Chapter 2
Asset Management and CMOM

Chapter Outline

This chapter is organized into the following sections:

- Introduction
- Asset Management
- Capacity, Management, Operation and Maintenance (CMOM)

Introduction

This chapter will discuss the topics of asset management and CMOM (capacity, management, operation, and maintenance). The chapter is organized into three sections: this brief introduction, Asset Management, and CMOM. The sections on asset management and CMOM each contain specific conclusions and recommendations and are not reiterated here. However, a general summary of the conclusions and recommendations is provided.

The topics of asset management and CMOM have received a lot of attention at both the State and national levels. The definition of what constitutes a good asset management plan or CMOM program is fuzzy at best. However, general guidance is available as are many examples of best practices. It is up to each utility to determine what approaches and practices will be most beneficial in providing the best service to its customers.

The District’s collection system facilities plan includes advanced asset management concepts and meets many of the criteria required in a CMOM program. Although the facilities plan may not include all aspects of either, it is certainly a part of the whole.

In this chapter, advanced asset management and CMOM concepts are reviewed and compared with the current practices used at the District. In general, the District takes a practical approach to managing its assets and in meeting regulations. Although the District’s present approach appears to meet most of its needs, improvements and better approaches are always possible. Those improvements have been included within the recommendations and may be summed up as follows: (1) Provide better documentation, (2) Migrate towards the use of more advanced asset management and CMOM concepts, and (3) Develop and implement systems that are monitored and continually improved.

Asset Management

The District’s Collection System Facilities Plan is an asset management plan. In conjunction with the District’s maintenance programs, it is used to manage the District’s collection system assets. The District has been progressively adopting additional asset
management concepts (advanced asset management concepts) since its first collection system facilities plan was implemented in 2002. Eventually all of those advanced concepts that fit the District’s approach will be incorporated into its asset management program. However, rather than a wholesale change, a migration toward using these more advanced asset management concepts is taking place.

The topic of asset management has received significant attention over the last five to ten years. As an engineering concept rather than an accounting concept, asset management considers how the assets of a utility can be optimized to provide the appropriate levels of service with an acceptable level of risk and at minimum life-cycle costs. Thus, asset management is defined as an integrated set of processes to minimize the life-cycle costs of infrastructure assets, at an acceptable level of risk, while continuously delivering established levels of service (definition from Implementing Asset Management: A Practical Guide). As stated in the EPA’s advanced asset management training materials, Asset Management is the systematic integration of advanced and sustainable management techniques into a management paradigm or way of thinking, with primary focus on the long-term life cycle of the asset and its sustained performance, rather than on short-term, day-to-day aspects of the asset.

The District’s Collection System Facilities Plan anticipates the timing of needs related to both condition and capacity. Each of the District’s pumping station’s physical condition is assessed by analyzing six categories on a scale of 1 to 5, with 1 being very good and 5 being very poor. The District’s sewers are assessed for condition via its sewer maintenance televising program. Maintaining the District’s sewers through cleaning, televising, and rehabilitation or replacement plays a major role in meeting expected levels of service. In addition, providing an appropriate level of maintenance is a part of minimizing life-cycle costs. The level of service is also established by determining the capacity adequate to meet peak events. The District has used a benchmark called the Madison Design Curve for many years to set the required capacity for its pumping and sewer systems. This benchmark sets a peaking factor of between 2.5 and 4.0 for all of the District’s facilities based upon the average flow of the system’s component. (This factor is described in more detail elsewhere in this facilities plan.)

The amount of information on advanced asset management concepts is significant although somewhat nebulous and non-standardized. This makes it difficult to compare what your organization is doing with a single standard or even with best practices. In the remainder of this section, comparisons have been made with what the EPA considers to be the Fundamentals of Asset Management and their ten step approach to developing an asset management plan. The District’s Collection System Facilities Plan is fundamentally an asset management plan and as such provides a framework for improving the District’s collection system and its assets (the system of pumps, pipes, manholes, structures, etc.). In addition, the Collection System Facilities Plan also provides a framework to continually improve the planning process itself, i.e., this “asset management” planning process and how it interfaces with the capital improvement plan.
The Five Core Questions

Per the US EPA’s Fundamentals of Asset Management (retrievable from the EPA’s website at http://www.epa.gov/OWM/assetmanage/assets_training.htm), there are five core questions to answer when developing an asset management framework. Those questions are as follows:

1. What is the current state of my assets?
   - What do I own?
   - Where is it?
   - What condition is it in?
   - What is its remaining useful life?
   - What is its remaining economic value?

2. What is my required level of service (LOS)?
   - What is the demand for my services by my stakeholders?
   - What do regulators require?
   - What is my actual performance?

3. Which assets are critical to sustained performance?
   - How does it fail? How can it fail?
   - What is the likelihood of failure?
   - What does it cost to repair?
   - What are the consequences of failure?

4. What are my best O&M and CIP investment strategies?
   - What alternative management options exist?
   - Which are the most feasible for my organization?

5. What is my best long-term funding strategy?

Answering most or all of these questions should lead to a well-developed and advanced asset management program.

The following comments should be made about several of the questions and more discussion will occur later. One of the questions under what is the state of my assets asks what the remaining useful life is. Age and better yet, the actual condition, can be good indicators of the remaining life of a piece of equipment from an operational standpoint, but may not be good indicators from the standpoint of capacity or the ability to meet actual system requirements or level of service. Therefore, from an asset management perspective, failures to meet capacity or other service level requirements are considered failure modes and can also limit the remaining useful life of an asset.

Note that another question asks about remaining economic value. This is sometimes difficult to assess. The original cost of a piece of equipment or system depreciated over time may be significantly different from its actual economic value. Perhaps a better
indicator of economic value is replacement cost and the timing of the replacement. If a replacement can be delayed by repair or rehab, what is the value to the ratepayers of extending its life?

Another fundamental key of asset management is determining the desired level of service to provide and measuring actual performance. The desired level of service sets the bar for the utility’s performance. Measuring actual performance determines where improvements need to be made.

**Ten Steps to an Asset Management Program**

One method of implementing the five core questions is a ten-step process also included in the EPA’s Fundamentals of Asset Management and obtainable at the same website location as the five core questions. The ten steps are listed below:

1. Develop asset registry
2. Assess condition, failure modes
3. Determine residual life
4. Determine life cycle & replacement costs
5. Set target levels of service (LOS)
6. Determine business risk (“criticality”)
7. Optimize O&M investment
8. Optimize capital investment
9. Determine funding strategy
10. Build asset management plan

Integrating the five core questions with the ten-step process answers the five core questions and helps develop a comprehensive asset management plan. Steps 1 to 4 relate to question 1. Step 5, and to some extent step 6, address question 2 regarding level of service. Step 6 relates primarily to question 3. Steps 7 and 8 address question 4. Step 9, and to some degree step 10, address question 5. Lastly, step 10 packages everything together. The list below adds a little more information related to each of the 10-steps without going into depth.

1. Develop asset registry
   - System layout
   - Data hierarchy, standards, and inventory

2. Assess condition, failure modes
   - Condition assessment protocol
   - Rating methodologies

3. Determine residual life
   - Expected life tables
   - Decay curves
4. Determine life cycle & replacement costs
   - Valuation
   - Life cycle costing

5. Set target levels of service (LOS)
   - Demand analysis
   - Balanced scorecard
   - Performance metrics

6. Determine business risk (“criticality”)
   - FMECA (failure mode effects and criticality analysis)
   - Business risk (probability of failure times consequence of failure)
   - Delphi techniques

7. Optimize O&M investment
   - Root cause
   - RCM (reliability centered maintenance)
   - PdM (predictive maintenance)
   - ORDM (optimized renewal decision making)

8. Optimize capital investment
   - Confidence level rating
   - Strategic validation
   - ORDM

9. Determine funding strategy
   - Renewal
   - Annuity

10. Build asset management plan
    - Asset management plan
    - Policies and strategy
    - Annual budget

**Existing Assessment of District Asset Management Practices**

The District’s Collection System Facility Plan addresses many of the above steps and other steps are addressed by the District’s CMMS (computerized maintenance management system) and CIP (capital improvement plan). Without addressing all of the details of the District’s approach, the following includes brief summaries of how the District meets or does not meet certain aspects of advanced asset management.

**Step 1 – Asset Registry**

Numerous drawings show the layout of the District’s collection system and the assets and components that make up that system.
The District’s computerized maintenance management system has a well-developed asset management registry with well-developed standards and a systematic parent-child hierarchy. The system is used for maintenance purposes, but is not used more globally for overall asset management. The District also has a financial asset management system (FAMS), which is used to track the book value of its assets. In general, this system is mainly used for accounting purposes, for not engineering or O&M purposes. Perhaps the future of asset management at the District will link these two systems together and the FAMS information will be based upon actual asset condition rather than the value of depreciated assets based solely on age, thus providing information that may be beneficial to engineering and O&M.

**Step 2 – Assessing Condition and Failure Modes**

A somewhat anecdotal and generalized system exists for assessing the condition of the District’s pumping station assets. The adequacy of the firm and maximum capacity are determined by Capital Area Regional Planning Commission (CARPC) projections and the adequacy of the pumping station to meet capacity now and for the next twenty years. Power system redundancy (emergency measures), electrical system condition, mechanical system condition, and structural condition are less specific in their determination and there is therefore quite a bit more subjectivity built into the related assessments. Therefore, the assessments do not roll up from specific assessments of all equipment at the facility (e.g., assessments that would be made by maintenance staff during preventive or predictive maintenance work). However, assessments are based upon professional judgment by knowledgeable staff. Still, a more direct link between predictive maintenance findings and the condition ratings used in the facilities plan may be desirable and could enhance the results of future facilities (asset management) plans.

The adequacy of the capacity of the District’s sewers is assessed using the same CARPC projections as were used to rate the pumping station capacities. The projections are used to determine the timeframe when the sewers will reach capacity and may need relief. Condition of the sewers is determined from findings of the sewer televising inspections that are completed on an annual basis. Deficiencies and problems are recorded in a database and this database is used to determine sewers that are most likely to require repair, rehab, or replacement. Although some problems exist with the present system, the system appears to be working reasonably well. With ongoing improvements to the system, it should be easily modifiable to meet the District’s overall needs for asset management.

**Step 3 – Determine Residual Life**

The District assumes an asset’s life based upon its age and type for purposes of depreciation in its Financial Asset Management System (FAMS). The actual useful life of equipment is determined by the asset’s actual condition and anticipated remaining life. The two different approaches generally result in significantly different numbers. In addition, the life of an asset is often determined more by its ability to meet the conditions
that are presently required and this can change over time, e.g., capacity requirements change or new regulations mean different equipment such as may occur with ventilation equipment.

Determining residual life and the use of decay curves does not presently receive much time or attention. In general, the condition of critical equipment is known and repair, rehab, or replacement of equipment and/or systems is anticipated and taken into account using the District’s budget and planning processes. Repairs are generally treated as O&M expenses and addressed as maintenance while major rehab or replacement projects are treated as capital expenses.

Doing a more thorough job of determining and recording the residual life of equipment could potentially benefit overall planning and financial management by providing better information related to equipment needs and scheduling of repairs, rehabs, or replacements. However, the benefits of attempting to be more precise need to be balanced with the time commitment involved.

**Step 4 – Determine Life Cycle and Replacement Costs**

The District’s present approach separates accounting requirements from actual long-term planning for needs. In addition, determining life cycle and replacement costs is only completed, if at all, at a very high level. Actual life, based upon asset condition, is oftentimes difficult to assess, and typically, capacity is the normal failure mode of the District’s collection system assets. Replacement costs, for inclusion in the District’s capital improvement plans, are also typically completed at a relatively high level until the design process begins and then, costs are refined as the project progresses.

Depreciated value says little about the actual value of a piece of equipment. In fact, even when equipment is depreciated using decay curve methods or by depreciating based upon the equipment’s remaining life, the number tells little about the equipment’s actual value. Depreciating based upon condition (the modified approach) may, however, help tell outside organizations more information than straight-line depreciation. If an organization is keeping its equipment well maintained and/or renewed, the modified approach will reflect some of the organization’s good practices in its financial numbers.

Perhaps a better indicator of actual equipment value is its life cycle and replacement costs and the timing of those costs. This may be where the District could work at improving its present approach to long-term planning. Replacement costs should include an estimate of the life cycle costs for the best options. Even a modest approach to determining overall long-term replacement costs could prove helpful in identifying periods where the District might experience relatively high financial burdens due to renewal or replacement of existing infrastructure.
Step 5 – Set Target Levels of Service (LOS)

Regardless of whether or not an organization uses advanced asset management concepts or not, organizations have to determine appropriate levels of service. Knowing the appropriate level of service for each service provided is fundamental to any business. It provides the business with knowledge of the proper balance between service cost and the service performance.

The District has operated with, for the most part, an informal set of rules regarding how its collection system is operated and maintained. A stable, well-trained and well-managed workforce, known regulations from governing bodies, reasonable reserve capacity, certain guiding principles, and proper levels of automation have all contributed to a collection system that has worked well and provided good quality service to its customers.

One key target level of service is the District’s capacity curve for sizing the capacity of its collection system assets. This curve, called the “Madison Design Curve” (MDC), is used to determine whether or not an existing sewer or pumping station is adequate as well as to help determine how large to size a new asset. The average flow is multiplied by a peaking factor from the Madison Design Curve to determine the peak flow capacity requirements for either the existing asset or a new one. Per EPA regulations, sanitary sewer overflows are strictly forbidden even in the event of a flood. Therefore, the MDC has received some attention regarding whether or not it is a conservative enough approach to designing facilities in the Madison area. This will be investigated further and is but one area where the target levels of service may need further review.

The District’s informal set of rules has served it well; however, making these rules more formal and defining key performance indicators (KPIs) may be appropriate as workforce turnover increases with the departure of many long-term employees. Although an area in which the District’s commission has not typically become involved, formalizing and communicating current levels of service to the District’s governing body may provide helpful direction to the staff. Increased levels of service mean increased costs; there are trade-offs that need to be made and risks that need to be taken.

Step 6 – Determine Business Risk (“Criticality”)

Risk and criticality are concepts that are used within asset management to help prioritize repair, renewal, or replacement of existing assets and/or installation of new assets. Not all projects can be constructed at the same time; there are financial, physical, and other resource constraints that hinder this. The level of risk or the critical nature of a specific asset can help determine how long the organization can wait to repair, renew, or replace it versus doing something with another asset in the same condition.

Although all of the District’s collection system assets were built to serve the fundamental purpose of conveying wastewater to the District’s Nine Springs Wastewater Treatment Plant, and all are therefore fundamentally important, some assets are more important than
others and some involve higher levels of risk. A method to factor in criticality and risk for the pumping stations was included in the first collection system facilities planning effort and the same system was used for the second effort. Presently, a method to include risk or criticality for the District’s sewers is also being developed.

Risk is defined as probability of failure times consequences of failure. The District’s present approach to risk has barely scratched the surface of this concept. However, how much could be gained by going into much more detail in this area remains to be seen. Including risk level in decision-making has always been part of the District’s approach and a general inclusion and understanding of risk while prioritizing maintenance and projects may provide the appropriate level of emphasis. As with many of the other advanced asset management concepts, this one may require further analysis to determine the appropriate level to meet the District’s needs.

**Step 7 – Optimize O&M Investment**

Most collection system assets are long-lived assets. Therefore, most of them will need some form of maintenance, repair, and/or renewal, and ultimately, they will need replacement. How much maintenance and repair are required and when to renew or replace are not simple questions to answer. Neither is optimizing investments in maintenance, repair, and renewal to provide the lowest life cycle costs while meeting appropriate levels of service. However, that is one of the goals of a good asset management program.

The District’s approach to maintenance has changed over the years and it has used a computer-based maintenance system for over ten years. The District continually modifies its approaches to maintenance based upon industry trends and specific pieces of equipment. Further analysis and improvements of the District’s maintenance practices will and should continue to optimize the investment in its assets and in its maintenance resources and practices.

**Step 8 – Optimize Capital Investment**

All utilities should optimize their capital investments. To optimize its capital investments, a utility must make sure that its capital investment decisions include the right solutions at just the right time. Capital investments in the wastewater industry are generally significant long-term infrastructure investments with significant long-term consequences. Therefore, the decisions cannot be approached lightly. Much thought and evaluation need to go into the decision-making process to make wise and cost-effective decisions.

The District, like other utilities, must use all of its assets wisely and optimize its capital investments. Its collection system facilities plan is a prime example of how it approaches investments in its collection system capital wisely and with cost-effectiveness in mind. Projects are prioritized based upon need and follow-up planning and pre-design further investigate the need and best approach to meeting the intended purpose. The following
techniques are best management practices for optimizing capital investment (taken from EPA’s fundamentals of Asset Management):

1. **Build a strategic CIP “Business Plan”**
   - Includes project identification, validation, prioritization, and financing
   - Asks the following questions:
     i. What are we going to do and why?
     ii. What will it cost?
     iii. How will it be funded?
     iv. Life cycle impact on level of service, rates, and financial condition
   - Essentially – Are these the right projects at the right time and at the right cost?

2. **Deliver the project on time and on budget**
   - Includes execution and control
   - Addresses the following areas:
     i. Managing costs
     ii. Managing schedules
     iii. Managing contracts and changes

3. **Integration into the portfolio of assets**
   - Includes handover
   - Addresses the following areas:
     i. Registry
     ii. Start-up, shake-down, burn-in, commissioning
     iii. Manuals, spares, and service
     iv. Initiating the maintenance regimen

In general, the District’s approach to capital investment covers all of these areas relatively well. That does not mean that the approach to any one technique could not be improved; however, all of the areas are covered and the District continually strives to improve how it performs them.

The District’s collection system facilities plan begins the process of building the strategic business plan and initial justification for the project. The pre-design and design phases further analyze alternatives and evaluate whether or not the project is the right project at the right time. The bidding process sets the initial costs and provides a last go or no go decision. During the construction process, proper project management helps keep the project on time and on budget helping determine the final construction cost. Lastly, the turnover to the District’s maintenance group integrates the new assets into the District’s group of existing assets. Proper O&M throughout the life of the asset ensures that assets operate effectively to control life-cycle costs appropriately.
Step 9 – Determine Funding Strategy

Determining a funding strategy is step 9 in the process of building an asset management plan and the District has a well-developed funding strategy for funding its capital improvements plan. Rather than collect funds that are allocated for replacement, the District borrows money to pay for capital improvements including renewal projects. The District’s philosophy behind this approach is that by borrowing, generally at below market rates, the District’s customers who continue to use the District’s system pay for the improvements while they are using them rather than having those who may or may not benefit from the improvements pay for them ahead of time.

In general, the District derives funds from three separate areas to help pay for capital improvements including borrowing, connection charges, and interest received on the capital account balance. The District takes advantage of State Revolving Fund loans to the extent possible to help fund rehabilitation projects. The District also funds new projects via connection charges for new connections to its collection system. Two separate connection charges are assessed, an interceptor connection charge and a treatment plant connection charge. In the past, connection charges have helped fund collection system expansion as well as fund a certain level of the renewal projects.

Additional funding also arrives in the way of interest derived from the balance in the capital fund accounts; the balance of these accounts should never go below a minimum of three million dollars. Recently, growth has slowed significantly as has the interest received on the capital account balance. Therefore, the District has had to borrow for a greater percentage of its overall capital expenditures. If this trend continues well into the future, the District might have to rethink some of its funding strategy.

Step 10 - Build Asset Management Plan

Step 10 integrates the previous nine steps into an asset management framework and continues to build upon and improve the plan going forward. As stated previously, the District does not have a formal advanced asset management plan; however, the District does use many of the concepts contained in the ten-step process to achieve an asset management plan and utilizes some steps more than others. The intended purpose of the District’s collection system facilities plan is the same as an asset management plan: to meet expected levels of service within the District’s collection system by managing those assets properly and/or by constructing new assets where necessary. The collection system facilities planning process, like any process, is subject to analysis and improvement. The components, and even the framework of this process, should be reviewed and improved periodically.

Conclusions and Recommendations

The District’s Collection System Facilities Plan is an asset management plan. It utilizes some advanced asset management concepts, but has certainly only touched some of them on the surface. Further analysis of advanced asset management concepts may be
warranted; however, ultimately, the usefulness of the original collection system facilities plan proves that even without major changes that would include more of these concepts, it provided a useful pathway for the District’s engineering staff and capital improvement planning. Each new advanced asset management concept must add a reasonable level of additional value to the plan or it’s not worth the additional effort to complete.

Although all advanced asset management concepts are not worth pursuing as part of the District’s approach to asset management, the District should at least consider reviewing some of them to a greater extent. The following are recommendations based upon a cursory review of asset management concepts and the District’s present practices. Further investigation and analysis is required in most instances.

- In general, become more knowledgeable in advanced asset management concepts and determine which, if any, to integrate into the District’s present system of managing its assets.

- Continue to improve asset registry for the District’s collection system and the condition assessment of those assets. A good systematic and consistent approach is preferred over one that is overly detailed and cannot be consistently followed.

- Improve methods to estimate remaining asset life, life cycle costs, and replacement costs.

- Review and/or establish written levels of service based upon stakeholder (customers, regulators, and other stakeholders) expectations. Consider presenting these to the District’s governing body for review and approval.

- Continue to use methods that include risk and criticality in decision-making to help prioritize maintenance, repair, renewal, and/or replacement. Determine appropriate level of risk analysis to meet the District’s needs.

- Optimize and continuously improve the District’s maintenance program, repair and renewal methods, and capital improvement planning methods. Integrate these programs and methods to optimize overall asset and process costs.

- Continuously monitor funding strategies for the District’s asset management program.

- Continue to monitor and improve the District’s approach to managing its assets by building upon and improving existing practices and adding advanced asset management concepts as appropriate.

An asset management plan does not need to include all advanced asset management concepts to be a successful asset management approach. Those concepts that add value to the program should be incorporated into the District’s asset management approach; those that do not should not be included. As with any change, it will take time to
incorporate these practices into the District’s present practices and these should occur over a reasonable timeframe. Advanced asset management and District practices are also likely to continue changing over time and therefore, review of both should continue. The ultimate goal is that the District fully optimizes how it uses its assets and continually searches for and incorporates methods to improve its practices.

**Capacity, Management, Operation, and Maintenance (CMOM)**

A CMOM program addresses the capacity, management, operation, and maintenance activities of a collection system. It contains many of the same elements that comprise an Asset Management Plan, with greater detail given to certain components. In general terms, a CMOM program consists of best management practices that have been developed by the wastewater industry with consideration given to the entire life cycle of the collection system components. The program helps the owner of a collection system provide a high level of service to its customers while at the same time working to improve regulatory compliance regarding sanitary sewer overflows.

Currently there are no formal requirements by state or federal governments for establishing or implementing CMOM programs. A guidance document for CMOM programs was published by EPA in 2005 to assist owners and operators in management of their collection systems (*Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems, EPA, 2005*). In August of 2007 the EPA released a document entitled “Model NPDES Permit Language for Sanitary Sewer Overflows” that essentially requires collection system owners and operators to develop and maintain a CMOM program as outlined in its guidance document.

While the proposed revisions to NPDES permits for SSO overflows have yet to be adopted, it is clear that development and adherence to such a program is likely to occur in the near future, and possibly within the planning horizon of this Facility Plan. As a result, this section is provided to: (1). Discuss the major requirements of a CMOM program (as defined by the EPA’s guidance document); (2). Summarize how the District’s facilities and operations are currently positioned to address each of these requirements; and (3). Provide recommendations for areas that may require further improvement.

Each major component of the EPA’s proposed CMOM program will be discussed in turn in the remainder of this section as shown below:

1. Capacity Assurance
2. Management
3. Operation
4. Maintenance
5. Sewer Rehabilitation
6. Conclusions and Recommendations
1) Capacity Assurance

a) General

Capacity of the collection system should be evaluated periodically to evaluate the effects of both dry and wet weather flows on system conveyance. The first step in this evaluation involves an inventory of existing facilities and system features, including service population, total system size, and a characterization of pipe sizes, lengths, materials, and ages. The District’s Collection System Database currently stores this information and integrates it with its Geographic Information System (GIS).

The second step in evaluating the capacity of the collection system is a general inspection of the system. This is discussed in more detail later in this subsection. The final step in the capacity evaluation involves identifying those areas of the collection system that are prone to capacity limitations in the form of wet weather related SSO’s, surcharging, or basement backups. Those areas that are identified should be investigated more fully using techniques such as flow and rainfall monitoring and hydraulic modeling.

The District’s Collection System Evaluation (2009), as prepared by CARPC, will be a useful tool in identifying areas with capacity limitations by comparing system capacities against projected peak flowrates for each section of the collection system. The District has also used its recently acquired hydraulic model to further analyze areas of the collection system where capacity limitations have been identified by CARPC’s analysis. The results of this investigation are discussed in more detail in Chapter 4 and Appendix 5.

b) Inspection Techniques

i) Flow Monitoring

Flow monitoring is used to collect fundamental information about the collection system, including dry weather flowrates and estimates of inflow and infiltration. The District employs a full-time crew to monitor flowrates from its satellite communities for billing purposes. Most in-line monitoring is done through weir measurements in manholes. This information is occasionally useful for establishing dry weather flowrates in District facilities, but it has limited applicability due to the short duration of the monitoring and due to the location in the system in which the monitoring is conducted. The District does not own any area-velocity or ultrasonic meters that are better suited for measuring flows in larger sewers. The District typically contracts with a consultant for flow monitoring in larger sewers for extended periods of time as part of flow and/or I/I studies. The District may want to consider investing in one or more meters if future I/I studies provide beneficial results and prove cost effective.
ii) Sewer System Testing

Leaks in the collection system are commonly identified through smoke testing or dyed water testing. Both of these techniques are used on a periodic basis when excessive I/I or a storm water cross connection is suspected in a portion of the collection system. Smoke testing is done by plugging each end of the test section, introducing smoke into the section via a blower, and recording those locations in the test section where smoke escapes. In a properly operating system the smoke should escape from the plumbing vents of adjacent buildings. In a leaky system the smoke will also escape from the ground at points along the sewer main or sewer laterals.

Dyed water testing is used to confirm the connection of a fixture or appurtenance to the sanitary sewer system. It is often used in conjunction with smoke testing to validate the results. The District has employed occasional use of both sewer system testing techniques, but would not likely have a routine need for either that would warrant additional investment.

iii) Sewer System Inspection

Visual inspection of manholes and pipelines is used to identify existing or potential problem areas that may limit capacity. Various defects in the pipeline can be identified and recorded such as root intrusion, corrosion, grease accumulation, and joint offsets. A variety of techniques for sewer inspection are available. They include lamping, camera inspection, sonar, sewer scanner, and closed circuit television (CCTV). The District aims to televise each segment of the collection system no less than once every ten years by contracting with a sewer cleaning and televising contractor. The use of CCTV by this process has served the District well in the past and should continue to do so in the future.

2) Management

Proper management of a collection system is crucial to the operation and management activities. The EPA’s guidance document cites six important goals of a management program:

- Protection of public health and property
- Minimization of I/I and capacity assurance
- Prompt response to service interruptions
- Efficient use of funds
- Identification and correction of system deficiencies
- Safety

In order to achieve these six goals, a good management program should contain a strong focus on the following elements: organizational structure, training, internal communication, customer service, management information systems, a SSO notification
program, and a clearly defined legal authority. Each of these areas will be discussed briefly in turn.

a) Organizational Structure

A well-defined organizational structure helps to delineate responsibilities and authority for each position in the collection system. This typically includes the use of an organizational chart, position descriptions for each employee, or both. The EPA recommends that vacant positions and work that is contracted out also be accounted for in the organizational chart. It is also recommended that one supervisor have overall responsibility for the collection system.

The District has a well-defined, overall organizational chart that is kept current and includes positions related to work in the collection system. Position descriptions for each employee have also been added to the organizational structure recently to help clarify job responsibilities and expectations. The District may want to consider developing an organizational chart specific to the collection system that shows contracted work responsibilities such as sewer cleaning and televising.

b) Training

While employee training is not explicitly required under current regulations, it is an important element of a collection system with regard to safety and regulatory compliance. The EPA recommends that training be provided in the following areas for collection system personnel:

- Routine line maintenance
- Confined space entry
- Traffic control
- Record keeping
- Pump Station O&M
- Electrical and instrumentation
- Public relations and customer service
- SSO/Emergency response

The District has a Training and Safety Manager on staff and a well-established safety program that addresses most of the areas identified above. Confined space entry policies are recorded in a written handbook and training is conducted for all affected personnel on an annual basis. A permit program for all entries is also in place. Operational and maintenance training for mechanics and electricians on all new or rehabilitated equipment at pump stations is routinely conducted by District staff or equipment suppliers.

While the District has prepared and periodically updates an emergency response manual that addresses SSO’s, no formal training for employees is currently
conducted. Written procedures for identification, clean-up, and notification of SSO’s should be considered by the District in addition to employee training on these items. In addition, the District should consider offering formal training related to proper traffic control procedures for conformance to local road and state highway requirements.

c) Internal Communication

Effective communication requires the exchange of ideas and information amongst staff. The EPA’s guidance document references the use of bulletin boards, regular staff meetings, e-mail, and employee incentive programs to promote effective communication. The District currently employs each of these communication tools as a way to exchange ideas between staff members.

d) Customer Service

Work in this area involves addressing all comments, questions, requests for information, and complaints from the public in a timely manner. This area also extends to the development of a public relations program that educates the general public, public officials and local utilities about the collection and treatment of wastewater.

The District provides wastewater conveyance and treatment to satellite communities of varying size. Thus, most of the District’s customer service involves municipal officials at the town, village, or city level. In general the District’s customer relations with these entities are very good. In the last year the District has worked to strengthen its public relations program. It recently contracted with a media relations company for radio advertisements promoting water conservation and I/I reduction efforts. In addition, the District recently completed a 50-year Master Planning effort and held extensive public meetings throughout the planning process to educate stakeholders about the Plan.

e) Management Information Systems

The collection, maintenance, and retrieval of data for collection system operations are important tools for system management. A good management information system improves preventive maintenance on equipment, allows work orders to be tracked more efficiently, and aids in preparing and justifying capital budget expenditures. The trend in the industry has been to use computer-based systems to manage data. For several years the District has used a computer-based Maintenance Management System (CMMS) to track the performance of assets in the collection system. Among other things, it is used to document problems and generate work orders, schedule routine maintenance activities, maintain equipment inventories, track costs, and create purchase orders.
The District has also developed a computerized database of its collection system for all pertinent physical characteristics. This database is used in conjunction with a Geographic Information System for locating and mapping of its facilities.

f) SSO Notification Program

A written procedure should be developed for all entities that could be affected in the event of an SSO. This includes the public, public health officials, and any regulatory authorities. The procedure should indicate the different agencies to be notified as well as contact information and responsibilities for all personnel involved. The District currently notifies the Wisconsin Department of Natural Resources for each sewer bypass or sewer overflow event. It also works directly with public health officials to notify the public in the rare cases where overflows occur to surface waters. Contact information for these agencies is currently in the District’s Emergency Response Manual, although specific written procedures are not included. The District should revise the manual to clarify the procedures to be used for SSO notification.

g) Legal Authority

This section deals with the regulation of flow that enters the collection system from residential, commercial, and industrial sources. The legal authority for this regulation can be in the form of a sewer use ordinance, contracts, service agreements, or some other legally binding document. Included in this authority is a pretreatment program to prevent the discharge of materials into the collection system that would interfere with the conveyance or treatment operations. This legal authority should also extend to include general prohibitions, grease control requirements, restrictions on stormwater inflow and infiltration from laterals, and new construction standards.

The District’s Sewer Use Ordinance, along with its pretreatment program, provides the legal authority to regulate most of the items described above. Among other regulations, it provides standards for new connections, restricts clear water and storm water flows, and prohibits grease discharges. The District’s pretreatment procedures are prepared in a written document and approved by WDNR on a periodic basis. These procedures specify sampling requirements and procedures and sets limits on constituents in wastewaters discharged from non-domestic sources.

With regard to the issue of excess flows from satellite communities, the District continually evaluates the effects of large rainfall events on the collection system and works with its customers to identify and correct problem areas. This approach has worked with success in the past. As such, the District currently does not employ the use of contracts, agreements, or allocations to regulate excess flows from its satellite communities. However, large storm events have increased in intensity and frequency over the last ten years and may cause the District to consider executing agreements for excess flow allocations in the future. Significant expense would be incurred by the District to enforce the monitoring requirements for such a program given the large number of customers served by the District as well as their geographic layout. The
costs for this monitoring effort would need to be balanced against the costs needed to reinforce the District’s conveyance facilities to accommodate larger wet weather flows. Non-economic factors should also be considered in this evaluation.

3) **Operation**

Collection systems have limited operability options relative to wastewater treatment plants as there usually is only one route for the wastewater to travel from the source to the plant. There are many factors to consider, though, with regard to operational activities of the collection system.

a) **Budgeting**

Budgeting is one of the most important components of a CMOM program. Inadequate funding makes achieving operational goals difficult. One way to avoid inadequate funding is to develop a consistent annual baseline for operating costs and to track expenditures closely. Costs of preventive and corrective maintenance and major repairs for the collection system are key components of the annual operating budget. An owner may develop a separate Capital Improvement Plan (CIP) to complete small projects (one to two year cycles) or larger projects (three to five year cycles).

The District prepares and adopts annual budgets for operational expenses and capital projects. The primary source of revenue to cover these expenses comes from service charges collected from the District’s satellite communities. As mentioned previously, the District uses a CMMS system to track its annual operating expenses and also projects a 10-year Capital Improvement Plan. As a result, increases in service charge rates are generally consistent and average approximately 5% per year. No further changes in budgetary practices are anticipated to meet CMOM program requirements.

b) **Monitoring**

Monitoring of wastewater discharges in the collection system may be done by the owner for a variety of reasons. These include monitoring of industrial users for permit compliance, monitoring of satellite communities for billing purposes, monitoring receiving waters to assess SSO effects, and monitoring required for NPDES permit compliance. The EPA guidance document recommends that written procedures be developed to ensure that sampling is done in a safe, effective, and consistent manner. This document should include key items such as instructions for sampling and field monitoring and laboratory procedures for analysis.

The District employs one full-time crew for monitoring and sampling of wastewater throughout the collection system. The majority of the crew’s time is devoted to quarterly sampling and monitoring of flows from satellite communities for determination of service charges. The crew also performs monitoring on a limited number of industrial users, although many of these users do their own monitoring. While the District’s pretreatment program does contain some written procedures
related to sampling and monitoring requirements (i.e. sample volumes and frequencies), the District may want to consider developing a more detailed procedure that contains all of the elements referenced in the EPA’s guidance document.

c) Hydrogen Sulfide Monitoring and Control

Hydrogen sulfide gas can collect in various parts of collection systems and react with bacteria to form sulfuric acid, which can corrode metal and concrete surfaces. The EPA’s guidance document recommends that a program be developed to monitor areas of the collection system which may be adversely affected by the presence of hydrogen sulfide.

The District performs routine manhole and sewer line inspections as part of its televising program. The condition of the manholes and sewers due to corrosion is recorded on inspection forms, although pH readings in the system are not generally taken. Acquiring pH readings in manholes in vulnerable parts of the collection system may be something the District wants to consider in its inspection program going forward.

The District has also addressed the issue of hydrogen sulfide control in specific parts of its collection system due to odor complaints or observations from operations staff. The addition of chemicals to reduce the level of sulfides has been studied but not implemented as a long-term solution. Other chemicals have been used to “mask” the odors caused by sulfides. The best operational strategy to eliminate problems due to hydrogen sulfides is to select materials of construction that are resistant to corrosion (i.e. PVC, fiberglass). The District has elected to use these pipe materials as its standard on new or rehabilitation projects over other materials such as concrete and steel.

d) Safety

Safety programs define the standards under which the work is to be accomplished and to make employees aware of safe working procedures and specific regulations. The safety program should be established in writing with respect to specific procedures and policies.

The EPA’s guidance document recommends that safety programs be enacted for the following areas related to collection systems:

- Confined spaces
- Chemical handling
- Trenching and excavations
- Material Safety Data Sheets
- Biological hazards in wastewater
- Traffic control and work site safety
- Lockout/Tagout
- Electrical and mechanical safety
- Pneumatic or hydraulic systems safety

The District holds weekly safety meetings for all employees that deal with most of the items listed above. Material Safety Data Sheets are readily available to all employees for materials which are routinely used in District operations. While clearly defined procedures and policies have been developed for some of the items such as confined spaces, more written documentation could be provided for some of the other areas.

e) Emergency Preparedness and Response

Comprehensive plans should be in place for handling both routine and catastrophic emergencies. Examples of routine emergencies include overflowing manholes, sewer main breaks, localized electrical failures, and power outages at pumping stations. Catastrophic emergencies include extreme events such as floods, tornados, earthquakes, chemical spills, and widespread electrical outages.

The District has prepared, and updates on an annual basis, its *Emergency Response Manual* to address emergency situations. Among other information, it provides procedures to be followed during pump station outages, information related to repair of force mains, and contact information related to sewer overflows and other types of spills. This manual is made available to each employee in written form and on the District’s internal website.

In addition, the District is in the preliminary stages of preparing a risk-based condition assessment for its collection system. This assessment will account for risk factors such as facility age, material, depth, location, and criticality in order to assess the risk of failure of each component and aid in prioritizing future rehabilitation projects.

f) Modeling

Sewer system modeling is done to help simulate non-uniform and unsteady flows throughout the collection system in response to different operating conditions and rainfall events. It can be a valuable tool in new designs and in evaluating different operating scenarios.

The District developed a hydraulic modeling tool for its collection system in 2005. It has been used primarily for evaluating capacity based on existing flows and future flow projections. The hydraulic model is described in more detail in Chapter 3 of this Plan.
g) Mapping

The creation and maintenance of good mapping records is crucial to the effectiveness of a collection system. The EPA’s guidance document specifies that the following information should be included at a minimum: sewer mains, laterals, manholes, cleanouts, force mains, pump stations, service area boundaries, and other landmarks. The District maintains all the physical characteristics described above in its collection system database and maps these features using its Geographic Information System. Aerial photography is included in the mapping to aid in the location of facilities. Map books are updated on a regular basis to incorporate system modifications and mapping improvements.

h) New Construction

This section calls for the strict control and regulation of flows into the collection system from new construction. This includes both public and private sewers. The owner should adopt standards for new construction and procedures for the review of proposed extensions.

The District specifies standards for plan review, construction, inspection, and testing of new connections through its Sewer Use Ordinance. Proposed sewer extensions are reviewed by District staff, a county regulatory agency for conformance to area water quality plans, and the Wisconsin Department of Natural Resources. The District’s review ensures that the collection system has adequate capacity to serve the proposed extension and that the proposed construction materials are adequate.

i) Pump Stations

Pump stations vary in their type, size, and complexity and require differing levels of specialized mechanical, electrical, and hydraulic knowledge. Failures can lead to equipment and environmental damage, or even endanger public health. The District owns and operates 17 regional pumping stations and employs its own electrical and mechanical maintenance staff to maintain and repair equipment.

4) Maintenance

Collection system owners should develop well-planned, systematic, and comprehensive maintenance programs which incorporate the following goals:

- Prevention of overflows
- Maximization of service and system reliability at minimum cost
- Assurance of infrastructure sustainability

Maintenance activities can be broadly classified as planned or unplanned. Planned maintenance includes both predictive and preventive measures, which aim to treat operational problems prior to equipment failure. Unplanned maintenance consists of corrective or emergency measures which are used to repair equipment once it has failed.
Proper maintenance programs should incorporate the various elements discussed further in this subsection.

a) Maintenance Budgeting

Maintenance costs can be a significant part of the annual operating budget. As such, these costs should be closely tracked throughout the year to ensure that future budgets have appropriate funding.

The District’s maintenance costs are included in its annual operational budget. As mentioned earlier in the discussion of operational budgets, the District employs the use of a CMMS system to track operational and maintenance costs. This system has served the District well and no changes to this system are recommended at this time.

b) Planned and Unplanned Maintenance

i) Predictive Maintenance

Planned maintenance involves a systematic approach to maintenance activities such that equipment failure is avoided. As mentioned previously, this includes both predictive and preventive maintenance. Examples of predictive maintenance include equipment inspection and monitoring equipment for early warning signs of failure such as vibration, heat, dirty oil and leakage. Recording and storing the data obtained from inspection and monitoring activities is a key component of predictive maintenance.

The 2002 Collection System Facilities Plan recommended development of a predictive maintenance program for pumping equipment in the collection system. The District has implemented this recommendation in its rehabilitation of Pump Stations 1, 2, 6, 8 and 10 through the installation of pump vibration sensors. In addition, the District recently purchased a thermal imaging scanner to detect unusual heat patterns or temperature changes in electrical equipment (i.e. motor control centers and control panels) as an indicator tool for impending electrical failure of the equipment. The goal is to scan each piece of equipment to develop a baseline for future comparison so that any problems can be corrected before equipment failure. One challenge of this thermal imaging program is to develop an efficient way to store all of the information that is obtained from the scans and link it to the District’s asset management software. This is an area that will require further study and work.

ii) Preventive Maintenance

Preventive maintenance aims to reduce equipment breakdowns, improve system reliability by minimizing equipment outages, lengthen equipment life, and avoid potential noncompliance situations. An effective preventive maintenance program should contain the following elements:
- Trained personnel
- Scheduling based on system specific knowledge and manufacturer’s recommendations
- Detailed instructions related to the maintenance of various pieces of equipment
- System for recordkeeping
- System knowledge in the form of maps, historical knowledge and records

A maintenance record for each piece of equipment should be maintained which contains information related to maintenance recommendations, schedule, instructions, and past maintenance history.

The District’s CMMS is used to store and track information on all District assets at the treatment plant and at pumping stations in the collection system. This includes equipment specifications, bill of materials, maintenance schedules, and other related maintenance materials. The District typically requires and receives an Operating and Maintenance Manual from the manufacturer for each new or rehabilitated piece of equipment in the collection system. This information is used to generate schedules and instructions for preventive maintenance items. An asset identifier for each gravity sewer segment in the collection system has recently been added to the District’s CMMS.

Other examples of predictive maintenance activities performed by the District include biweekly inspections of its 17 regional pumping stations, periodic inspection and cleaning of air release valves on force mains, and lubrication of equipment at pumping stations. Air release valves have historically been inspected and cleaned as necessary. Due to repeated problems with plugging of these valves, the District recently began a program to inspect and clean these valves no less than twice a year.

Pump station inspections include starting and stopping each pumping unit to check for vibration or plugged vent lines and documentation of other items that may require corrective maintenance. In addition, the District employs one full-time lubrication mechanic to ensure that all pumping equipment is greased according to the manufacturer’s schedules.

On an annual basis inspections of all the District’s pumping stations are made by the Director of Operations and Maintenance to identify and document large repair items that may be outside the scope of routine work orders. These items are prioritized and inserted into the Capital or Operational budgets as appropriate.

iii) Corrective Maintenance

Maintenance of this type can occur as a result of predictive or preventive maintenance activities which identify a problem. In these instances a work order
is generally issued to the proper personnel for repair as soon as a problem is identified. Maintenance of this type usually results in the equipment being taken out of service for a period of time and reduces redundancy in the system.

The District’s CMMS is used to generate, store, and track all work orders that pertain to corrective maintenance. Lengthy service disruptions are minimized through use of the CMMS by the ability to easily review open work orders.

iv) Emergency Maintenance

Emergency maintenance requires immediate attention and repair of a problem to avoid equipment failure or threats to public health or the environment. In large collection systems this may require emergency crews to be available at all times throughout the year, while smaller systems may utilize an “on-call” system. Written procedures should be in place to outline actions to be taken and the equipment needed for emergency situations.

The District has prepared, and updates on an annual basis, its *Emergency Response Manual* for responses to emergency events. This document deals with situations such as repairs to force mains, outages at pumping stations, emergency spills (including SSO’s), and contact information for contractors, satellite communities, and regulators. For emergency events such as force main breaks, the District usually hires a contractor to excavate and make repairs.

c) Sewer Cleaning

Sewer cleaning removes accumulated material from the sewer and helps to prevent blockages and prepare the sewer line for televising. The key to an effective sewer cleaning program is recordkeeping. Not all areas of the collection system need to be cleaned at the same frequency. For example, those parts of the system with a high density of restaurants may need to be cleaned every six months, while a residential area with new pipe may not require cleaning for several years. An owner should be able to identify problem areas in the system and show how the preventive maintenance schedule addresses these areas. In addition, an owner should be able to document the number of stoppages experienced per mile of sewer.

The District does not clean sewers with its own forces. All sewer cleaning is contracted out on an annual basis under one contract. In general all sewers are cleaned no less than once every ten years, with any problem areas receiving more frequent attention. Due to the larger pipe sizes and magnitude of flows in the District’s sewers compared to local sewers, this frequency of cleaning has found to be adequate based on past experience. The District links its sewer cleaning and televising operations and manages them through a computerized database. While the database has proved to be a useful tool, challenges have been noted with regards to development of a scoring and rating system for sewer condition and with the reporting of these scores for use in scheduling cleaning operations and repair or
rehabilitation projects. The District should continue to develop the database to refine these areas.

d) Parts and Equipment Inventory

Spare parts, equipment, and supplies should be kept in inventory to keep equipment from being placed out of service for long periods of time after breakdown or malfunction. Inventory should be based on the equipment manufacturer’s recommendations as well as the owner’s past experience.

The District’s Purchasing Manager is responsible for overall management of inventory for equipment used in the collection system, with assistance from the mechanical and electrical maintenance departments. Information regarding inventory is stored and tracked via the District’s CMMS. Sign-out procedures for parts are in place for replenishing inventory. No changes to the District’s inventory practices are recommended at this time.

5) Sewer Rehabilitation

The owner should develop a sewer rehabilitation program to incorporate the results of the capacity assurance, management, operation, and maintenance activities. Sewer rehabilitation helps to ensure that the collection system remains viable by: (1). Maintaining structural integrity; (2). Limiting the loss of conveyance; and (3). Controlling the rate of exfiltration from the pipe network to protect groundwater. The sewer rehabilitation program should clearly indicate how projects are prioritized and how rehabilitation methods are selected (i.e. open cut vs. trenchless construction).

The District currently does not have a formal sewer rehabilitation program. Projects are currently identified as a result of periodic capacity analyses or condition reports. The decision on the type of repair method to be used is generally made based on facility planning or pre-design reports. The District has completed a number of sewer lining projects in the last 3-4 years and has found them to be a cost-effective tool to prolong the service life of sewers in certain applications. As this technology evolves and improves and the District’s collection system ages and grows, the District may want to consider a more formalized approach for identifying rehabilitation projects and construction methods.

As mentioned in the Emergency Preparedness and Response section for Operational activities, the District recently began development of a risk-based condition assessment tool to help identify and rank the most critical portions of the collection system. Continued development, refinement, and use of this tool with other data regarding the collection system are recommended to help prioritize future rehabilitation projects.

6) Conclusions and Recommendations

After reviewing the key elements and requirements for a CMOM program as found in the EPA’s guidance document, it appears that the District is well positioned in the event that
the program gets enacted. The District currently implements many facets of the program in its current operation of its collection system. Recommendations for improvements to the collection system have been discussed in the preceding sections. These recommendations are summarized by section below:

- **Capacity Assurance**
  - Consider purchase of flow metering equipment for I/I studies.

- **Management**
  - Develop an organizational chart specific to the collection system.
  - Identify all contracted work in the structure.
  - Develop a written procedure for SSO events. This should include procedures for identification and clean-up of overflows and notification requirements.
  - Offer or conduct training program for traffic control procedures.
  - Consider use of service agreements or contracts with satellite communities to regulate wet weather flows and I/I into District’s collection system.

- **Operation**
  - Develop written rules and procedures for monitoring of wastewater.
  - Acquire pH readings in manholes as part of hydrogen sulfide monitoring program.
  - Develop and assemble a written safety program relating to collection system work areas.

- **Maintenance**
  - Develop a system to link thermal imaging scans for predictive maintenance to equipment asset information in CMMS.
  - Refine District televising database to improve scoring and ranking system. Incorporate the scheduling of cleaning and televising operations into database.

- **Sewer Rehabilitation**
  - Develop a risk-based condition assessment model to aid in prioritizing sewer rehabilitation and replacement projects.

The District will also need to consider the format of its CMOM document. At present the required information can be found in several separate locations (i.e. Geographic Information System, Collection System Facilities Plan, Emergency Response Plan, etc.). The District will need to consider the advantages and disadvantages of compiling all of this information in one central location and/or document.