Sanitary Sewers - Condition Assessment and Rehabilitation

An Online Continuing Education Course for Engineers

Course Number: EN-5001

Credit: 5 Hours / 5 PDH / 5 CPD

Sanitary Sewers:
Condition Assessment and Rehabilitation

Section 1: Condition Assessment Solutions

Introduction

Condition assessment is a critical component of an effective program to resolve Sanitary Sewer Overflows (SSOs). Decisions regarding the maintenance, operation, and rehabilitation of the collection system to eliminate SSOs can be based on the results of a condition assessment of the system. Condition assessment may address the structural and/or infiltration/inflow conditions.

Condition assessment is typically based on inspections by closed circuit television (CCTV), Sewer Scanning Evaluation Technology (SSET), manhole inspections, smoke testing, dyed water flooding or other appropriate evaluation means. For structural assessment, particular attention is made to defects such as pipe breakages, cracks, displaced joints, missing pipe pieces, sags, pipe corrosion and manhole structural defects.

I/I condition assessment is performed by utilizing a combination of methods such as manhole inspection, CCTV inspection of sewer lines, and flow monitoring. An analysis of the data is performed to estimate amount of infiltration and inflow into the pipe or sewers.

Protocols for Identifying Location of SSOs

Identification of the likely location of SSOs and evaluation of their causes should be a part of a comprehensive preventative maintenance program and capital expenditure plan. Cities, sewerage authorities and agencies need established and proven guidance for identifying and evaluating the causes of SSOs. Such guidance material should cover both wet weather and dry weather SSOs.

Several techniques for identifying the locations where SSOs may occur include:

- Sewer inspections by CCTV monitoring;
- Analysis of sewage indicators in nearby streams and storm drains;
- Flow monitoring and hydraulic modeling;
- System inspections including those at manholes, pumping stations, private sector sources, and smoke and dye testing;
- Review of customer complaints and/or maintenance records; and
- Engineering analysis of the structural integrity of the sewer system.

Sanitary Sewer Evaluation Survey Activities

Sanitary Sewer Evaluation Survey (SSES) activities include quantifying flows including III and assessing the structural and III condition of the system pipes, manholes, and other structures and facilities.

Flow & Rainfall Monitoring

Flow monitoring is used to quantify wastewater production (base) and infiltration and inflow (III) in the collection system. The data collected can be used for hydraulic evaluation of the sewer system, calibration of hydraulic models, assessment of III, and assessment of effectiveness of rehabilitation measures in eliminating III. Flow monitors are installed at strategic locations in the sewer system and the flow is measured at frequent intervals, typically 15 minutes.

Flow meters may be installed as "permanent" or "temporary." Permanent open channel flow meters include:

- Flumes such as Parshall flumes and Palmer-Bowlus flumes,
- Weirs, such as V-notch, rectangular, and trapezoidal,
- Velocity measuring devices, both doppler and ultrasonic, and
- Depth measuring devices, including ultrasonic, bubbler, static pressure devices, and transducers.
- Various combinations of all of the above

Temporary flow metering devices include ultrasonic, doppler, or bubbler devices for flow measurement. The instrument is often installed in the upstream reach of the access manhole. The monitoring device has the capability of storing data, which can be downloaded to a laptop computer in the field or transferred to the office via a phone line or over the internet. Specialized software is also available which can help analyze the data. In addition to monitoring flow meters at strategic open channel locations in the sewer system, flow meters can also be installed at pumping stations and the wastewater treatment plant. Both short-term monitoring (typically 60 to 120 days) and long-term monitoring (one year or longer) may be performed to capture data under various weather and loading conditions.

For areas concerned with wet weather flows, rain gauges should also be installed and monitored. Alternatively, rainfall data may be obtained by utilizing remote sensing radar technology, known as Next Generation Weather Radar System (NEXRAD). This system has approximately 138 Weather Surveillance Radar Doppler sites throughout the United States. NEXRAD provides a great amount accuracy in both rainfall intensity and its spatial distribution. The rain gauge data is used to determine the spatial distribution of rainfall and its impact on system flows. A ground rain gauge network is important to properly calibrate the NEXRAD data (Seremet, 2002).

The number of flow meters required for adequate characterization of the wastewater flow and the level of infiltration/inflow depends on a number of factors such as the objective of the flow

monitoring program, sewer system configuration and size, the number of sewersheds or drainage basins, and budget and time constraints.

Flow Isolation

Flow isolation and measurements (I&M) are used to quantify localized infiltration levels into the sewer system. This typically involves isolating one or more sewer segments and measuring the flow manually during early morning hours of low domestic activity, such as midnight through 5 am. Night I&M usually is performed during high groundwater conditions. During flow isolation, the upstream sewer line is plugged and flow is measured with a v-notch weir in a manhole downstream of the plugged sewer section. Portable pre-calibrated weirs or flow depth and velocity measuring devices are used for flow measurement. This flow quantification procedure allows for more precise measurement of leakage and confirmation of infiltration values obtained from a flow monitoring program.

Smoke Testing

The purpose of smoke testing is to locate rainfall- dependent III sources, which could lead to an SSO during a storm event. Specific sources detected include roof, yard and area drain connections, catch basins, area drains, and broken main and service lines. A non-toxic, non-staining low-pressure smoke is pumped through a manhole into the sewer pipe for distances up to 600 feet. Smoke emissions from manholes and from the ground indicate defects in manholes, sewer lines, and sewer laterals through which III may enter the sewer. Both single blower and dual blower techniques have been used. The dual blower technique uses a blower on both the upstream and downstream test section manholes. The smoke emissions from sources such as roof leaders, stairwell drains, and around building foundations indicate possible surface connection to the sanitary sewer. The absence of observed smoke emission from a potential source does not prove that problems do not exist. Surface water connections indicated by smoke testing can be tested with dye tracing, to confirm or rule out the connection.

All potential sources identified by smoke testing should be photographed and documented. A schematic drawing, giving explicit directions for locating the observed smoke, should be included for each observed smoke emission. Observations of smoke emissions and the appropriate manhole identification number shown on the agency's map should be recorded appropriately on each smoke testing form. An assessment of the quantity of III should be made based on the area and type of ground cover of the catch basin.

Public notification is an important part of a smoke testing program because of the potential for smoke appearing in and around buildings. Adequate notice of the impending smoke testing of every building served by the sewers to be tested should be served. Also, to reduce the possibility of fire alarms, the Fire Department should be kept informed of the areas to be tested each day. Smoke testing should not be done when the ground is saturated; the pipe is flowing full, or during rainy or windy days.

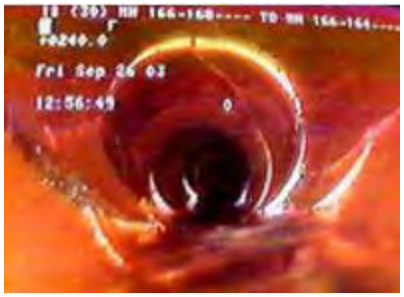
Dyed Water Testing

Dyed water testing includes dye tracing or flooding. It is performed to determine possible sources of inflow. Sources can include area drains or catch basins suspected of being connected to the sewer line, or sources of rainfall-induced infiltration/inflow which indirectly contribute to the flow in the sewer line through the soil and pipe cracks. The dye testing is normally used to complement smoke testing of suspect areas. A manhole downstream of the test area is monitored to see if the dye water injected in an outside source such as a downspout has found its way into the sewer system. Color CCTV may also be used for locating problem areas after the dye penetrates the pipeline from the surrounding soil. For major sources (such as storm water catch basins), verification is achieved by comparing flows at the downstream manhole before and during testing.

- Dyed water is made by mixing a nontoxic indicator dye with water. The test methods include:
- Pouring the dyed water into the suspect source,
- Flooding storm sewer catch basins or ditches with dyed water
- Injecting dyed water in the area of underground suspect sources.

All test results should be appropriately recorded on a dye testing form. A schematic drawing, giving explicit directions for locating the observed dye, should be included for each positive dye test. All positive dye tests should be quantified by giving consideration to the surrounding area contributing to the problem, and the amount or intensity of dye observed.

Closed Circuit Television Inspection (CCTV)



Since 95 percent of the collection system is non-man entry due to small diameters, it can only be inspected by CCTV. CCTV is often performed on selected defective sewer lines identified through other less costly preliminary inspection techniques such as lamping, smoke testing, and dye water testing. CCTV inspection is performed by pulling the camera through the sewer line. Alternatively, the camera may be installed on a tractor transporter which advances in the sewer line by motorized tracks or tires. The CCTV unit can traverse up to 1,800 feet each way from a given access point. Most of the CCTV equipment available in the market has color cameras with tilt and pan capabilities. Some CCTVs have also been combined with a sonar unit on partially surcharged sewers to give a complete picture of the sewer both above and below the flow surface.

During inspection, the images from the camera are observed on a monitor. If the camera becomes obstructed and cannot continue, a reverse setup is usually used to enter the camera from the downstream manhole. If flow depth is above the camera lens, bypass pumping may be necessary. It is important to clean the line prior to CCTV inspection.

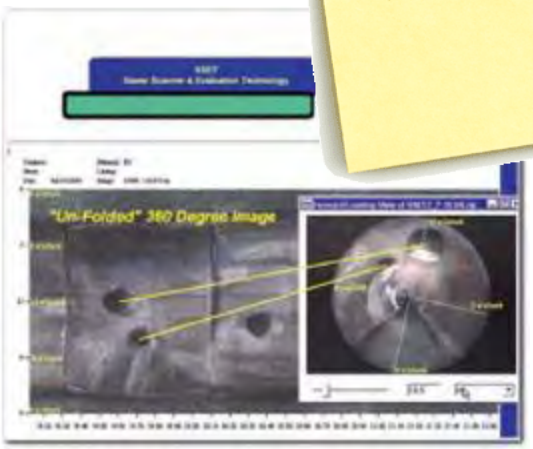
The CCTV images are stored on videotape, CD or DVD. Encoding the images in MPEG format allows searching for a particular section of sewer in a few seconds instead of several minutes.

Observations are summarized in field logs which are prepared and narrated by an operator. Still photographs of defects and of other features of interest are also taken. The videotape provides a visual and audio record of the problem areas of the sewer line. The evaluation of the CCTV records will help identify structural problems of the sewer line, locate leaking joints and non-structural cracks, blockages, dropped joints, and identify areas of root intrusion.

The analysis and interpretation of the CCTV data i s collection. A standard should be selected and applied fo Association of Sewer Service Companies (ented a Pipeline Condition Assessment and Cert ion and consistency in the way sewer pipe cond on of the Water Research Center (WRC) CCTV ase for further analysis. A number of proprieta used for this purpose.

Although CCTV is a v III), its use is very limited in evaluating ex While it is easy to visually identify defect lt to identify. It is also very difficult to survey ss the effluent is very clear.

Sewer Scanner and Ev



e technology effective tool in assessment of sewer systems. emoval or repair of defects discovered during the inspection can reduce the level of infiltration/inflow and/or enhance the structural integrity of the sewer line, thereby decreasing the potential for SSOs. An important feature of this technology is the possibility of measuring the rate of deterioration of the sewer system. This can be achieved by comparing the SSET images taken at a certain time with those taken at a later date. Since the images are digital, it is possible to develop software which can compare these images and detect any deterioration which may have occurred since the last inspection.

This will allow for the calculation of a deterioration rate. Such information is critical in estimating the remaining service life of the sewer line and allows the wastewater utility managers in planning the rehabilitation or replacement of sewer system assets in a timely manner.