Collection System Asset Management Plan

Operations and Maintenance

Finance

Information Management

Engineering/Planning

APRIL 2015
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1. INTRODUCTION

The Wastewater Enterprise (WWE), a division of the San Francisco Public Utilities Commission (SFPUC), initiated an Asset Management Program (AMP) to enhance infrastructure planning, develop and reliably meet identified level of service goals, and optimize its operations and maintenance activities. Within this enterprise-wide program, the WWE Collection System Division (CSD) developed a Collection System Asset Management Program (CSAMP). The CSAMP is specific to the unique considerations of linear sewer assets. The CSAMP was developed based on techniques recommended by the National Association of Clean Water Agencies (NACWA), the International Infrastructure Management Manual (IIMM), and the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP). The CSAMP is a modern management method that enables the CSD to plan and replace the aging sewer system using a proactive, risk-centric approach.

This document describes all asset management initiatives within the CSD and underscores the web of people, activities, and plans that comprise the CSAMP. This document serves as an overarching program guide, defining the framework of the CSAMP and providing a directory for the dynamic reports that constitute asset management within the Collection System Division.

Asset management: Integrated set of processes that minimize the lifecycle costs of Wastewater Enterprise assets while delivering established levels of service, all at an acceptable level of risk.
2. BACKGROUND

Asset management principles reflect a holistic business approach. Accordingly, the CSAMP encompasses and unites several existing reports and programs while introducing new concepts. Figure 1 illustrates the relationship of the CSAMP to other planning documents developed within the SFPUC.

The Sustainability Plan serves the entire SFPUC. The Strategic Business Plan applies the initiatives of the Sustainability Plan to the WWE and dictates the need for a WWE AMP, which includes both treatment and collection system programs. The Sewer System Improvement Plan (SSIP) and its subcomponent, the Urban Watershed Framework (UWF), fit within the context of asset management and address long-range planning needs to enable the WWE to meet established goals that cannot be attained with existing infrastructure.

![Figure 1 - How the CSAMP Relates to Other Planning Documents](image-url)
ASSET MANAGEMENT BACKGROUND/ APPROACH

The term “asset management” refers to a body of principles aimed at balancing risk while minimizing life cycle costs. For the water and wastewater industry, this pertains to the physical assets of a utility: pipes, structures, equipment, etc. In simple terms, asset management encompasses:

- Risk management
- Optimizing expenditures across capital, operations, and maintenance
- Responsible planning for rehabilitation and replacement (i.e., renewal) expenditures

Over recent years, asset management has proliferated as a result of reductions in federal grants, aging of infrastructure, and a transitioning workforce. This latter issue reflects the fact that with the retirement of many baby boomers, many agencies are losing institutional knowledge. The WWE embraces asset management as a way to better plan and manage assets in light of these challenges.

COLLECTION SYSTEM GOALS AND OBJECTIVES OF ASSET OWNERSHIP

The SFPUC’s mission, vision, and values are linked to the goals and objectives that guide planning decisions. While the mission, vision, and values are general and omnipresent, goals and objectives are more specific and may be unique to different divisions.

Asset management reflects the mission of the SFPUC at multiple levels of planning. The SFPUC Sustainability Plan states the goal to “effectively managing and maintain assets while ensuring reliability and efficiency of infrastructure and assets”. Table 1 details the goals stated in the Sustainability Plan for the Infrastructure and Assets category. The Strategic Business Plan develops these further for the WWE. This figure demonstrates the branching of the high-level mission/vision/values to increasingly detailed objectives and, ultimately, actions. Additionally, asset management principles are explicitly stated within the Strategic Business Plan. As will be described in further sections of this report, the CSAMP has been designed in response to these initiatives.

STRATEGIC BUSINESS PLAN

The purpose of the Strategic Business Plan is to translate the WWE’s long term needs into short-term strategies and actions. Development of the Strategic Business Plan relied on multiple workshops and meetings with the WWE Assistant General Manager, division managers, and focus area leads. The Strategic Business Plan is composed of two major sections, one that is considered static while the other one is dynamic. The static section of the plan consists of the mission, vision, and values of the SFPUC and will remain relatively stable although it is susceptible to change over time to reflect the evolving needs of the WWE. The dynamic section of the plan includes strategies and action, targets, completion dates, leads and budgets, with change occurring annually as part of quarterly and annual reviews and updates. Figure 3 shows the goals of the WWE Strategic Business Plan.
The WWE developed an asset management program that delegates responsibility for providing services for each type of asset. Each asset is assigned to either the private property owner or one of three WWE operating divisions: Collection System Division (CSD), Operations and Maintenance Division (O&M), and Wastewater Engineering Division (ENG). Each of the WWE operating divisions are responsible for management of activities associated with the assets including:

- Establishing level of service goals and key performance indicators
- Developing an adequate budget

Table 1 - Infrastructure and Assets Draft Sustainability Goals

<table>
<thead>
<tr>
<th>Framework</th>
<th>Goal/Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Management and Planning</td>
<td>Optimize the management, planning, and maintenance of assets and infrastructure.</td>
</tr>
<tr>
<td>Asset Efficiency, Security and Resilience</td>
<td>Improve efficiency, reliability and resilience of service delivery</td>
</tr>
<tr>
<td>System Maintenance and Management</td>
<td>Maintain assets in good working order</td>
</tr>
</tbody>
</table>

Figure 3 - Goals of the WWE Strategic Business Plan

**MANAGEMENT STRUCTURE/ROLES AND RESPONSIBILITIES**

The WWE developed an asset management program that delegates responsibility for providing services for each type of asset. Each asset is assigned to either the private property owner or one of three WWE operating divisions: Collection System Division (CSD), Operations and Maintenance Division (O&M), and Wastewater Engineering Division (ENG). Each of the WWE operating divisions are responsible for management of activities associated with the assets including:

- Staffing and resource planning
- Monitoring performance of activities versus established goals
- Tracking, analyzing, and controlling costs
- Developing a performance plan
- Developing procedures
- Documentation and document control

The organizational structure of the SFPUC, WWE, and CSD are provided in Figures 4 and 5. The CSAMP requires collaboration across many levels and divisions within the organizational structure. The responsibilities for management activities for the various WWE assets are shown on Figure 6.
* The Department of Public Works' structure has been simplified to show key relationships for the CSD.

Figure 4 - Organizational Structure of the SFPUC and Wastewater Enterprise

Figure 5 - Wastewater Enterprise Collection System Division Organizational Structure
Figure 6 - WWE Asset Management Roles and Responsibilities

*SD performs source control inspections and enforcement to protect WWE assets from point source discharges, including construction site run-off.
3. LEVELS OF SERVICE

Level of Service (LOS) goals are standards developed by a utility that must be managed to satisfy the utility’s mission and the expectations of ratepayers. To measure the success of satisfying the LOS goals, Key Performance Indicators (KPIs) are developed as metrics that can be supported by objective data.

When LOS goals are farther-reaching and cannot be met with existing infrastructure, KPIs are typically not defined. Rather, capital plans are implemented to provide the infrastructure necessary to meet the goals. For the WWE, this is reflected in the long-range LOS goals being addressed by the SSIP, as shown in Figure 7.

Figure 7 - Level of Service Goals

Level of service (LOS) goals bridge the overall mission of a utility with its day-to-day accomplishments. Where existing infrastructure and capabilities enable the utility to meet these goals, Key Performance Indicators (KPIs) provide the metrics that prove success or show need for improvement.
COLLECTION SYSTEM STRATEGIC GOALS

The SFPUC developed the Strategic Sustainability Plan goals and Sewer System Improvement Program (SSIP) LOS goals, which complement the CSAMP LOS goals. These are shown in Figure 8. This figure also shows the relationship between goals and scoring criteria used in the risk analysis, to be discussed later in this report.

LEGISLATIVE REQUIREMENTS

There are various legislative and/or regulatory requirements that affect asset operation or require a certain LOS. An example of a regulation-driven LOS goal is the Combined Sewer Overflow (CSO) Control Policy. The Clean Water Act’s CSO Control Policy establishes a nationwide approach for controlling CSO discharges. This policy applies to San Francisco’s wet weather discharges from the combined system, including near shore discharges from the transport/storage facilities, Southwest Ocean Outfall (SWOO) decant, and wet weather Southeast Water Pollution Control Plant (SEP) discharges. In conformance with the CSO Policy, the City has implemented nine control technologies and developed a Long-Term Control Plan (LTCP).

Although a small part of the overall system, San Francisco’s Municipal Separate Storm Sewer System (MS4) areas are subject to their own regulatory requirements. The City’s National Pollutant Discharge Elimination System (NPDES) permit requires that MS4 areas comply with U.S. EPA’s storm water discharge requirements. This means that each MS4 area is required to develop and implement a storm water management program (SWMP) to reduce the contamination of storm water runoff and prohibit illicit discharges.

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**Figure 8 - The Evolution of CSAMP Goals**

2. SFPUC Wastewater Enterprise Combined Sewer System Operation and Maintenance Plan.
MINIMIZE EXCURSIONS

Releases of wastewater from San Francisco’s collection system are referred to as “excursions”. One of San Francisco’s Level of Service goals seeks to minimize excursions from the combined sewer. Excursions occur when the sewer system is unable to convey flow, either because the pipe is too small, the pipe has become obstructed, or because rainfall-runoff has exceeded the design capacity of the sewer. While San Francisco proactively identifies areas prone to excursions and minimizes the risk of excursions through its CSAMP efforts, these events are inevitable in any combined collection system.

Excursions differ from overflows from a separate sanitary system (SSOs). While it is possible for SSOs to enter a catch basin where the flow will be directed to waters of the state (creeks, or the Bay), excursions from San Francisco’s combined system, on the other hand, will drain back into the sewer system and flow to the treatment plant. In this way, the unique design of San Francisco’s combined sewer system protects receiving waters.

CSAMP LEVEL OF SERVICE GOALS

The WWE AMP operational LOS and KPIs have been developed and refined over the course of several years through a series of workshops conducted with stakeholders at various stages of the CSAMP\(^3\). Figure 9 shows the LOS/KPIs identified for the CSD which has responsibility for nine of the LOS Goals. The LOS/KPIs reflect a collaborative effort between engineering, planning, and operations to identify attainable yet meaningful LOS goals and measurable KPIs. As the CSAMP continues to evolve, the KPIs will be brought together into a single reporting utility so that managers may readily track performance across varying topics, such as odor control, permit compliance, and safety.

### Wastewater Enterprise Level of Service Goals and Key Performance Indicators

<table>
<thead>
<tr>
<th>Sustainability Category</th>
<th>Level of Service Category</th>
<th>Index Category</th>
<th>Level of Service Goal</th>
<th>Key Performance Indicator (KPI)</th>
<th>Target Performance</th>
<th>KPI Data Source(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Be Environmentally Responsible</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Be Environmentally Responsible</td>
<td>T1</td>
<td>Minimize Unpermitted Discharges</td>
<td>Number of unpermitted discharges (NPDES, etc.).</td>
<td>0 unpermitted discharges per year</td>
<td>NPDES self-monitoring report (CIWQS)</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Be Environmentally Responsible</td>
<td>T2</td>
<td>Meet Effluent Permit Requirements</td>
<td>Number of exceedances of daily effluent limits as defined in NPDES permit (BOD, TSS) and reported to state.</td>
<td>100% of 30-day avg. BOD and TSS</td>
<td>NPDES self-monitoring report (CIWQS)</td>
<td></td>
</tr>
<tr>
<td><strong>Be Cost Effective</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td>Be Cost Effective</td>
<td>T3/C1</td>
<td>Minimize Unplanned Capital Expenditures</td>
<td>Cumulative actual capital expenditures as a percent of established capital budget for the year.</td>
<td>+/- 10% of budget</td>
<td>P6, FAMIS</td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td>Be Cost Effective</td>
<td>T4/C2</td>
<td>Minimize Unplanned O&amp;M Expenditures</td>
<td>Cumulative actual O&amp;M expenditures as a percent of established O&amp;M budget for the year.</td>
<td>+/- 10% of budget</td>
<td>P6, FAMIS</td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td>Be Cost Effective</td>
<td>T5/C3</td>
<td>Minimize Unplanned R&amp;R Expenditures</td>
<td>Cumulative actual R&amp;R expenditures as a percent of established R&amp;R budget for the year.</td>
<td>+/- 10% of budget</td>
<td>P6, FAMIS</td>
<td></td>
</tr>
<tr>
<td><strong>Preserve and Improve Quality of Life</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Society</td>
<td>Preserve and Improve Quality of Life</td>
<td>C4</td>
<td>Minimize Main Sewer Excursions</td>
<td>Number of dry weather events resulting in wastewater leaving the collection system due to a backup in the main sewer (i.e., excludes laterals).</td>
<td>&lt;100 per year</td>
<td>Maximo excursions report</td>
<td>Excursions are defined as flow leaving the sewer system. Dry weather only. Training held on Maximo coding using four options for excursions. Zero flow is not an excursion.</td>
</tr>
<tr>
<td>Society</td>
<td>Preserve and Improve Quality of Life</td>
<td>C5</td>
<td>Reduce Street Ponding</td>
<td>Number of surface accumulation events due to maintenance or structural issues during wet weather events.</td>
<td>&lt;150 events per year</td>
<td>Maximo excursions report</td>
<td>Ponding is defined as flow not being able to enter the system. Ponding is a yes or no flag in Maximo work order. Training held regarding when and how this flag will be used.</td>
</tr>
<tr>
<td>Society</td>
<td>Preserve and Improve Quality of Life</td>
<td>C6</td>
<td>Minimize Collection System Odors</td>
<td>Number of verified customer complaints of odors resulting from the collection system (gravity sewers).</td>
<td>&lt;100 verified complaints per year</td>
<td>Maximo work orders</td>
<td>Odor complaint is within the failure hierarchy in Maximo. Standard Operating Procedures established on field characterization of sewer odor.</td>
</tr>
<tr>
<td>Society</td>
<td>Preserve and Improve Quality of Life</td>
<td>T6</td>
<td>Minimize Facility/Plant Odors</td>
<td>Number of verified customer complaints of odors at the fenceline of treatment facilities, pump stations, and storage boxes.</td>
<td>&lt;50 verified complaints per year</td>
<td>Maximo work orders</td>
<td>Transport storage boxes are part of treatment plants and considered within the “fence line”. Consider adding a measurable and verifiable H2S level (e.g. 50ppb detection level).</td>
</tr>
<tr>
<td><strong>Protect the Public</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Society</td>
<td>Protect the Public</td>
<td>T7</td>
<td>Eliminate Chemical Releases</td>
<td>Number of uncontained releases of chemicals from within treatment facilities to outside the property line.</td>
<td>0 uncontained releases per year</td>
<td>NPDES self-monitoring report (CIWQS)</td>
<td>Diesel fuel is included.</td>
</tr>
<tr>
<td>Society</td>
<td>Protect the Public</td>
<td>T8/C7</td>
<td>Eliminate Lost-time Injuries</td>
<td>Number of injuries resulting in employee lost time of 8 hours or more.</td>
<td>0 per year</td>
<td>Log 300 report</td>
<td></td>
</tr>
<tr>
<td><strong>Provide Excellent Customer Service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Society</td>
<td>Provide Excellent Customer Service</td>
<td>C8</td>
<td>Minimize Response Time to Complaints</td>
<td>Percent of customer complaints with response within 8 hours (call back, in person, or other contact).</td>
<td>100% of customer complaints</td>
<td>Maximo work orders</td>
<td>Time of call received to Sewer Operations until the time of dispatch. Maximo report on 311 calls with date and time. Once a work order is created, it is assigned to a person with a date/time.</td>
</tr>
<tr>
<td>Society</td>
<td>Provide Excellent Customer Service</td>
<td>C9</td>
<td>Communicate with Public Prior to Work Activities</td>
<td>Percent of public notices provided in the impacted area greater than 48 hours prior to commencement of work.</td>
<td>100% of public notices</td>
<td>Maximo work orders</td>
<td>DPW has partial responsibility for the communication.</td>
</tr>
</tbody>
</table>

*Figure 9 - Collection System Division Level of Service goals and Key Performance Indicators*
PHYSICAL PARAMETERS

System Description

The majority of the collection sewers in San Francisco are combined sewers; this means that they collect both sanitary sewage and urban storm water runoff (both wet and dry weather). In the Port of San Francisco, lands near the Bay shoreline and the Mission Bay Development, the sewers are separated and urban storm water runoff flows to the Bay.

The combined sewers flow primarily by gravity to the Combined Sewer Overflow (CSO) control system. The CSO control system includes the transport/storage (T/S) facilities that ring the shoreline of the City like an underground moat as shown in Figure 10. The T/S facilities capture, collect, store, and transport the dry and wet weather combined sewage to the two treatment plants and the wet weather treatment facility with the aid of major pump stations.
Asset Types and Quantity

As mentioned previously, the WWE is responsible for protecting the public health and the surrounding San Francisco Bay and Pacific Ocean receiving waters by collecting and treating storm and sanitary flows within the City of San Francisco. In particular, the WWE is responsible for the operations, maintenance, capital improvements, and rehabilitation/replacement of the following collection system assets:

- 56 pump stations
- 21,000 catch basins
- 29,800 manholes
- 920 miles of laterals
- Not including the T/S system, approximately 960 miles of sewers
- 8 T/S facilities with 195 MG capacity for combined sewage
- 36 combined sewage discharge structures

Table 2 provides a breakdown of the collection system assets including the miles of side sewers (private sewers) and side sewer connections.

Materials and Age of Sewers

For proper operations and maintenance of the sewers, it is critical to know the age and construction material of the sewers. These two attributes can contribute to increased potential for failure and, along with the consequences of failure, will dictate the approach of maintenance. Tables 3 and 4 provide information about the materials and age of the sewers, respectively.

The pump stations listed above maximize the amount of combined flow to the treatment plants. The purpose and operations of each of these pump stations are described in the Southeast and Oceanside Operations Plans. There are several other pump stations that serve the sewer system to ensure that storage in the collection system is maximized and that the flow reaches the treatment facilities.

The average dry weather flow in the sewers is 85 million gallons per day (mgd). During wet weather, the flow can increase to as high as 575 mgd. Gravity is the main force that moves the combined sewage through the sewers. At the bottom of a hill or when the sewer is too deep, either the flow empties into the T/S structures (boxes or tunnels) or a pump station lifts the flow and pushes it along through another larger sewer, as depicted in Figure 11. Figure 6 also shows a simplified representation of how the system works.

Urban Watersheds

There are two main watersheds in San Francisco, the Bay Watershed and the Ocean Watershed. Within these two, there are eight smaller urban watersheds as shown in Figure 12. Table 5 shows the miles of sewers per urban watershed.
Figure 11 - SFPUC WWE Sewer System – Major Sewers and Transport/Storage Facilities

Figure 12 - Urban Watersheds in San Francisco
The SSIP process has developed an Urban Watershed Framework to determine appropriate solutions (e.g., collection system improvements, storm water control, and low impact design) to maximize the amount of storage in the collection system and minimize flooding, while incorporating additional community benefits when possible. The elements of an Integrated Urban Watershed Management approach include the entire sewershed and its management programs. The sewershed consists of:

- Streets and upland areas (including roofs) that contribute to storm water runoff
- Capture and conveyance system (streets, catch basins and inlets, sewer laterals, trunk sewers, (T/S structures, and pump stations)
- Treatment and discharge system (treatment facilities, outfalls, and combined sewer discharge structures)
- Receiving waters of San Francisco Bay and the Pacific Ocean

An Integrated Urban Watershed Management approach will be used to evaluate each of the City’s eight drainage basins to determine problem areas and potential solutions. The CSD is continuing a program to monitor the collection system to characterize the sewage discharged from the different drainage districts in the collection system and to provide data on pollutants from residential neighborhoods. This information will support the Urban Watershed Framework (UWF) and the Source Control, Pretreatment, and Pollution Prevention programs.

### Asset Capacity/Performance

The hydraulic performance of the combined sewer system is monitored and improved by a team of engineers from CSO Technician Services and the Hydraulics Engineering group within the DPW. This group is responsible for assessing all drainage related projects, examining hydraulic performance, sizing sewers, and supporting the SSIP. Capacity improvements are generally identified, designed, and scheduled for construction based on a 5-year planning horizon and the actual timing of projects is closely coordinated with street paving. Critical projects such as those caused by aging infrastructure (e.g., a malfunctioning line or an unexpected collapse) are fast-tracked. In addition to basic hydraulic improvements, the Hydraulics Group is working in concert with the UWF and the SSIP efforts to identify watershed-based solutions to systemic capacity issues.

The Hydraulics Storm Watch Program Section and Collection System Division staff are also deployed when San Francisco field crews or the public notifies the City about localized street or property flooding. Crews are dispatched to visit the areas and document what they observe (with notes and photographs), what they note from the caller, remove blockages washed to the catch basin, and provide a report to DPW Bureau of Engineering for them to evaluate whether the sewer needs to be repaired or replaced.

### Asset Condition

San Francisco monitors the condition of sewer assets based on closed-circuit television (CCTV) and condition assessment criteria developed by the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) as shown in Table 7 and demonstrated in Figure 13. The NASSCO PACP condition assessment method standardizes the defect scoring of all sewers inspected utilizing remotely controlled robotic equipment. More information is provided in the next section.

---

<table>
<thead>
<tr>
<th>Urban Watershed</th>
<th>Approximate Miles of Sewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Shore</td>
<td>100</td>
</tr>
<tr>
<td>Channel</td>
<td>230</td>
</tr>
<tr>
<td>Islais Creek</td>
<td>250</td>
</tr>
<tr>
<td>Yosemite</td>
<td>50</td>
</tr>
<tr>
<td>Sunnydale</td>
<td>30</td>
</tr>
<tr>
<td>Richmond</td>
<td>70</td>
</tr>
<tr>
<td>Sunset</td>
<td>220</td>
</tr>
<tr>
<td>Lake Merced</td>
<td>70</td>
</tr>
</tbody>
</table>

*This includes all linear facilities as well as T/S boxes and tunnels.
The CSAMP program has an ongoing condition assessment program for all sewers. It includes cleaning the sewers, closed-circuit television (CCTV), and, in some cases, a walking inspection with digital and video cameras. Because the sewers have to be cleaned before the CCTV is done, these inspections are, in effect, maintenance for the sewer system. As sewers are cleaned, sewer cleaning crews document the type and quantity of material found in the pipe and store the information in the Flexidata Database. The City has anticipated a significant increase in the number of pipes to be added to the “hot spot” cleaning schedules as a result of the current program’s data. They have included additional operations and maintenance budget, staffing, and equipment in the 5-year plan for inspection and maintenance of the sewer system to address the projected increase in workload.

The CSD uses a grid system to systematically track, monitor, and plan the cleaning and inspection process for the entire City sewer system. The grids are approximately 3000 feet by 3000 feet. The grids were sized to maximize the efforts of the current Sewer Operations crews given currently available inspection technologies. Preliminary analysis was conducted to assign each grid a preliminary average risk score. The preliminary analysis considered the type of assets, their age, and other known information within the grid. These scores were then used to ensure the highest risk grids are inspected first to determine the actual condition of the suspected high-risk assets. The cleaning and inspection grid is shown in the Figure 14.

The Sewer Inspection Coding Quality Assurance Quality Control (QA/QC) Manual contains complete standard operating procedures (SOPs) for all processes involved in inspection and coding of sewers. The coding of defects and construction features in the sewers, manholes, and side sewers, are done in accordance with the PACP manual developed by NASSCO, which also includes the Manhole Assessment Certification Program (MACP) and the Lateral Assessment Certification Program (LACP), and the SFPUC coding policies.

This quality assurance program involves random audits of all certified personnel to determine if standards are being met. The program is administered by the CSO Technical Services Section.

4. 5-Year Operations Plan.

Table 7 - Collection System Condition Grade and R&R Summary Utilizing NASSCO PACP Standards and Guidelines

<table>
<thead>
<tr>
<th>PACP Grade</th>
<th>Description</th>
<th>General Guidelines for Timing of Pipe Failure</th>
<th>General Guidelines for R&amp;R Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minor Defects</td>
<td>Failure unlikely in the foreseeable future</td>
<td>Continue to monitor and schedule re-inspection</td>
</tr>
<tr>
<td>2</td>
<td>Defects that have not begun to deteriorate</td>
<td>Failure unlikely for 20 years</td>
<td>Perform needed maintenance and/or minor repairs</td>
</tr>
<tr>
<td>3</td>
<td>Moderate defects that will continue to deteriorate</td>
<td>May fail in 10 to 20 years</td>
<td>Stabilize the sewer – perform point repairs, grouting, etc.</td>
</tr>
<tr>
<td>4</td>
<td>Defects will become a grade 5 in the foreseeable future</td>
<td>Likely to fail in 5 to 10 years</td>
<td>Line the sewer – restore structural integrity</td>
</tr>
<tr>
<td>5</td>
<td>Defects requiring immediate action</td>
<td>Has failed, or will fail in less than 5 years</td>
<td>Replace the sewer – deterioration is beyond repair</td>
</tr>
</tbody>
</table>

Figure 13 - Example of sewer inspection as captured by NASSCO PACP.

Sewer Condition Assessment Program

The CSAMP program has an ongoing condition assessment program for all sewers. It includes cleaning the sewers, closed-circuit television (CCTV), and, in some cases, a walking inspection with digital and video cameras. Because the sewers have to be cleaned before the CCTV is done, these inspections are, in effect, maintenance for the sewer system. As sewers are cleaned, sewer cleaning crews document the type and quantity of material found in the pipe and store the information in the Flexidata Database. The City has anticipated a significant increase in the number of pipes to be added to the “hot spot” cleaning schedules as a result of the current program’s data. They have included additional operations and maintenance budget, staffing, and equipment in the 5-year plan for inspection and maintenance of the sewer system to address the projected increase in workload.

The CSD uses a grid system to systematically track, monitor, and plan the cleaning and inspection process for the entire City sewer system. The grids are approximately 3000 feet by 3000 feet. The grids were sized to maximize the efforts of the current Sewer Operations crews given currently available inspection technologies. Preliminary analysis was conducted to assign each grid a preliminary average risk score. The preliminary analysis considered the type of assets, their age, and other known information within the grid. These scores were then used to ensure the highest risk grids are inspected first to determine the actual condition of the suspected high-risk assets. The cleaning and inspection grid is shown in the Figure 14.

The Sewer Inspection Coding Quality Assurance Quality Control (QA/QC) Manual contains complete standard operating procedures (SOPs) for all processes involved in inspection and coding of sewers. The coding of defects and construction features in the sewers, manholes, and side sewers, are done in accordance with the PACP manual developed by NASSCO, which also includes the Manhole Assessment Certification Program (MACP) and the Lateral Assessment Certification Program (LACP), and the SFPUC coding policies.

This quality assurance program involves random audits of all certified personnel to determine if standards are being met. The program is administered by the CSO Technical Services Section.
Figure 14 - Cleaning and Inspection Grid

Figure 15 - Likelihood of Failure of the San Francisco Sewer System
Figure 16 - Construction History of San Francisco Sewer System

Figure 17 - Cumulative Likelihood of Failure Comparison – Brick versus Non-Brick
**MAINTENANCE**

The SFPUC WWE performs preventive and corrective maintenance on the combined sewer system. Preventive maintenance is scheduled to be completed with the least disruption to operations. All other maintenance is considered corrective.

The information developed from condition assessments, ranks the risk level of each sewer asset. Sewer assets requiring repair or replacement are input into the 5-Year Repair and Replacement Plan or the Spot Repair Program, where possible jobs are coordinated with the DPW Paving Program to schedule the sewer work. All of these maintenance programs are considered “Preventive Maintenance.”

As part of this CSAMP, goals, objectives, and targets have been developed that require the implementation of maintenance and inspection program initiatives to lengthen the operational life of collection system assets and collect information necessary to make decisions regarding asset renewal. The 5-Year Plan for Sewer Inspection and Maintenance describes nine initiatives, as shown in Table 8, that Sewer Operations will implement over the next several years to achieve the CSAMP goals.

### Table 8 - Sewer Operations Initiatives

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
<th>Reason/Result</th>
<th>Related 5-Year Business Plan Strategies Asset Management KPIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increase Small and Local Sewer Preventive and Proactive Maintenance</td>
<td>Reduce the number of mainline sewer excursions.</td>
<td>• No. of maintenance related sewer excursions/year</td>
</tr>
<tr>
<td>2</td>
<td>Increase Catch Basin Cleaning</td>
<td>Reduce street ponding incidents.</td>
<td>• No. of street pondings/year</td>
</tr>
<tr>
<td>3</td>
<td>Increase Major Sewer and Transport Box Proactive Maintenance</td>
<td>Increase system capacity.</td>
<td>• Percent of PM inspection work on critical linear assets</td>
</tr>
<tr>
<td>4</td>
<td>Increase Mainline, Side Sewer, Force Main, and Transport Box Inspection</td>
<td>Assess system condition. Identify pipes with high risk of failure.</td>
<td>• Miles of linear assets inspected/year using CCTV</td>
</tr>
<tr>
<td>5</td>
<td>Increase Manhole and Catch Basin Inspection</td>
<td>Assess system condition. Identify structures with high risk of failure.</td>
<td>• KPI to be developed</td>
</tr>
</tbody>
</table>
| 6          | Increase Supervision and Improve Investigative, Planning and Scheduling Capability | Maximize use of available resources. Improve productivity through improved supervision, planning, scheduling, routing and optimization of maintenance frequencies. | • Planned/unplanned maintenance ratio  
• Percent of PM work orders using SCADA real-time condition data  
• Deviation in actual vs. planned work for fixed and linear assets |
| 7          | Reduce Equipment Downtime | Increase available production time of existing staff. | • Percent of critical equipment with PMs and within life expectancy  
• Percent reduction of high and very high risk process equipment |
| 8          | Upgrade MAXIMO to Support Updated Business Requirements | Increase efficiency and effectiveness of operation through improved maintenance management. | • Percent of all work orders on linear assets tracked in CMMS  
• Percent of all work orders on fixed assets tracked in CMMS  
• Percent of service calls using Maximo GIS spatial work orders |
| 9          | Implement Environmental Management System for Collection System Division | Improve management systems and overall efficiency and effectiveness of operation. | • Percent of processes with formal procedures |
RISK-BASED PROJECT PLANNING

The WWE has developed the CSAMP to strategically maintain and replace linear assets based on risk. With the CSAMP, a risk scoring methodology is used to assign a risk score to each linear asset based on its likelihood of failure and consequence of failure. The risk scores are then used to prioritize each asset and, in turn, prioritize repair and replacement projects within the Wastewater Enterprise, as well as repair and replacement projects shared with the Water Enterprises. This risk-based approach to asset management is at the forefront of the utility industry and incorporates leading edge strategic asset management principles. Using a risk-based approach promotes better coordination of projects, improved coordination with the DPW Paving Program, as well as delivery of services at the lowest life cycle cost of the assets.

This section provides a summary of the risk assessment used to develop the CSAMP. The “Using a Risk Based Approach to Planning Sewer Replacement in San Francisco” report provides the detailed description of the risk-based approach used to develop the CSAMP.

Risk Assessment Methodology and Criteria

Figure 18 summarizes the risk-based project planning approach used by the CSAMP to evaluate the risk of each asset and prioritize asset repair and replacement projects. The approach includes:

- LOS development
- Risk assessment, which includes likelihood of failure assessment, consequence of failure analysis, and risk scoring
- Project prioritization and CIP development

To assign a Risk Score to an asset, the asset’s consequence of failure, redundancy, likelihood of failure and system risk factor are each evaluated. Based on these factors, the risk score is calculated as shown below.

Consequence of Failure

Table 9 summarizes the criteria that are used to quantify an asset’s consequence of failure. Based on data available to the CSD, these criteria were developed to describe the outcome of not achieving the prescribed goals and LOS established by the SFPUC WWE. Consequence of failure scores are generated by querying the database associated with the GIS currently operated and maintained by DPW Bureau of Engineering for the SFPUC.

Redundancy

An asset inventory is conducted to determine the level of redundancy needed for each asset. Assets with redundancy are typically limited to fixed assets such as pumps, valves, bar screens, etc. Linear assets, which typically do not have redundancy, are assumed to have a redundancy factor of 1.

Figure 18 - Key Elements of CSAMP Risk Assessment Process

6. Using a Risk Based Approach to Planning Sewer Replacement in San Francisco.
Likelihood of Failure

The “Likelihood of Failure” (LOF) score of an asset is a possible numerical value of 1, 2, 4, 7, 10. The LOF score is based on condition assessment information or, if no inspection data is available, an estimate of remaining useful life. Inspections are conducted as part of the CSAMP Inspection Program (described earlier) and these inspections produce a condition score of 1 to 5 for each asset based on the NASSCO PACP defect coding system. This score is converted to a likelihood of failure score as shown in Table 10.

When no inspection data is available, the remaining useful life is predicted using a Weibull Analysis—a statistical method specifically adapted for calculating the life expectancy of assets based on their material, age, environment (e.g., soil conditions, etc). As an example, Figure 19 shows the relationship between condition score, remaining useful life, and LOF score for a non-brick sewer pipe.

System Risk Factor

The System Risk Factor is a measure of how well the WWE is organized according to Best Management Practices (BMPs). This factor acknowledges that a poor or inefficient organization adds risk to the ability to maintain the system to acceptable LOS. The value of this factor can potentially increase the Risk Score by 10 percent or more. The BMPs have not yet been developed and, as such, this factor is currently assumed to be 1 for all assets. Future phases of the CSAMP will include the development of BMP’s and this factor will be adjusted accordingly.

Risk Result

The Risk Score can range from 1 to 100. A Risk Score of 1 includes pipes that are in excellent condition and located in an area of low consequence of failure. A Risk Score of 100 includes pipes that are in a failed or near failed condition and located in an area of high consequence of failure. Using the Risk Score data, the assets are assigned to four broad risk classes: Very High, High, Medium and Low Risk. This is shown in Figure 20.
### Table 9 - Asset Failure Consequence Matrix

<table>
<thead>
<tr>
<th>LOS Category</th>
<th>Goal: Result to be Achieved</th>
<th>Negligible – 1</th>
<th>Low – 4</th>
<th>Moderate – 7</th>
<th>Severe – 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect the Public from exposure to pathogens &amp; toxins</td>
<td>Protect the public from exposure to pathogens &amp; toxins</td>
<td>Low likelihood of public exposure</td>
<td>Moderate likelihood of public exposure (near BART stations, MUNI stops, etc.)</td>
<td>Located next to public facility (school, hospital, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;15 inches in diameter</td>
<td>15 ≤36 inches in diameter</td>
<td>36 ≤60 inches in diameter</td>
<td>&gt;60 inches in diameter</td>
</tr>
<tr>
<td>Preserve and Improve Quality of Life</td>
<td>Commercial impacts or public annoyance</td>
<td>Minimal to no commercial impacts or public annoyance</td>
<td>Impact to cable car, MUNI Diesel, highway road approach, or neighborhood commercial district</td>
<td>Impact to major arterial, primary transportation route, MUNI Electric, or major commercial district</td>
<td>Impact to emergency transportation route, bridge approach roadway, MUNI Rail, or downtown core</td>
</tr>
<tr>
<td>Be Cost Effective</td>
<td>Deliver LOS at lowest long term cost (or competitive with other agencies)</td>
<td>Under asphalt street and not under moratorium</td>
<td>Under concrete street</td>
<td>Opportunity to coordinate with other infrastructure projects Easement sewer</td>
<td>Under moratorium street Easement sewer near building or a steep slope</td>
</tr>
<tr>
<td></td>
<td>Deliver LOS at lowest long term cost</td>
<td>No history of repairs</td>
<td>1 point repair per 300 feet in maintenance history</td>
<td>2 point repairs per 300 feet in maintenance history</td>
<td>≥3 point repairs per 300 feet in maintenance history</td>
</tr>
<tr>
<td>Provide Excellent Customer Service</td>
<td>High level of customer satisfaction</td>
<td>Can restore service in &lt;4 hrs</td>
<td>Can restore service in 4 to &lt;8 hrs</td>
<td>Can restore service in 8 to &lt;24 hrs</td>
<td>More than 24 hrs to restore service</td>
</tr>
<tr>
<td>Be Environmentally Responsible</td>
<td>Protect the environment</td>
<td>Flows back to combined system</td>
<td>Flows to MS4 facility or CDS structure</td>
<td>Flows to surface water</td>
<td>Impacts emergency drinking water supply</td>
</tr>
<tr>
<td>Meet regulations</td>
<td>100 percent compliance with permits and regulations</td>
<td>Technical violation without an enforcement action</td>
<td>Violation with potential for minor enforcement action</td>
<td>Past history of violation and/ or potential for enforcement action and fines</td>
<td></td>
</tr>
</tbody>
</table>

### Table 10 - Asset Failure Likelihood Matrix

<table>
<thead>
<tr>
<th>Likelihood Category</th>
<th>Negligible – 1</th>
<th>Unlikely – 2</th>
<th>Possible – 4</th>
<th>Likely – 7</th>
<th>Very Likely – 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Condition Score (Related to PACP Score)</td>
<td>Very Good (Condition Grade 1)</td>
<td>Good (Condition Grade 2)</td>
<td>Fair (Condition Grade 3)</td>
<td>Poor (Condition Grade 4)</td>
<td>Very Poor (Condition Grade 5)</td>
</tr>
</tbody>
</table>
Project Prioritization

The WWE aggregate various repair and replacement needs into repair and maintenance projects based on the Risk Class data. Figure 21 shows that the highest density of pipes in the highest risk classes are located in the north and northeastern sections of the City. This directly corresponds to the age of the brick and non-brick sewers and the land uses in those areas. The process allows the SFPUC to assure that the highest priority pipes are being replaced based on risk, while providing the highest value to the ratepayers. As experience with this process is gained, the SFPUC will be able to determine increasingly effective ways to perform work and increase coordination between different City agencies.
SEWER REPAIR, REHABILITATION, AND REPLACEMENT PLANNING

Sewer repair, rehabilitation, and replacement projects are coordinated with water and paving programs. The DPW’s Hydraulics Department conducts the detailed design and/or cost estimates for these projects. During the detailed design phase, staff determines if the approach for repair and/or replacement should be trenchless or not. The projects are conducted in one of three ways:

1. Spot Repairs
Spot repairs are managed using the Spot Repair Program, which is supported with work order requests through Maximo. Sewer Operations and others submit data to the Spot Repair Program. Spot repairs are scheduled based on either video documentation or complaints. Spot repairs are typically completed prior to paving projects and are left with temporary asphalt.

2. Bureau Street Sewer Repair (BSSR) Program
This program is managed through interdepartmental work orders and consists of funding City repair crews to complete jobs.

3. Paving Program
This program is managed through contracts. The sewer department conducts joint contracts with the Paving Program as the lead. Projects are selected for completion based on CSAMP scores presented in a running 3-year Excel-based list. The list shows sewer condition and inspection reports (completed within the last 5 years) for the collection system, and it is updated and reviewed at least biweekly. Projects within close proximity that need to be completed within the next 5 years are coordinated.

A “repair versus replace” decision matrix is employed to determine the best course of action. Most repairs are either done through contractors or City crews. However, some repairs may be completed through the paving program contracts in order to expedite the work.

Rehabilitation and Replacement Programs
Asset improvement projects are based on engineering analysis, risk assessment, paving schedules and available CIP funding. WWE has three specific maintenance programs: Sewer System Improvement Program (SSIP), Capital Improvement Program (CIP), and the Repair and Replacement Program (R&R).

Sewer System Improvement Program
The purpose of the SSIP is to upgrade the existing wastewater system so it can meet the needs of the present and the future. The implementation of the SSIP projects and their associated expenditures will be phased over the next twenty years in an effort to maintain affordability and to minimize impacts throughout San Francisco.

Wastewater Capital Improvement Program
The WWE Capital Improvement Program (CIP), which precedes the SSIP, addresses the immediate wastewater needs in the areas of flood control, odor control, and aging facilities.

Renewal and Replacement Program
The WWE Renewal and Replacement (R&R) Program is a continuing annual program that aims to address deficiencies in two wastewater infrastructure categories: the Collection System and the Treatment Facilities. The R&R Program also complies with the State requirement that a provision be made for the periodic repair and replacement of sewer system facilities.
5. FINANCIAL SUMMARY

FINANCIAL STATEMENTS AND PROJECTIONS

As a utility, a good portion of the SFPUC budget is allocated for the acquisition, construction, repair and replacement of critical, physical assets. Purchasing, construction and the contracting for repair services are subject to extensive legal and administrative regulation. Asset costs are ultimately driven by the assets acquired and the way in which they are maintained. In order to minimize the utility cost of service over time, it is the policy of the SFPUC to acquire, design, construct, repair and replace assets such that their life cycle cost is minimized, and to fund such activities accordingly.

The Wastewater Enterprise’s fiscal year 2012-13 operating budget totals $143.8 million and funds the operations and maintenance of the SFPUC’s sewer system. The fiscal year 2012-13 budget increased by $2.2 million from the fiscal year 2011-12 budget of $141.6 million. The net increase reflects funding for the SFGreasecycle Program and increased health and retirement costs.

The Wastewater Enterprise’s CIP for fiscal year 2012-13 is $299.4 million and includes $157 million for theSSIP; $25.9 million for the last year of the Interim CIP; $59.9 million for the Renewal and Replacement (R&R) Program, $25.1 million for other Wastewater facilities and infrastructure including Treasure Island, and $31.5 million for financing costs. The capital budget is funded by Wastewater Enterprise revenues, revenue bonds and a $24.1 million State voter approved grant.

In total, the adopted capital project costs for the Wastewater Enterprise total approximately $5.1 billion over the next ten years. The Plan includes the Renewal and Replacement (R&R) program, which is partially revenue-financed, the Interim Capital Improvement Program (CIP), and improvements to Treasure Island (which are debt financed). It also includes the recently approved Sewer System Improvement Program (SSIP). Specifically, capital investments related to the collection system during the ten-year period include:

- Sewer/Collection System, $1,456.5 million;
- Flood Control, $350.7 million;
- Wastewater Interim, $25.9 million;
- Collection System, $757.2 million;

FUNDING STRATEGY

SFPUC is an enterprise department of the City and County of San Francisco which receives no support from the San Francisco General Fund. The cost of providing utility service including the funds necessary for asset management and capital improvements is covered through ratepaying customers including service based rates; fees and charges; and non-operating revenues (i.e. land leases). Recently SFPUC approved a Ten-Year Financial Plan with projected rate increases and bond issuance needed to carry out the planned capital work.

ASSET VALUATIONS

In June 1999, the Governmental Accounting Standards Board issued GASB 34, changing the way state and local governments’ financial accounting and reporting standards are handled. These changes required governments to begin reporting depreciation of their assets or to implement what is termed “the modified approach”, also known as the Asset Management program. Under the new standards, any Asset Management program utilized by a state or local government must provide documentation that assets are being preserved.

Asset are depreciated each year in SFPUC’s balance sheet. This work is conducted by the Finance Department, who is responsible for providing the financial services for the utility enterprises, including support for financial accounting and reporting, accounts payable, billing and collection of water, wastewater, and power charges, and other revenues.

Assets are depreciated annually based their original cost, the number of years they have been in service, and their estimated service lives. The straight-line
depreciation method is used. Estimated service lives are defined for multiple asset categories. Useful lives range from 3 to 75 years for equipment and 3 to 175 years for buildings, structures, and improvements.

For newer assets, bid tab data is used to capture asset value, and depreciation is handled for individual line items. For older assets, lump sum entries for each decade are used to approximate depreciated asset value using metrics such as Engineering News Record cost indices.

The SFPUC’s financial statements and records are maintained on an enterprise basis, using full accrual to ensure the timely matching of revenues against the costs of providing services. The SFPUC management is responsible for establishing and maintaining a system of internal controls designed to safeguard the enterprises’ assets from loss, theft, or misuse and to ensure that adequate accounting data are compiled to allow for the preparation of financial statements in accordance with generally accepted accounting principles.

CSAMP supports the Finance Department’s ability to fulfill these requirements. With increasing data collection and analysis, CSAMP will further support the Finance Department’s ability to value equity in the system and account for loss of equity through asset decay.

**IDENTIFICATION OF CAPITAL RENEWAL FUNDING NEEDS**

SFPUC has an integrated process for working with Finance to find the most efficient ways to finance ongoing renewal needs. For example, upcoming wastewater bonds are issued specifically to collection lines, based on the defined capital needs from the risk based prioritization as well as financial capacity and other resource limitations. The specific timing of capital projects reflects a culmination of need (risk) as well as general financial and bond planning. The Capital Improvement Program and Long-Term Financial Plan serve as a basis and supporting documentation for the Commission’s capital budget, the issuance of revenue bonds, other forms of indebtedness, and execution of governmental loans.

The issuance of revenue bonds, other forms of indebtedness, and the execution of governmental loans are provided for under the San Francisco City Charter to finance the SFPUC’s capital programs. Pursuant to this Charter, an independent rate study is performed at least once every five years. A rate study was undertaken in the spring of 2009 to examine the future revenue requirements and costs of service of both the Water and Wastewater Enterprises, and it was used to set the retail rates through fiscal year 2014.

In addition to the direct link between the CSAMP’s risk-based project prioritization and the Finance Department’s budget forecasting, the CSAMP relies on the Finance Department for its own program funding. The operating budgets include funding for the asset management program to focus on continuous assessment of work processes to identify improvement opportunities, develop recommendations, and improve asset performance.
6. INFORMATION MANAGEMENT

ASSET MANAGEMENT SYSTEMS

San Francisco maintains a variety of niche data systems that successfully perform their unique functions. These databases are connected through Oracle system linkages.

Flexidata Database
Flexidata is a proprietary database and interface system by PipeLogix that houses CCTV sewer condition data. Information such as the type and distribution of defects as well as the digital video inspection can be accessed through the Flexidata software.

OPOC Repair Database
Maximo is the single repository for repairs, which prevents duplicate efforts and provides the opportunity for multiple related dig-up repairs to be constructed under one contract, saving time and money.

CMMS - Maximo
San Francisco’s primary computerized maintenance management system (CMMS) is IBM’s Maximo software. Maximo is San Francisco’s interface for asset deployment, specifications, monitoring, costing and tracking from a single system. Specifically, San Francisco uses the CMMS to schedule and track preventive, reactive and condition-based maintenance work orders on the collection system. This data can then be mined for resource optimization and key performance indicators – all of which are important inputs to the asset management portion of the Wastewater Enterprise Strategic Business Plan.

Until recently, Maximo was primarily used to manage and track “fixed” assets (facilities and equipment) but contained limited information on collection system linear assets (sewer pipes). Maximo’s reach includes all linear assets such as sewer pipes, transport storage boxes, tunnels, force mains, CSO structures, etc. Now, all collection system work orders are tied to specific assets and are visible in a GIS format provided by Maximo Spatial.

The WWE and the SPPUC are in the final planning stage of implementing in Maximo the CiM Visual Planner and Scheduler Suite that would allow a more effective process to plan and schedule work. This could lead in increased wrench time from 30 to 50 percent and reduce time to complete jobs by 33 percent.

In addition, Maximo has integrated the City’s 311 customer service system. 311 is a call center that operates 24 hours, 7 days a week, and assists with non-emergency City matters such as flooding, odor control, and sewer overflow.

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Gis

San Francisco manages an extensive amount of geographic information system (GIS) data related to the collection system and surrounding utilities. The data is derived from surveying data, engineering records, and GPS field work. The GIS informs engineering analysis and asset management decisions and the collection system GIS data is used in concert with other City GIS data such as schools, hospitals, water bodies, etc. to evaluate the spatial proximity of sewers to sensitive parts of the City – this is the basis for the “consequence of failure” calculation in the CSAMP Risk Model.

The City’s GIS data is constantly improving. When new assets are constructed, office staff update the dataset as appropriate. There is now a formal process for documenting changes to the sewer system that are found in the field. As designs are inputted into the database, the sewer lines are marked as “future” until the as-built drawings are released and the lines are changed to “active” in the database. Over time, the sewer lines can be changed to “inactive” or “abandoned” accordingly. Ownership of the sewer lines is also recorded.

Hydraulics Engineering Group

To provide modeling, monitoring, and other support services, the Hydraulics Engineering Group uses various software that ultimately ties into Oracle Spatial.

These tools include MS Access, Maximo, Oracle Spatial, Munsys, Infoworks, Computer-Aided Design (CAD), and Structured Query Language (SQL). Figure 22 shows the relationships between tools and software used by the Hydraulics Engineering Group.

San Francisco’s sewer system, including low impact development features, will be entered into the SFPUC databases. The databases feed into the sewer system models developed by engineers and allow for the City to perform real-time runs, create Esri shape files, create drawings of the sewer system, query age and miles of pipeline types, and ultimately evaluate asset capacity and performance to identify areas that need attention.

Information Flow Requirements and Processes

The CSAMP user interface allows for a complete picture of the collection systems disposition and condition. The user is able to integrate the City’s GIS with CMMS and coordinate the operation and maintenance of physical assets, increasing efficiency by combining multiple databases. This integration of GIS and Maximo Asset management system allows a single interface for asset location and characteristic information. Figure 23 shows the data repositories used within the CSAMP and the relationships between them.

Figure 23 - Software, tools, and tasks utilized in CSAMP risk based prioritization
7. IMPROVEMENT AND MONITORING

The WWE is in the initial stages of developing a complete environmental management system (EMS) that will enable the organization to reduce its environmental impacts and increase its operating efficiency. The basic elements of the EMS include:

- Setting environmental objectives and targets to reduce environmental impacts and comply with legal requirements
- Establishing programs to meet these objectives and targets
- Monitoring and measuring progress in achieving the objectives
- Ensuring employees’ environmental awareness and competence
- Reviewing progress of the EMS and making improvements

PAS 55

The PAS 55 guidelines are a Publicly Available Specification published by the British Standards Institution. The standard was originally produced in 2004 and it has recently undergone a substantial revision with 50 participating organizations from 15 industry sectors in 10 countries. PAS 55 provides objectivity across 28 aspects of good asset management, from lifecycle strategy to everyday maintenance (cost/risk/performance). It enables the integration of all aspects of the asset lifecycle: from the first recognition of a need to design, acquisition, construction, commissioning, utilization or operation, maintenance, renewal, modification and/or ultimate disposal.

ISO 14001

Part of a family of standards related to environmental management, ISO 14001 was developed by the International Organization for Standardization (ISO) and is the most commonly used EMS framework. The five main stages of an EMS, as defined by the ISO 14001 standard, are illustrated in Figure 24.

The WWE has developed several standard operating procedures (SOP) documents that comply with the ISO 14001 standard. Consistent with ISO standards, these documents will periodically be reviewed and their effectiveness will be monitored. The current goal is for section supervisors to perform a documented review of their section’s SOPs every two years to make sure that the documents are current and correct.
8. REFERENCES


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