Using CMOM to Optimize Utility Operations

By Chris Browning, Utility Management Director, McKim & Creed

Through the development of good regulatory policy and the advancement of technology over the past 40 years, utilities have made significant improvements in the ecological balance of the waterways throughout the United States. However, we are on the brink of another environmental crisis. The focus has been primarily on water and wastewater treatment issues and not on the pipes. As a result, the infrastructure 'outside the fence' has aged and deteriorated to the point where it no longer performs as intended.

There is a bright side to this potentially dismal reality. Through the diligence of the Environmental Protection Agency (EPA) and with input from various utility members, a program was developed several years ago to curtail the impacts of failing infrastructure; this program is known as CMOM (Capacity Management Operations and Maintenance). Even though it was never promulgated, it established Best Management Practices (BMP) for collection systems to ensure capacity for growth, and identified practical operation and maintenance guidelines.

CMOM as Proactive Planning Tool

Sanitary sewer overflows (SSOs) are illegal under the *Clean Water Act*, but EPA estimates that there are at least 23,000-75,000 occurrences each year in the US. The CMOM program identifies critical elements that focus on preventing or reducing the likelihood of SSOs. In addition, CMOM offers guidelines for maintaining intended system performance, extending the life of sewer system components, improving customer satisfaction, protecting treatment facilities/pumping stations from harmful elements, enhancing public health and safety, and protecting the environment.

CMOM can be applied to all types of systems, and is a proactive planning tool that can help utilities provide a high level of customer service while reducing instances of regulatory non-compliance.

The primary elements of CMOM include:

- Emergency Response/Mitigation Plan
- Inspection/Cleaning Program
- Mapping and Inventory
- Hydraulic Model
- Maintenance Management System
- Grease/Roots Management Program
- Capacity Certification Program
- Operations and Maintenance Training Program
- Repair and Replacement Program

Emergency Response/Mitigation Plan

The law requires wastewater collection system owners/operators to construct, operate, and maintain their systems in a manner to avoid SSOs. However, we all know that standard is somewhat difficult. Therefore, until we are all able to meet that goal, a comprehensive response and mitigation plan is an integral part of CMOM. A well-developed and executed plan can also significantly minimize the impact on the environment and public health.

States have varying requirements for reporting SSOs, however, all plans should focus first on response and mitigation. The emergency response/mitigation plan should include the following procedures:

- immediate personnel and equipment dispatch to mitigate the problem;
- public access limitation/control;

Sanitary sewer overflows (SSOs) can negatively impact public health, water quality, and the environment.

According to the 2008 EPA Clean Water Survey, the cost to repair the collection systems in the United States exceeds $83 billion.

- cleaning and disinfecting the affected area to minimize the public health impact;
- notifying the general public, downstream water providers, and regulatory agencies;
- volume estimation;
- cause evaluation and remediation, including aeration schedules for SSOs entering impoundments;
- corrective action to minimize the likelihood of future occurrences; and
- monitoring and sampling impacted waters to ensure proper ecosystem recovery.

In addition to the development of the procedures listed above, a comprehensive, ongoing training program should be developed and implemented to enable all responders to execute their assigned duties efficiently and expeditiously the goal is to ensure minimum environmental and public health impacts.

Inspection/Cleaning (I/C) Program

In past years, utilities periodically cleaned 100% of their collection systems and inspected a representative sample. That practice should be reversed. About 70% of the system does not require cleaning, but 100% of the system should be inspected to identify and quantify defects. The inspection interval should be once every five to ten years, dependent on the system age, size, and material.

A standard defect coding system should be used to ensure all data is consistent. The National Association of Sewer Service Companies (NASSCO) has developed standards for pipe and manhole inspections. Their standard coding and ranking systems—Manhole Assessment and Certification Program (MACP), and Pipeline Assessment and Certification Program (PACP)—use visual assessment of manholes and video pipe inspection to objectively prioritize maintenance or repair/replacement requirements. In addition to identifying obvious defects needing immediate attention, utility staff can use PACP (coupled with various software systems) to qualify and quantify defects, help avoid potential catastrophic failure, and assist in Capital Improvement Plan (CIP) development.

As part of CMOM, the program should be structured to provide staff and equipment to enable the following: 1) dedicated routine activities without interruption, and 2) emergency responses to mitigate SSOs, and 3) preventative maintenance activities. To ensure the system is inspected and cleaned within the desired interval, the routine activities should be dedicated so staff and equipment can meet the required production rates. Dedicated crews can complete about 300,000 feet annually. Standard procedures are necessary to enable emergency responders to minimize the impact of an SSO and ensure the problem has been properly mitigated. In addition, upstream and downstream I/C should be executed after every SSO.

Every system has areas where grease and debris collect, creating a potential SSO. To avoid overflows, a preventive maintenance program should be developed to inspect and clean those areas in shorter intervals (i.e., quarterly, semi-annually, or annually).

In addition to the physical inspection of the manholes and pipelines, smoke/dye testing and right-of-way (ROW)/easement inspections should be included in the program. Smoke testing will identify sources of inflow and infiltration (I&I) into the sewer main, illegal connections, and buried manholes. ROW and easement inspections will help identify potential system failures and missing or damaged manhole lids.

Mapping and Inventory

The foundation of a successful CMOM program is a comprehensive system map. The map should include highly accurate vertical and horizontal data for each manhole and the related attributes, including the follow-

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EPA estimates that a $390-billion investment in wastewater infrastructure is needed over the next 20 years, according to ASCE's 2010 Report Card for America's Infrastructure. (Photo by Jerry Blow Architectural Photography) ing: 1) pipe size, material, condition, age, and slope; 2) manhole diameter, condition, depth, material, enter/exit pipe size, and flow direction; and 3) pump station location, capacity, number/type of pumps, condition, level alarm type and backup power availability/type. In addition to fulfilling operational, maintenance, engineering and management needs, this information is essential for the development of a dynamic collection system model.

Generally, 5-10% of manholes are buried or covered by pavement. To effectively execute the mapping and inventory project, consideration should be given to implementing the I/C program prior to initiating the mapping and inventory project. The I/C process will locate hidden manholes so they can be raised and made accessible for the mapping and inventory process.

Although the mapping and inventory can be compiled on paper maps and files, utility owners should consider electronic GIS-based mapping and inventory systems. With electronic data systems, additions or modifications to the collection system can be easily captured, and modifications to the base map can be made accordingly. The process is ongoing, and system modifications or additions should be made in a timely manner to enable access to maintain accurate information.

To enable staff to better understand their system and easily retrieve the information for operational, maintenance or management purposes, the maps and related attribute information must be accurate. New data and attributes need to be captured and entered into the system in a timely manner; therefore, data standards must be developed and adopted for new construction and repair/replacement activities. In addition, to avoid corruption of the base map, proper quality control measures should be in place.

Hydraulic Model

A computerized dynamic hydraulic model is an essential tool for the development of a capacity management program and the prioritization of the CIP. After data is captured in the mapping and inventory phase of the program, a hydraulic model can be developed and used as a tool to determine available sewer system capacity, evaluate the impact of proposed development projects or forecasted growth, identify deficiencies during rainfall events, and project impacts related to proposed system improvements.

The development of a dynamic model is contingent upon the high-resolution data and related attributes gathered during the mapping and inventory phase, along with dry/wet weather system flow and rainfall data. To develop realistic, manageable scenarios, the model should include wet weather assumptions for maximum system peaks related to I&I during various rainfall events. The peak flow assumptions will provide the limits to enable the model to calculate the amount of I&I that can be effectively managed at the treatment/pumping facilities, and to determine the relative upgrade requirements of the collection system to avoid SSOs.

Maintenance Management System

The general focus of collection system maintenance is to ensure the intended hydraulic capacity, function, and reliability of both the gravity and pressurized systems. An effective maintenance management program is essential for proactive utility management, and will reduce the likelihood of mechanical failure and reduced pipe capacity related to obstructions or defects within the system.

Preventive and predictive maintenance costs are generally 25-30% lower than reactive maintenance costs. In addition, planned maintenance is less likely to impact customers and sends a positive message to rate payers, elected officials and regulatory agencies.

An effective maintenance management system should include:

- asset information and related maintenance requirements;
- standard operating/maintenance procedures;
- preventive/predictive maintenance schedules for mechanical systems, pipelines and rights-of-way/easements; and
- maintenance activity tracking/historical information system.

A maintenance management system can be manual or computerized, however, even though a well-developed manual system can meet needs, a computerized system enables more diversity and flexibility when managing complex systems. The Computerized Maintenance Management System (CMMS) can provide quick access to rela-

If capital investment and O&M spending for wastewater infrastructure remain at current levels, EPA estimates a funding gap of approximately $270 billion 2000–2019. (Photo by Jerry Blow Architectural Photography)

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By 2020, up to half the assets in US sewer systems may be beyond the midpoint of their useful lives, which is generally assumed to be about 100 years. (Source: Optimization of Collection System Maintenance Frequencies and System Performance, a 1999 study prepared by the American Society of Civil Engineers under an EPA Cooperative Agreement) tive asset information/maintenance recommendations, schedules, and resources. In addition, the CMMS can be integrated with customer information systems, warehousing software systems, maps, and other critical information.

Grease/Roots Management Program

Within most collection systems, grease and root intrusion are the primary cause of sanitary sewer system failure resulting in system overflows. Many utilities have grease abatement programs, however, in areas with a high concentration of multi-family housing, grease build-up within the system is a continual problem.

Current building codes do not require residential buildings to separate the kitchen waste from the sanitary system, so conventional grease traps will not correct the problem. In addition, within residential areas where sewer laterals and mains are close to trees and large shrubbery, roots enter the system through defects or poorly sealed joints causing blockages and accelerated pipeline deterioration.

Proper grease abatement/root control strategies can minimize the likelihood of system failures. In addition to properly drafted and enforced ordinances developed to reduce grease discharge and root intrusion into the sewer system, the following preventive measures should be considered:

- regularly scheduled cleaning and inspection in high-density residential areas;
- grease management educational programs;
- grease reuse programs to develop viable uses for used grease/oil; and
- root control programs to physically or chemically remove roots from the system.

Proactive grease/root abatement programs can significantly reduce the likelihood of blockages, reduce corrective maintenance costs, and extend the life of the collection system.

Capacity Certification Program

Understanding the dry and wet weather collection system capacity is essential to a proactive SSO reduction program. To ensure capacity for future growth and redevelopment, a capacity certification program must be developed and implemented.

The program should include processes and procedures to evaluate development impacts on both the upstream and downstream areas of the system relative to the proposed connection. To properly evaluate the impact, a dynamic model that simulates system conditions under various weather scenarios should be used. Because the introduction of additional flow can have varying impacts on the system, the certification program should include pumping systems and treatment facilities, as well as the gravity system in the evaluation.

To effectively evaluate and certify capacity, rainfall data, development flow data, system flow data (dry and wet weather), and infrastructure data should be considered within the model. Dynamic models can simulate the varying system conditions both upstream and downstream. On the other hand, static models are less versatile because they are limited to instantaneous events and may not be able to detect deficiencies that can occur under typical diurnal conditions.

Operations and Maintenance (O&M) Training Program

Requirements for collection system operations and maintenance training/certification vary from state to state, however, the effective management of a collection system that is focused on reducing SSO quantity and volume requires a comprehensive O&M training program. Collection system staff should be fully capable of executing techniques, evaluating data, and responding to changing conditions in a proactive manner.

Techniques, technology, and system dynamics change regularly. To ensure a high level of O&M efficiency and to retain institutional knowledge, an ongoing training program is required. Because each system is unique, training activities should be logistical and practical, and designed for the individual collection system dynamics. Fundamental practices and principles—including operation, maintenance, management, inspection, cleaning, repairing, and safety—should be incorporated in the program. Standard operating procedures should be used to demonstrate the practices and principles accordingly.

Repair and Replacement Program

Generally speaking, the nation's collection system infrastructure has aged to the point of unreliability. According to the *2008 EPA Clean Water Survey,* the cost to repair the collection systems in the United States exceeds $83 billion. Therefore, to further reduce future SSOs, utilities must limit system failures and reduce wet weather impacts.

Improvement in technology and the development of standards have provided a means to evaluate deteriorating systems and systematically prioritize the repair and replacement requirements of the collection systems based upon defects, cost effectiveness, and hydraulic capacity. To minimize the impacts on limited budgets and maximize the effectiveness of the repair and replacement program, the inspection program and defect coding system should be used to help prioritize the CIP.

Technology improvements have also made repair and replacement more cost effective and less intrusive to the community. However, each rehabilitation technique has unique characteristics that have both advantages and disadvantages. Therefore, the program should include a very deliberate process to evaluate the various options during the prioritization process.

Conclusions

The CMOM program includes practices, principles, and guidelines for every aspect of the operation, maintenance, and management of a wastewater system. It is designed to minimize the likelihood of system failure, respond to failures efficiently, maintain a well-trained and efficient workforce, and protect the environment and public health. It is not a one-time process; it is an ongoing, complex, comprehensive program that requires a significant commitment from the utility. The CMOM program is a culmination of the BMPs for a wastewater collection system. ■

About the author

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