4 Sources of Inflow & Infiltration
The EPA estimates there are up to 75,000 SSOs per year (not including sewage backups into buildings).

General result of high wet weather flows when collection system see 100–500% increases in average daily flows.
Rehabilitation Technologies For I&I Removal

How can I get the most return from my investment?

- Dig & Replace
- Pipe Bursting
- Cured-in-Place Pipe (CIPP)
- Chemical Grouting
Milwaukee Metropolitan Sewerage District:

- 28 member communities
- 2010 – 2020 Private Property I&I Program
- Incentivize member communities to address PPII
- Budget – $59 million from 2011–2021
- 80% rehabilitation & 20% investigation
- Exceeding maximum flow limits
Project Approach

- Multi-phase investigative approach with rehabilitation
  - CCTV required as part of selected rehabilitation method
  - Rain event simulation:
    - Soaker Hose & Storm Sewer Dye Flooding
    - Flow monitoring – V-notch weir flow meter
Soaker Hose and Dyed Water Test

Soaker hose used to wet the ground over the private lateral

Plug stormwater pipe and fill with dyed water.

Dyed water leaking out of the stormwater pipe can infiltrate into the lateral and main

Visu-Sewer
Round 0 (Pre-Rehabilitation)

- Establishing Baseline Flows
  - 2011 storm sewer dye flooding
    - Manholes Surcharged to casting
  - Round one of soaker hose testing
    - 3” per hour simulated rain event
    - Soaker hose components
    - Nearby hydrants
  - LETS camera inspections
    - Lateral leak location detection
Round 0 (Pre-Rehabilitation)

Sewer main & lateral connection prior to dye flooding

Sewer main & lateral connection during dye flooding
City of Wauwatosa PPll Investigative Pilot Project

Eagle St. (Between 76th St. & 80th St.)–2011 storm sewer dye flooding data.
Round A (Laterals in ROW)

- ROW lateral lining from sewer main
  - Sewer main previously lined with CIPP
  - Lined 30 feet with LMK T-liner
  - Required Vac-A-Tee near foundation
  - Second round of rain event simulation, CCTV inspection and flow monitoring
Lateral T–Liniers & Vac–A–Tees

- T–Liner limited length without Vac–A–Tee upstream
- Up to 200’ with a Vac–A–Tee
Round B (Targeted Laterals)

- Targeted laterals were lined from the ROW to the Vac–A–Tee near the foundation.
  - Laterals targeted–leakage rate of 5 gpm or more (During 2011 dye flooding project)
  - Approximately 30 additional feet with LMK lateral liner
  - Third round of rain event simulation, CCTV inspection and continuous flow monitoring
Round C (Remaining Laterals)

- Remaining laterals were lined from the ROW to the upstream access point near the foundation.
  - 30 feet with LMK lateral liner
  - Bury vac-a-tee access points
  - Fourth round of rain event simulation, CCTV inspection and continuous flow monitoring
Eagle St. - Project Implementation Diagram

Round 0 = Pre-rehabilitation
(2011 Dye Testing of former system, Phase IV Inspection by R.A. Smith)

- CIPP Lining of Targeted Laterals 42% Round B
- CIPP lining of laterals from main to ROW
- CIPP lining of sanitary sewer main

Round A

- Private Property
- Public Right-of-way

Round C

- CIPP Lining of Remaining Laterals

Visu-Sewer
Total Infiltration Reduction Diagram

Cumulative Lateral Flow Rates
Soaker Hose and Dye Water Test

Round 0 = Pre-rehabilitation
Round A = all laterals lined to ROW and sanitary sewer main lined
Round B = targeted lateral liners from ROW to house
Round C = remaining lateral liners from ROW to house

No stormwater pipe in front of these properties
Not tested in Round 0

Addresses on Eagle St, Wauwatosa
Total PPII Reduction & Lining Costs

- Average of 75% cumulative PPII reduction
  - Foundation drains and sump pump connections
  - Majority of PPII reduction achieved in the ROW
- Estimated larger scope lining costs:
  - Sewer main to the ROW – $4,700.00
  - Sewer main to the upstream access point – $6,000.00
- Not cost effective solely for PPII reduction
The Quest for an Affordable Alternative

- Lateral & lateral connection chemical grouting
  - Acrylamide Grout (Avanti’s AV100)
  - Effective—Stops leaks & stabilizes pipe
  - Affordable

- Contractors consulted for project parameters
  - LETS Lateral Inspections
  - Lateral cleaning & root cutting
  - Up to 15” mainline grout packers (readily available)
  - 5 foot lateral bladder lengths (high rate of success)
Lateral Grouting Example

Incident Code: MWL
Incident Description: Water Level
Feet: 0002.0
Percentage: 20

0033.5 F

- **Grouting Challenges:**
  - Protruding laterals
  - Root & deposit blockages
  - Structural defects
  - Tuberculation

- **Solutions:**
  - Mainline & Lateral jetting/cutting
  - Excavation or elimination?
City of Wauwatosa 2014 Lateral & Lateral Connection Grouting Project

- Project scope: 931 private sanitary sewer laterals in sewer basin WA 4002
  - 8” – 15” sewer main diameters
  - 5 gallons per lateral (AV100 or equal)
  - Removal of 83 protruding laterals
  - Root removal from 56 laterals (Mains & manholes)
  - CCTV connection verification of 78 laterals
Actual project quantities:

- 857 laterals grouted (92 % of planned quantity)
- 77 protruding laterals (92.7% of planned quantity)
- Root removal 79 laterals (141% of planned quantity)
- 2,993 gallons of excess ($8.00 per gallon)
- City of Wauwatosa video review estimated 25% PPII reduction
Lateral Lining (ROW):
- 75% reduction in overall PPII
- $4,700.00/lateral (Estimated)
- $4.02 million for 857 laterals

Lateral & Lateral Connection Grouting:
- 25% reduction in overall PPII (Estimated)
- $469.49/lateral (Actual)
- $402,352 for 857 laterals—10% of the cost to achieve a 33% reduction
- 3.3 times greater reduction in PPII volume (dollar for dollar)
Conclusions & Future Projects

- Grouting laterals and lateral connections:
  - Effective, Affordable, Sustainable
  - Lining laterals for PPII & structural rehabilitation
    - Public vs. private benefits
  - Lining solely for PPII reduction
    - Cost prohibitive for large scale
    - Not financially sustainable
Questions?