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# Sanitary Sewer Design Options for Treating Inflow and Infiltration

April 20, 2015

# Inflow

Inflow: Stormwater that enters the sanitary sewer at points of direct connection to the system. These connections are typically unauthorized, and tend to peak during precipitation events contributing to sanitary sewer overflows.

*examples: sump pumps, roof drains, yard drains, etc.*

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# Infiltration

Infiltration: Groundwater that enters the sanitary sewer system through defective joints or cracks/leaks in the pipes and manholes. Sanitary sewers installed below the water table or near creeks and streams are most susceptible.

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# Early Sewage Conveyance Systems

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# Gravity Systems (Late 1800's – Early 1900's)

- Typically constructed with brick manholes and clay pipe.
- Clay pipe manufactured in 2' to 3' sections and installed with mortared joints.
- Poor pipe joint construction and little concern regarding the introduction of groundwater into the system. Infiltration was still considered beneficial in keeping the system cleaned.
- Dilution was the solution, and in many cases sewage was discharged directly into a body of water with no treatment.
- Some of these conveyance systems are still in-place today and present challenging maintenance and I&I concerns.

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# Modern Sewage Conveyance Systems

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# Gravity Systems

- Typically constructed with concrete manholes and varying pipe materials. (plastic, concrete, ductile iron, etc.) Almost always used in conjunction with local or regional pumping stations.
- Modern manufactured pipe provides better and fewer connections; installation practices and site characteristics affect likelihood of watertight system.
- May require construction at great depths and/or adjacent to low lying streams in order achieve desired pipe slope.
- A large number of gravity systems are susceptible to I&I.

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# Why is I&I a Problem?

I&I introduces clear water into the sanitary sewer system, which is then transported and treated as sanitary waste. In addition to increased treatment costs, this clear water flow increases the potential for sanitary sewer overflows (SSO), both at the collection system and at the treatment plant.

SSOs present a danger to the health and welfare of the community and can have devastating environmental impacts. Sanitary sewer systems influenced by I&I can be very costly to the municipality or facility owner.

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# Is I&I Regulated by the State?

Yes. In accordance with Chapter 94, Municipal Wasteload Management, sanitary system owners and operators are required to report existing and projected overloads, and provide a plan for their reduction or elimination.

I&I issues can significantly decrease the capacity of a conveyance system, and result in a ban on new connections to the sanitary sewer.

The Pennsylvania Department of Environmental Protection (PADEP) can assess fines for violations of the Clean Water Act caused by SSOs.

# How is I&I Detected?

Due to the complexity and size of most systems, the extent of I&I issues can be extremely difficult to assess. In the preliminary evaluation of the sanitary system, the following data should be utilized to determine the affected areas and prioritize the approach to additional investigation and remediation:

- Overflow/surcharge history and locations
- Recurring maintenance issues
- Customer backups
- Daily or hourly rainfall totals
- Water records
- System maps
- Video inspection
- Flow meter records (if available)

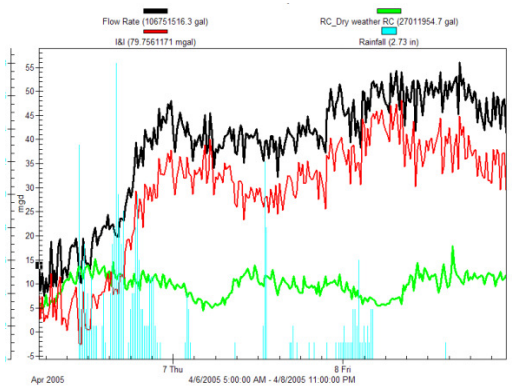


**Figure 1-3 Graphic Identification of Infiltration/Inflow**
(Source: Flow Assessment Services, LLC)

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# Flow Metering

Following the initial data collection, potential problem areas can be pinpointed and monitored using flow meters to compare actual flows vs. theoretical flows.

Flow meters should be installed in appropriate sewer "watersheds" and the data evaluated in conjunction with rainfall data to determine inflow contributions and baseline infiltration.

Micro-Metering can be utilized within the "watersheds" to locate I&I issues in low flow reaches of the system.

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# Inflow Detection

Flow metering data can be used to identify “spikes” in the system during precipitation events, indicating the possibility of inflow conditions in a particular area. The next step is to locate the source or multiple sources of inflow in that location.

- Smoke testing
- Dye Testing
- Public outreach
- Home inspections
- Video inspection
- Micro-metering

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# Infiltration Detection

Flow metering data can be used to identify baseline flows in the system during dry weather, indicating the possibility of infiltration in a particular area. The next step is to locate the source or multiple sources of infiltration in that location.

- Night-time, clear water inspections
  - 2AM-4AM
- Peizometers
  - Water table level
- Video inspection
  - Defects
  - Offset joints
  - Root intrusion
- Micro-metering
  - Pinpoint and prioritize

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# How is I&I Remediated?

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# Inflow Remediation

- Manhole inserts
- Sump-pump disconnects
- Roof Drain disconnects

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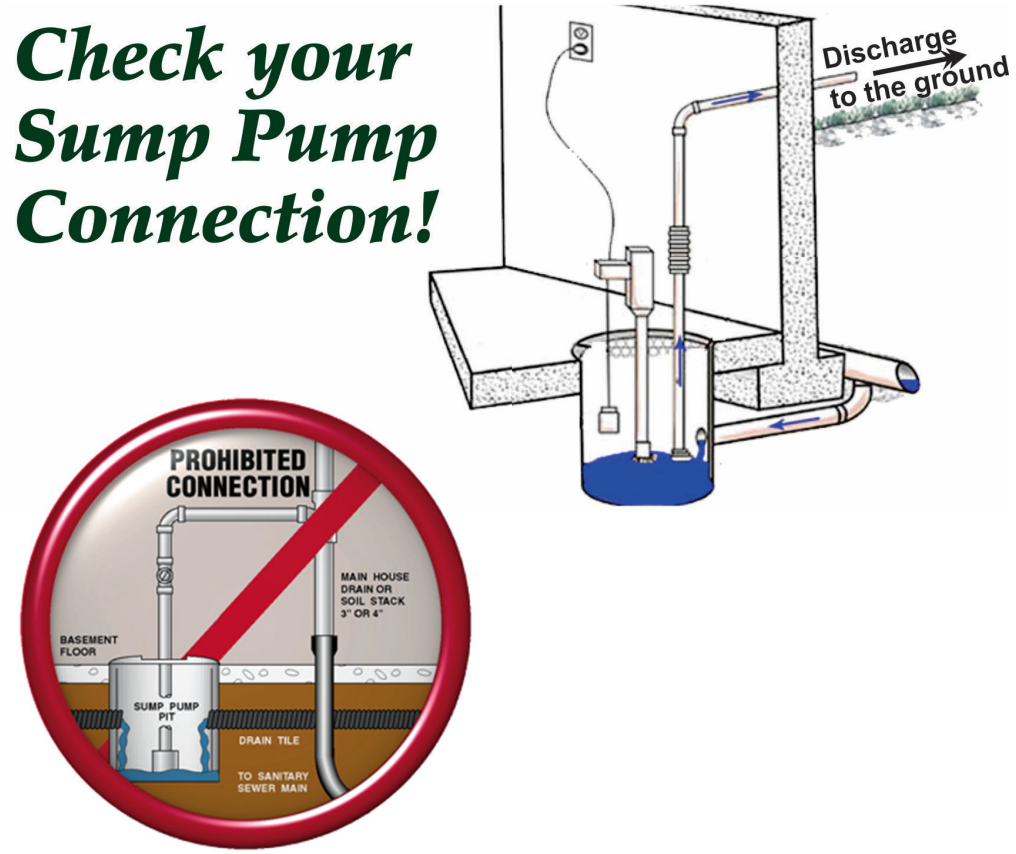
# Manhole Inserts

- Inexpensive
- Easy to install
- Limited effectiveness
- Used in manholes located in:
  - swales
  - low lying areas
  - gutter line of the road
- Capture sand and grit carried into system from roadway runoff
- Require routine maintenance and are easily damaged

# Sump Pump Disconnects

- Sump pumps introduce high volumes of clean water
- Difficult for municipalities to detect and enforce
  - Voluntary disconnect (Public outreach and education)
  - Mandatory disconnect (U&O inspection at time of sale or rent)
- Disconnects are highly effective in reducing inflow



# Roof Drain Disconnects

- Roof drains introduce high volumes of clean water during rain events
- Can be detected by smoke testing
- Difficult for municipalities to detect and enforce
  - Voluntary disconnect (Public outreach and education)
  - Mandatory disconnect (U&O inspection at time of sale or rent)
- Disconnects are highly effective in reducing inflow

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# Infiltration Remediation

- Manhole Lining
- Manhole Wraps
- Joint Grouting
- Root Cutting
- Cured in Place Pipe (CIPP) Lining
- Slip Lining
- System Replacement

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# Manhole Liners

- Repairs defects in manhole walls and benches
- Inexpensive
- Multiple systems
  - Epoxy
  - Cured in Place
  - Fiberglass
  - Cementitious
- Effective in reducing infiltration in high water tables
- Extend the life of the manhole

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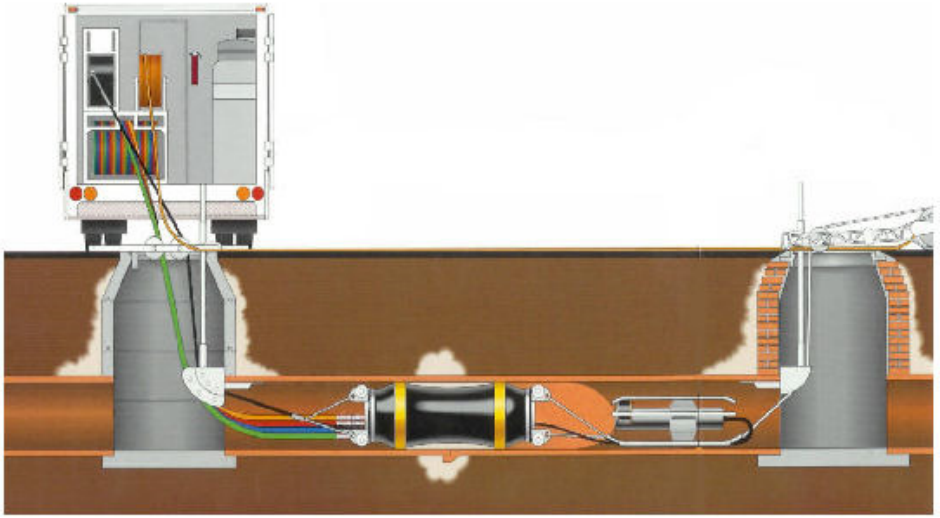
# Manhole Wraps

- Provides additional protection from infiltration.
- Installed on exterior of manhole, usually at joints
- Often used at the transition from structure to casting
- Inexpensive


# Joint Grouting

- Grouting to seal  defective or open joints
  - Pipe cleaning and Video inspection required to identify and prepare area
- Expensive for small projects
- Extends the useful life of the pipe
- Can be effective at reducing infiltration through open or damaged joints
- Groundwater often moves to next closest opening in pipe



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# Root Cutting

- Root intrusion allows groundwater to infiltrate the system
- Compromise integrity of pipe
- Root obstructions must be cleared before further remediation efforts
  - Grouting
  - Re-lining

# Cured in Place Pipe (CIPP) Lining

- Expensive
- Curing Alternatives
  - Hot water
  - Steam
  - Infrared
- Sleeves (short section of repair)
- Full length (manhole to manhole)
- Effective in reducing infiltration in high water tables
- Lateral connections cut and reinstated from inside of pipe
  - lateral connections may be weak link – allowing infiltration
- Extends the life of the pipe

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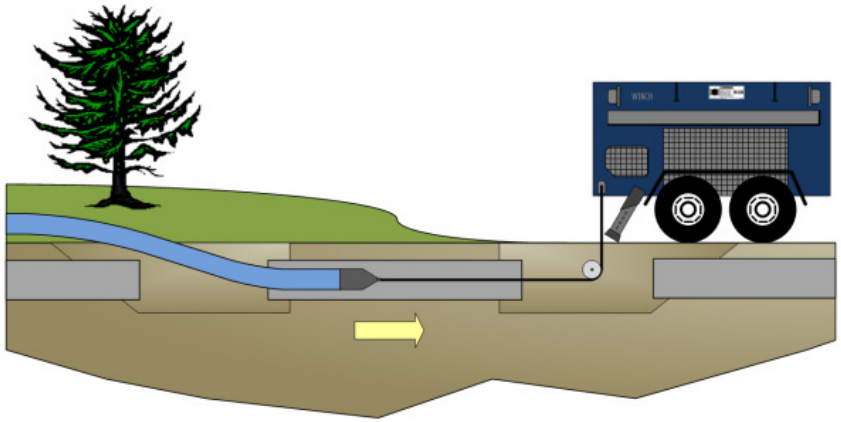
# Slip Lining

- Expensive
- Excavation required for insertion pits
- Always full length (manhole to manhole)
- Effective in reducing infiltration in high water tables
  - Lateral connections must be excavated and physically reconnected
- Extends the life of the pipe



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# System Replacement

- Extremely expensive
- Excavation required with significant restoration
- Site conditions and existing infrastructure may make replacement nearly impossible
- Effective in reducing infiltration - but still no guarantee of total elimination
- Extends the life of the system

# Private Lateral I&I

Arguably the largest contributor to I&I in a system, and the most difficult to address.

Only recently have efforts been made by municipalities to inspect and require replacement of private laterals.

- Legal Issues
- Program implementation & planning is costly
- Long term municipal commitment

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# Sewer Alternatives to Reduce I&I

The design of conventionall gravity sewer systems have remained relatively unchanged over the last 100 years.

Some notable improvements in materials and construction methods have reduced but not eliminated the occurrence of I&I in newer gravity systems.

There are exciting alternatives to gravity systems that effectively eliminate Inflow and Infiltration.

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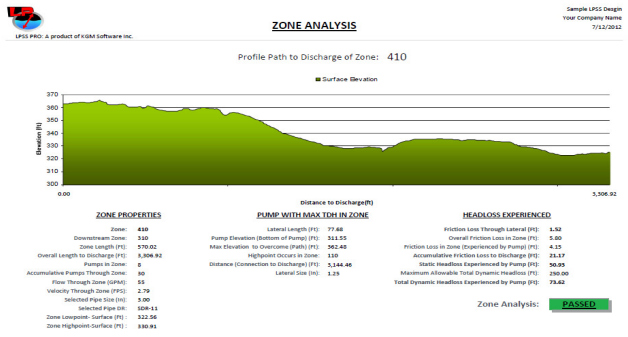
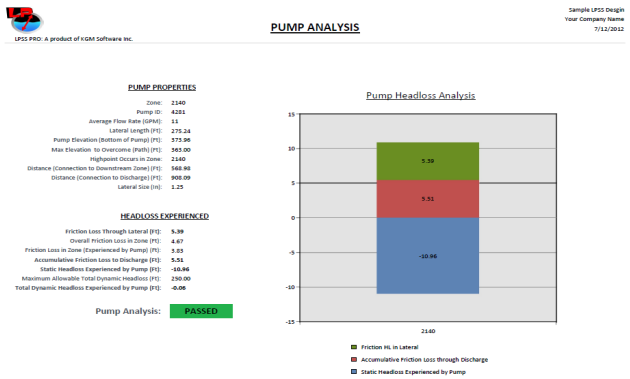
# Low Pressure Sanitary Sewer

- **I&I Benefits**
  - **Design**
  - **Construction**
  - **Operations and Maintenance**

# Low Pressure Sanitary Sewer Design

- Systems Components
  - Grinder Pump(s)
  - Small-Diameter pipe
- Design follows contour of land
  - No need to utilize low lying areas or follow streams and rivers
  - Can be designed in hilly areas
- Grinder Pumps work together to push effluent to discharge point – eliminates design of conventional pump station
- Treatment plants can account for lower peak flows in rain events



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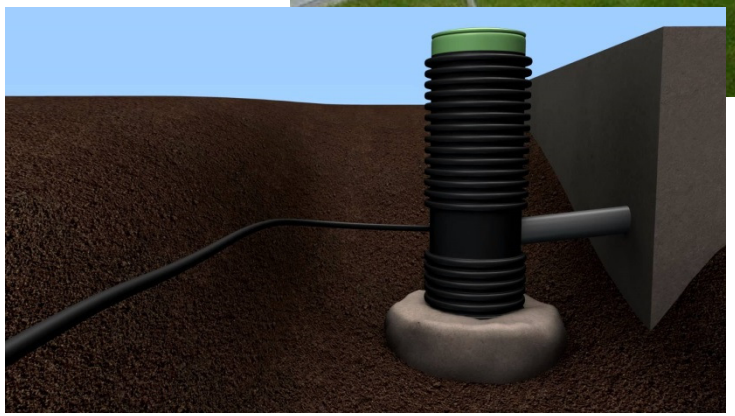
# Low Pressure Sanitary Sewer Construction

- Pressure systems are inherently watertight
- Seamless pipe (Polyethylene)
  - Fuse welded or electro-fused.
  - Eliminates root intrusion issues
  - Eliminates leaky joints
- Installation options reduce restoration costs
  - Shallow and narrow trenches
  - Pipe can be installed on shoulder of road
  - Directional drilling

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# Low Pressure Sanitary Sewer Operation and Maintenance

- Current grinder pumps are very reliable and, when used properly, require little maintenance.
- Electricity costs can range from $40-$60 per year for each grinder pump.
- Pipe network rarely requires cleaning
- Building lateral connections to the grinder pumps still require routine inspection to identify infiltration and/or illegal clean water connections.

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# Questions?