



Sanitary Sewer Evaluation Surveys

Thursday October 1 (1pm – 2pm EST)





Today's Agenda

Sanitary Sewer Evaluation Surveys (SSES)

Infiltration & Inflow

- Identify Common Sources
- Understand Impact on Collection Systems

Inspection & Condition Assessment Methods

- Introduce Standard Inspection Methods

Understand Data Collection & How To Use It

- Benchmarking System Condition
- Use Data to Prioritize Repairs & Improvements

Infiltration & Inflow





Key Concepts Infiltration & Inflow (I&I)

Inflow- Storm water or groundwater that flows into the sanitary sewer system through direct connections, primarily from various types of stormwater drainage features

Infiltration- Storm water or groundwater that flows into the sewer system through defects in sewer collection mains & structures

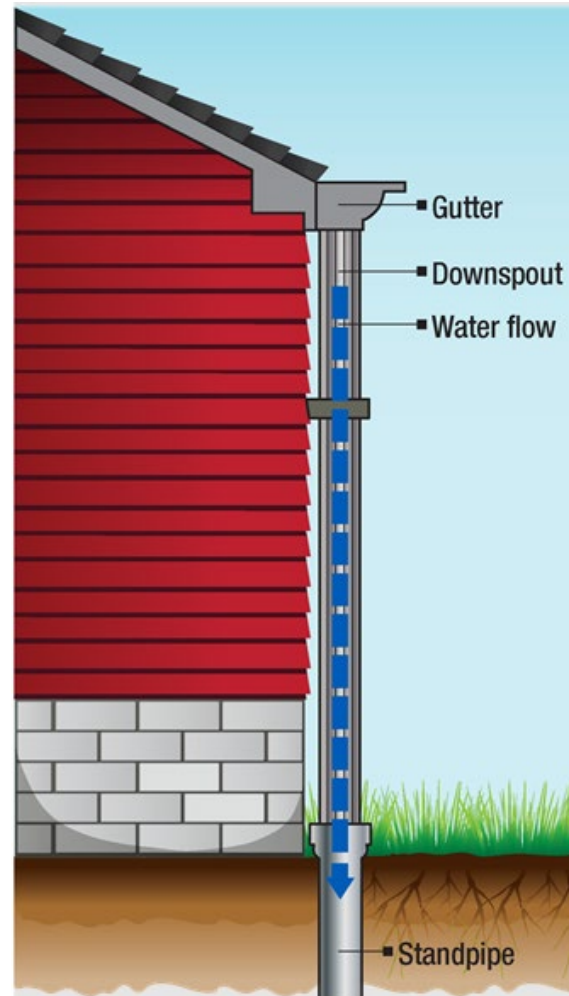


Sump Pumps



Sources of Inflow

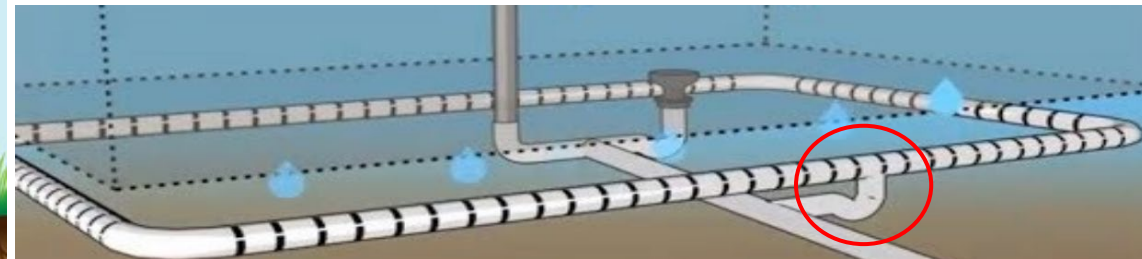
Roof Drains



Storm Sewer

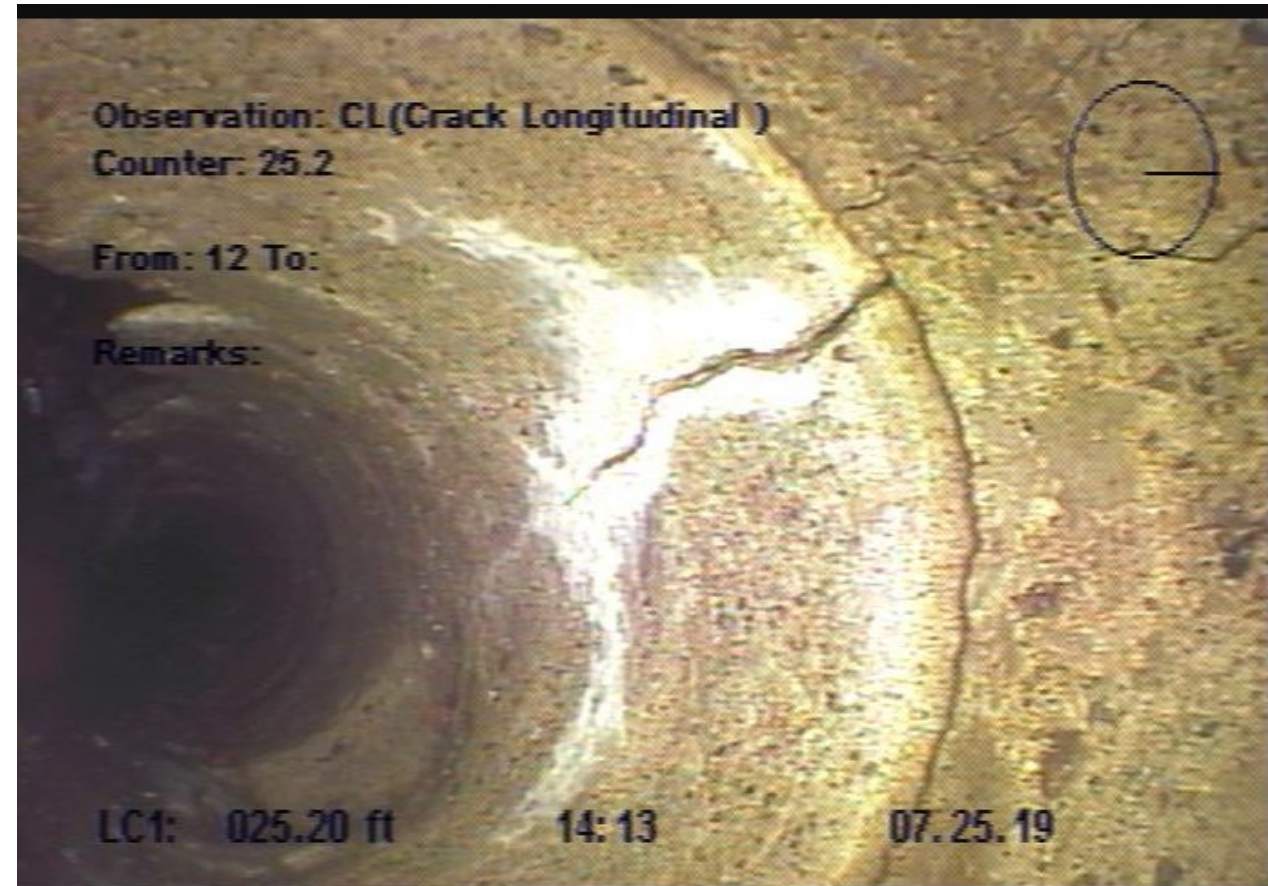
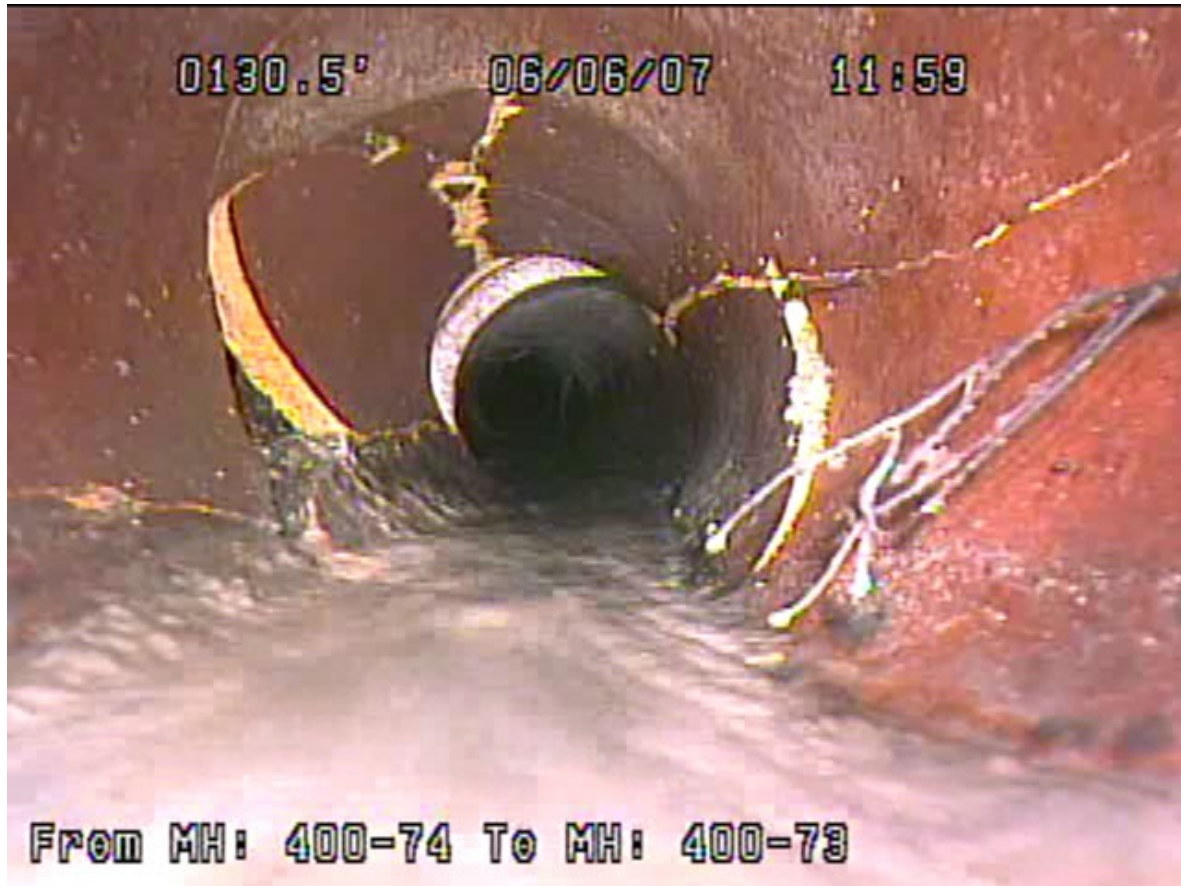


Drain Tile



Sources of Infiltration

Cracked Pipe



Sources of Infiltration

Offset Joint



Poor Joint Seal



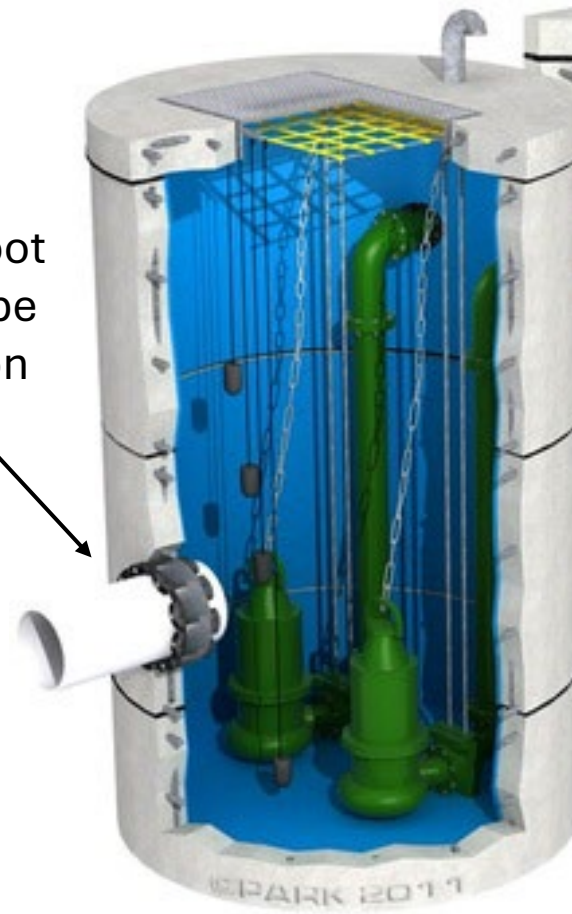
Sources of Infiltration

Manhole Lid



Poor Joint Seal

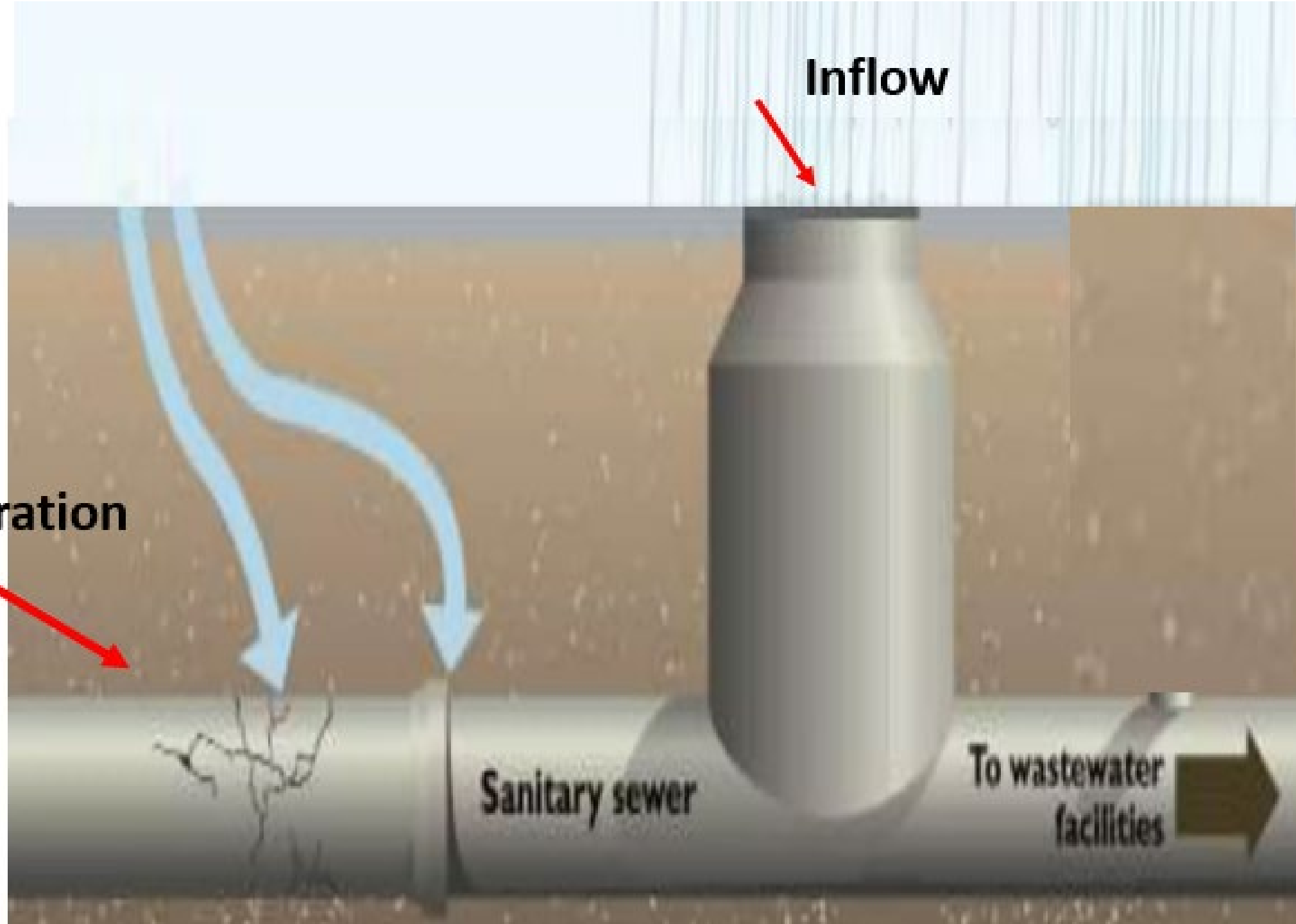
Rubber boot
sealing pipe
penetration





Infiltration

Inflow



Poll #1

Which of the following are examples of inflow when connected to the sanitary sewer system?

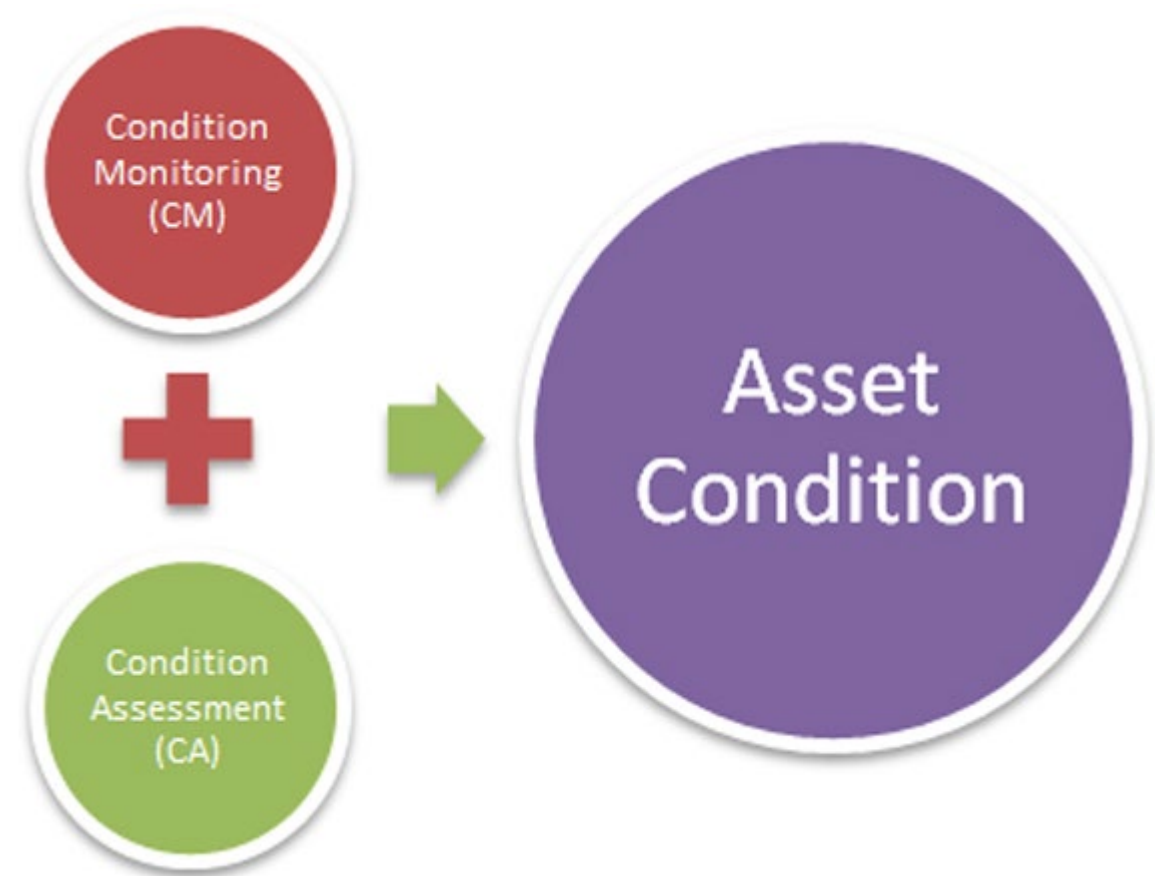
Choose all that apply.

- a. Sump pump
- b. Cracked sanitary sewer lateral **(Infiltration)**
- c. Drain tile
- d. Catch basin



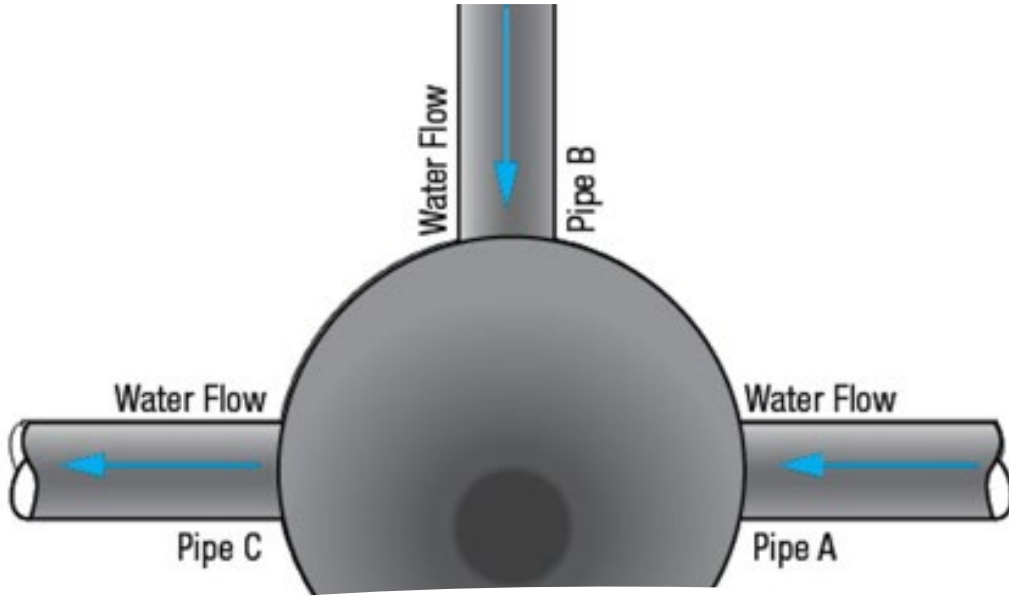
Town of Gilbert, AZ

Inspection & Condition Assessment Methods



Suzane Greeman, Greeman AM Solutions

Flow Monitoring



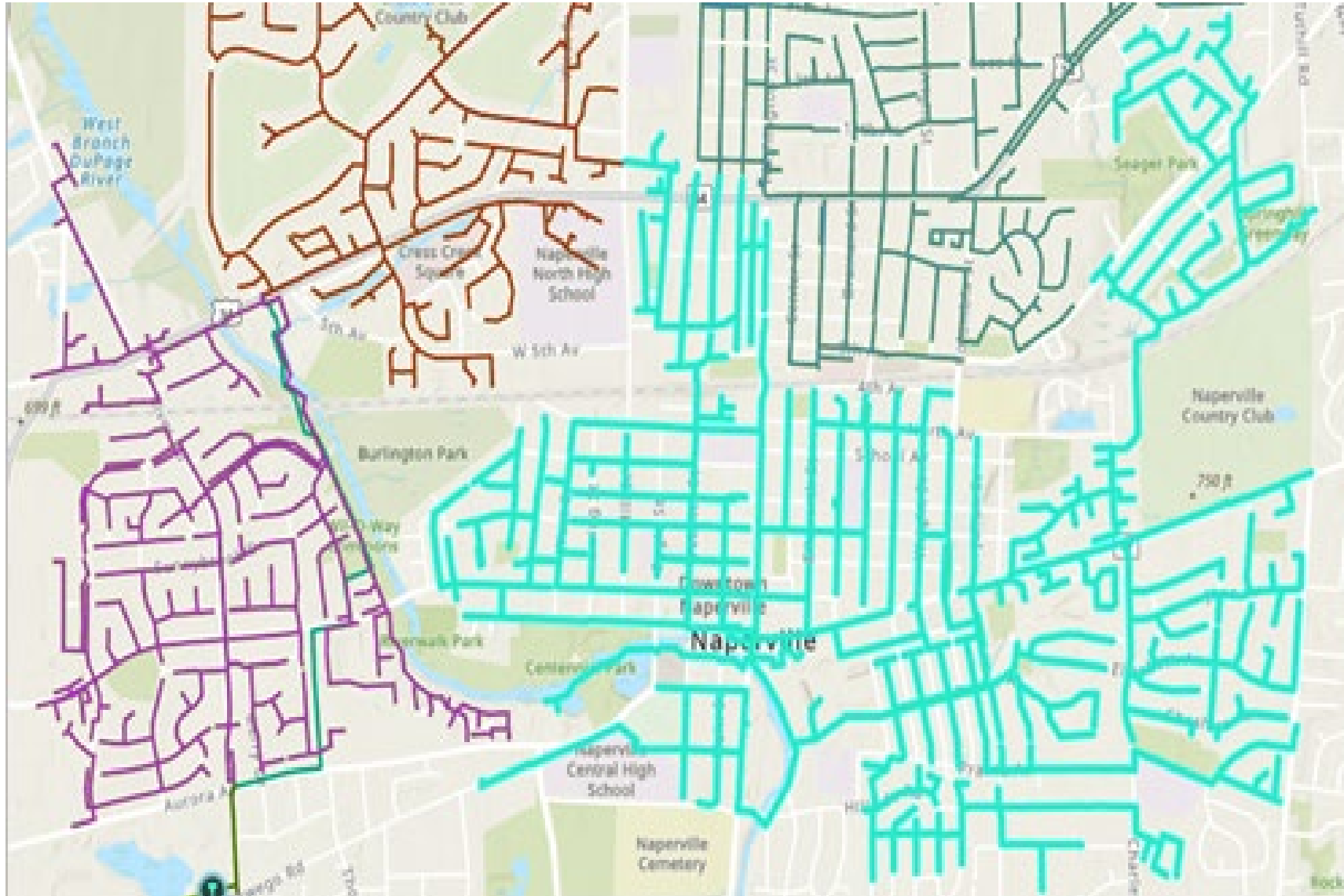
Set up at key manholes with water level and velocity sensors

Comparison of wet and dry weather flows

Conducted for a significant amount of time to assess flows after a variety of weather events

Sewer-sheds

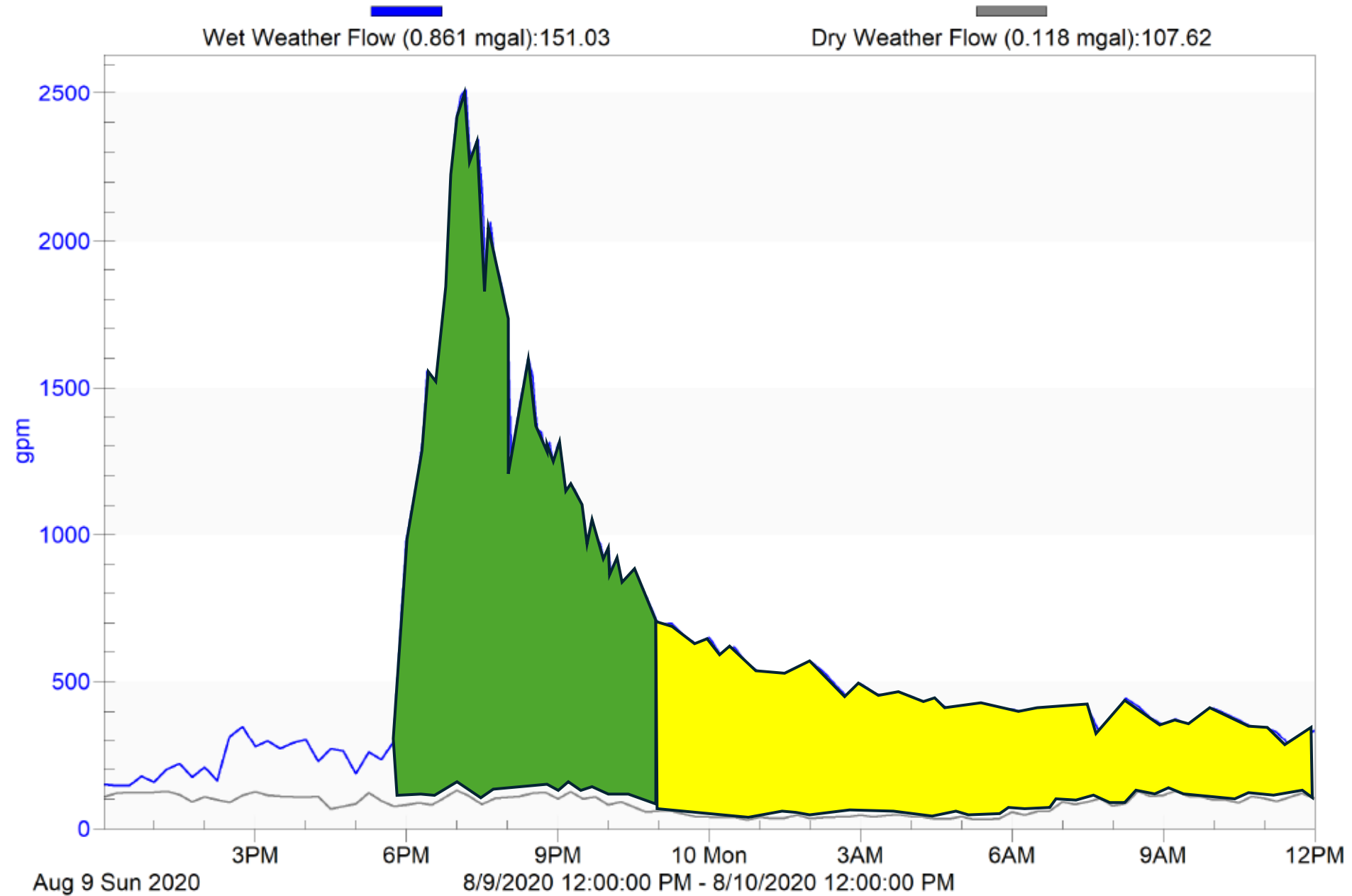
Sewershed-portion of a collection system with a common piping system





Ashland D-7

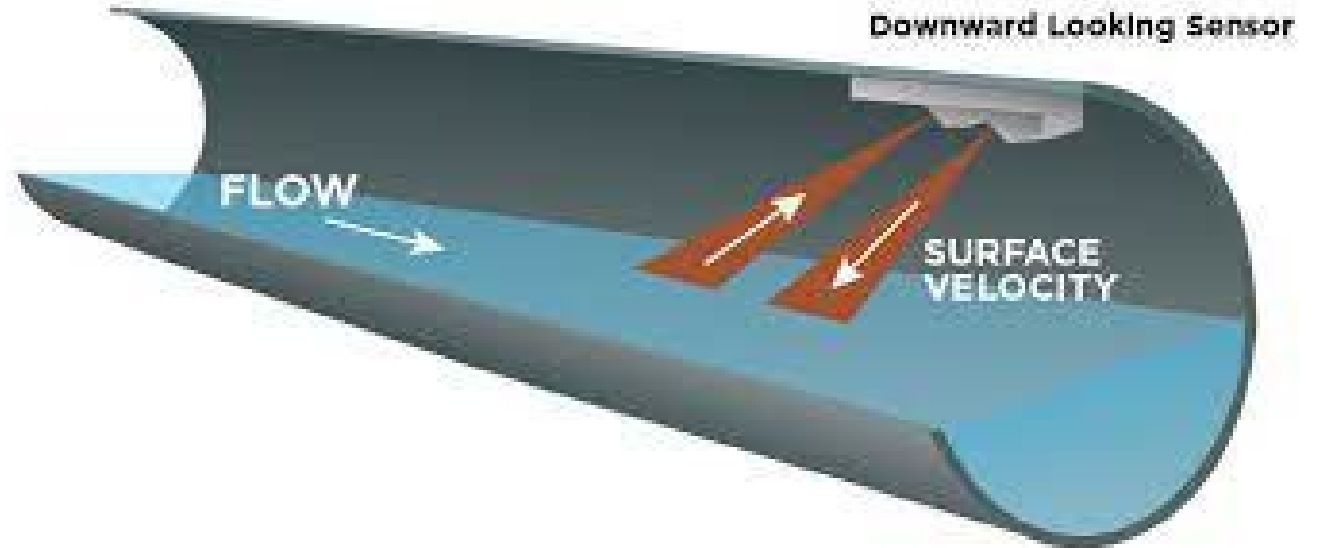
August 9, 2020 Wet Weather Event



Flow Monitoring

Evaluate depth of flow and flow velocity in sewer pipes.

- Increased depth of flow indicates a possible restriction, negative slope, or a surcharged condition.
- Velocity changes can indicate restrictions or need for jetting



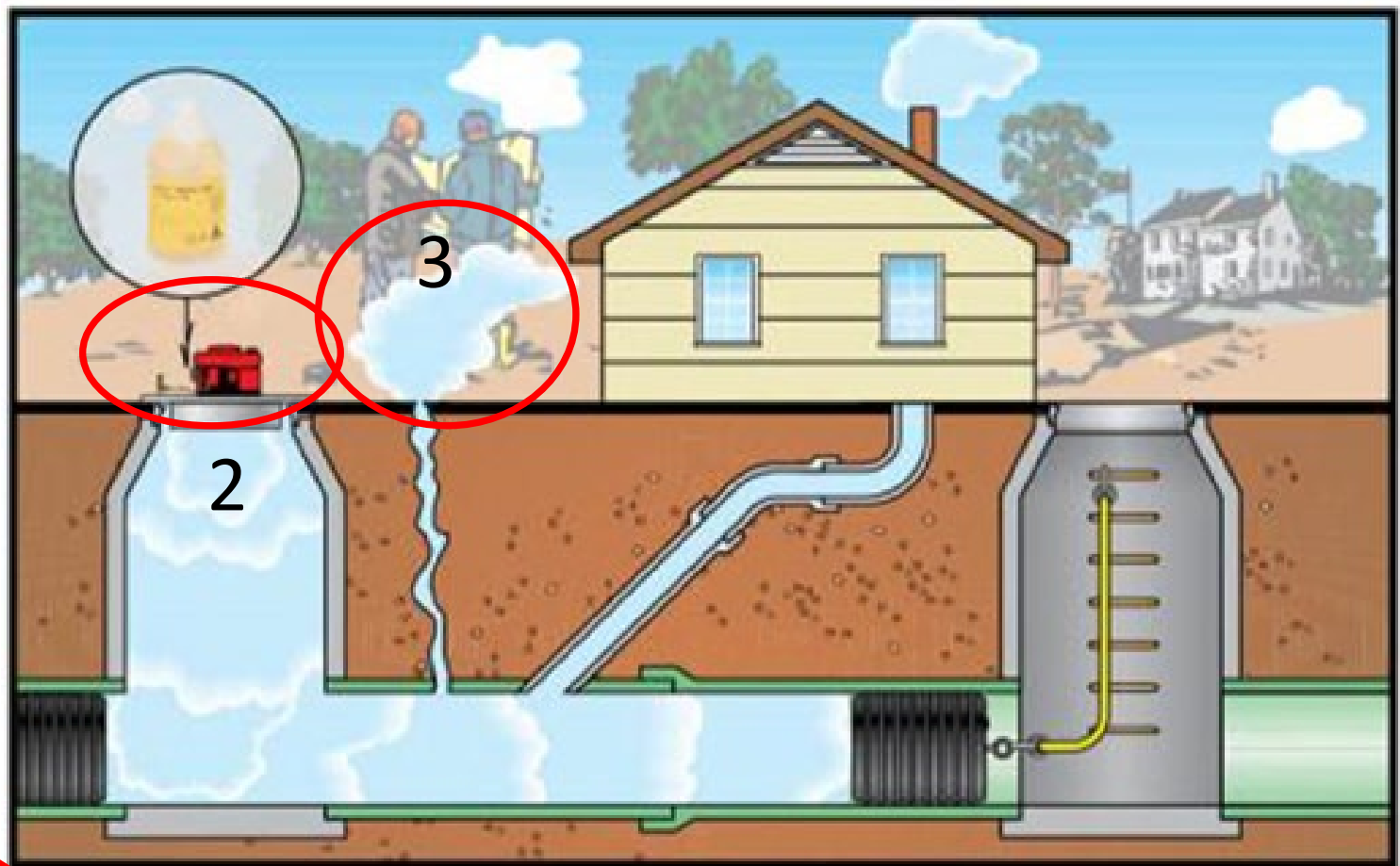
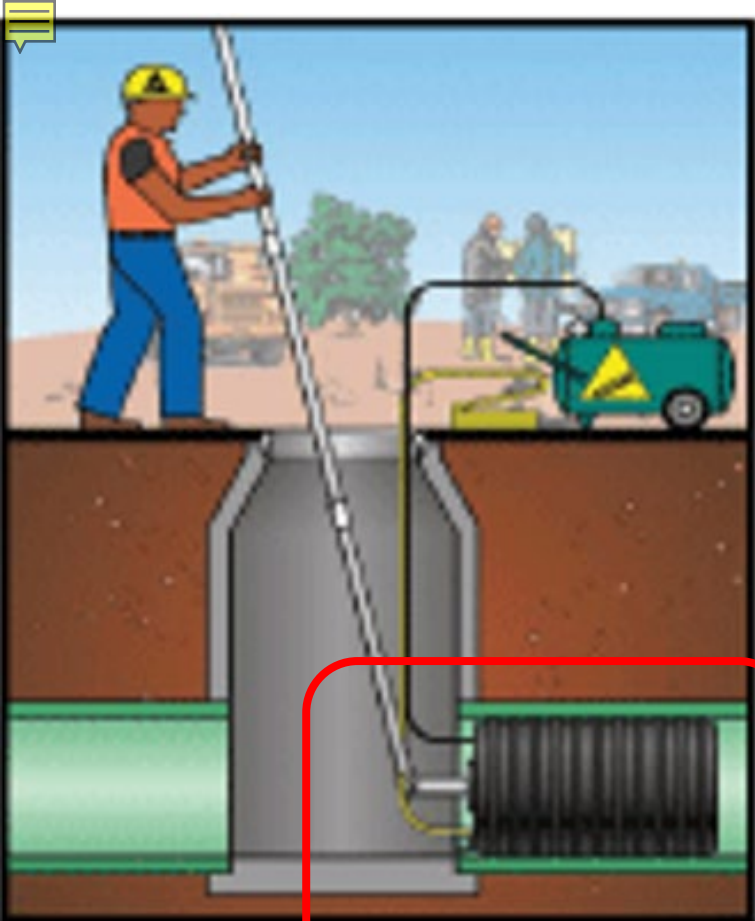
Smoke testing



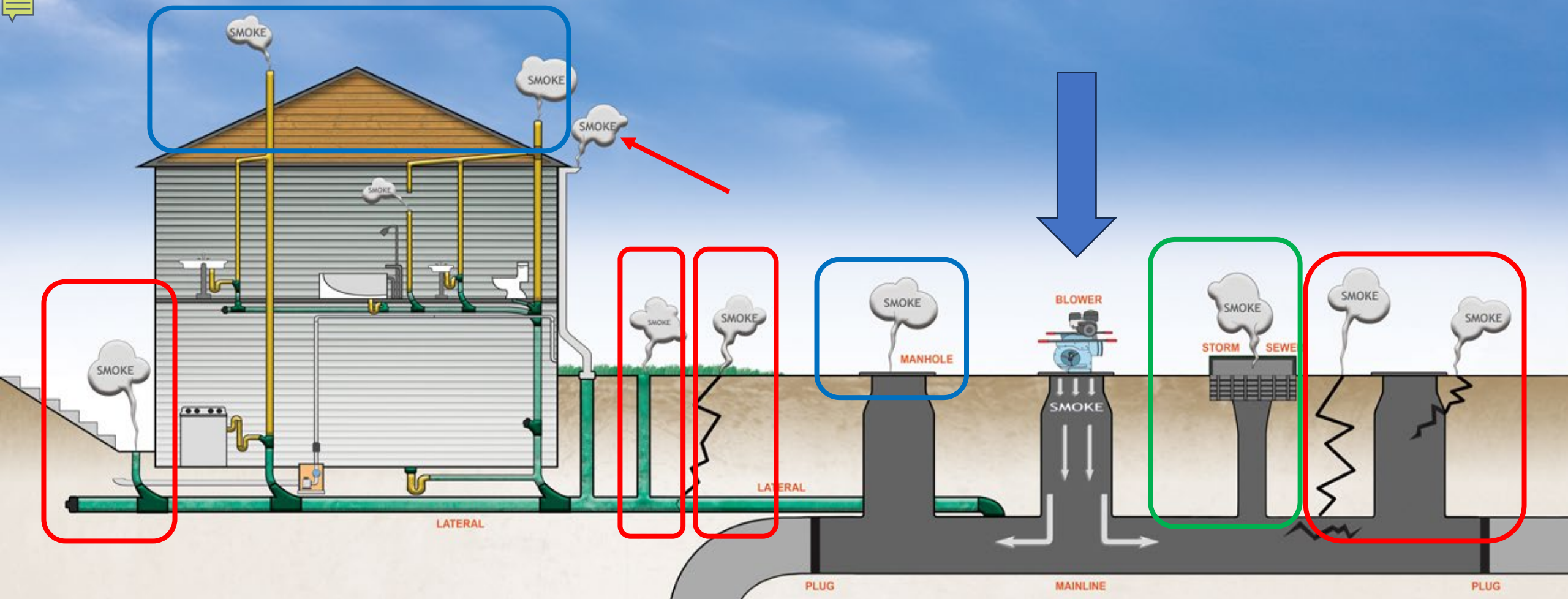


Smoke testing

- Quick & inexpensive way to detect sources of inflow and, in some cases, infiltration
- Not a routine method of inspection. Used when evidence of I&I has previously been detected
- Frequently the only method to investigate unauthorized connections to sanitary sewer (yard drains, foundation drains, downspouts)
- Requires coordination with building inspection entity
- Be sure to notify the Public & Emergency Services prior to conducting on any scale



1. Use sewer plugs to isolate test volume
2. Place smoker on manhole with liquid smoke chemical
3. View and record results



- ☐ Smoke from rain gutters is a source of inflow.
- ☐ Smoke from lawn areas can indicate an uncapped cleanout or broken lateral.
- ☐ Smoke from roof vents and through manhole covers is normal
- ☐ Smoke along the sewer between manholes can indicate collection main damage.
- ☐ Smoke from storm sewer indicates a potential cross connection for sanitary sewers



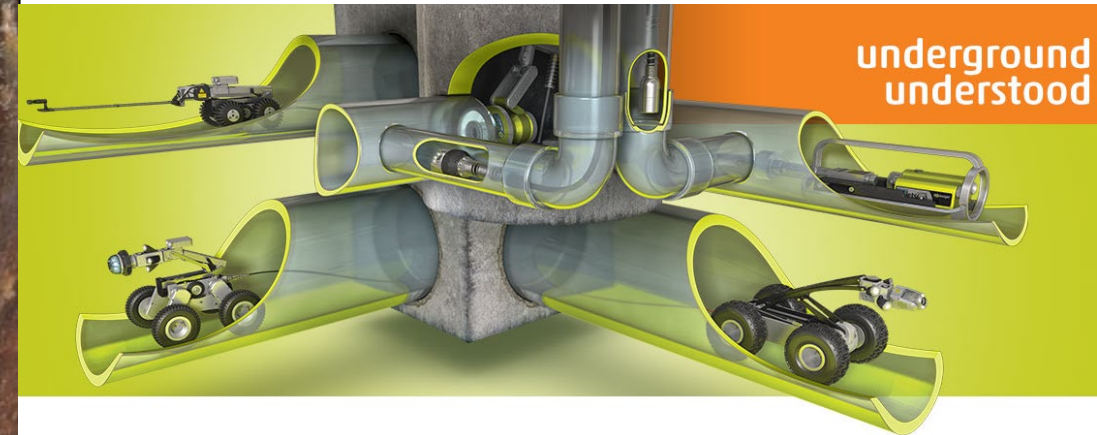
Dye Testing

- Diagnose inflow from specific sources (roof drains & sump pumps)
- Dyes available are non-toxic & fluorescent to allow detection during day/night
- No impact to downstream treatment process
- Select color based on system conditions
 - Yellow/green for clay tile pipes
 - Red if viewing lagoon or pond
 - Blue when public view is a consideration
- Be sure to notify the Public, EMS & Public Safety prior to conducting on large scale





CCTV Inspection



CCTV Inspection

Truck launches
camera into sewer



Self-propelled
“mud-monster”
camera carrier

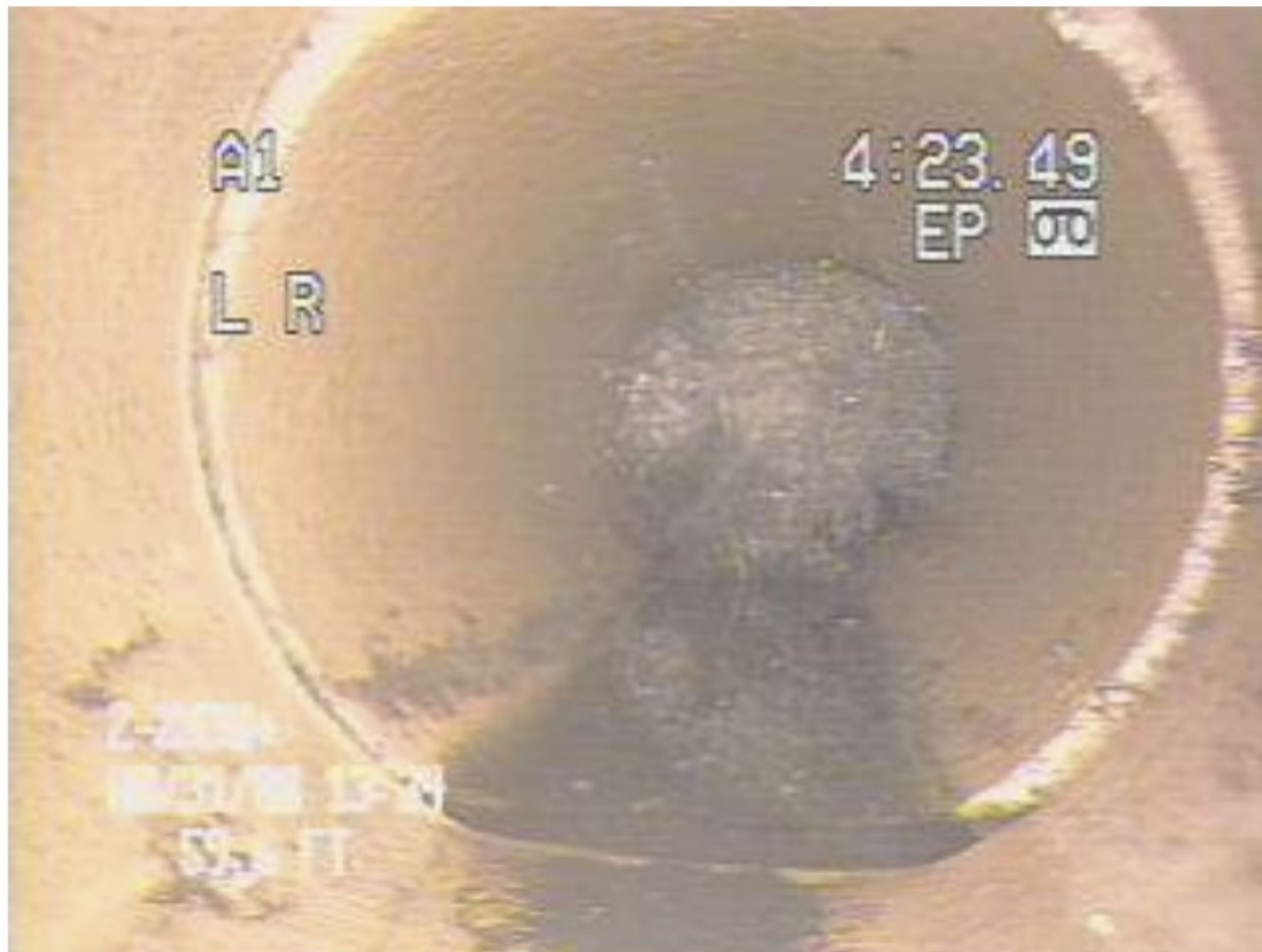
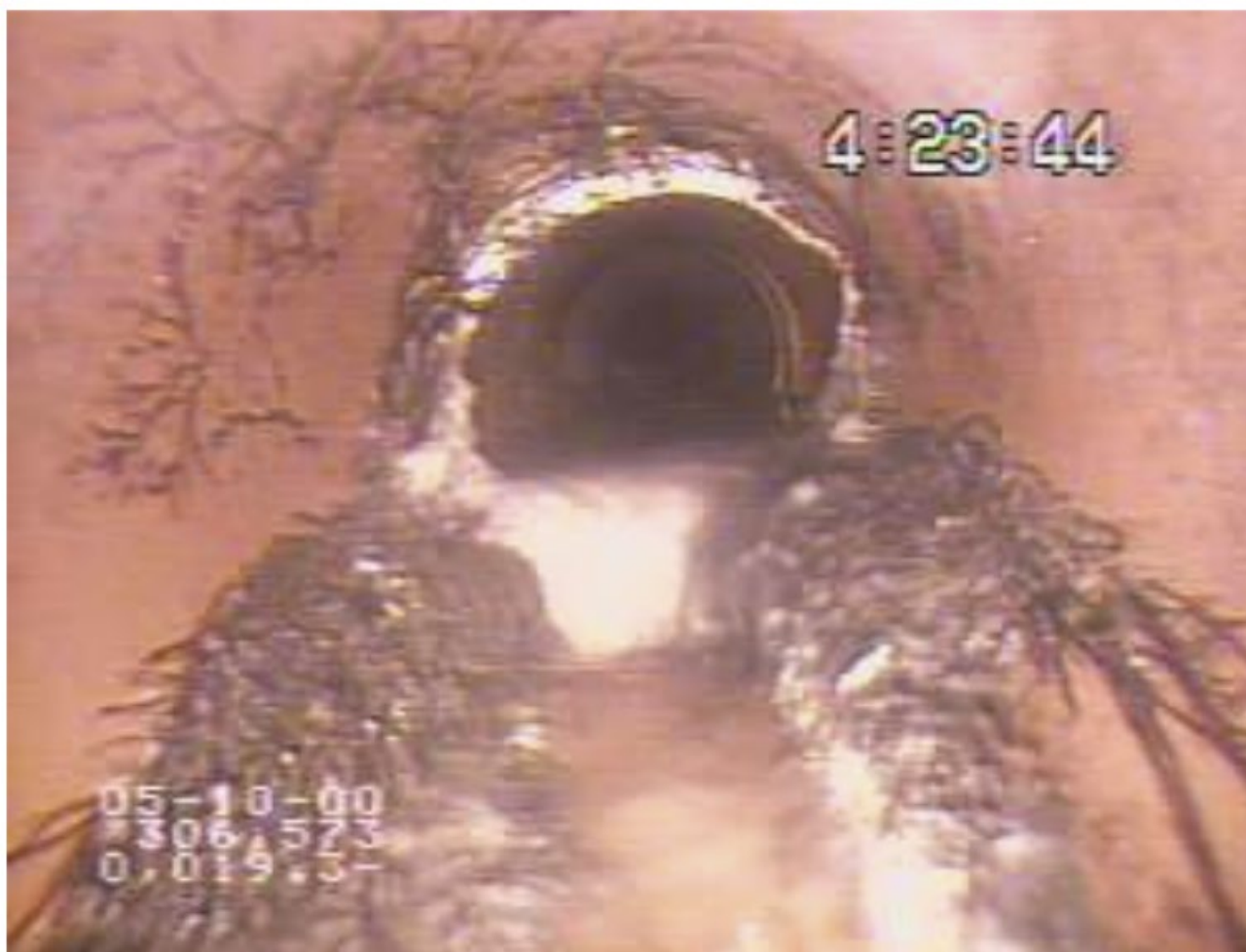


Control panel and
CCTV screen



Louisville/Jefferson County MSD

Root intrusion



Grease buildup



Structural Pipe Failure



I&I Source Identification



CCTV inspection results example

The distance into the main is recorded (Pos = position)

RJ = Roots at joint

OJL = Open joint large

Pos	Video Ref	Code	Description	Image
03.30m	0:00:32	RJ	Roots at joint - Severity 3	Image Provided - Ref: 1_7 
04.60m	0:00:44	RJ	Roots at joint - Severity 3	Image Provided - Ref: 1_8 
06.50m	0:01:05	OJL	Open joint large - Severity 4	Image Provided - Ref: 1_9 

Poll #2

Staff at your Wastewater Utility suspects a large industrial facility of contributing significant inflow to your system based on observations during wet weather events. The facility is willing to cooperate in assessing but denies any direct connections of stormwater facilities to the sewer system.

What method would you select to investigate?

- a. Dye testing
- b. CCTV
- c. Smoke Testing
- d. Flow Monitoring

SANITARY SEWER DATA COLLECTION





Flow Monitoring

- **Base Wastewater Flow** is wastewater from households, based on metered water flow to indoor plumbing. Estimated. Typ. 100 gpd per person. Excludes I&I.
- **Average Daily Dry Weather Flow:** Average flow of wastewater during dry weather. Flow measured at the treatment plant. Includes groundwater infiltration.
- **Average Daily Wet Weather Flow:** Average flow of wastewater flow following wet weather. Flow measured at the treatment plant. Includes infiltration and inflow (I&I).

Groundwater infiltration = **Average Daily Dry Weather Flow** – **Base Wastewater Flow**

Inflow = **Average Wet Weather Flow** – **Average Daily Dry Weather Flow**



Smoke & Dye Testing

- Difficult to replicate tests, important to document as they are performed
- Document via photos of smoke/dye observations
- Use report to document other info such as location, date of testing





Sanitary Smoke Testing

City of Ashland

Incident ID	22	Incident Date	11/7/2013	Technician	Strand - RJL
Basin ID	District 7	Incident Time	11:10:00 AM		

Set Up Number	22	Plug 1 Loc	451	Plug 3 Loc		Plug 5 Loc	
Smoker Location	451	Plug 2 Loc	452	Plug 4 Loc		Plug 6 Loc	

Incident Location	Storm Inlet at NE Corner of 5th St E and 16th Ave E		
Incident Category	Public - Connected Storm Inlet	Inflow Potential	High
Estimated Severity	Severe	Infiltration Potential	Unknown - Add'l Investigation Needed
Observations	Smoke observed coming from storm inlet located at the northeast corner of 5th St. E and 16th Ave. E.		
Additional Investigation Recommended?	☒		
	Recommended Additional Investigation		
	Televise/dye test storm and sanitary sewers in this area.		
Recommended Repair	To be determined after further investigation.		

Area Photo



IMG_0693.JPG

Close Up Photo



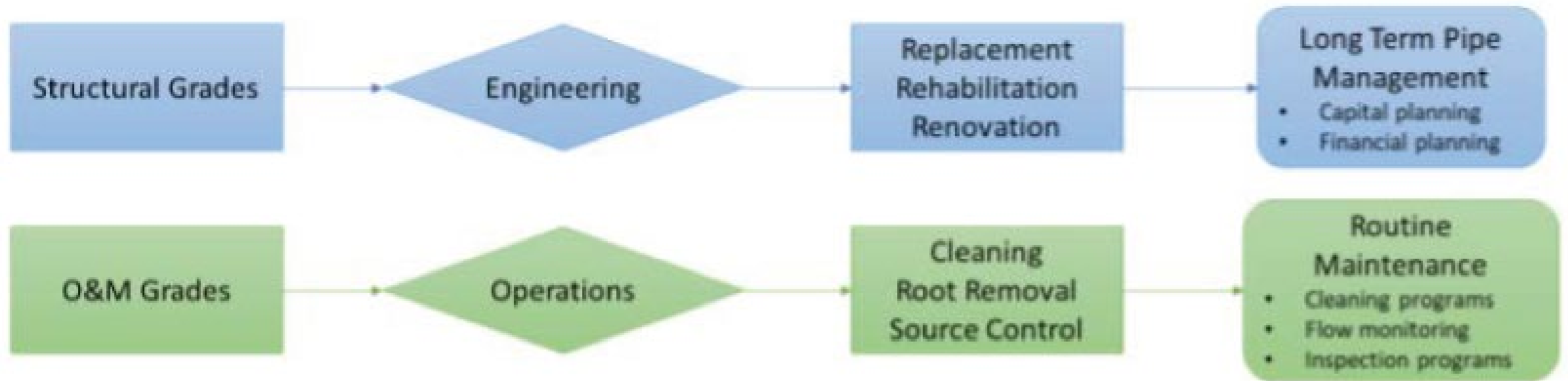
IMG_0692.JPG

Pipe Condition Ratings

- Industry standard created by National Assoc. of Sewer Service Companies
- Pipeline Assessment Certification Program (PACP)
- Critical to use for “apples to apples” condition assessment
- Structural, Operational & Maintenance, Overall Ratings Component



Pipe Condition Ratings



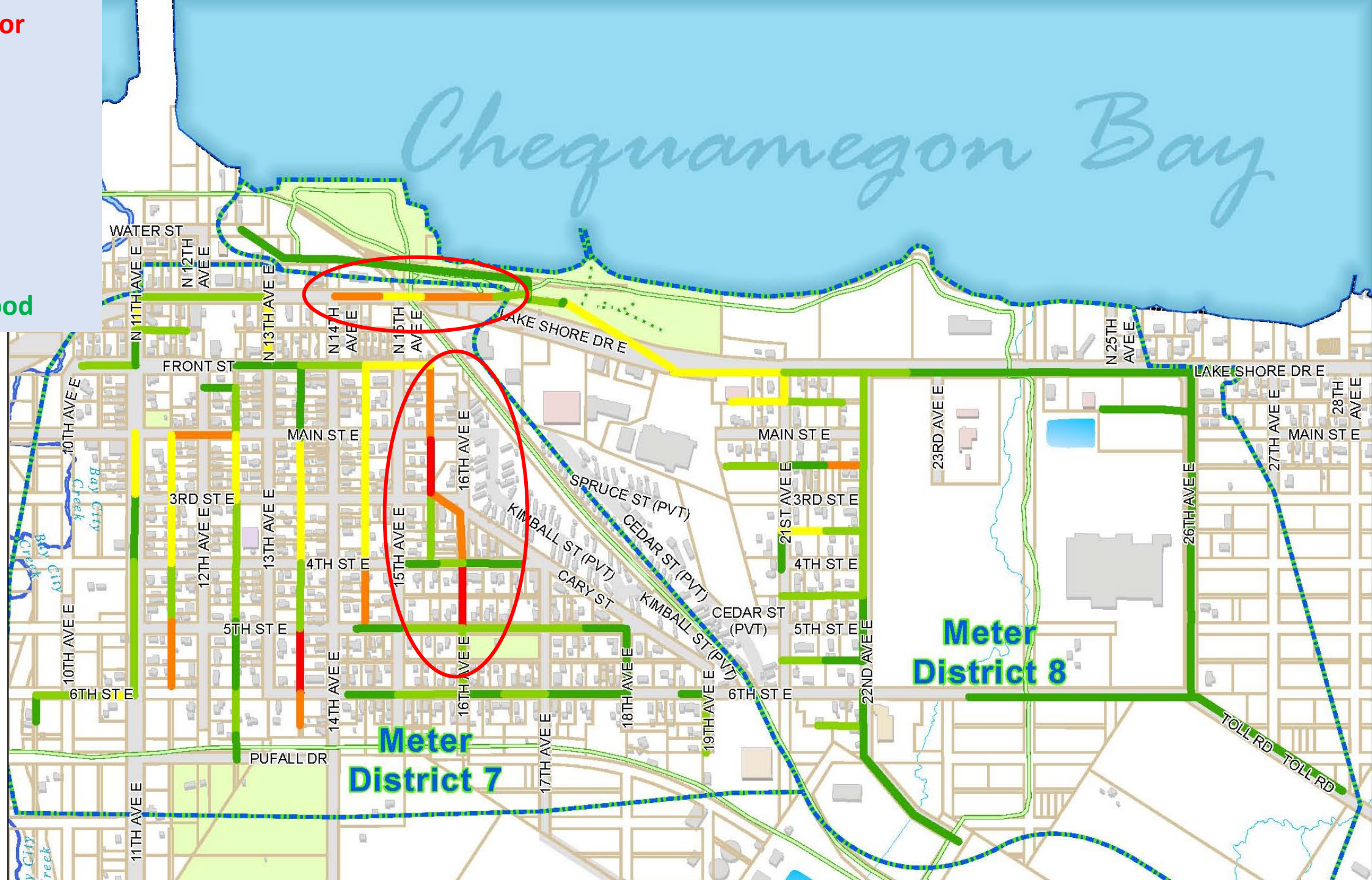
Very Poor

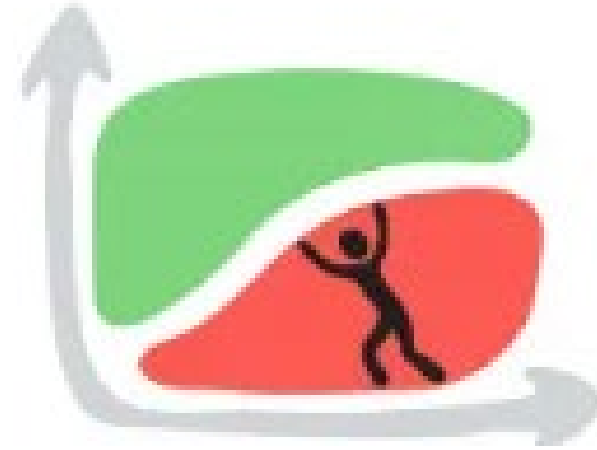
Poor

Fair

Good

Very Good





Benchmarking Sanitary Sewer Collection Systems





I&I Rate

- I&I is measured in terms of gallons per day per inch diameter mile of pipe.
- **GPD/IDM** = $\frac{\text{Gallons per day}}{\text{Inch-diam pipe} \times \text{miles of pipe}}$
- **Gallons per day** is the Average Daily Wet Weather Flow over a 24-hour period at a point in the system.
- **Inch-diameter mile** represents the size of the sewer system upstream of the study point. It is calculated by multiplying the diameter of a sewer pipe by the number of miles of that pipe size.
- This allows I&I rates to be assessed per collection system size.
- Over **1,500 GPD/IDM** is considered excessive I&I requiring some type of corrective action. This is a general benchmark.

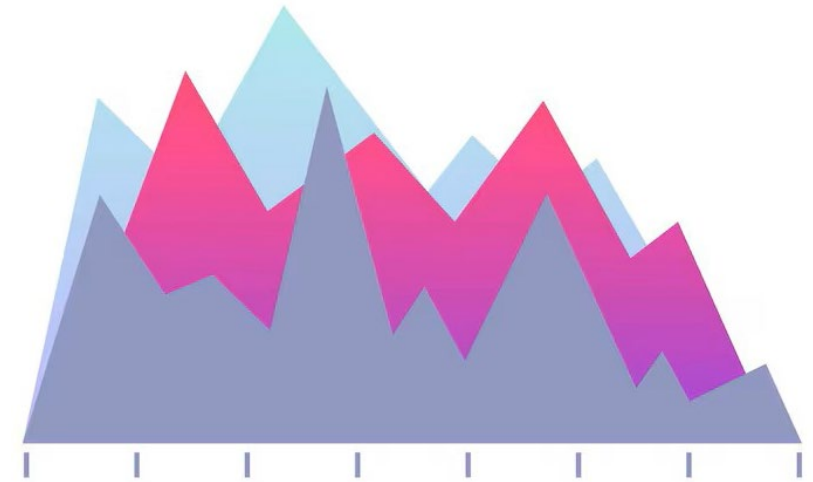


I&I Rate

- A simple approach to benchmarking I&I rate involves comparison of Base Wastewater Flow to Average Daily Wet Weather Flow.

$$\frac{\text{Average Daily Wet Weather Flow}}{\text{Base Wastewater Flow}} = \text{Peak Flow Factor}$$

- Because some level of I&I is expected, the Peak Flow Factor should not exceed 4.0.
- A Peak Flow Factor greater than 4.0 indicates excessive I&I requiring some type of corrective action. This is a general benchmark.
- A Peak Flow Factor of 4.0 is generally used in design of lift stations and wastewater treatment plants.





Collection System Performance



SSOs: Both number & volume of overflow events are fundamental metrics. Both measure impact of I&I on the system.



Sewage Back Ups: total number per 100 miles of sewer. Allows for comparing performance across different systems, considering variations in size. Indicator of level of maintenance being performed & level of service provided to customers.



Lift Station Failures: total number per year. Indicator of system reliability



Poll #3

You divide the average daily wet-weather flow by the base wastewater flow, yielding 3.0. What does this mean?

- a) Infiltration is excessive
- b) Inflow is excessive
- c) It shows a normal, expected condition
- d) The base wastewater flow is too low.

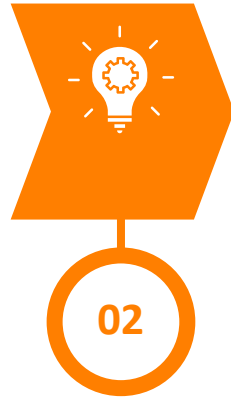


Sanitary Sewer Evaluation Surveys (SSES) Main Takeaways



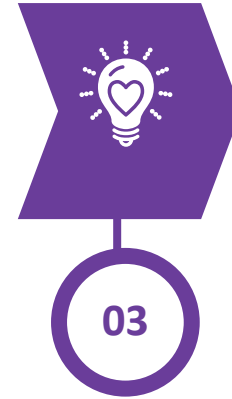
Infiltration & Inflow (I&I)

Inflow is generally due to unauthorized connections to the system. Infiltration is generally due to defects in the system.



System Condition

Flow monitoring, smoke testing, dye testing and CCTV inspection are the main tools to evaluate sanitary sewer systems.



System Benchmarking

Data collected from a SSES can support benchmarking, which is an important tool for communication and advocacy.

Thank you for attending!

Great Lakes Environmental Infrastructure Center

<https://gleic.org/>

National EFC Network

www.efcnetwork.org

John Butler, P.E. | jcbutler@mtu.edu

