Stormwater Best Management Practice

Preventing Stormwater Contamination from Sanitary Sewage

Minimum Measure: Illicit Discharge Detection and Elimination
Subcategory: Developing an IDDE Program

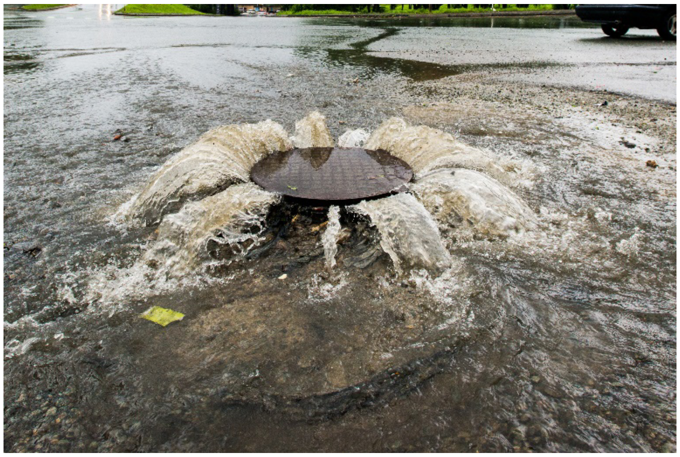
Description

Sanitary sewer overflows (SSOs) are releases of raw sewage from a separate sanitary sewer system before it has reached a treatment facility. Raw sewage contains bacteria and nutrients that endanger both human health and the environment. SSOs occur when flow into the sewer system exceeds the design capacity of the conveyances, resulting in discharges into storm sewers, basements, streets and waterbodies. While SSOs can occur in any system due to flooding or temporary blockages, chronic overflows indicate a deteriorating system or a system where flow has exceeded capacity. A 2004 EPA report to Congress estimated that between 23,000 and 75,000 SSOs—discharging 3 to 10 billion gallons of wastewater—occur per year (U.S. EPA, 2004). SSOs are primary caused by inflow and infiltration (I/I) of stormwater and groundwater. The term “inflow” generally refers to rain or snowmelt that enters a sewer system through a direct connection to the sewer (§ 35.2005(b)(21)), such as illicit connections like storm sewers, roof drains, and basement sump pumps. The term “infiltration” generally refers to stormwater or groundwater that enters a sewer system through defects in the sewer (§ 35.2005(b)(20)), such as leaking joints, cracked or compromised sewer mains, root infiltration into the pipes, and compromised manholes and manhole covers.

These SSOs can sometimes make their way into the municipal separate storm sewer system (MS4), and MS4 operators should address these as illicit discharges. While entities or departments separate from the MS4 program often manage sanitary sewers, coordination between the MS4 program and sewer authorities can lead to improved stormwater quality for communities.

Applicability

It is important to detect and eliminate SSOs because sanitary sewer collection systems without proper management can be a source of water pollution. Therefore, localities should have not only programs to identify and eliminate overflows, but also programs for preventative maintenance. Under the illicit discharge detection and elimination program, the MS4 operator tracks, detects and eliminates any illegal cross connections and sewage that enter the MS4.



Sanitary Sewer Overflows can contribute significant pollutants to stormwater when not properly addressed.

Several factors contribute to a sanitary system’s vulnerability to failure and overflows. The age of the pipe system is an important factor. In older systems, deteriorating main and lateral pipes and their joints can cause cracks and holes in the sewer line. The type of material the pipe system uses can also impact deterioration and failure. For example, vitrified clay pipes can be more susceptible to cracks compared with concrete or plastic.

Poor siting or inferior installation techniques are other contributors to sanitary system failure. Sewer lines depend on support from the surrounding earth. When ground shifts occur, sewer lines crack or misalign, causing open joints. Subsequently, this can lead to sanitary sewage flowing into storm sewers through groundwater or, in some cases, surface flow.

The inadequate size of existing sewer pipes may be another factor. New sewer hook-ups; underground water infiltration and inflow; and incorrect inputs from roof, yard drain and sump pump connections can combine to cause increases in wet weather discharges.

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Cumulatively, these sources can lead to system overloading.

Other factors, both human-made and natural, can also contribute to SSOs. Roots can create stoppages and damage the structural integrity of sewer lines. Fats, oils and grease from residential and commercial sources can partially block or clog sewer lines. Groundwater influences and temperature fluctuations can contribute to sanitary sewer system failure. Equipment failure and power outages affecting pumping stations and sewage treatment plant operations also can contribute to overflows.

Program Considerations

SSOs may result from excess I/I, inadequate operation and maintenance, improper design and construction, and failure to consider the effects of new development on system capacity during the planning phase. A number of practices can help reduce or eliminate SSOs from entering MS4s, including the following:

- Regularly cleaning and maintaining the sewer system.
- Replacing or lining the sewer main (slip lining, cured-in-place pipe lining, fold and form lining).
- Reducing infiltration and inflow through rehabilitation and repair of broken or leaking sewer lines and the removal of illicit connections.
- Enlarging or upgrading the capacity of sewer lines, pump stations or sewage treatment plants to match demands of current and future development.
- Upgrading manholes to prevent infiltration
- Constructing wet weather storage and treatment facilities to treat excess flows.
- Addressing SSOs during sewer system master planning and facilities planning.
- Performing lateral replacements.
- Using real-time controls for collection system monitoring and management.

In most cases, a sewer authority or a separate department from the MS4 program implements the sanitary sewer system control program. However, in some cases, an MS4 permit may require tracking and addressing SSOs that impact the MS4. Proper management of the sanitary sewer is a crucial component of protecting water quality.

Several key elements should be part of a locality's sanitary sewer system control program. EPA's *Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems* (U.S. EPA, 2005) suggests that CMOM programs include the following best management practices over the life cycle of the collection system:

- Designing and constructing for ease of operation and maintenance.
- Creating an inventory with physical attributes.
- Creating maps to know the system's location.
- Assessing the condition of the system.
- Planning and scheduling work based on condition and performance.
- Repairing, replacing and rehabilitating system components based on condition and performance.
- Managing timely, relevant information to establish and prioritize CMOM activities.
- Training personnel.

Many monitoring techniques for identifying other illicit connection sources are also part of sewer system evaluation surveys. These tools can be useful for MS4 programs that need to track, detect and eliminate SSO discharges to the MS4. These include the following:

- **Physical inspection.** This involves examining the physical condition of manholes and other sewer structures to determine their structural integrity and to identify possible sources of infiltration and inflow.
- **Flow monitoring/flow isolation.** This involves installing rainfall gauges to monitor sub-basins with overflow problems by collecting and analyzing flow data during normal and storm-related weather events.
- **Smoke testing.** Smoke testing can locate defects in sewer mains and laterals that contribute to infiltration or inflow to the sewer system. Smoke testing involves injecting a non-toxic vapor (smoke) into the manholes and following its path of travel in the mains and laterals.
- **Dye testing.** Dye testing involves adding colored dye to the storm drain water. Dyed water appearing

in the sanitary sewer system indicates an existing connection between the sewer and storm drain system. The test can be done in reverse as well.

- **Closed-circuit television inspection.** This useful tool can locate specific sources of infiltration and determine the structural condition of the sewer system. This information is necessary for the design of sewer replacement and rehabilitation projects.
- **Sewer maintenance records.** Reviewing records helps identify areas with frequent maintenance problems, and records can indicate potential locations of system failure. During a routine review of sewer maintenance records, consider the following:
  - Short-term and long-term remediation actions and the modification of operation and maintenance measures to mitigate the impacts of overflows.
  - Public notification of overflow events and impacts.
  - Adequate maintenance, both preventative and routine, and updates to procedures as problems arise.
  - Measures to ensure adequate maintenance facilities, equipment and inventory.
  - Implementation and enforcement of sewer-use ordinances or other legal documents that prohibit new connections from inflow sources, guarantees of the testing and inspection of all portions of the collection system that handle discharge (including new collector sewers and service laterals, which another entity may own), and the regulation of the discharges of toxics and pollutants that may endanger public safety or the physical integrity of the system or cause the municipality to violate water quality limitations.
  - The development and tracking of system performance indicators, including hydraulic performance, during wet weather flows.
  - Areas with known industrial users that discharge to the sewer system.
  - **Sewer system mapping.** Knowing what constitutes the system (through an inventory of physical attributes)—and where the system is—is essential to developing an effective maintenance program and preventing SSOs.

Several excellent resources in the reference section below detail the monitoring techniques and reporting requirements for sewer collection systems and the operation and maintenance procedures for correcting system problems.

Limitations

As with most illicit connection detection activities, identifying the exact causes of an SSO can be time-consuming and difficult. The biggest obstacle to identifying and correcting SSOs is often public access to private property. In some areas, improper connections from private sources (such as illicit sump pump connections from private residences) may contribute significant inflows to the system.

Wastewater ordinances should clearly specify what parts of the system are privately owned (e.g., laterals versus mains) and which the sewer authority owns. The ordinances should also indicate who is responsible for maintenance and what triggers a maintenance event. Similarly, wastewater ordinances should give the sewer authority the right to inspect any portion of a privately owned system that is or may be connecting to the sewer authority's system (CWB, 2015). An ordinance, such as St. Louis, Missouri's sewer-use ordinance, may be necessary to ensure the authority to inspect and correct these connections. Some municipalities have taken the opposite approach and instituted programs that provide property owners with cash incentives or financial assistance to correct improper connections.

The cost of equipment and staff time for SSO correction may present a burden for some municipalities. These costs include purchasing inspection equipment, replacing undersized sewer lines, and upgrading treatment plants or pumping stations. These system repairs and the necessary materials can be expensive, and taxpayers may be reluctant to pay for a service that they perceive as having no benefit to them.

Maintenance

An effective way to avoid system failure and expensive repairs is to regularly maintain the sanitary sewer collection system. Preventative maintenance through scheduled inspections and routine cleaning of the sewer system can identify and help eliminate many of the causes of SSOs.

A robust maintenance and cleaning program depends on the key elements in the above discussion, including developing an inventory and map of the current system. Additionally, the inventory should include infrastructure age, maintenance and cleaning records for each part of the system. A variety of methods, including work order-tracking or various software packages, can accomplish this.

Completely removing and replacing sewer pipelines can be difficult and sometimes costly, due to the cost to repair roadways or other associated infrastructure. Private industry has developed alternatives such as slip lining and cure-in-place pipes. Contractors place these systems inside an existing sewer line and then cure them in place through heat and/or chemical reactions. This allows staff to install a new pipe with minimal earth disturbance and a negligible loss in flow capacity. Different pipe materials have different life expectancies, but most materials (e.g., slip lining, cure-in-place pipe, spiral-wound pipe) should last 50 years with proper maintenance (WEF, 2017).

Effectiveness

Eliminating SSOs can significantly improve water quality and public health. Blockages, breaks, and subsequent infiltration and inflow in municipal sewer systems create significant risk to humans and the environment. SSOs discharge raw sewage containing microorganisms that affect the health of urban populations. Untreated sewage also contains nutrients and toxic compounds that affect the health of receiving waters and aquatic organisms by reducing dissolved oxygen and promoting algal blooms.

Cost Considerations

The collection system of a single large municipality can be worth billions of dollars; a smaller city's could cost millions. Reducing or eliminating SSOs can be expensive, but municipalities should weigh this cost against the value of the collection system, the cost of replacing it if it deteriorates, and the subsequent environmental and economic impacts from SSOs. Economically, SSOs can cause waterbody closures that affect tourism and lower property values. They can also cause shellfish bed closures and bans on fish consumption, creating economic hardships for associated industries. At the household scale, sewage backups can damage basements and household plumbing, resulting in economic and health impacts to individual property owners.

Deferring routine maintenance can be more expensive in the long run, as it can accelerate system deterioration. Ongoing maintenance and rehabilitation add value to the system by maintaining its capacity and extending its life. The costs of correcting SSOs vary according to community size and sewer system type. Costs are often highest—and ratepayers pay more—in communities lacking preventive maintenance or remediation programs to handle system failures. Table 1 gives examples of the costs associated with SSO remediation programs.

Table 1. SSO remediation case study costs.

Location	Maintenance Action	City Population
Belmont, California	▪ Slip lining of the sanitary sewers most critical sections (about 80,000 linear feet): $10.6 million to $12.6 million. ▪ Pump station improvements at five pump stations: $1.6 million. ▪ Replacement of about 8,500 linear feet of force: $2.5 million.	27,000
Boulder, Colorado	▪ After historic flooding and SSOs in 2013, the city placed a 30 percent rate increase on residents to increase the Sanitary Sewer Rehabilitation Program budget to $3.8 million annually. This allowed the city to replace its sanitary sewer system in 20 years, as opposed to the previous 100-year timeline.	110,000

Source: RMC Water and Environment, 2007; City of Boulder, 2020

Additional Resources

- EPA Combined Sewer Overflow (CSO) Technology Fact Sheet on inflow reduction
- EPA CSO Technology Fact Sheet on maximization of in-line storage
- EPA CSO Fact Sheet on proper O&M
- EPA Collection System O&M Fact Sheet on sewer cleaning and inspection
- Related resources can be found on the EPA Wastewater Technology Clearinghouse Web site.

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

California Water Board (CWB). (2015). *A guide for developing and updating of sewer system management plans (SSMPs)*.

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RMC Water and Environment. (2007). *Sanitary sewer rehabilitation master plan: final report*. City of Belmont.

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