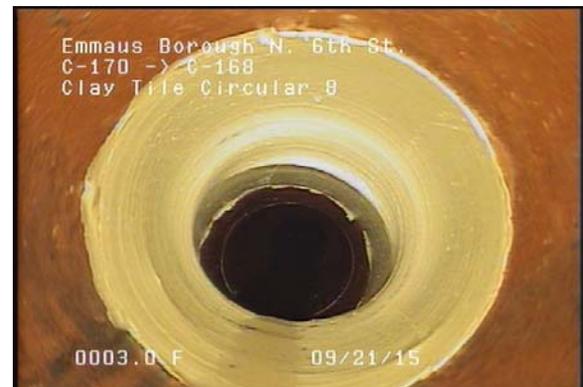
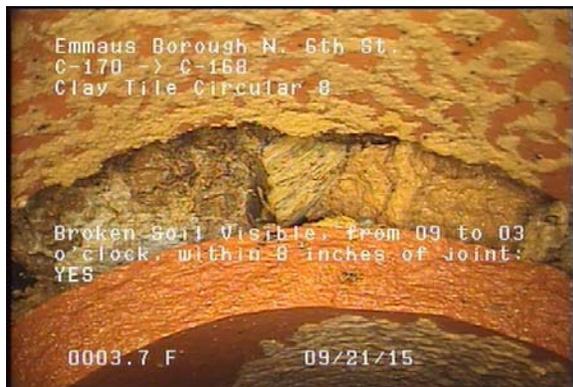


Borough of Emmaus Inflow and Infiltration Source Reduction Program



Overview

Sanitary sewer systems are designed and constructed to safely collect wastewater from the customer's facilities (homes, businesses, industries, etc.) and transport these flows to the wastewater plant for treatment prior to discharge to Waters of the Commonwealth. Borough of Emmaus wastewater is collected and transported via multiple interceptors to the Kline's Island Wastewater Treatment Plant (KI WWTP) in Allentown where it is treated, disinfected, and discharged to the Lehigh River.

Ideally, sanitary sewer systems would only collect and convey used water and human waste. However, extraneous stormwater and groundwater can enter typical gravity sanitary systems and significantly increase peak flows, potentially causing pipe overloads, backups into buildings, overflows into streets and streams, and disruption of the treatment plant process.

Inflow occurs when rainwater is misdirected into the sanitary sewer system instead of storm sewers. Examples are: roof leaders, sump pumps, yard and area drains, manhole covers, and cross connections from storm drains. The remedy for inflow is to remove improper connections to the sanitary sewer system. *Infiltration* occurs when ground water seeps into the sanitary sewer system through cracks or leaks in sewer pipes or manhole structures. The cracks or leaks may be caused by age related deterioration, loose joints, physical damage, or root intrusion. The remedy for infiltration is repairing or replacing the leaking infrastructure and removing the underlying causes of the defects. Identifying the sources followed by reducing the volume of Inflow and Infiltration (I&I) that enters the sanitary sewer system are the ultimate goals of the Borough's I&I Source Reduction Program.

As I&I becomes a significant component of sanitary flow, it is generally more cost-effective to reduce I&I than upgrade infrastructure to convey and treat additional non-wastewater flows. Literature shows that success reducing I&I has been mixed, and that a well-planned I&I management plan is required to achieve satisfactory I&I control with the limited funds available. Traditionally, most I&I reduction efforts have been targeted at rehabilitating publicly owned sewer infrastructure. However, dealing with private service laterals for I&I reduction is now recognized as a necessary component of municipal sewer system maintenance.

Identification of I & I

Studies conducted to identify I&I can be very elaborate involving special consultants and costing large amounts of money or they can be basic and conducted by system operators. The size of the system and the extent of the problem will dictate what measures are necessary.

Methods that are commonly used for identifying the location and extent of infiltration and inflow are:

- Windshield Surveys – Operations staff can perform neighborhood drive-by inspections to learn much about potential I&I in the sewer system. Uneven road surfaces over sewer trenches may indicate unstable ground conditions and possible damage to sewer lines. Broken paving around manholes can indicate failure of masonry risers. Significant trees along streets and front yards may be an indicator of potential root intrusion in service laterals.
- Late Night Surveys – Very little flow should be occurring in the collection system in the early morning hours (2:00 AM – 4:00 AM). By surveying manholes for clear water that is near ground temperature a generalized idea of the extent of infiltration can be made.
- Closed Circuit Television (CCTV) Inspections – CCTV inspection is primarily used to identify infiltration problems and structural defects in sewer pipes. A purpose built camera is inserted into the collections lines and the line is videotaped so problem areas can be analyzed. A thorough line cleaning prior to video tapping is very important. Sewer pipe joint pressure testing is sometimes performed in conjunction with CCTV inspections.
- Physical Inspections – Manholes can be opened and inspected to identify structural deterioration and evidence of leakage. This work can be performed in conjunction with CCTV inspections or it can be done as a stand-alone program.
- Smoke Testing – Smoke testing is sometimes used to identify broken joints and leaking manhole barrels that could allow infiltration to enter the system and to identify illegal taps or connections to the sewer system that would allow storm water to enter. For this test, smoke is forced into the collection system by an engine driven fan located over a manhole opening.
- Flow Records – Wastewater flow meter records are often used to identify and quantify the severity of storm events that introduce inflow into the collection system. Also, flow records that show a constant early morning flow during periods of run-off can be used to identify infiltration. Chart recording flow measurement devices and digital data logging systems allow the volume and duration of I&I to be characterized.
- In-Home Inspections – Individual properties can be inspected for open or missing caps on cleanouts, and yard/roof drain and sump pump connections to sewer piping.

Remediation of I&I

Following the identification of specific sources of I&I, the Borough can determine the appropriate remedial actions to repair or replace the affected components, develop a budget of estimated costs, and prioritize implementation of the remedial work.

Specific pipe repairs may include one or more the following methods, depending upon site conditions:

- Pressure Grouting Pipe Joints – This involves specialized equipment to inject a self-setting grout, typically acrylamide gel, into structurally sound leaking joints or small wall cracks in mainline sewer pipes. The grout travels outside of the joint into surrounding soils and bonds with those soils to create a seal collar of material around the leaking joint or wall defect. Equipment advancements in recent years have expanded the capabilities of this methodology to allow

sealing of defects in lateral pipes. The maximum life expectancy of properly mixed and placed grout is not yet known, but samples have been examined after 30 years and found to be in "like new" condition. However, if humidity in the soil declines for a long period, the grout may begin to dry out. In areas of the Borough sewer system that have been inspected, tested, and repaired with pressure grout, it is recommended that spot checks be performed in subsequent years to verify the water tightness of the joints.

- Cured in Place Pipe (CIPP) Lining – This involves installation of a complete new fiberglass or polyester based interior lining into sewer pipe runs from manhole to manhole. This method is appropriate where the pipe run has many leaks or extensive but moderate structural damage. Service lateral penetrations are typically re-opened after the lining is installed from within the sewer main pipe. Numerous companies have developed methods to insert, expand, seal, and cure a tubular mat saturated with 100% solids epoxy resins into damaged pipes, creating structural repairs with an expected minimum lifespan of 50 years. New equipment has been developed to expand the capabilities of CIPP lining to include repairing service lateral pipes and connections.
- Pipe Lining Spot Repair – This involves placement of a short length (typically 2 to 10 feet) of lining material at isolated cracks or damaged locations inside a sewer pipe. These spot repairs can involve CIPP lining or thin metal sleeves that are bonded to the pipe interior to cover and seal the defect.
- Pipe Bursting – This method is used on pipes that are severely damaged, for replacing an entire pipe system, or for repairing larger sections of sewer pipeline. Hydraulic power is used to drag a "bursting head" through the pipe. As it makes its way through the system, breaking the old pipe apart, it pulls in a new seamless pipe behind it. Service lateral connections must be excavated and cut into the new pipe. The replacement pipe is a plastic material that should be impervious to root intrusion for up to a 100 year life expectancy.
- Open Trench Pipe Repair – This method is generally used, as a last resort, when a pipe section is found to have severe structural damage including collapse or full tree root intrusion that cannot be removed with a remote cutter.

Specific manhole repairs may include one or more the following methods, depending upon site conditions:

- Manhole Cover Inserts – One of the simplest manhole I&I reduction methods, this involves placement of a pre-formed plastic dish into the manhole frame immediately under the cover to limit the amount of water that can enter the sewer system from around the rim or through vent holes in the lid. Since the Borough currently uses metal-edge snow plows, these inserts can only be used where the perimeter of the manhole frame is at an elevation of at least one quarter inch below the surrounding roadway elevation so the lid does not protrude above the pavement. Manhole frames can be set at a depressed elevation during repaving operations or reconstruction of sewer manholes. As an alternative, thin, tapered pads can be applied to the paving around the manhole frame to create a small ramp for plows to glide over without catching the edge of the manhole lid.
- Manhole Frame Riser Repair – This can involve one or multiple repair methods, including replacing the grade rings between the concrete manhole "chimney" and the frame, wrapping the exterior of the riser and frame with a waterproof membrane, or placing a waterproof liner inside the riser. Concrete or brick grade adjustment rings can be subject to significant deterioration from traffic loads and frost impacts. Brick risers, split or multi-piece concrete rings, and the use of multiple layers of rings when manhole structures are significantly lower than the

finished road surface can introduce many more joint locations for subgrade water to penetrate and enter the sewer system. If the riser and grade adjustment rings are in good structural condition, an interior rubber seal can be installed with stainless steel compression rings without having to excavate and repair the paving around the manhole. If the grade rings are deteriorated and/or the profile of the manhole frame does not match the cross slope of the paving, the riser can be excavated, rebuilt with level or tapered grade rings, and sealed with an exterior wrap prior to backfilling and repaving. A new manhole frame and lid can be installed if needed.

- Grouting – This involves drilling holes in the manhole walls and injecting pressurized grout through the walls into the surrounding backfill to seal the exterior surface from water intrusion. Grouting can be used to reduce leaks in otherwise structurally sound manholes and can be performed without excavation.
- Interior Sealing – This involves spray or trowel installation of a surface coating on the interior surfaces of manholes, and is effective at repairing surface damage from sulfide corrosion. These coatings can be fiber reinforced cementitious mortar or high-build epoxy. Interior coatings can reduce water intrusion, but water actively flowing through holes and cracks in the manhole walls should be remediated by grouting before attempting to install most interior sealing products.

Borough I&I Reduction Projects

Flow Characterization

The Borough has reviewed the condition of its four (4) permanent master sewer meter stations and has determined that some data logger equipment is obsolete and that some flow measurement elements are not ideally situated to ensure accurate measurement over a wide range of flows. The Borough has applied for a grant to replace two (2) data loggers and to replace the digital readout faceplate on a third. The grant would also fund the replacement of the primary flow nozzle at the Fox Street (Meter #1) Station and the complete replacement of the vault and flume at the Berger Street (Meter #2) Station. These replacements will help the Borough obtain more accurate flow data during normal and wet weather events.

The Borough will continue its periodic visual inspections of the sewer system at night and during rainfall events to identify areas contributing higher than expected peak flows. This inspection program is also expected to identify key junctions in the sewer system where temporary, portable meters can be installed to record sub-area flows over extended periods of time for further analysis and pin-pointing of problem areas for additional investigation and rehabilitation.

Pipe Inspection, Joint Testing, and Pressure Grouting

In previous years, the Borough awarded bid contracts for televideo inspection, cleaning, and pipe joint grout repair for sewer Districts #1 and #3 (the areas draining to the Fox Street and Orchid Place Meter Stations, respectively) and for numerous sub-areas within District #4. Now that the Borough has acquired its own televideo equipment, inspections can be performed without having to pre-arrange the work area and timing. Borough inspection records can be used to visually identify areas with structural defects and potentially leaking joints so that future contracted projects can more cost-effectively focus on the areas with specifically identified problems.

Borough personnel should “circle back” to previously grouted pipe sections on a rotating basis at intervals of ten to fifteen (10 to 15) years, or more frequently if found to be needed, to see if the grouted lines are remaining watertight. Signs of leaks should be identified for preparing contracts to have specialty contractors re-grout or apply CIPP lining repairs.

Inspection and Spot Repairs

Video inspections in certain sub-areas of Basin #4 identified dozens of locations where structural defects required localized repair. Bid contracts were awarded for spot repairs in those areas. Now that the Borough has acquired its own televideo equipment, on-going inspections can be performed in other areas of the sewer system to identify locations of defects requiring specialty contractor repairs.

Inspection and CIPP Lining

Video inspections in 2008 identified two (2) adjacent pipe runs near a creek crossing in Basin #4 where numerous severe leaks were allowing excessive groundwater into the pipes. A bid contract was later awarded for full-length CIPP relining in that area. Now that the Borough has acquired its own televideo equipment, on-going inspections can be performed in other areas of the sewer system to identify locations of defects requiring specialty contractor repairs.

Customer Site Inspections

The Borough initiated a site inspection program, beginning in 2006, that required inspection of Borough sewer customers' buildings to identify basement floor drains, sump pumps, driveway drains, yard drains and downspouts, and to require disconnection from the sewer system if such connections were found. By the end of 2014, the Borough successfully completed the program with 3,899 properties inspected, and only 5 properties refusing entry for inspection. Based on reduced average annual flow in the Borough sewer system over this timeframe, it is believed that this program resulted in significant reductions of extraneous flow in the system.

Service Lateral Inspection and Repair

Previous and on-going sewer video inspections have revealed a number of potential I&I issues related to lateral connections throughout the Borough. These include tree root intrusion, clear water flow, and broken/unsealed lateral connections to the sewer mains.

The Borough Council is currently researching regulations adopted in other jurisdictions, requiring inspection of customer sewer connections when a property is placed on the market for sale. Defects identified would need to be repaired prior to settlement or sufficient funds would need to be escrowed to cover the cost of performing the repair work within an allotted period of time. This type of program is expected to address as many as fifty to seventy percent (50% to 70%) of Borough properties within a ten-year period without adding an undue financial burden to long-time occupants.

Manhole Inspection and Rehabilitation

The Borough has recently increased its Public Works Department sewer maintenance staff and has increased the level of expertise in the Department. Borough staff inspected 240 manholes in 2017 and

identified many locations requiring sealing or complete reconstruction of access frame risers. Some manholes were also found to have deteriorated or missing steps and many should have flow reducing dish inserts added below the lids. The Borough was awarded a grant to partially fund the required rehabilitation and repair work, which will be publically bid in 2018.

Borough forces will continue the annual manhole inspection program to identify leaks and other structural defects so that repair projects can be planned, budgeted, and bid in subsequent years.

Upstream Watershed Management

The Borough sanitary sewer system transports wastewater from multiple upstream sub-areas in Lower Macungie, Salisbury, and Upper Milford Townships to the downstream interceptors and the City's wastewater treatment plant. Only two (2) of these out-of-Borough sub-areas are metered. Flow from the others is unmetered and may have an impact on peak flows transported through the Borough and measured at the Borough's master meter stations. Inter-municipal agreements require the upstream townships to monitor and maintain their systems in good repair and prohibit the introduction of stormwater and groundwater flows into the sewer system. Without master metering, however, it is difficult to routinely confirm that township sewer system I&I is being properly controlled.

The Borough, in conjunction with the neighboring townships' personnel, should periodically conduct visual inspections of the township sewer connection points at night and during rainfall events to identify areas contributing higher than expected peak flows. The appropriate township would then be responsible for the necessary upstream investigation and rehabilitation of their system. Temporary, portable flow meters might be useful for identifying excess wet weather flows at connections of the larger sub-areas, but may not be accurate enough for sub-areas that serve limited numbers of out-of-Borough customers.