



Infiltration & Inflow Investigation Achieves an “As Tight As Possible” Collection System

Presented to
Council Committee-of-the-Whole Meeting
Bettendorf, Iowa
June 15, 2009

Agenda

- **Infiltration and Inflow (I&I) Defined.**
- **Identify and Quantify I&I Sources.**
- **Innovative and Cost-Efficient Testing Methods.**
- **Recommend Practical Rehabilitative Solutions.**

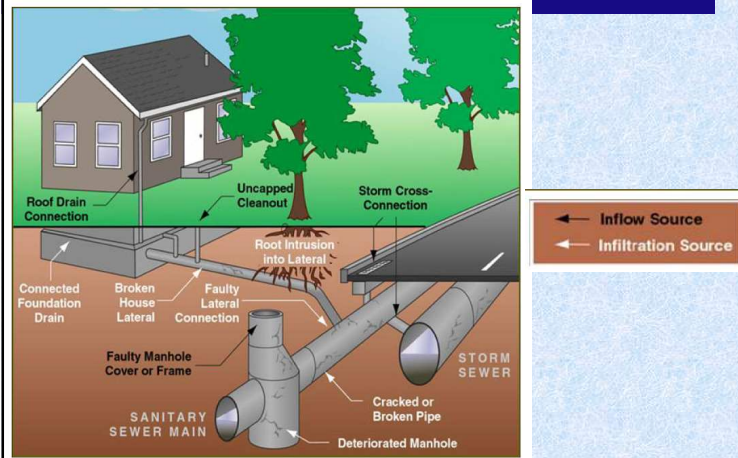
Sanitary Sewer System Conveys Hydraulic Flows

- **Wastewater**
 - Residential, commercial, industrial customer discharges that must be collected and treated.
- **Infiltration**
 - Clear groundwater that enters through cracks and/or leaks in the system that occurs continuously.
- **Inflow**
 - Storm water and snow melt runoff that enters through direct connections to the system that occurs during wet weather.

Excess I&I Leads to Environmental Problems

- **Joint Use Water Pollution Control Plant**
 - Primary treatment hydraulic capacity = 66 mgd.
 - Joint Use Interceptor capacity = 175 ± mgd.
 - Sluice gate closed to prevent lift station flooding.
- **Backup in Interceptor**
 - Excess I&I in both Bettendorf and Davenport.

I&I Approach Must Investigate All Sources



I&I Study Approach Uses Innovative and Cost-Efficient Approaches

- **Field Investigations. Walk Sewers.**
 - **Flow Monitoring.**
 - **Manhole Inspections.**
-
- **Smoke Testing.**
 - **Dye Testing.**
 - **Building Inspections.**
 - **Televising Inspections of Main Sewers.**
 - **Televising Inspections of House Laterals.**

Bettendorf Sewer Components Give Magnitude of Effort

- **980,000 linear feet (185 miles) of sewers.**
- **Size from 6" to 72".**
- **4,200 manholes.**
- **3 lift stations.**
- **Pipe Materials: Vitrified Clay, Reinforced Concrete, Ductile Iron.**

Bettendorf Sewer Aging Infrastructure

Installation dating back to:

Basin 1, 2, 3:
1916.

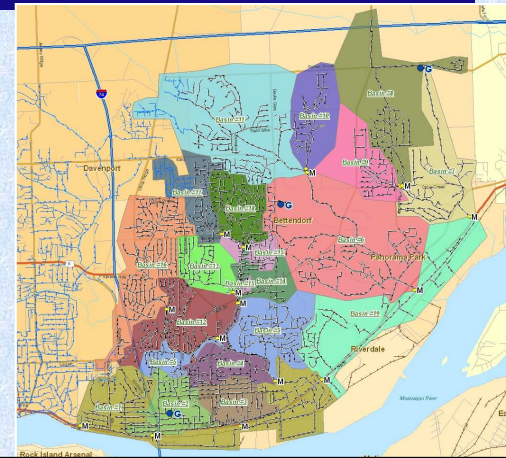
Basin 4, 5, 12:
1950s.

Basin 13, 14, 15, 16, 17, 18:
1960s.

Basin 6, 7, 9, 11, 19: 1970s.

Basin 8: 1980s.

Basin 10: 2002.

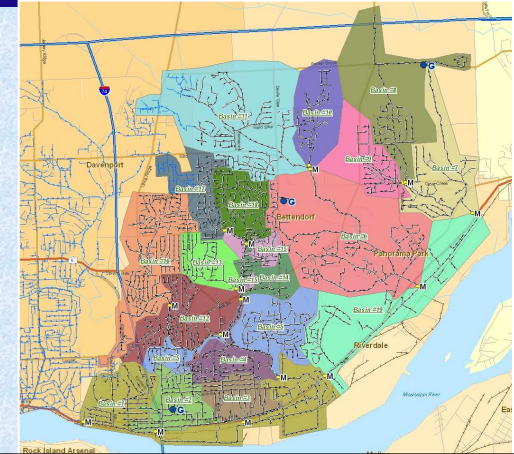


Flow Monitoring Evaluates Existing Sewer System

- Determines flow per basin monitored.
 - Base Sanitary Flow.
 - Infiltration Locations and Quantities.
 - Inflow Locations and Quantities.
- Does not tell cause.

Drainage Basins Delineation Localizes Problem Areas

19 Flow Meters
3 Rain Gauges



Rainfall Events Result in Wet Weather Flows

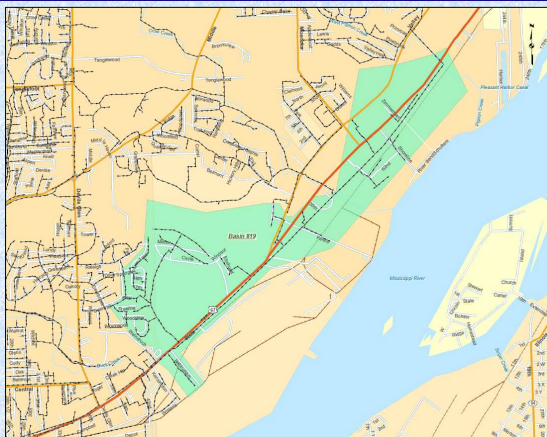
August 27 – October 2, 2008

	9/4/08 (16 hr)	9/8/08 (8 hr)	9/13/08 (3 day)	9/29/08 (90 min)
City Hall	2.18"	0.70"	3.95"	0.69"
Public Works	1.89"	0.66"	3.42"	0.51"
Lift Station (Forest Grove Rd)	1.45"	0.56"	2.90"	0.51"

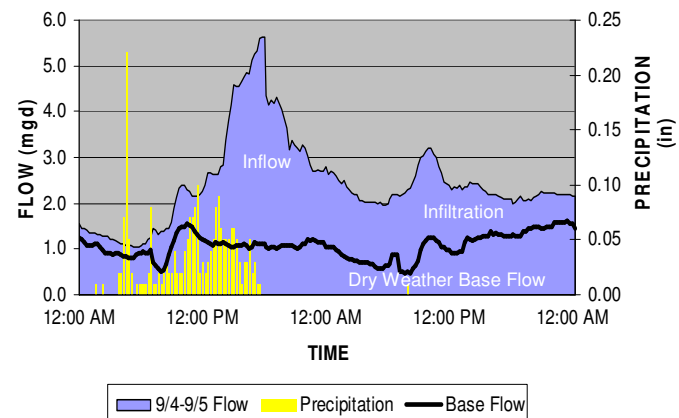
Flow Monitoring Results Analyzed Using September 4th Storm

- Bettendorf Base Flow = 6.8 mgd
- Total I&I = 11.2 mgd
- Total Wet Weather = 18.0 mgd
- Highest I&I Occurred in Basin 19, 5, 17, and 2.
- Highlights areas for further investigation.

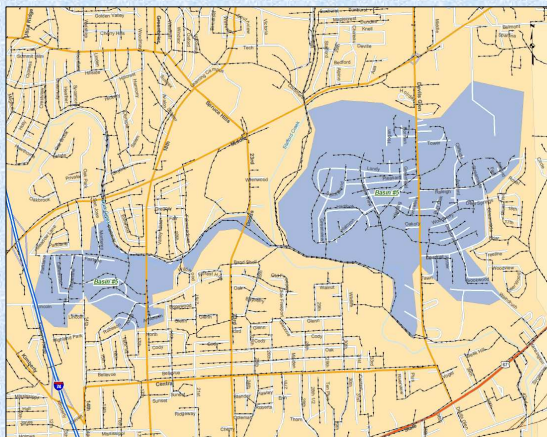
Basin 19 has Significant I&I



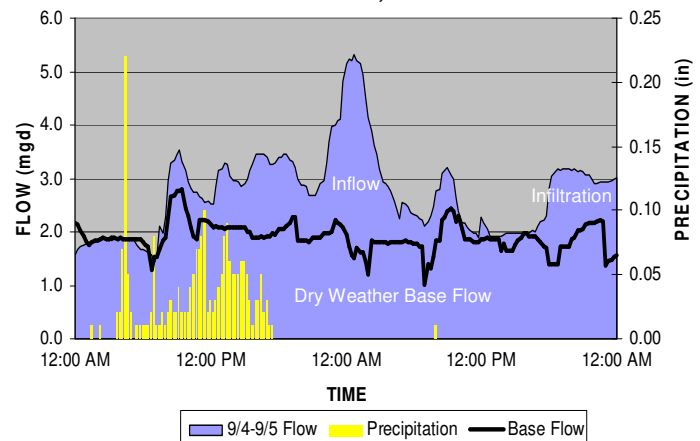
BASIN 19 FLOW and PRECIPITATION vs TIME SEPTEMBER 4, 2008 - 2.18"



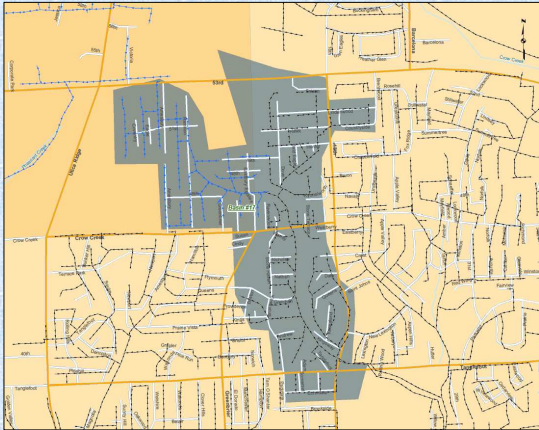
Basin 5 has Significant I&I



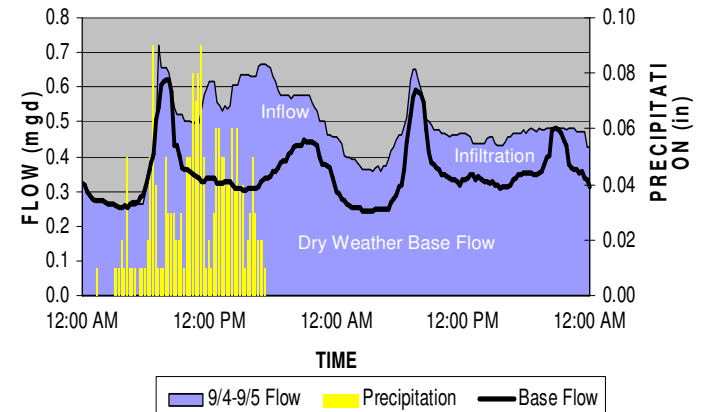
BASIN 5 FLOW and PRECIPITATION vs TIME SEPTEMBER 4, 2008 - 2.18"



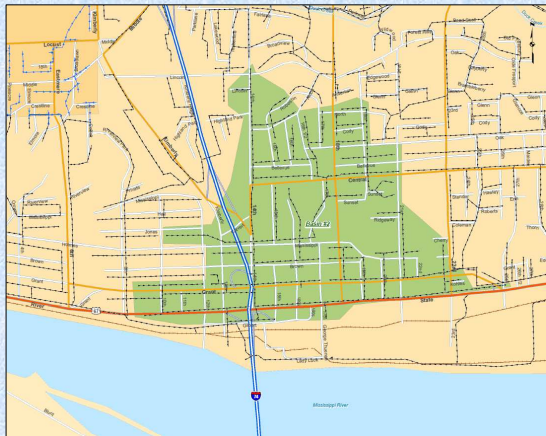
Basin 17 has Significant I&I



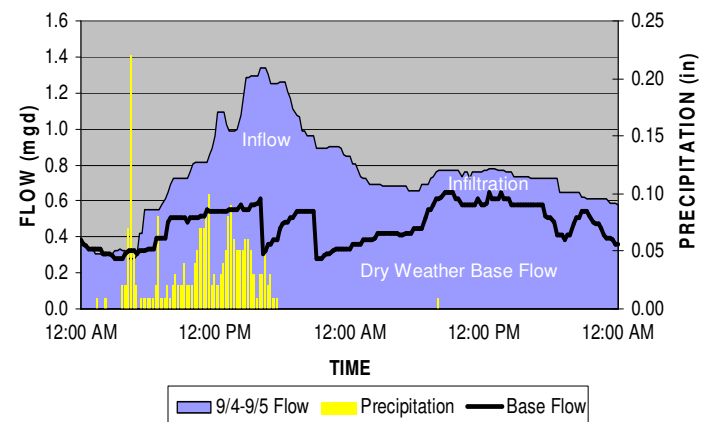
BASIN 17 FLOW and PRECIPITATION vs TIME SEPTEMBER 4, 2008 - 1.89"



Basin 2 has Significant I&I

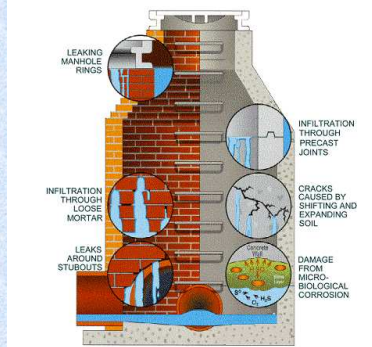


BASIN 2 FLOW and PRECIPITATION vs TIME SEPTEMBER 4, 2008 - 2.18"



Manhole Inspections Identify Significant I/I Sources

- What is Manhole Condition?
- Does MH Lid have Openings?
- Does Manhole Lid Get Flooded?
- Are Adjustment Rings Deteriorated?
- Are Frame and Cover Sunken?
- Any Obstructions or Root Intrusion?
- Any Evidence of Leakage?
- Any Cross-Connections?



Manhole Inspections Identified Sources of I&I

Basin	MHs Inspected	Defects				
		Lid	Frame Seal	Wall	Bench Trough	Pipe Seals
19	146	92	24	95	45	20/46
5	274	216	16	59	22	26/79
17	145	107	20	47	32	44/85
2	170	139	58	90	65	8/9
Total	735	554	118	291	164	98/219

Manhole Inspections Quantified Inflow into Manholes

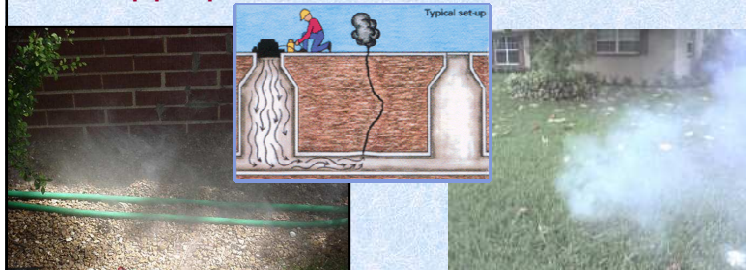
Basin	Inflow Measured During Flow Monitoring (gpd)	Inflow Identified during Manhole Inspections (gpd)	% Inflow Identified
19	2,389,000	106,997	4%
5	1,460,000	284,427	19%
17	194,000	164,105	85%
2	519,000	380,759	73%
Total	4,562,000	936,288	21%

I&I Study Approach Uses Innovative and Cost-Efficient Approaches

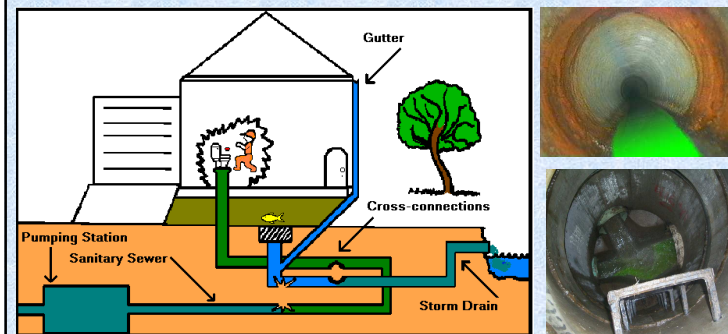
- Field Investigations. Walk Sewers.
- Flow Monitoring.
- Manhole Inspections.
- Smoke Testing.
- Dye Testing.
- Building Inspections.
- Televising Inspections of Main Sewers.
- Televising Inspections of House Laterals.

Smoke Testing Locates Illicit Connections

- Are There Cross Connections?
- Are There Broken or Cracked Pipes?
- Are There Illegal Connections - downspout, cellar, yard or foundation drain connections, sump pumps?

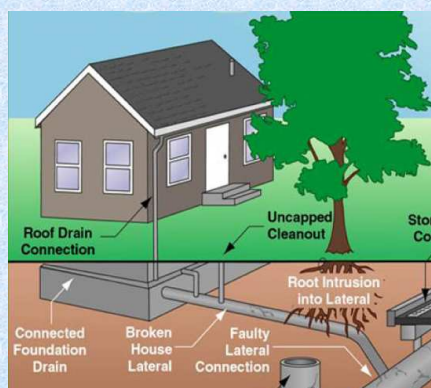


Dye Injection / Testing Isolates Cross Connections



Building Inspections Identify Customer Service Lateral Problems

- Are Downspouts Connected to Service Lateral?
- Are Sump Pumps Connected to Service Lateral?
- Are Cleanout Caps Flooding?

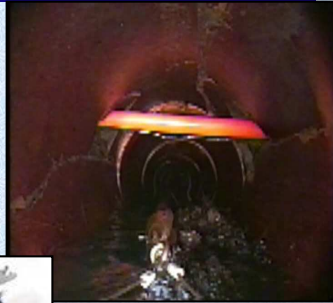


Televising Captures Visual Conditions in Sewer Main

- Assessment Includes:
 - Root Intrusion.
 - Cracks (Longitudinal, Circumferential, etc...).
 - Offset Joints.
 - Cavity in Pipes.
 - Misaligned Service Connections.
 - Vertical Depression in Pipeline.
 - Flow Obstructions.
 - Grease Buildup.

Televising Main Sewers Locates Problem Areas

- What are Actual Condition of Sewers?
- What is Extent of Problem Areas?
- What is Location of Problem Areas?



Televising Lateral Sewers Gives Property Owner Understanding

- Is Lateral Cracked?
- Is Lateral Near Collapse?
- Does Lateral Have Bottom?
- Are Tree Roots Protruding into Lateral?
- Are Joints Offset?
- Does Pipe Have a Cavity?
- Are Service Connections Misaligned?
- Is the Flow Obstructed?
- Is Grease Build Up?

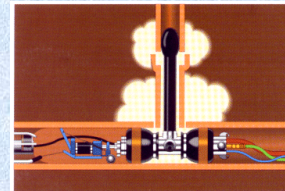


I&I Investigation Results in Cost Effective Solutions

- Identify Possible Solutions for Each I&I Problem.
- Analyze Each Practical Alternative I&I Solution.
- Recommend Practical, Cost-Effective Solutions.
- Use Most Efficient Expenditure for Quantity of I&I Removed.
- May Use Different Solutions for Different Problems.

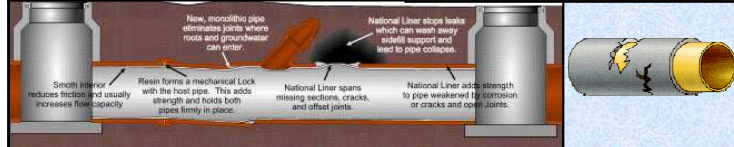
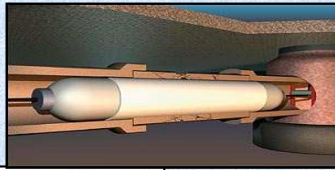
Inflow Repairs Remove Surface Water

- Replace Manhole Lids.
- Frame And Cover Height Adjustment.
- Remove Storm Water Connections.
- Disconnect Downspouts.
- Disconnect Sump Pump Discharges.
- Disconnect Footing Drains.



Infiltration Repairs Remove Groundwater

- **Line and/or Grout Manhole.**
- **Repair Sewer Cracks and Joint Separations.**
- **Line Sewer.**
- **Spot Repair Sewers.**



Manhole Inspections Identified Rehabilitation Needs

Adjustments in
Poor Condition



Manhole Inspections Identified Rehabilitation Needs

MH 17 - 12244
Pic # 26



MH 17 - 12223
Pic # 24



MH 17 - 12256
Pic # 29



MH 17 - 13114
Pic # 15



Further Investigation & Manhole Rehabilitation - Basin 2, 5, 17, 19

Year 2009

- **Additional Investigation - Basin 2, 5, 17, 19**
 - ▶ **Additional Flow Monitoring - Basin 19**
 - ▶ **Smoke Testing**
 - ▶ **Locate & Inspect Remaining Manholes**
 - ▶ **Building Inspections**
- **Total For Additional Testing** **\$175,000**
- **Testing Budget Remaining** **\$ 35,000**
- **Additional Estimated Cost** **\$140,000**
- **Estimated Cost for Manhole Rehabilitation Design & Construction** **\$750,000**
- **Total Estimated 2009 Cost** **\$890,000**

Continue Investigation in Other Basins

Year 2010

- Investigation - Basin 1, 3, 4, 7, 12, 14
 - ▶ Manhole Inspections
 - ▶ Smoke Testing
 - ▶ Building Inspections
 - Total Estimated Cost \$200,000
- Estimated Cost for Manhole Rehabilitation Design & Construction \$750,000
- TOTAL Estimated 2010 Cost \$950,000