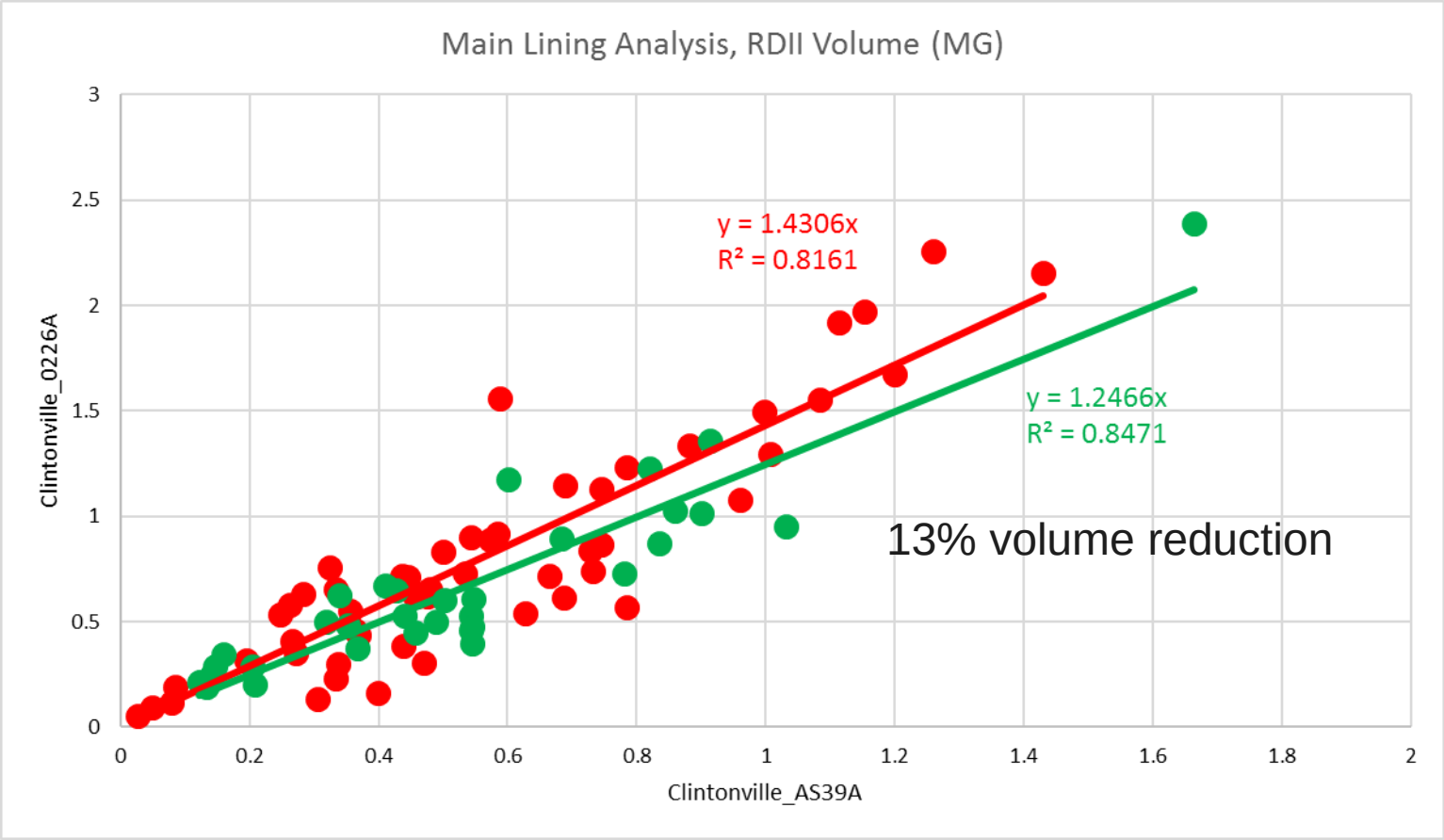
Main Sewers Lining - Peak Flow



Pre Lining (2009 – 2012), Clintonville_0226A

Post Lining (2015 – 2016), Clintonville_0226A

Main Sewers Lining, RDII Volume



● Pre Main Lining (2009 – 2012), Clintonville_0226A

● Post Main Lining (2015 – 2016), Clintonville_0226A

Laterals Pilot Lining

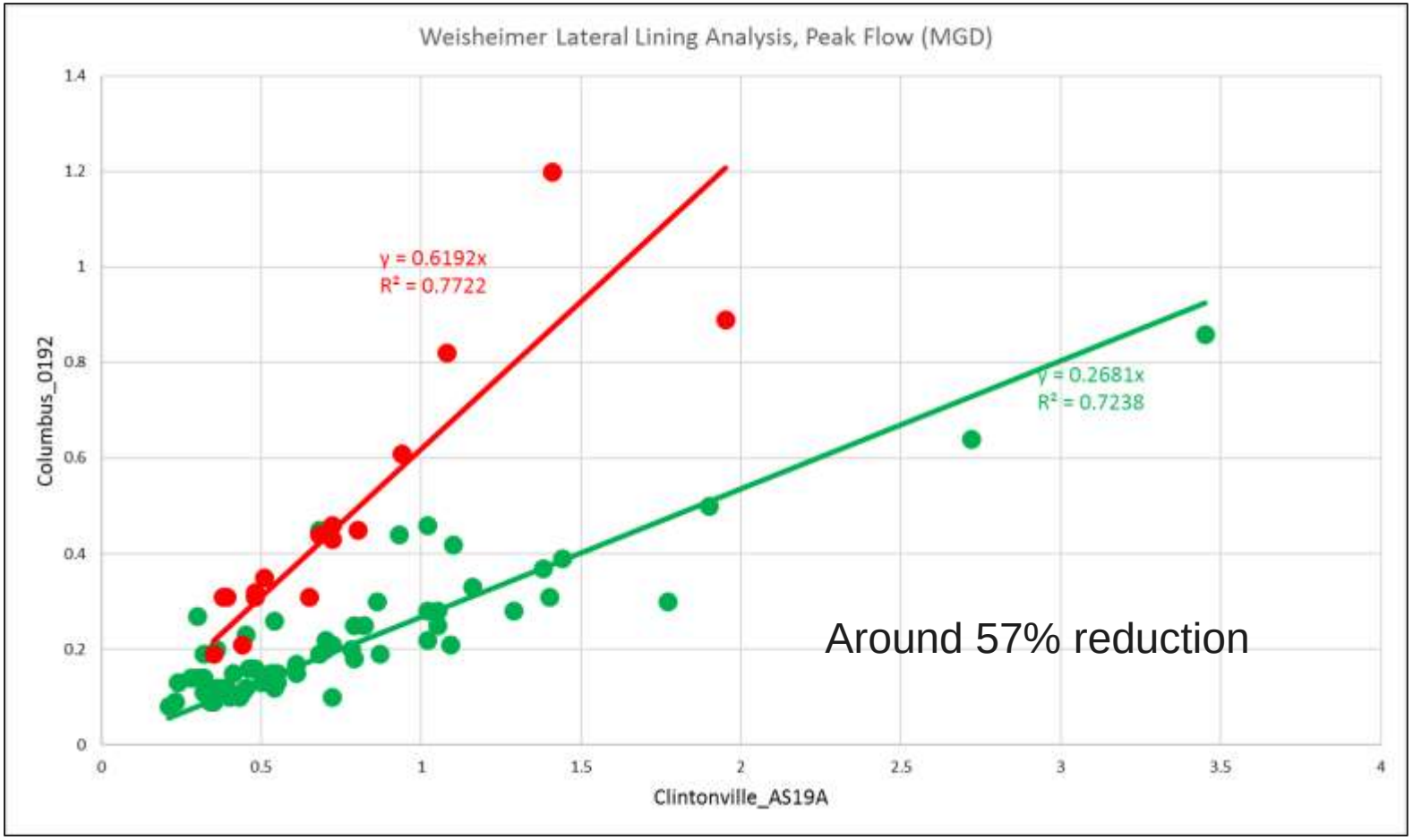
Control Basin is AS_19A

Improvements at two basins:

Torrence (0370)
- Laterals lined between 12/2009 – 1/2011

Weisheimer (0192)
- Laterals lined between 5/2008 – 1/2011

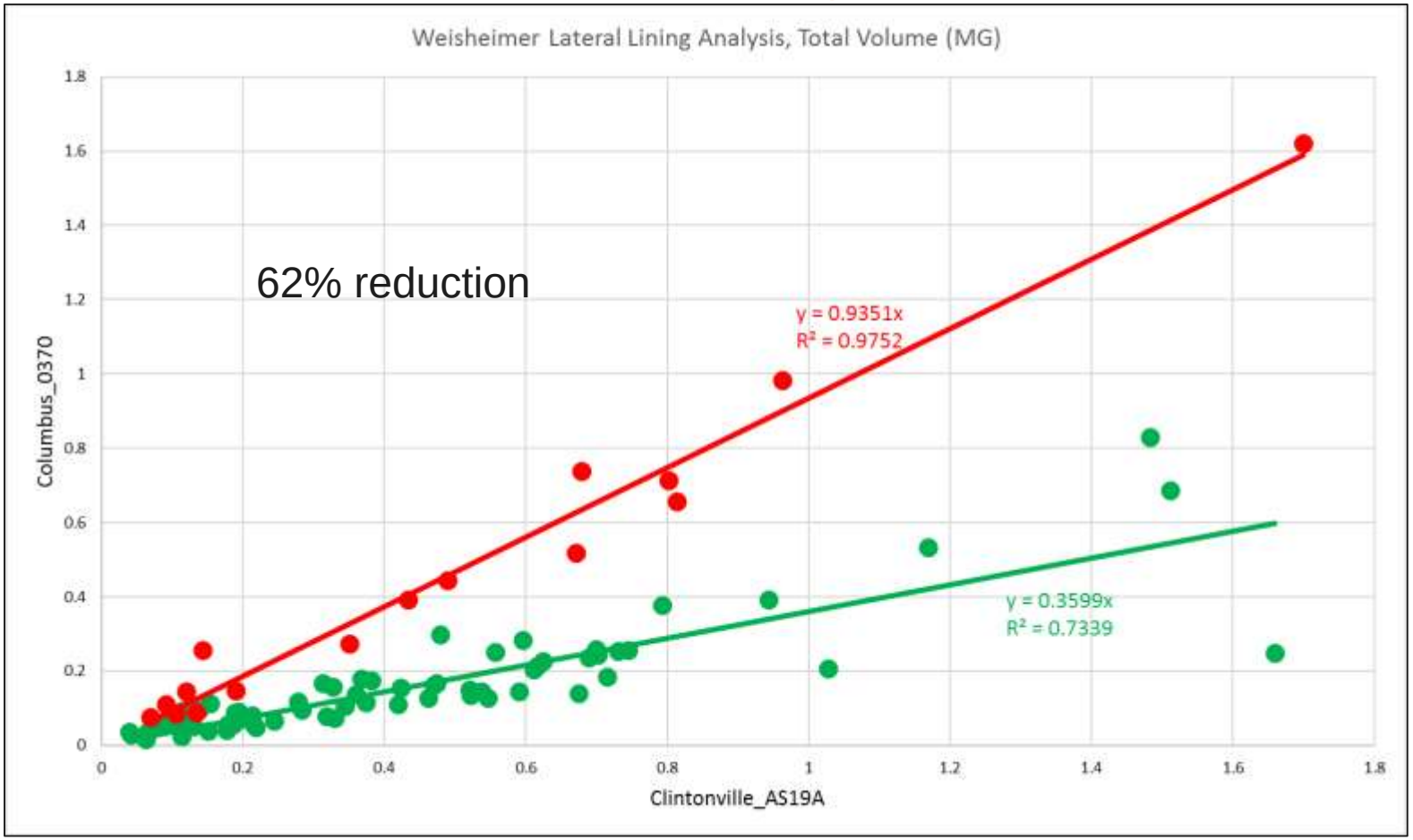
Weisheimer Laterals Lining – Peak Flow



● Pre Lining (1/2007 – 5/2008), Columbus_0192

● Post Lining (1/2012 – 12/2016), Columbus_0192

Weisheimer Laterals Lining – RDII Volume

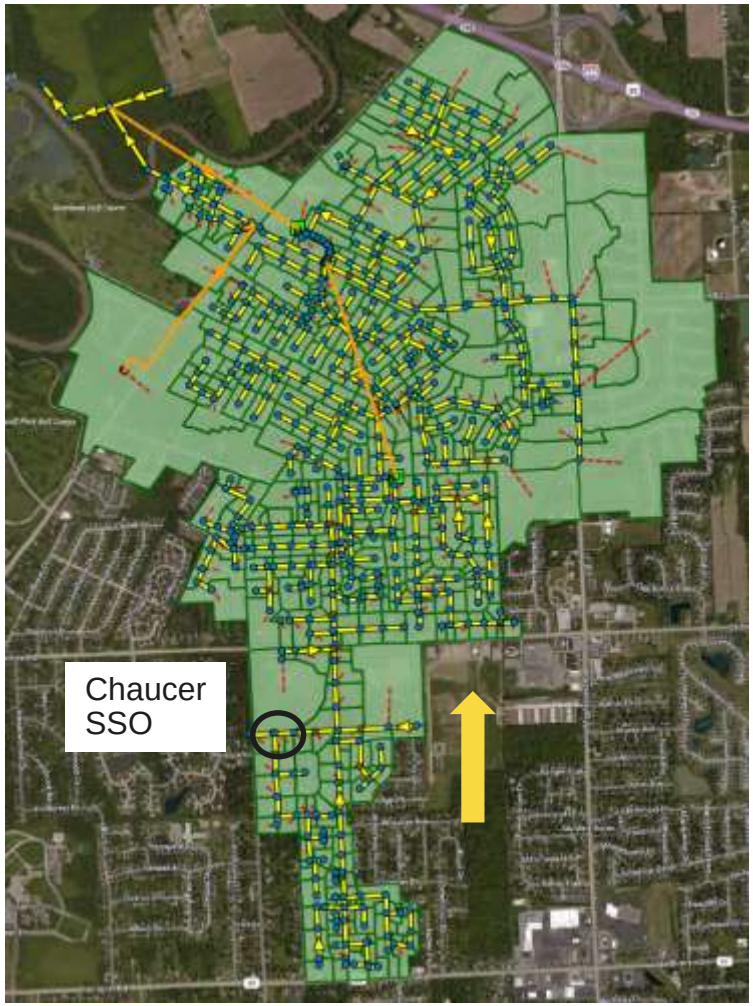


● Pre Lining (1/2007 – 5/2008), Columbus_0192

● Post Lining (1/2012 – 12/2016), Columbus_0192

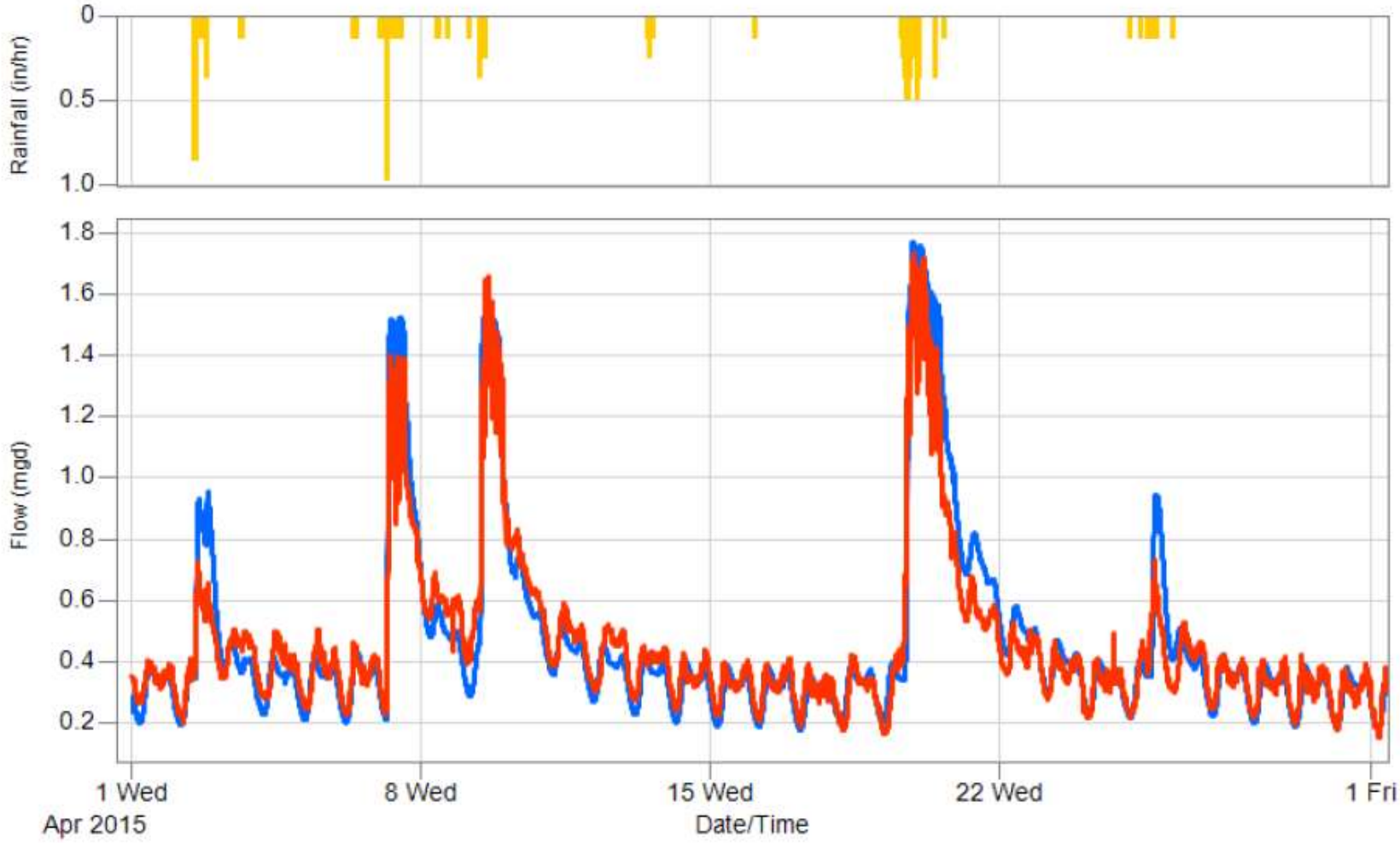
Ft Wayne – IN Chaucer SSO Mitigation

- High SSO Activation (4-6/year) to backyard of housing complex
- Lined mains and replaced several laterals upstream the SSO – limited improvements
- Understand why and plan a comprehensive source control program



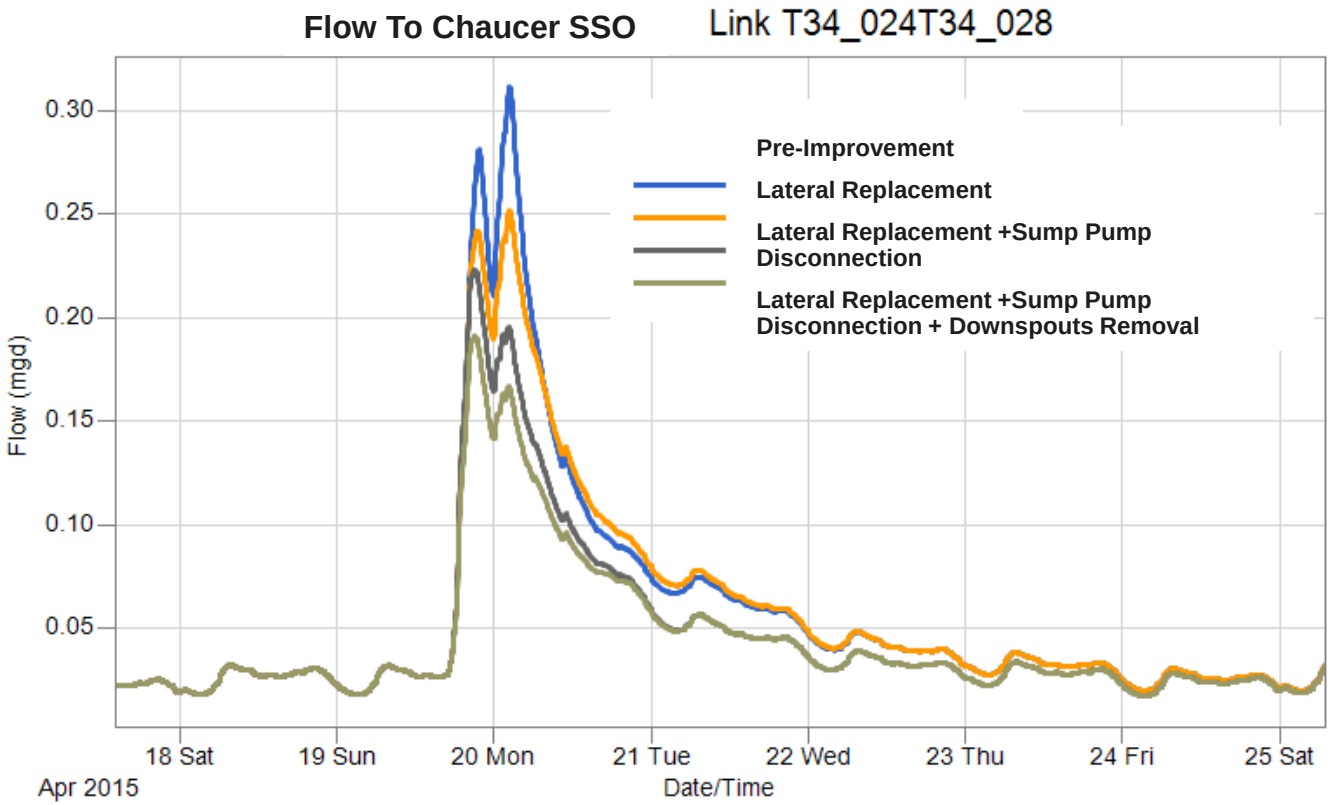
ARCADIS Design & Consultancy for natural and built assets

Calibration Examples – Ft Wayne



Ft Wayne – Previous Activities

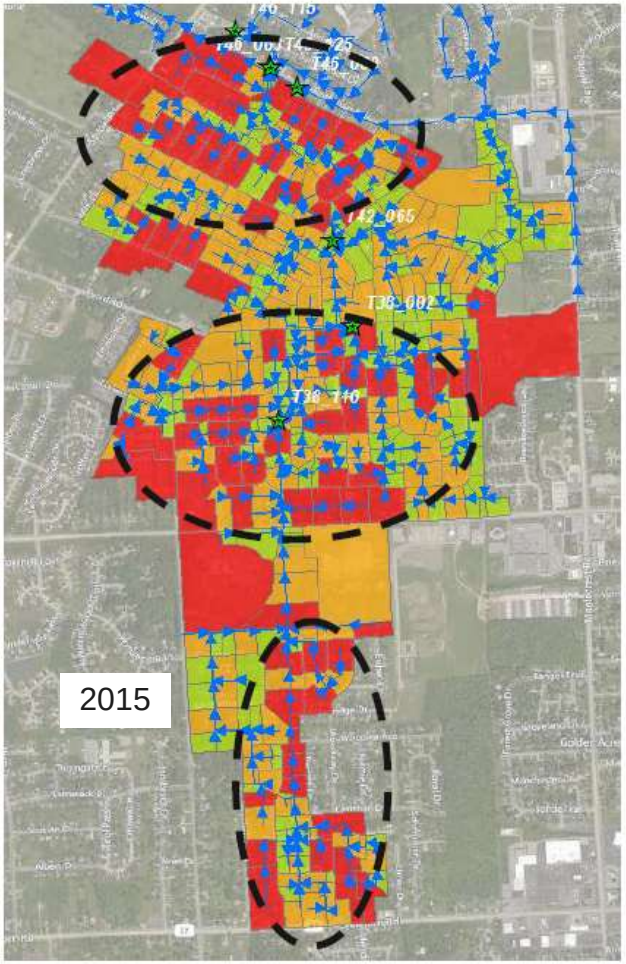
I/I improvement reduced I/I, but not enough to impact the Chaucer SSO chronic activation



Impact of I/I Previous Activities

Ft Wayne – Chaucer SSO Mitigation Plan

- Thematic map to identify areas with high I/I
- Focused I/I source reduction program including downspouts redirection away from house foundation



Outline

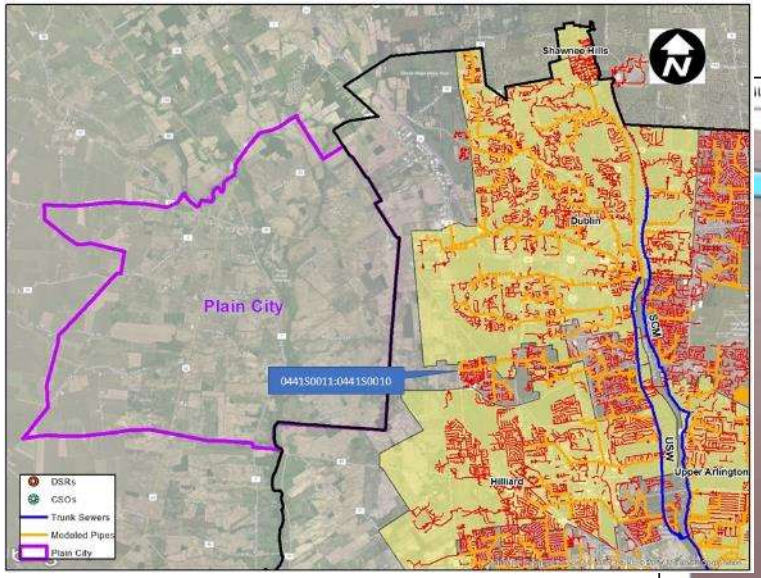
- Sources of Unintended Peak Flow
- Deficiencies and Level of Service
- Peak Flow Prediction - Modeling
- Mitigation Approaches
  - I/I Reduction
  - Capital Improvements
- Integrated Plan Programs

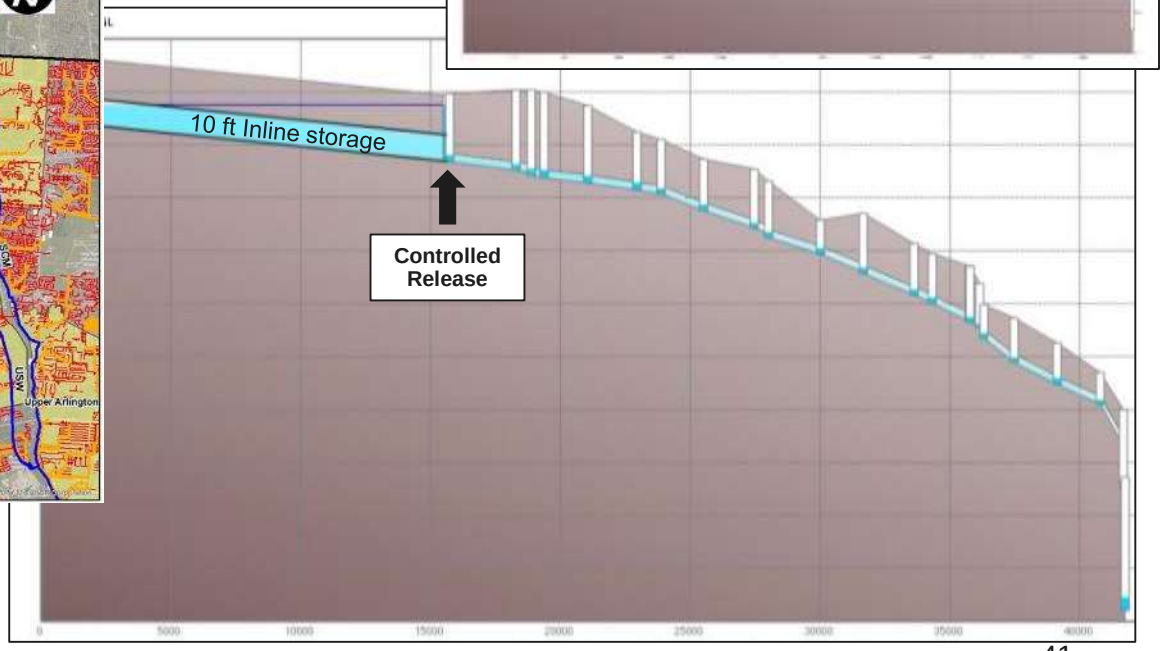
Capital Improvements

- Inline storage – pipes upsize with downstream release control
- Offline storage – storage tanks/equalization basins
- Tunnels – gravity in/pumping out
- Pipes' replacement/upsizing
- Real Time Control – maximize storage in existing system
- High rate treatment facilities

Plain City - OH Abandoning Remote WWTP

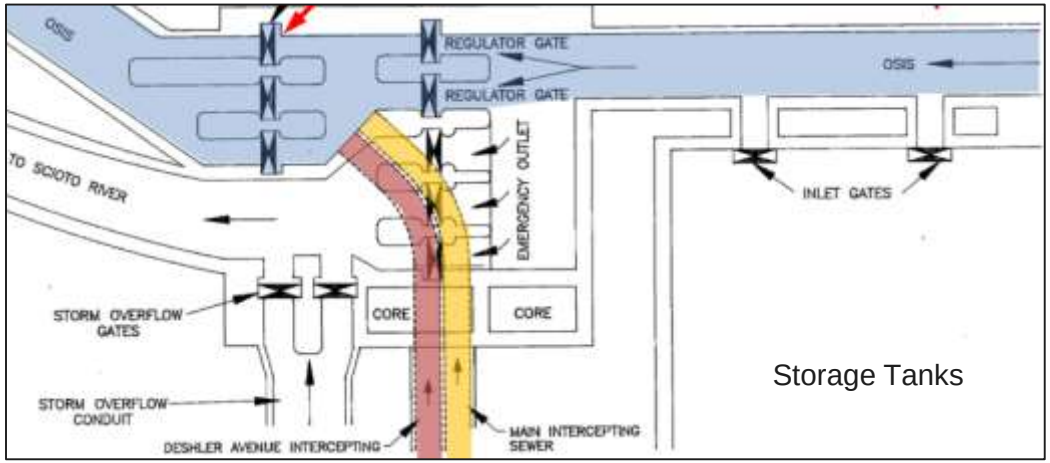
- Inline Storage
  - Large conveyance pipes with downstream controlled release





Columbus – OH Whittier St Storm Tank

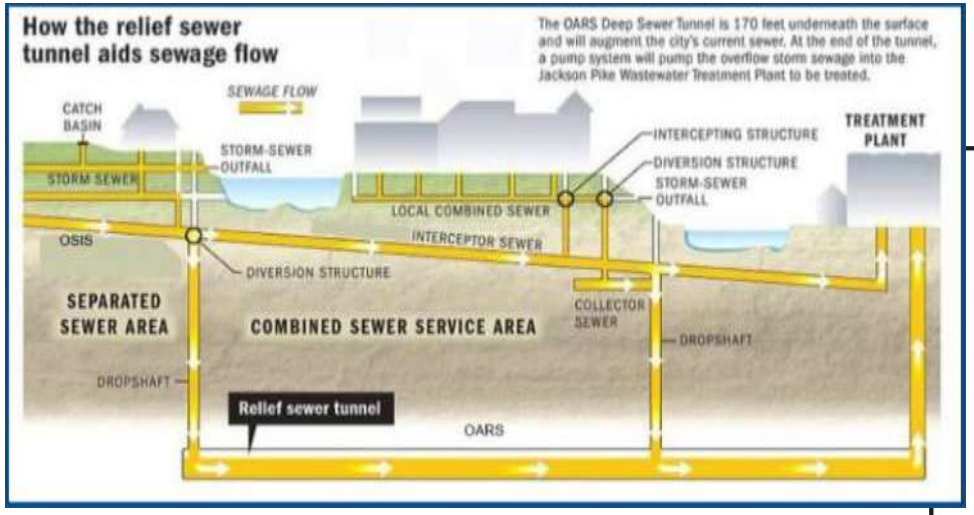
- Excessive combined flow
- Offline storage
  - Storage tanks / equalization basins
  - Requires washing mechanism after each use

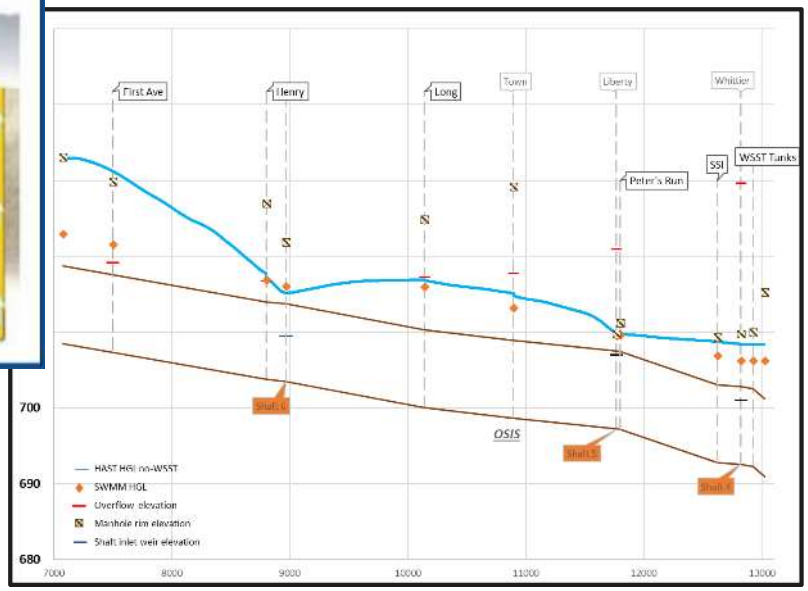


Storage Tanks

Columbus – OH Tunnel Operation

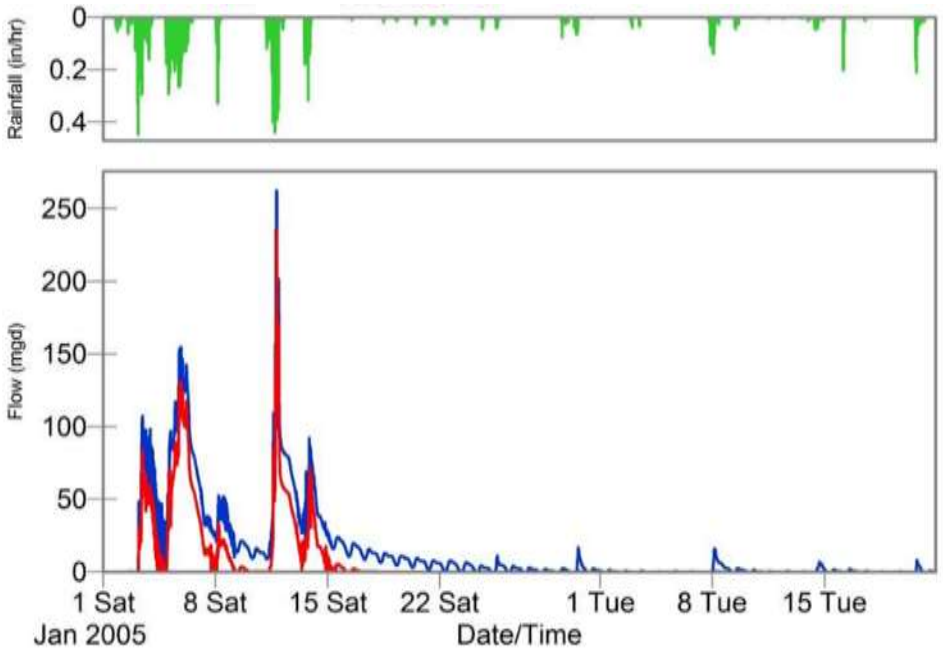
- Surge Analysis
- Adding vents at airpockets formation locations

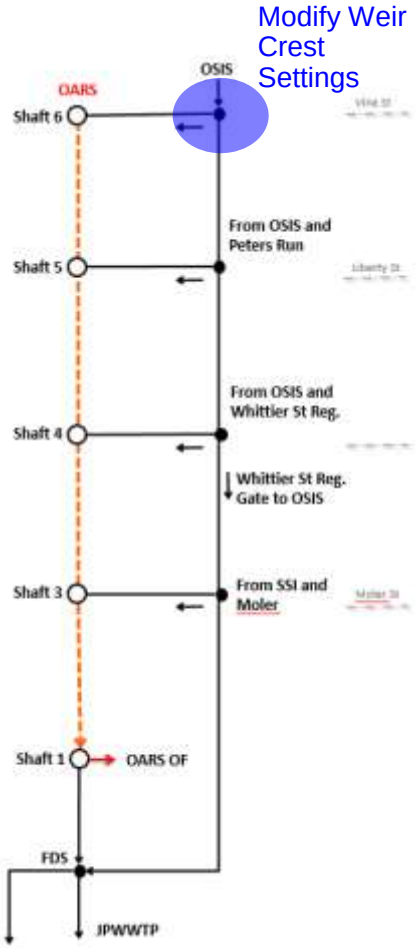




Columbus – OH Tunnel Operation

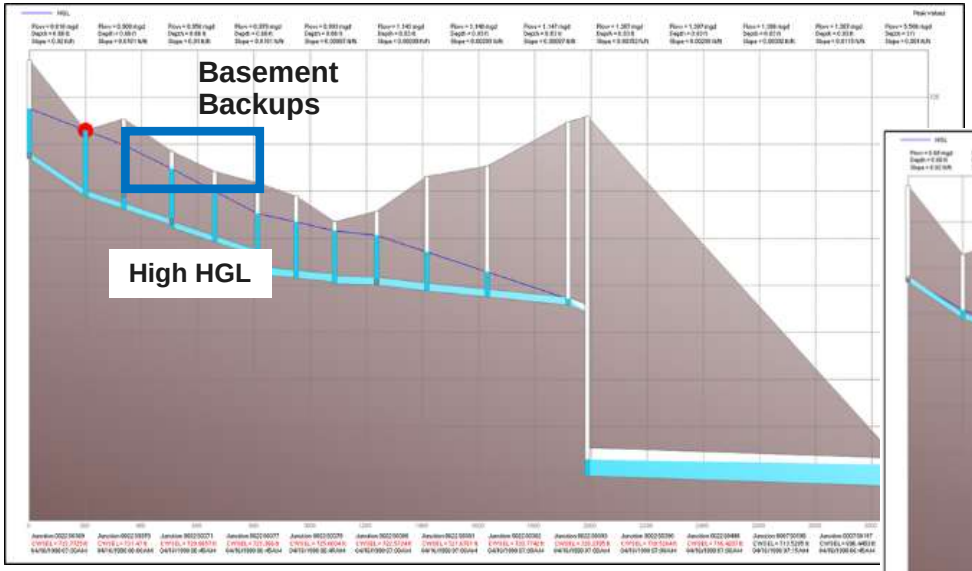
- Real Time Control
  - Modulate gates/weirs to maximize storage in existing system
  - Example: Reduce pumping cost in OASR Tunne

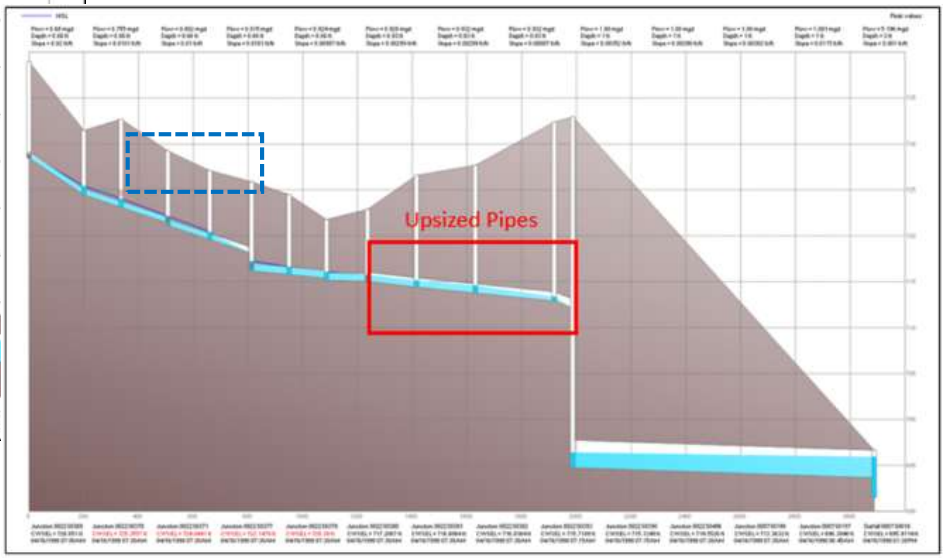




Hilltop – OH Basement Backups

- Chronic Basement backups
- Pipes' replacement/upsizing
  - H/H Model ensures we upsize the right pipes to resolve deficiencies in the collection system





Thank You

Hazem Gheith,
hazem.gheith@arcadis.com

ARCADIS Design & Consultancy for natural and built assets

Downspouts Redirection