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1. **Introduction**

This document presents the framework for implementing sustainable asset management (SAM) within the Madison Metropolitan Sewerage District (MMSD). This framework has been developed collaboratively with staff from MMSD and builds upon the District’s previous SAM efforts.

The SAM framework is based upon the asset management framework developed by GHD for the US Environmental Protection Agency (EPA) that is the most widely used asset management framework in the US. The US EPA framework is based on answering five Core Questions of infrastructure asset management using a process that is comprised of 10 steps (or elements). This document presents the structure for the SAM framework that is appropriate for MMSD based on staff input and forms the basis of the SAM framework implementation plan. It is anticipated that this document will evolve and ultimately become the Asset Management Implementation Plan (AMIP) once the details of the framework are developed and agreed upon.

### 1.1 Definition of Asset Management

Asset management is often defined as a framework, which is a way of thinking that is built around a body of leading practices. This way of thinking and the body of leading practices focus on seeking the lowest total lifecycle cost of ownership for infrastructure assets while delivering services at a level customers and stakeholders require and are willing to pay for at an acceptable level of risk to the community. While asset management is a strategic-level framework that embraces the primary function of the organization, it is only fully effective when also practiced day-to-day at the asset level – that is, when individual capital investments that support growth, augmentation, or renewal are the right solutions, for the right reasons, at the right time, and when maintenance investment is cost-effective in extending asset life, sustaining performance, and enhancing reliability.

One of the foundational asset management reference sources, the *International Infrastructure Management Manual*, 2011 Edition, describes the key elements of asset management as:

- Taking a lifecycle approach to managing assets
- Developing cost-effective management strategies for the long-term
- Providing a defined level of service and monitoring performance
- Understanding and meeting the impact of growth through demand management and infrastructure investment
- Managing risks associated with asset failures
- Using of resources (physical, natural, human, etc.) sustainably
- Achieving continuous improvement in asset processes.

In short, asset management is an integrated set of methods that take a lifecycle approach to managing assets, developing cost-effective management strategies, providing a defined level of service and monitoring performance, understanding and meeting the impact of growth through demand management and infrastructure investment, managing risks associated with asset failures, using resources sustainably, and achieving continuous improvement in asset processes.

The goal of infrastructure asset management is to meet a required level of service, in the most cost effective manner, through the management of assets for present and future customers. A formal approach to the management of infrastructure assets that takes a long term view and incorporates Triple Bottom Line (TBL) considerations is essential in order to provide services in a cost-effective manner, and to demonstrate this to customers and other stakeholders.
processes that minimize the lifecycle costs of owning, operating, and maintaining assets, at an acceptable level of risk, while continuously delivering established levels of service.

In addition to being based on the EPA asset management framework, MMSD’s asset management framework and approach must also fit MMSD’s specific organizational circumstances. In this vein, the elements of MMSD’s SAM Framework, must consider the following:

- MMSD’s corporate objectives and strategic planning initiatives
- Integrated and holistic management approaches;
- Triple Bottom Line (TBL) impacts and benefits
- Short, medium and long term sustainability components

To describe MMSD’s SAM Framework, this document is presented in the following sections:

- Section 2 – Asset Management Current State
- Section 3 – Sustainable Asset Management Framework
- Section 4 – MMSD SAM Framework Elements
- Section 5 – Asset Management Governance and Leading Change
- Section 6 – Data and System Support Requirements

### 1.2 List of acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>Asset Management</td>
</tr>
<tr>
<td>AMIP</td>
<td>Asset Management Implementation Plan</td>
</tr>
<tr>
<td>AMP</td>
<td>Asset Management Plan</td>
</tr>
<tr>
<td>BRE</td>
<td>Business Risk Exposure</td>
</tr>
<tr>
<td>CCTV</td>
<td>Close Circuit Television</td>
</tr>
<tr>
<td>CIP</td>
<td>Capital Improvement Plan</td>
</tr>
<tr>
<td>CMMS</td>
<td>Computerized Maintenance Management System</td>
</tr>
<tr>
<td>CoF</td>
<td>Consequence of Failure</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision Support System</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>FIS</td>
<td>Financial Information System</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
</tr>
<tr>
<td>IIMM</td>
<td>International Infrastructure Maintenance Manual</td>
</tr>
<tr>
<td>LOS</td>
<td>Levels of Service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMI</td>
<td>Maintenance Managed Item</td>
</tr>
<tr>
<td>MMSD</td>
<td>Madison Metropolitan Sewerage District</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operations and Maintenance</td>
</tr>
<tr>
<td>OWAM</td>
<td>Oracle Work and Asset Management</td>
</tr>
<tr>
<td>PdM</td>
<td>Predictive Maintenance</td>
</tr>
<tr>
<td>PoF</td>
<td>Probability of Failure</td>
</tr>
<tr>
<td>SAM</td>
<td>Sustainable Asset Management</td>
</tr>
<tr>
<td>SIMPLE</td>
<td>Sustainable Infrastructure Management Program Learning Environment</td>
</tr>
<tr>
<td>TBL</td>
<td>Triple Bottom Line</td>
</tr>
<tr>
<td>WERF</td>
<td>Water Environment Research Foundation</td>
</tr>
</tbody>
</table>
2. **Asset Management Current State**

As part of the development of the SAM Framework, it is important to understand the current state of practice at MMSD regarding asset management. MMSD first began thinking in terms of asset management in 2001 with the development of the first draft of the Sewer Collection System Facilities Plan. While not called such at the time, this document was the first asset management plan developed for the District. Since then, there have been several updates to the Collection System Facilities Plan, and two internal asset management practices gap assessments completed. Reference is made to the 2008 and the 2014 gap assessment reports which identified several areas of needed improvements.

Within the last year, MMSD has completed the WERF SIMPLE best practice guide and the SAM GAP assessment to identify the gaps within the organization. The main gaps identified in the most recent assessment in 2014 are associated with Data & Knowledge of the assets; People and Processes; and Information Systems. From the completed assessment, MMSD determined the following three findings:

1. There are few, if any, queries, reports, or other tools that support asset management activities.

2. There are several data sources that contain asset data as primary or secondary sources that are currently not integrated or readily accessible, such as: Oracle Work and Asset Management (OWAM), GIS, Manhole Inspection Database, Pipelogix, various spreadsheets, (including those for the most recent addition) and the easement data. There are significant barriers to the integration due to the fact that different definitions and asset ID’s are used.

3. While there is an inventory of assets and data about the assets is plentiful, the data lacks standardization and some key elements/attribute data are missing.

Below are a few of the 2014 implementation goals that MMSD set upon proceeding with the asset management program.

- Establish an asset management program. MMSD will begin to address the findings of the gap assessment. The team was able to complete an initial assessment to determine improvement activities. The primary focus is to further develop the program so that activities related to the management of the life cycle of an asset can be shared across the organization.

- Improve data for asset management. MMSD is in the process of developing a standard practice for collecting and using data within the asset management program. As part of MMSD’s early discussions regarding the asset management program, it was determined that the collection system would be the initial area of focus. As MMSD begins to look at the collection system, the team decided that there was a need to develop the methodology, procedures and processes to collect, update and complete base data.

- Integrate data, develop needed interfaces, reports, queries and/or custom applications.

- Research secondary and tertiary asset management systems. To be able to fill the gap, MMSD will need to research and assess available solutions from a Triple Bottom Line perspective.
During February 2015, a series of workshops and interviews were conducted with MMSD staff. These interviews focused on understanding the current state of asset management functional areas within MMSD. These interviews and workshops confirmed the results of the of the previous SAM Gap assessments and identified a few other areas of focus. In addition to Data and Knowledge; People & Practices; and Information Systems, the following additional areas were identified:

- Business Case Evaluations do not consider full life cycle costs analysis nor risk reduction metrics.
- The majority of the levels of service performance measure are internally focused.
- Business risk exposure (BRE) is not used in infrastructure management decision making.
- There is no Asset Management Plan (or equivalent document) for the Nine Springs Wastewater Treatment Plant.
- Existing organizational structure for asset data governance and analysis is not within the asset management group.

Key summary outputs from these interviews are presented in Table 1.

### Table 1 Summary of February workshop/meetings

<table>
<thead>
<tr>
<th>AM Process Element</th>
<th>Process Owner</th>
<th>Description</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| Business Case Evaluations        | Planning      | A business case is developed for each project as part of the capital program development. | Does not incorporate full life cycle cost.  
|                                  |               |                                                                            | Does not consider risk.  
|                                  |               |                                                                            | Does not consider Triple Bottom Line cost and benefits.                  |
| Geographic Information Systems (GIS) | Engineering | GIS software used by MMSD for tracking assets in the field, as well as helping technicians and operators locate assets when needing to repair, rehab or replace. | GIS does not work well with other MMSD software or other common industry software packages.  
|                                  |               |                                                                            | GIS is not accessible to all.  
|                                  |               |                                                                            | GIS maintains mostly pipelines, manholes and associated features. Other features provided externally |
| Creating CIP/Budgeting Process   | All Departments | The development of capital improvements program and the need to identify projects. | Time commitment for directors on an annual basis is significant.  
|                                  |               |                                                                            | Finalization process of the budget is not streamlined.  
<p>|                                  |               |                                                                            | The mechanism for making sure there is sufficient personnel resources available to be able to deliver the projects that are approved is inadequate. |</p>
<table>
<thead>
<tr>
<th>AM Process Element</th>
<th>Process Owner</th>
<th>Description</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying out Maintenance of Assets</td>
<td>Operations</td>
<td>Performing routine maintenance of MMSD assets</td>
<td>Failure modes are not utilized well.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Written documentation of maintenance activities is not standardized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The process for commissioning assets needs to be better defined and implemented.</td>
</tr>
<tr>
<td>Condition Assessment</td>
<td>Operations</td>
<td>Assessing the condition of both vertical and linear assets</td>
<td>A condition assessment protocol is not established for vertical assets.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Condition inspection data is available for some linear assets but needs to be translated into AM condition scores to use within the SAM program.</td>
</tr>
</tbody>
</table>
3. **Sustainable Asset Management Framework**

Sustainable Asset Management (SAM) is about determining the mix of management investment in maintenance, operations, and capital that sustains organizational performance over a long term horizon while minimizing lifecycle costs. It is about building confidence in decision-making – guiding investment in the right work, on the right projects, at the right time. Ultimately, MMSD’s SAM Framework provides the means for effective management of assets by finding the right balance between levels of service, cost of service and some acceptable risk as shown in Figure 1. Also shown in Figure 1 are the concepts of other sustainable aspects that are also considered part of finding this right balance at MMSD. These additional considerations are:

- Institute of Sustainable Infrastructure (ISI) Envision™ Rating System.
- Triple Bottom Line (TBL) parameters.
- Integrated and holistic management approaches.

![Cost of Service & Sustainable Asset Management](image)

**Figure 1 MMSD’s asset management core elements**

The SAM Framework is based on the US EPA’s 5 Core Questions of Asset Management.

This framework poses five questions about assets that all managers of infrastructure should pose on a regular basis to their management teams. These questions are presented below:

**Question 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?
**Question 2: What is my required level of production or service?**
- What is the demand for my services by my stakeholders/customers?
- What do the regulators require?
- What is my actual performance?
- What are the physical capabilities of my assets?

**Question 3: Which assets are critical to sustained performance?**
- How can assets fail?
- How do assets fail?
- What are the likelihoods (probabilities) and consequences of asset failure?
- What does it cost to repair the asset?
- What are the other costs (social, environmental, etc.) that are associated with asset failure?

**Question 4: What are my best O&M and CIP investment strategies?**
- What alternative strategies exist for managing O&M, personnel, and capital budget accounts?
- What strategies are the most feasible for my organization?
- What are the costs of rehabilitation, repair, and replacement for critical assets?

**Question 5: What is my best long-term funding strategy?**
- Do we have enough funding to maintain our assets for our required level of service?
- Is our rate structure sustainable for our system’s long-term needs?

Leading practice in asset management that has evolved over the past two decades points to the development of asset management plans as key to answering the questions and telling the story. Asset management plans (AMPs) are developed by organizations and updated on a periodic basis as central, living documents that help articulate to the organization and to stakeholders how assets are managed.

An asset management plan will systematically:
- Characterize the state of the assets
- Identify levels of service expected from the assets
- Identify critical assets (assets with both high probability and high consequence of failure)
- Identify a set of cost effective maintenance, operations, and capital investment strategies based on the above
- Define a funding strategy
Implementing improved asset management practices and building an asset management plan is comprised of ten steps or elements that are directly related to the five Core Questions discussed above. Note that certain leading practice processes and techniques are necessary for the execution of each of these steps. To successfully execute the steps, an organization must master the basics of the associated practices and processes. Figure 2 shows the five Core Questions, the ten elements, and the primary asset management work processes that support them.

**Figure 2 10 elements of asset management plan development**
4. **MMSD SAM Framework Elements**

4.1 **SAM Framework Overview**

The SAM Framework is the context within which asset management activities and initiatives will occur at MMSD. Figure 3 provides an overview of the key elements of the AM framework from an organizational structure and service delivery perspective. The framework combines key business management concepts that, when implemented, collectively facilitate the effective delivery of services.

The framework presented above has several major elements as described below:

**Business drivers and services** – (shown in yellow) provide the boundaries or ‘book ends’ to the framework. Business drivers are both external and internal influences to MMSD’s business and include service requirements such as customer expectations, strategic goals, regulatory

**Figure 3 SAM key framework elements**

![Diagram of SAM framework elements](image-url)
requirements, environmental factors, aging infrastructure, knowledge loss through staff retirement, technology improvements, and political and social priorities.

**Core Processes** - (shown in blue) contribute directly to the delivery of services to program areas and cover the entire lifecycle of the assets, with individual practices required for different asset types, and include planning, service delivery, and performance management.

a. **Planning** converts the business drivers into a set of operational plans that describe how MMSD will deliver services: the scope and quality of services, the programs (or processes) that will be used to deliver the defined services and the inputs required, including financial resources, human resources, and technology resources. The levels of planning include:

- Strategic/Long Term Planning which converts regulatory and customer requirements into service outcomes and overall long-term strategies (e.g., corporate/departmental strategic plans, organizational policies, long term funding strategy, demand forecasting, facility planning)
- Tactical/Medium Term Planning which develops sub-plans to allocate resources (natural, physical, financial, human, etc.) to achieve the strategic goals, while meeting defined levels of service (e.g., Master Plans, Performance Management, Asset Management Plans, Human Resources Plan, Business Continuity Plans)
- Operational/Short Term Planning which converts tactical, medium term plans into short term executable plans and budgets (e.g., Capital Programs, Annual Operating Budgets,
b. **Service Delivery** implements the short term executable plans including the following:
   - Operations and programming (including Metrogro)
   - Engineering and Capital Project Delivery
   - Lifecycle asset management
   - Asset performance and reliability maintenance - to retain an asset as near as practicable to its original condition, but excluding rehabilitation or renewal
   - Asset renewal (rehabilitation and disposal) - to rebuild or replace an asset to restore it to a required functional condition and/or extend its life, using available techniques and standards
   - Ecosystem Services
     - Laboratory services.
     - Environmental programs.
     - Work and resource management.
     - Community service and outreach.

   c. **Performance Management** checks that MMSD is doing what it intended to do. This occurs at multiple levels: meeting program area's needs (the ultimate outcome), delivering the defined scope and quality of services (the key output), delivering the defined programs through the efficient and effective use of infrastructure, financial, human and technology resources (interim outputs). Activities associated with performance management include:
   - Developing and reviewing Levels of Service targets
   - Monitoring actual results and reporting against targets over time
   - Conducting results based benchmarking (over a multi-year time horizon)
   - Assessing gaps
   - Adapting existing processes and/or creating new processes to effect continuous improvement

   **Support Services** - (shown in grey), include administration, information technology and data management, human resources, finance and administration, and purchasing.

### 4.2 Vision of the SAM Program

MMSD's SAM Program aligns with MMSD's overall Vision, Mission and Strategic Plan as shown in Figure 4.
MMSD’s Vision is “Enriching life through clean water and resource recovery.” Our Mission is “To protect public health and the environment.” The vision and mission are supported by guiding principles and strategic priorities as shown in Figure 5.

The proposed Vision of the SAM Program as determined in the March 2015 workshops is:

*We will manage infrastructure to meet community expectations at the lowest cost of ownership.*

### 4.3 Policy and Objectives for the SAM Program

To meet the SAM Program Vision, the following are objectives and guiding principles for the program:
Understand and manage the current state of our assets, including condition and remaining life.

- Know what assets MMSD owns and for which assets we have responsibility or legal liability. MMSD will record these assets in an asset register down to a maintenance-managed item (MMI) level.
- Monitor the condition, performance, use and cost of infrastructure assets down to the appropriate level and against prescribed service levels and regulatory requirements.

Understand and manage our level of service (LOS) to our customers.

- Understand and record the current levels of service with which we provide our customers. We will define target future levels of service required in order to continue to serve our customers for the long term.
- Understand customer expectations including the regulatory (e.g., compliance, water quality, public health, etc.) and non-regulatory aspects of our business (e.g., noise, customer service, appearance, cleanliness, customer outreach).

Understand and manage our business risk exposure (BRE).

- Focus emphasis on those infrastructure assets that are critical to our service levels and prioritize their management to prevent their failure. (This is not to imply that non-critical assets are ignored.)
- Identify, understand, and manage the risks associated with running the utility.

Prepare asset management plans for capital and operational strategies.

- Prepare an asset management plan for the Nine Springs WWTP and an asset management plan for the Collection System. Together, these two asset management plans will constitute the asset management plan for the organization.
- Create the asset management plans as living, active documents. Investment projections from the asset management plans should be reviewed and validated on an annual basis. The asset management plan is intended to be updated as needed on a periodic basis every 5 to 10 years.
- Understand the total cost of service delivery, including financial, social and environmental costs.

Embed sustainable asset management practices throughout the organization and develop a long-term sustainable funding strategy.

- Develop funding strategies to sustainably manage the utility. MMSD will monitor and report in Triple Bottom Line terms (financial, environmental, social/community/organizational).
- Link MMSD’s organizational and asset management strategic goals to asset related investments and action plans.
- Use validation processes to evaluate planned investment in capital projects, maintenance programs, operations and associated support services, as well as their impact on rates (including business cases, decision support systems, etc.).
- Establish an appropriate governance model with defined roles and responsibilities to sustain asset management practices.
- Provide information technology (IT) and data management support.
- Review progress to continuously improve our asset management performance.
- Allocate resources to effect the continued development and implementation of an asset management program.
- Provide training as needed on asset management processes and procedures.

Appendix A provides the SAM Program Policy and Objectives as a stand-alone document for MMSD to use as a communication tool.

### 4.4 SAM Key Elements

The SAM vision, objectives and policy will be implemented within MMSD as a key element in MMSD’s SAM Framework. The other key elements of MMSD’s SAM Framework are shown in Figure 5. MMSD already is implementing several asset management related functions across the organization such as assessing asset condition, developing business cases for new capital projects, and tracking performance. Figure 6 shows both existing and new SAM key elements needed for implementation and their relationships to each other.
Figure 6 SAM key elements needed for implementation
Existing key SAM elements are shown in grey and include:

- Determining asset condition (though not currently done for all assets).
- Administration of the Oracle Work and Asset Management (OWAM) work order system.
- Geographical Information Systems (GIS).
- Identification of capital and operational needs.
- Development of business cases.
- Development of the annual Operations Budget and Capital Improvements Plan.
- Performance measurement.

For the implementation of the SAM Framework additional key elements will be required as well as improving some of the existing key elements. The new or to be improved key elements include:

- SAM Policy and Objectives (see Section 4.3)
- Levels of Service Framework
- Business Risk Exposure Framework
  - Asset Consequence of Failure
- Risk Register
- Decision Support System.
  - Management Strategy Groups (that incorporate decay curves, asset lives, rehabilitation approaches, and costs)
  - Annual “Nessie” curve (investment forecasting)
- Development of asset management plans.
- Improvements to the Business Case Evaluation process.
- Determining and tracking SAM asset information and information systems, including maintenance and further development of MMSD’s asset register (see Section 6).

Each of the new SAM key elements needed for implementing the SAM Framework are described in more detail in the following sections.
4.5 Levels of Service Framework and Performance Measurement

Policy Statement - We will understand and manage our level of service (LOS) to our customers.

Objectives:

Understand and record the current levels of service with which we provide our customers.
We will define target future levels of service required in order to continue to serve our customers for the long term.

Understand customer expectations including the regulatory (e.g., compliance, water quality, public health, etc.) and non-regulatory aspects of our business (e.g., noise, customer service, appearance, cleanliness, customer outreach).

An effective LOS Framework connects the strategic direction of MMSD and the SAM Vision, Mission and Objectives to the performance requirements established within the various parts of the organization.

As stated in the International Infrastructure Management Manual 2011, Levels of Service “are a key business driver and influence all Asset Management decisions. Levels of Service statements:

- Describe the outputs the organization intends to deliver to customers;
- Commonly relate to service attributes such as quality, reliability, responsiveness, sustainability, timeliness, accessibility and cost;
- Should be written in terms the end user can understand and relate to; and
- Should drive the selection of performance measures.

LOS and performance measures provide the linkage between assets and technical and organizational objectives, by articulating how the management of assets contributes to MMSD’s overall vision, mission and guiding principles.

LOS define a product or a set of service characteristics that identify the minimum level of performance expected to be generated by the assets. These characteristics typically include aspects such as how much and how frequently the service will be delivered.

Related to LOS, performance measures are the specific indicators that are used to demonstrate how the organization is doing with respect to delivering services. Performance measures define what needs to be monitored and measured to evaluate MMSD’s performance.

As shown in Table 2, the following are the existing performance measures used by MMSD, including the organizational owner as well as targets, goals and actuals from 2014. This list was derived from the 2015 Operations Budget and Capital improvements Plan. Within the list of LOS parameters, some are external in that they are those LOS directly experienced by MMSD’s customers. Some LOS’ are internal performance measures important to the functional areas of the organization. Finally, some are regulatory permit driven measures that are technical in nature and have direct impact to the environment.
### Table 2 Existing MMSD performance measures

<table>
<thead>
<tr>
<th>Key result measure</th>
<th>Target</th>
<th>FY14 Actual</th>
<th>FY15 Projected</th>
<th>LoS Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to fill a vacancy</td>
<td>40</td>
<td>43</td>
<td>40</td>
<td>Internal</td>
</tr>
<tr>
<td>Lost time accidents</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Internal</td>
</tr>
<tr>
<td>Connect in person with each City, Town, or Village administrator at least once per year</td>
<td>15</td>
<td>8</td>
<td>15</td>
<td>External</td>
</tr>
<tr>
<td>5 sustainable activities/projects completed (Mpower)</td>
<td>5</td>
<td>2</td>
<td>TBD</td>
<td>Internal</td>
</tr>
<tr>
<td>Number of bypass events</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>External</td>
</tr>
<tr>
<td>Number of spill events</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>External</td>
</tr>
<tr>
<td>Number of basement backup events</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>External</td>
</tr>
<tr>
<td>Percent of time BOD limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Percent of time TSS limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Percent of time Ammonia limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Percent of time Phosphorus limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Percent of time Fecal Coliform limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Percent of time Chlorides limit is met</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Permit</td>
</tr>
<tr>
<td>Tons of struvite produced</td>
<td>2</td>
<td>1.3</td>
<td>1.5</td>
<td>Internal</td>
</tr>
<tr>
<td>Purchased electricity per gallon treated (kwh/gal)</td>
<td>1400</td>
<td>1643</td>
<td>1500</td>
<td>Internal</td>
</tr>
<tr>
<td>Percent of preventative work orders completed within allowable time frame</td>
<td>90%</td>
<td>Pending</td>
<td>90%</td>
<td>Internal</td>
</tr>
<tr>
<td>Keep capital improvement construction project contract modifications below 5%</td>
<td>&lt;5%</td>
<td>Varies by project</td>
<td>&lt;5%</td>
<td>Internal</td>
</tr>
<tr>
<td>Keep total non-construction costs for projects below 20% of the final construction contract amount</td>
<td>&lt;20%</td>
<td>Varies by project</td>
<td>&lt;20%</td>
<td>Internal</td>
</tr>
<tr>
<td>Percent of time laboratory turn around times are met</td>
<td>&gt;=93.8%</td>
<td>95.8%</td>
<td>&gt;=98%</td>
<td>Internal</td>
</tr>
<tr>
<td>Reduction in chloride mass</td>
<td>15% by permit</td>
<td>4%</td>
<td>7%</td>
<td>Permit</td>
</tr>
<tr>
<td>Achieve a rating of proficient or better for mandatory criteria for the GFOA Budget Presentation Award</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Internal</td>
</tr>
<tr>
<td>Achieve a rating of proficient or better on optional criteria for the GFOA Budget Presentation Award</td>
<td>80%</td>
<td>92%</td>
<td>100%</td>
<td>Internal</td>
</tr>
<tr>
<td>Maintain 98% availability for our network servers</td>
<td>98%</td>
<td>99%</td>
<td>98%</td>
<td>Internal</td>
</tr>
</tbody>
</table>
Additional performance measures identified in the March 2015 workshops that will be considered in the implementation of the SAM Framework are presented in Table 3. These new measures are based on the experience of other similar utilities and are also derived from the Infrastructure Sustainability Institute’s Envision Rating System (see Appendix B for Envision™ rating descriptions).

**Table 3 Additional MMSD performance measures**

<table>
<thead>
<tr>
<th>Based on other utilities</th>
<th>Based on Envision™ rating system</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of assets in intolerable risk zone</td>
<td>RA2.1 Reduce energy consumption</td>
</tr>
<tr>
<td>% length of miles of sewer pipe inspected via closed circuit television and cleaned vs. budgeted length</td>
<td>QL2.1 Enhance public health and safety</td>
</tr>
<tr>
<td>Periodic survey showing that (x) % of customers are satisfied they have been adequately informed about water and wastewater issues and given the opportunity to provide input.</td>
<td>CR1.2 Reduce air pollutant emissions</td>
</tr>
<tr>
<td>% program driven maintenance hours vs. total (reactive and program driven) maintenance hours</td>
<td>RA3.1 Protect fresh water availability</td>
</tr>
<tr>
<td>% assets with applied PdM vs. the total number of assets with recommended PdM</td>
<td>LD1.4 Provide for stakeholder involvement</td>
</tr>
<tr>
<td>Number of verified odor complaints</td>
<td>LD2.1 Pursue by-product synergy opportunities</td>
</tr>
<tr>
<td>Confidence Level Rating of Enterprise AMP exceeds X%</td>
<td>QL2.2 Minimize noise and vibration</td>
</tr>
</tbody>
</table>
4.6 Business Risk Exposure Framework

Policy Statement - We will understand and manage our business risk exposure (BRE).

Objectives:

Focus emphasis on those infrastructure assets that are critical to our service levels and prioritize their management to prevent their failure. (This is not to imply that non-critical assets are ignored.)

Identify, understand, and manage the risks associated with running the utility.

Business Risk Exposure (BRE) is an advanced asset management methodology used to focus management teams on high-risk assets and issues. The BRE Framework as a key element for MMSD is shown in Figure 7. There are multiple inputs and outputs with ownership of different elements of the process predominantly in Planning, Engineering and Operations & Maintenance. Inputs include condition assessment data, staff knowledge and understanding of what happens if an asset fails, and geo-spatial proximity analysis using GIS. Outputs are used in the development of asset management plans (including development of the risk register) and in business case evaluations.
Figure 7 Strategic business process mapping - Business Risk Exposure

The BRE for an asset is the product of the consequence and probability of a possible failure, adjusted for risk mitigation measures currently in place. Risk mitigation are those practices applied to an asset on a case by case basis to either reduce the probability of failure (by adding “resistance” to the asset) or the consequence of failure (improving resiliency of the asset). Figure 8 is a schematic representation of the key variables of business risk exposure with components that address each variable.
"Core Risk" is defined as the product of full consequence of failure (CoF) and the probability of failure (PoF) adjusted only for current risk mitigation measures in place for the asset/system. Once the core risk is available as a base line measurement, risk mitigation strategies can be developed that can reduce the level of risk, in turn impacting the level and cost of service.

The probability of failure aspect of BRE is directly related to the asset’s condition and is further discussed in Section 4.7 Asset Condition and Remaining Life.

The consequence of an event can be expressed in Triple Bottom Line (TBL) categories. Triple bottom line categories used for the MMSD SAM Framework are as follows:

**Table 4 Triple Bottom Line categories and elements**

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong Community (Social)</td>
<td>Customers Affected, Loss of Service, Health and Safety</td>
</tr>
<tr>
<td>Vital Economy (Financial)</td>
<td>Financial Impact (total cost to fix and mitigate including indirect costs), Rates</td>
</tr>
<tr>
<td>Healthy Environment (Environmental)</td>
<td>SSOs, Basement Backups and Regulatory (permit) Compliance</td>
</tr>
</tbody>
</table>

Table 5 presents the consequence of failure scoring matrix for the SAM Framework. The scoring system is based on a 1 to 5 score, with 1 being a low consequence and 5 being a high consequence.
Table 5 MMSD SAM consequence of failure scoring table

<table>
<thead>
<tr>
<th>Strong Community</th>
<th>Customers Affected</th>
<th>Less than 10</th>
<th>&lt; 100</th>
<th>&lt;1,000</th>
<th>&lt;10,000</th>
<th>&gt; 10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of Service</td>
<td>Can be out of service for more than one month</td>
<td>Can be out of service for less than one month</td>
<td>Can be out of service for one day</td>
<td>Can be out of service for four hours</td>
<td>Critical - cannot lose service</td>
<td></td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>No impact</td>
<td>Minor injury</td>
<td>Moderate injury and some sickness</td>
<td>Major injury, sickness</td>
<td>Potential for fatalities</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vital Economy</th>
<th>Financial impact</th>
<th>Less than $5,000</th>
<th>&lt; $50,000</th>
<th>&lt; $500,000</th>
<th>&lt; $5,000,000</th>
<th>&gt; $5,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Healthy Environment</th>
<th>SSOs and Basement Backups</th>
<th>None</th>
<th>&lt; 50,000 gallons</th>
<th>&lt; 500,000 gallons</th>
<th>&lt; 5,000,000 gallons</th>
<th>&gt; 5,000,000 gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory (permit) compliance</td>
<td>No consequence</td>
<td>Regulatory sanction possible</td>
<td>Regulatory sanction likely; damage reversible in less than one year</td>
<td>Regulatory sanctions</td>
<td>Severe sanctions - damage</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Depending on asset type, there are different attributes that help measure the impact associated with each of the elements shown in Table 5. The hierarchical relationship between categories, elements, and attributes is shown in Figure 9.

**Figure 9 Hierarchical relationship between Consequence of Failure terms (categories, elements, and attributes)**

The consequences based on each of the attributes that are applicable to an asset type (e.g., interceptors, force mains) are added in order to develop a comprehensive consequence rating for that asset. The consequence of an event is calculated based on a 1 to 5 score for each TBL category and associated elements. The minimum consequence of failure score is three and the maximum is 15.

Table 6 presents example attributes for each element.

**Table 6 Example Triple Bottom Line attributes and elements**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>LoS Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loss of Service</td>
</tr>
<tr>
<td>Number of customers connected to the segment</td>
<td>●</td>
</tr>
<tr>
<td>Critical customer category</td>
<td>●</td>
</tr>
<tr>
<td>Proximity to roads</td>
<td>●</td>
</tr>
<tr>
<td>Proximity to railroads</td>
<td>●</td>
</tr>
<tr>
<td>Proximity to environmentally sensitive areas</td>
<td>●</td>
</tr>
<tr>
<td>Proximity to buildings</td>
<td>●</td>
</tr>
<tr>
<td>Repair costs</td>
<td>●</td>
</tr>
<tr>
<td>Zoning and land use</td>
<td>●</td>
</tr>
</tbody>
</table>
Example data requirements for the consequence of failure analysis are summarized in Table 7.

**Table 7 Example data requirements for pipe CoF assessment**

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Attributes</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset attributes</td>
<td>Date of installation</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Material</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Size</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Customer count</td>
<td>GIS / Customer Billing database</td>
</tr>
<tr>
<td></td>
<td>Critical customer type</td>
<td>GIS / Customer Billing database</td>
</tr>
<tr>
<td></td>
<td>Repair costs</td>
<td>Contract Data</td>
</tr>
<tr>
<td>Geospatial parameters</td>
<td>Proximity to roads</td>
<td>GIS</td>
</tr>
<tr>
<td></td>
<td>Proximity to other utilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximity to railway lines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximity to environmentally sensitive areas (e.g., wetlands, open water)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximity to high risk institutions (hospitals, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximity to buildings</td>
<td></td>
</tr>
</tbody>
</table>

The likelihood and consequence of events are used to develop the BRE chart. An example BRE chart is shown in Figure 10. The BRE chart is divided into five risk management zones. Each zone is described as follows:

**Figure 10 Example BRE chart (with example assets)**

**Zone 1**: Contains assets that represent significant risk to the organization. In general, these assets are approaching the end of their useful life and upon failure, may cause significant social, financial, and environmental impacts.
Zone 2: Contains assets that have high consequence of failure but have not deteriorated enough to be included in the significant risk zone (Zone 1). Increased visual and/or predictive condition assessments (thermal scanning, oil analysis, etc.) may be justified as their condition deteriorates and they move vertically in the graph approaching Zone 1.

Zone 3: Contains assets that would experience failure consequences that are tolerable because they may be being managed through designed redundancy and operational mitigation such as spares and condition monitoring. Zone 3 assets can also migrate into Zone 1 and as such require additional focus by management.

Zones 4 & 5: Contains assets with lower consequences of failure. Applicable management strategies for these assets may be run to fail and maintenance optimization.
4.7 Asset Condition and Remaining Life

Policy Statement - We will understand and manage the current state of our assets, including condition and remaining life.

Objectives:

Know what assets MMSD owns and for which assets we have responsibility or legal liability. MMSD will record these assets in an asset register down to a maintenance-managed item (MMI) level.

Monitor the condition, performance, use and cost of infrastructure assets down to the appropriate level and against prescribed service levels and regulatory requirements.

The likelihood of an asset failing may be the result of physical mortality (structural integrity), capacity, changes in levels of service or because of inefficient operations. Example influences of physical mortality include material type, age, construction methods, operational environment and external influences among others. Table 8 presents examples of data source requirements needed for asset condition and determining remaining life.

Table 8 Data requirements for pipe condition assessment

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Attributes</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset attributes</td>
<td>Date of installation</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Material</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Size</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>GIS / Record drawings</td>
</tr>
<tr>
<td></td>
<td>Lining/Rehab status</td>
<td>GIS / Contract data</td>
</tr>
<tr>
<td>Geospatial parameters</td>
<td>Proximity to roads</td>
<td>GIS</td>
</tr>
<tr>
<td></td>
<td>Proximity to other utilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximity to railway lines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Groundwater elevation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil type</td>
<td></td>
</tr>
<tr>
<td>Work order data, when available</td>
<td>Type of work order (structural failure vs operational failure)</td>
<td>Maintenance records</td>
</tr>
<tr>
<td></td>
<td>Date of work order</td>
<td></td>
</tr>
<tr>
<td>Inspection records, when available</td>
<td>CCTV inspections</td>
<td>Inspection records</td>
</tr>
<tr>
<td></td>
<td>Leak detection</td>
<td>Contract data</td>
</tr>
<tr>
<td></td>
<td>Condition assessment technologies</td>
<td>Contract data</td>
</tr>
</tbody>
</table>

A condition rating system using a scoring range of 1 to 5 (Table 9) is recommended for use by MMSD. This type of rating system is simple and it matches the scales used by NASSCO\(^1\) for PACP\(^2\) scoring.

---

\(^1\) NASSCO stands for National Associations of Sewer Service Companies.

\(^2\) PACP stands for Pipeline Assessment and Certification Program.
Table 9 Condition rating system for pipes

<table>
<thead>
<tr>
<th>Condition Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New or Excellent</td>
</tr>
<tr>
<td>2</td>
<td>Minor Defects Only</td>
</tr>
<tr>
<td>3</td>
<td>Moderate Deterioration</td>
</tr>
<tr>
<td>4</td>
<td>Significant Deterioration</td>
</tr>
<tr>
<td>5</td>
<td>Virtually Unserviceable</td>
</tr>
</tbody>
</table>

An example approach for the determination asset condition score for linear assets is illustrated in Figure 11.

Policy Statement - We will prepare asset management plans for capital and operational strategies.

Objectives:

Prepare an asset management plan for the Nine Springs WWTP and an asset management plan for the Collection System. Together, these two asset management plans will constitute the asset management plan for the organization.

Create the asset management plans as living, active documents. Investment projections from the asset management plans should be reviewed and validated on an annual basis. The asset management plan is intended to be updated as needed on a periodic basis every 5 to 10 years.

Understand the total cost of service delivery, including financial, social and environmental costs.

4.8 Decision Support System and Asset Management Plans
As described in Section 3, a critical element of the SAM Framework is the development of asset management plans (AMPs). An AMP systematically tells the story of the state of MMSD’s infrastructure and provides both capital and O&M management strategies. The AMP answers the 5 Core Questions and an additional question focused on challenges in implementing the AMP. The list below provides an initial content outline for MMSD’s AMP development. The content sections are organized directly around each of the 5 Core Questions (+1 additional).

Q1 – What is the State of our Assets?
- Asset Description
- Asset Statistics
- Management Strategy Groups
- Management Strategies
- Condition Assessment
- Probability of Failure
- Consequence of Failure

Q2 – What is Required Level of Service?
- Levels of Service Targets and Calculations
- Levels of Service Measures and Performance
- Demand and Need Forecasting

Q3 – What Assets are Critical to Sustained Performance?
- Business Risk Exposure

Q4 – What is Our Infrastructure Improvement Plan?
- CIP Information and Integration
- Operations and Maintenance
- Needed Projects

Q5 – What will it Cost to Implement the Asset Management Plan?
- Cost Estimates
- Year-by-Year Cost Projections

Q6 – What Business Improvement Opportunities Should be Pursued?
- Areas of Evaluation
- Areas of Implementation

Ultimately, the AMP identifies needs and recommended management strategies that are an input into the capital and operational budgeting process.
For MMSD it is recommended that two separate AMPs be developed. The first would be for the Nine Springs Wastewater Treatment Plant and the other would be to build upon the work already completed on the Collection System AMP by developing updated version. The Collection System AMP would include interceptors, pumping stations and force mains.

Developing an AMP can be effectively supported through the use of a Decision Support System (DSS). A DSS allows for the analysis of the application of different infrastructure management strategies and their resultant future investment requirements. A main output of the DSS is the "Nessie Curve" or future capital and O&M investment profile as shown in Figure 13.

![Figure 13 Example Nessie Curve from DSS analysis](image)

**Figure 13 Example Nessie Curve from DSS analysis**

The DSS is a major “tool” used by managers to make better decisions. While the DSS is data driven, it is important to note that there are other inputs into the process. For example, data driven DSS analysis may indicate that an asset should be rehabilitated due to physical mortality in the next 5 years. However, a new regulatory requirement (Levels of Service) may result in the need for an asset to be replaced earlier (eg permit change). There are also Triple Bottom Line (TBL) inputs that are not data driven such as social/community considerations.

The backbone of a DSS is a set of business rules used to model the rehabilitation, renewal and replacement schedule for assets. Each total predicted annual expenditure is based on life cycle analysis and management strategies for each asset. A DSS allows asset managers to build the AMP “bottom up” from the data and information at the asset level. The DSS inputs include asset condition data, consequence of failure data, physical effective lives, rehabilitation strategies (including costs), replacement strategies (including costs) and intervention triggers. Outputs from the DSS primarily are an input into the AMP, but it can also be used as a decision tool to inform various aspects of MMSD outside of the AMP process as shown graphically in Figure 14.
Initially, a DSS for MMSD could simply be a spreadsheet (or a set of spreadsheets) used to analyze the inputs described above and to develop “what-if” scenarios for different management and investment strategies. Longer term implementation considerations for a DSS include:

- Desired functionality.
- Reporting requirements.
- Integration with other planning tools, such as contract packaging

The “To Be” Strategic Business Process mapping for implementing DSS and AMP development within MMSD is presented in Figure 15. Please note the following:

- The DSS analysis function and development of AMPs resides in the Sustainable Infrastructure Management function of Planning.
- Outputs of the DSS and AMP process reside primarily in Planning (e.g., business case development), however, other functional areas will have inputs and outputs to the process.
- GIS data management resides in Engineering, however, the SAM functional element of GIS Spatial Analysis is recommended to reside in the Sustainable Infrastructure Management organizational group.
- The development of the financial forecasting and modelling (including debt service impacts, etc.) reside in the Administration Group.
Figure 15 Strategic Business Process Mapping - To Be DSS and AMP
4.9  Business Case Evaluation Process

Policy Statement - We will embed sustainable asset management practices throughout the organization and develop a long-term sustainable funding strategy.

Objectives:

- Develop funding strategies to sustainably manage the utility. MMSD will monitor and report in Triple Bottom Line terms (financial, environmental, social/community/organizational).

- Link MMSD’s organizational and asset management strategic goals to asset related investments and action plans.

- Use validation processes to evaluate planned investment in capital projects, maintenance programs, operations and associated support services, as well as their impact on rates (including business cases, decision support systems, etc.).

A Business Case is a methodology for documenting and presenting a solution to an identified infrastructure need as a result of the asset management planning process and or through other ad-hoc processes. The final solution to addressing the need could be a capital project, an operational program or changes to O&M strategies. A Business Case discusses the supply and demand issues, documents the range of alternatives analyzed, reasons for accepting and rejecting each option, makes a recommendation on how the project should proceed, and provides the documented justification for proceeding with the project.

An important component of Asset Management is validating the Capital Improvement Program (CIP). MMSD uses a Business Case process for all projects that are included in the CIP. The existing MMSD process thoroughly documents the reason for the identified need, evaluates multiple alternatives, and includes many aspects of life cycle costs analysis, however, it does not consistently include all life cycle costs, TBL considerations nor is there a common methodology to assess risks and risk reductions by each alternative as part of the evaluation.

The following is the basis for the improved Business Case Evaluation Process at MMSD. The main elements include: Need Identification and Validation, Life Cycle Cost Analysis, Risk Reduction, and Benefit Cost Analysis, which are summarized in a Business Case and then prioritized by the CIP Committee. The main elements are shown in Figure 16.
The Business Case provides the following benefits:

- A record of the issues and analysis done to prepare and justify a project;
- A framework for summarizing and reporting on the results of the Project Validation, Risk Reduction, the Life Cycle Cost, and the benefit cost for each project option considered;
- A basis for selecting the appropriate treatment option for a project;
- A structured way of presenting a project’s justification to stakeholders;
- A consistent way of receiving projects for consideration;
- A consistent way of considering and analyzing projects at a committee level, allowing comparison between projects more easily;
- Improved decision making based on improved project data;
- Improved basis for justifying decisions made to the District’s Commissioners.

The Business Case makes a recommendation on how a CIP project should proceed and presents a concrete case for the project justification. It discusses and documents the supply and demand issues for the project, the Project Validation score in the analysis completed for the project, the risk reduction value that the project represents to the business, the range of alternatives analyzed, the reasons for accepting or rejecting each option, and documents the project metrics justifying project approval.


A business case for a need can be developed either in-house by MMSD or outsourced to a consulting firm for development. The outsourcing option can be exercised if the effort associated with a business case is anticipated to exceed the availability of the in-house resources.
The definitions of terms used in the Business Case Development are listed in Table 3.

**Table 10 Main business case components and definitions**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Initiation</td>
<td>The process of validating and documenting that an identified failure or impending failure (physical mortality, level of service, capacity, financial efficiency) requires a capital project solution that warrants development into a project for consideration in the CIP (Capital Improvements Program) or other Operational, regulation-driven and Ad-hoc investments.</td>
</tr>
<tr>
<td>Initial Project Validation</td>
<td>The Initial Project Validation rating is a percentage score that reflects an assessment of the process, data and knowledge associated with identifying renewal, level of service, capacity, or financial efficiency failures/needs.</td>
</tr>
<tr>
<td>Need Prioritization</td>
<td>A need can be identified by anyone in the organization. Once a need is identified to remedy an existing or an anticipated failure and validated with the Initial Project Validation, the need is prioritized with respect to other identified needs to assess which need goes through the business case development process.</td>
</tr>
<tr>
<td>Project Development (Initial Planning)</td>
<td>The process of developing an initiated project into an initially planned (or developed) project with a business case for consideration in the CIP. This step includes the development of alternatives prior to the business case development.</td>
</tr>
<tr>
<td>Engineering Studies</td>
<td>Studies required to identify alternatives to address an infrastructure need. Studies required to improve the Initial Project Validation score to the hurdle amount to enable a project to progress through to RR/LCC and business case development. Studies to improve the level of understanding of factors impacting asset life and performance.</td>
</tr>
<tr>
<td>Life Cycle Cost</td>
<td>The sum of all outgoing costs associated with the ownership and operation of the infrastructure installed or constructed through the project. Cost components are planning, design, construction, operations, maintenance, decommissioning, and rehabilitation.</td>
</tr>
<tr>
<td>Risk Reduction</td>
<td>An estimate of the likelihood that an asset will fail multiplied by the consequences that will likely result from that failure taking into account the current level of risk mitigation.</td>
</tr>
<tr>
<td>Benefit / Cost</td>
<td>Benefit/Cost ratio is an expression of the total estimated benefits and costs associated with a project assessed on a triple bottom line basis and including organizational and community (indirect and intangible) benefits and costs.</td>
</tr>
</tbody>
</table>

Figure 17 presents the Strategic Business Process Flow for developing business cases at MMSD.
Figure 17 Strategic Business Process Flow for developing business cases
5. **Asset Management Governance and Leading Change**

**Policy Statement** - We will embed sustainable asset management practices throughout the organization and develop a long-term sustainable funding strategy.

**Objectives:**
- Establish an appropriate governance model with defined roles and responsibilities to sustain asset management practices.
- Review progress to continuously improve our asset management performance.
- Allocate resources to effect the continued development and implementation of an asset management program.

To realize the full benefit and value of enhanced asset management, the right organizational structure with the right people in the right roles with the right expertise needs to be in place.

One definition of governance is:

*The establishment of policies, and continuous monitoring of their proper implementation, by the members of the governing body of an organization. It includes the mechanisms required to balance the powers of the members (with the associated accountability), and their primary duty of enhancing the success and viability of the organization* (source: BusinessDictionary.com).

Developing an appropriate governance model (or organization design) that supports work management, maintenance management, and enhanced asset management practices and the understanding that with enhancing asset management practices comes the need to be mindful and intentional about how real change comes about is an important element for the SAM Framework. Governance activities include: overseeing strategy, creating policies and practices to achieve the strategy, overseeing the implementation of the strategy, monitoring and measuring the implementation, and reporting and communicating regularly.

Specifically, governance models promote improved coordination and effectiveness in the following areas:

- **Work Management and Maintenance Management**
  - Service request management
  - Asset data entry at the front line
  - Work planning and scheduling
- **Materials Management**
  - Inventory
  - Purchasing
- **Physical Asset Management**
  - Setting direction, including strategy, policy and SAM Framework
- Levels of service and performance management
- Risk management and project options analysis
- Asset renewal and replacement planning
- Project prioritization
- Developing and managing asset management plans
- Strategic and tactical SAM implementation

- Technology Asset Management
  - General technology support
  - CMMS support, maintenance and upgrade
  - Integration and coordination with other core systems
  - System development and lifecycle management

- Skills and Competency Development
  - Support of new or revised roles and responsibilities for asset management
  - Driving leading practices
  - Effective use of technology enablers

Good governance also includes characteristics like:

- Creates the right environment for individuals and groups within an organization to work together
- Fosters communication and removes barriers to it
- Minimizes silos and reduces barriers to collaboration
- Organizes an efficient, moderately lean organization structure suitable to the task (i.e., overly lean organizations can be taxing on personnel trying achieve asset management goals)
- Generates energy and momentum (including recognizing when energy is flagging and doing something about it)
- Provides an appropriate forum for raising conflict and resolving them (e.g., manages the ‘healthy tension’ and minimizes the other more destructive kinds of conflict)
- Sets priorities
- Creates focus in the organization

5.1 Organizational Design Principles (Leading Practices)

The structural configuration of an organizational design should reflect the way work is divided and how the organization wants to achieve coordination among its various work activities. An organizational design structure resolves the two basic tasks of getting work done by: (1) Dividing up the work in the organization into logical units (this enables performance management); and (2) ensuring the work gets done by providing the coordination and control of work.

The organizational and governance model for asset and work/maintenance management should focus on effectiveness as defined in Figure 18 where effectiveness is a function of an organization’s inherent capability and delivered execution.
Figure 18 Model of Organizational Effectiveness

Understanding the assets that MMSD manages and the work needed throughout the full lifecycle (plan, design, create, operate, maintain rehabilitate/replace and dispose) of these assets to provide the required customer service is fundamental to the organizational design process.

In general, organization structures can be designed to achieve the desired outcomes based on functional responsibilities, geographic boundaries, service departments, or a matrix approach as shown in Table 11.

Table 11 Main business case components and definitions

<table>
<thead>
<tr>
<th>Organizational Structure Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>Logical reflection of the organization’s activities. Based on specialization that is efficient.</td>
</tr>
<tr>
<td>Service-Based Focus</td>
<td>Adaptable and flexible to meeting the needs of managers as they use assets to deliver a set of related services.</td>
</tr>
<tr>
<td>Territorial (or Geographic)</td>
<td>Establishes work groups based on a geographic area.</td>
</tr>
<tr>
<td>Matrix</td>
<td>Composed of managers and project teams who are employees from different functional units.</td>
</tr>
</tbody>
</table>

Successful and effective AM governance models most commonly:

1. Reflect the strategic vision, mission and values of the organization and the department as well as the vision for AM strategy implementation.

2. Allocate and balance human resources and workload across positions within existing and vacant positions and provide for appropriate critical functions.

3. Acknowledge and leverage the existing skill and expertise areas of management and staff; acknowledge the strengths of management and staff involved and identify and create opportunities for further enhancing skills (gap and skills analysis – development and succession planning).

4. Reflect the organization’s current Human Resources policies and practices.

5. Foster a decision-making process that considers the best interests of the organization, customers and staff.

6. Define clearly roles, responsibilities, communication links and decision making rights.
7. Support the integration of asset management across the organization and the necessary interdepartmental relationships required for moving the organization towards its vision so that activities that need to be coordinated fall within program boundaries.

8. Foster an environment and culture that enables the organization to attract and retain the right people/skills.

9. Provide for performance measurement of asset management program implementation.

10. Demonstrate flexibility in supporting and adapting to future evolving asset management needs.

5.2 Current Organizational Structure

The current organization structure for MMSD has six departments (Operations & Maintenance, Planning, Human Resources, Engineering, Ecosystem Services and Administration) reporting to the District Chief Engineer/Director and Commissioners. Figure 19 shows the primary organization structure for the department and work groups. Operations & Maintenance is the largest part of the organization and has work groups that include: Reliability Engineer, Buildings and Grounds, Collection System, Electrical and Mechanical Maintenance, Purchasing, MetroGro, Operations, and Asset Information.

Figure 19 Current MMSD Organizational Structure

Formal Sustainable Infrastructure Management, where the SAM Framework is led, is part of the Planning Department in the organization. In addition, informal support and responsibility for Strategic Asset Management is provided from each of the other primary departments and work groups reflecting MMSD’s approach that asset management integrates with all aspects of the organization.

Of the different types of governance models discussed during the March 2015 workshops, MMSD’s current Sustainable Asset Management governance structure is most closely described as: Departmental AM Steering Team (Facilitation and Advisory), Centralized AM Work Group and
Formal Decentralization Departmental Delivery (referred to as Model 1 during the workshops and shown in Figure 20). At MMSD, there is a designated position for a Sustainable Infrastructure Manager, an informal AM Steering Team (as part of the Executive Team) has been formed and is convening on a regular and as-needed basis, and a Core Sustainable Infrastructure Management Team are all in place. In addition some of the Departments (operating units) of MMSD have begun to participate in certain AM related task initiatives.

![Figure 20 MMSD Current Sustainable Asset Management Governance Model](image)

During the March 2015 workshops, the three primary elements of organizational effectiveness were discussed: communication, coordination, and task control. Current strengths and challenges of the current organizational structure were discussed and are summarized in Table 12.

**Table 12 Current MMSD organizational strengths and challenges**

<table>
<thead>
<tr>
<th>Element</th>
<th>Current Strengths</th>
<th>Current Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Communication within each department, division or function.</td>
<td>Communication across multiple departments, divisions, or functions.</td>
</tr>
<tr>
<td></td>
<td>One-way directional communication for giving instruction or directing tasks.</td>
<td>Receiving feedback on instructed or directed tasks.</td>
</tr>
<tr>
<td></td>
<td>Lots of data is available to staff.</td>
<td>Mining and analysis of the volume of data available.</td>
</tr>
<tr>
<td></td>
<td>Opportunities for group discussions to decide collectively on needs.</td>
<td>Crafting the right message for the right audiences.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Too much jargon being used and not enough plain English explanation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insufficient explanation of “What’s in it for...”</td>
</tr>
<tr>
<td>Element</td>
<td>Current Strengths</td>
<td>Current Challenges</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>me?” and “What's in it for MMSD?”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asset management job responsibilities insufficiently defined in current job descriptions.</td>
</tr>
</tbody>
</table>
| Coordination | Interaction between Planning and Design functions.  
Construction phase execution.  
Sewer maintenance coordination.  
Coordination with Metrogro.  
Waste acceptance.  
Opportunities for staff to meet with supervisors.  
Maintenance scheduling using Oracle WAM. | Hand-off between Engineering and Operations & Maintenance.  
Maintenance notifying Operations when requested repairs are completed.  
Performing condition assessment.  
Waste acceptance (both strength and challenge)  
Asset valuation and connection of asset financial data to other asset information.  
IT advanced planning and different software platforms.  
Entering new assets into Oracle WAM. |
| Control | No rivalry between Operations and Maintenance | Inertia to move initiatives forward.  
Functioning of the AM Steering Committee (more can be done).  
Embedding SAM accountability and responsibility beyond the AM Steering Committee.  
Personnel resources are limited and people have little additional availability.  
Communicating time availability and task overload situations.  
Culture emphasizes getting things done through individual work relationships. |

The SAM Framework defines the organizational functions that relate either formally (through direct supervision under the Planning Department) or informally (through coordination and collaboration with other MMSD departments). Table 13 provides a list of SAM functions that under the SAM Framework are aligned either formally under the Planning Department, Informally through dotted-line relationships between Planning and other MMSD departments, or ‘Either’.
Table 13 Formal and informal SAM functions

<table>
<thead>
<tr>
<th>Formal SAM Functions</th>
<th>Either Formal or Informal</th>
<th>Informal SAM Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide SAM leadership and direction</td>
<td>Update and maintain the asset inventory, asset hierarchy and asset register</td>
<td>Implement SAM vision, policies, framework and procedures</td>
</tr>
<tr>
<td>Develop and communicate SAM vision, policies, framework and procedures</td>
<td>Define procedures for collecting, validating, analyzing, storing and retrieving data</td>
<td>Procure, implement, and support IT systems that support SAM</td>
</tr>
<tr>
<td>Define Levels of Service</td>
<td>Perform asset life cycle cost analyses and asset remaining life analyses</td>
<td>Perform reliability evaluations to enhance maintenance and operational asset performance</td>
</tr>
<tr>
<td>Establish, implement and maintain the SAM Program</td>
<td>Identify and communicate needed and potential asset investment projects</td>
<td>Perform condition assessment and collect required asset data</td>
</tr>
<tr>
<td>Provide input to the Capital Program</td>
<td>Perform business case analyses and resulting project prioritization</td>
<td>Implement work management processes and procedures, including work order prioritization</td>
</tr>
<tr>
<td>Drive SAM continuous improvement</td>
<td>Identify database system user requirements</td>
<td>Report on asset performance</td>
</tr>
<tr>
<td>Establish and implement risk-based decision-making practices</td>
<td>Provide wide access across the divisions to asset data and analysis tools</td>
<td>Manage asset inventory and spare parts</td>
</tr>
<tr>
<td>Develop and update Asset Management Plans (AMPs)</td>
<td>Manage the handover of assets from design to construction to operation</td>
<td>Research and report on alternative project approaches</td>
</tr>
<tr>
<td>Define SAM technology requirements</td>
<td>GIS data entry and other asset data source management</td>
<td></td>
</tr>
<tr>
<td>Provide SAM training and skill development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicate SAM progress to the Executive Team &amp; Commission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the current stage of MMSD’s asset management program evolution, the Asset Management function is led through the position of the Sustainable Infrastructure Manager within the Planning Department of the organization structure.

As MMSD’s asset management program develops, the functions of the Sustainable Infrastructure Manager should have ownership and direct responsibility for the following key primary programmatic functions:

- SAM Asset Register
  - Establishment of the asset hierarchy
  - Definition of asset data fields to be collected, including asset naming and numbering conventions
• Direction to the rest of the organization on the population and maintenance of the data in the asset register
• Development of quality review systems to periodically evaluate the asset data quality of the organization

• Business Intelligence
  o Definition of the categories, types, and formats of asset data to be collected in the SAM asset register
  o Analysis of asset condition and determination of asset remaining life for each asset
  o Determination and recording of asset consequence of failure for each asset
  o Integration and analysis of available GIS spatial data with asset attribute information and visualization of asset management analysis using GIS tools
  o Lead the technical requirements development process for asset management database systems implementation and upgrade

• Risk Framework
  o Review and have input to the Planning division’s risk register development
  o Leadership and implementation of MMSD’s Business Risk Exposure (BRE) process
  o Identification of MMSD’s critical assets

• Capital and O&M Strategies
  o Define Management Strategy Groups (MSGs)
  o Analyze legacy and current information to determine MMSD specific asset decay patterns and compare the decay patterns to industry standards
  o Implement and manage MMSD’s Decision Support System (DSS)
  o Develop and evaluate capital investment options and decisions
  o Provide input to O&M procedures with the aim of optimizing asset life
  o Participate in Business Case Evaluation activities of the Planning division

• Asset Management Plans (AMPs)
  o Perform asset life cycle cost analysis
  o Develop the content requirements for MMSD’s AMPs
  o Develop draft AMP content based on asset data analysis
  o Develop and review asset management–related processes and procedures, and communicate these to the rest of the organization
  o Communicate AMP content and recommendations to the rest of the organization for input and refinement

• Business Case Evaluation (BCE) Process
  o Establish standards and guidelines.
  o Provide analytical support to the BCE process
• **Performance Measurement**
  - Provide input to the Chief Engineer and Director on the development of appropriate key performance indicators
  - Provide input to the development of Levels of Service targets
  - Provide input to the procedures for measuring progress against Levels of Service targets
  - Analyze asset life performance and cost information and compare to MMSD’s applicable Levels of Service targets
  - Lead asset management training activities for all staff according to their role
  - Recommend asset management related roles and responsibilities to MMSD’s Human Resources division for inclusion in job descriptions and performance evaluation processes.

• **Asset Management Governance**
  - Facilitate and coordinate the Core Sustainable Infrastructure Management Team
  - Lead the development of the asset management vision, policies, and framework elements
  - Facilitate and coordinate the asset management functions and practitioners from across the operation

The above responsibilities are substantial and require sufficient resources in order to execute properly. GHD recommends that at this time in MMSD’s Sustainable Asset Management development process, special consideration should be given to how the primary programmatic functions are accomplished. This should include the potential of adding staff members that report directly to the Sustainable Infrastructure Manager. Ideally, most programmatic functions would be consolidated under the Sustainable Infrastructure Manager. Table 14 lists the primary programmatic functions required.

**Table 14 Description of Sustainable Infrastructure Management Programmatic Functions**

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provide asset management leadership formally and informally.</td>
</tr>
<tr>
<td>• Develop and communicate the asset management vision, policies, framework, and procedures.</td>
</tr>
<tr>
<td>• Establish and maintain a sustainable asset management program.</td>
</tr>
<tr>
<td>• Participate in levels of service targets development.</td>
</tr>
<tr>
<td>• Champion and communicate asset management and asset data processes and procedures.</td>
</tr>
<tr>
<td>• Lead risk-based decision processes for managing assets.</td>
</tr>
<tr>
<td>• Develop and maintain MMSD’s Asset Management Plan.</td>
</tr>
<tr>
<td>• Participate in the development of MMSD capital program.</td>
</tr>
<tr>
<td>• Drive asset-related continuous improvement and communicate asset</td>
</tr>
</tbody>
</table>
### Description

- Manage performance results to MMSD leadership.
- Define technology requirements for asset database systems.
- Track and report benefits and value of the asset management program.

- Develop and implement asset management framework procedures for asset register development and risk evaluation.
- Perform asset life cycle cost analyses.
- Perform business case analysis for robust identification of project alternatives selection that provide the greatest overall benefit and risk reduction to the organization.
- Engage the front-line workforce in asset management approaches appropriate to operations, maintenance and field activities.
- Make asset knowledge available widely across MMSD through effective communication and delivering asset management training.
- Support asset reliability analyses.
- Identify potential capital investment projects based on asset data analysis.
- Develop and implement performance measures that can demonstrate asset management benefit to MMSD.
- Define the asset management skill requirements required for MMSD employees.
- Develop, implement and coordinate an asset management training program.
- Support the development of the division capital program based on asset management principles.
- Develop procedures for prioritizing work tasks, projects and programs.
- Develop the framework for managing the division’s relationships with consultants and contractors for planning, design, construction and operation of assets.

- Develop and maintain asset inventory, hierarchy and asset register.
- Develop and support the implementation of asset data standards including procedures for adding and retiring assets from the asset register.
- Be responsible for data accuracy and completeness.
- Coordinate with Operations, Engineering and Planning regarding asset register data and information for use in an AM decision making,
including providing data to support analyses such as asset management plan development and business case evaluations.

- Develop and implement procedures for data collection, asset condition assessment and collection of asset failure/performance information.
- Support and contributed to O&M reliability studies including developing strategies and techniques to enhance the effectiveness and efficiencies of operations and maintenance efforts.
- Based on management strategies developed in the AM program, assist in the development of maintenance procedures, job procedures and tracking preventative vs corrective work orders.
- Support the establishment and tracking of O&M related key performance indicators.

In addition to these direct programmatic functions, all departments within the MMSD organization participate in and contribute to asset management activities. GHD recommends that MMSD establish informal coordination relationships between the Core Sustainable Infrastructure Management Team and the six departments as shown in Figure 21. Please note that the model presented in Figure 21 is for a sustainable asset management governance model and does not represent a proposed change to the organizational structure as shown in Figure 19 above. An individual from each of these departments should be identified to serve as the asset management champion for their department (or Work Group in some cases). These individuals would be the point persons for implementing asset management practices and procedures developed by the Sustainable Infrastructure Manager and the Core Sustainable Infrastructure Management Team. The asset management unit champions would also participate significantly in training MMSD staff on asset management procedures as well as be responsible for leading or overseeing other asset management related functions such as data collection.
5.3 Leading Organizational Change Considerations

A key to a successful SAM implementation program is the incorporation of organizational change management principles. Effective change management drives successful transformation of strategy to process, technology, and performance improvements in ways that allow people to contribute meaningfully and feel part of the action. One effective model is Jeff Hiatt’s recognized ADKAR model for organizational change. The model is simple and proven and illustrates how people move through change in a predictable way. ADKAR stands for:

- **Awareness** of the need for change
- **Desire** to participate and support the change
- **Knowledge** on how to change
- **Ability** to implement required skills and behaviours
- **Reinforcement** to sustain the change

Table 15 shows some of the key elements for each of the five areas.
## Table 15 Key elements of ADKAR change model

<table>
<thead>
<tr>
<th>Awareness</th>
<th>Desire</th>
<th>Knowledge</th>
<th>Ability</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective communications</td>
<td>Effectively sponsor change with employees</td>
<td>Effective training and education</td>
<td>Day-to-day involvement of supervisors</td>
<td>Celebration and recognition</td>
</tr>
<tr>
<td>Executive sponsorship</td>
<td>Equip managers to be change leaders</td>
<td>Job aides, checklists, templates</td>
<td>Access to subject matter experts</td>
<td>Rewards</td>
</tr>
<tr>
<td>Coaching by managers and supervisors</td>
<td>Assess risks and anticipate resistance</td>
<td>One-on-one coaching</td>
<td>Performance monitoring</td>
<td>Feedback from employees</td>
</tr>
<tr>
<td>Ready access to information</td>
<td>Engage employees in the change process</td>
<td>Knowledge groups and forums</td>
<td>Hands-on exercises during training</td>
<td>Reviews and performance measurement systems</td>
</tr>
<tr>
<td>Align incentive programs</td>
<td></td>
<td></td>
<td></td>
<td>Accountability systems</td>
</tr>
</tbody>
</table>

There are several effective change models that have been developed and used successfully within the utility sector. The ADKAR model is just one of these. MMSD may elect to use this model or a different model as part of implementing technical, operational, procedural, or organizational changes associated with the SAM Program. An intentional and planned approach to enacting change has a much higher probability of success than doing so without.

All change models include emphasis on effective communication. The following are key elements of effective communication that should be implemented as part of the organizational change and alignment efforts.

- Visible, active and frequent leadership engagement.
- Frequent communications directed appropriately to managers, supervisors, foremen, and front line staff with the intention of make these enhancement topics regularly talked about by the staff.
- Emphasis that some business, technical, and operational processes will be different going forward with explanation for the reasons and benefits for the changes.
- Clear communication to all levels of the organization of answers to ‘What’s in it for me?’ type questions.
- Effective and sustained training opportunities to drive awareness and to be a catalyst for change, including a strong train-the-trainer program.
- Frequent updated communication to stakeholders such as Human Resources, IT, and Purchasing divisions so they are aware of potential support they can provide personnel, systems and projects.
- Frequent update communication with union representatives with the aim of enable proposed adjustments to roles and responsibilities to be understood and embraced.
- Frequent progress updates at various levels (including full department communication) with candid status updates (both positive and less positive progress information).
As each District SAMFIP activity is planned and executed, attention to these change principles and clear communication should be applied. In addition, identifying and fostering those in the organization who can act as champions for asset management will yield accelerated results over the case where asset management is only implemented top-down from the leadership or governance committee. As respected and credible individuals within the organization visibly demonstrate support for and early adoption of asset management, the pace of embedment of the new processes will increase. Conversely, attention should be paid to monitoring for pockets of resistance and intervening with the help of champions quickly and effectively to minimize the chance of a significant roadblock and to demonstrate leadership commitment to moving forward with the new approaches.
6. **Data and Information Technology Support Requirements**

In order to implement the SAM Framework presented in Section 4, MMSD will need to make some modifications and improvements to its data management and information technology (IT) systems. Business process improvement as described in Section 4 is ideally done as a precursor to any technology development and changes to organization design or governance models.

MMSD is beginning the process of developing an IT and a GIS Strategic Plan. In an effort to inform those planning processes MMSD should develop an Asset Management Information Systems (AMIS) requirements document as part of the development of the AMIP.

### 6.1 Technology and Data Management

**Policy Statement** - We will embed sustainable asset management practices throughout the organization and develop a long-term sustainable funding strategy.

**Objectives:**

- Provide information technology (IT) and data management support.
- Allocate resources to effect the continued development and implementation of an asset management program.
- Provide training as needed on asset management processes and procedures.

Technology assets (hardware, connectivity and software) are enablers of the key business processes at MMSD. They allow staff to improve their productivity and capture key asset knowledge to support daily activities. Making the right choices in technology assets requires a focus on the following:

- Developing functional requirements that are consistent with desired business processes and workflows
- Developing technical requirements that meet corporate standards (e.g., operating systems, databases, etc.)
- Following a rigorous standard for selecting the right system and vendor partners to meet MMSD’s needs

An AMIS requirements document is critical and helps enable a rigorous implementation process and systems that are properly configured to the redesigned business processes discussed above. The AMIS requirements document considers workflows, business rules, and value lists with choices that reflect leading practices (e.g., condition rating grades). Standard and specialized queries and reports are developed as part of the system configuration process. Attention to system testing, training and managing the overall change process is essential to successful implementation.

Implementation also requires the development of a data model that provides input on:
• Fixed asset register content
• Asset hierarchies/parent-child relationships (satisfying budget and cost roll up, capital planning, system monitoring and LOS reporting)
• Interface requirements that help minimize duplication of data entry and maximize automated data analysis and reporting
• Database rationalization

System integration is also a key implementation activity. The need to enter data once and provide access to others who need the data to support their work activities requires definition and development of system interfaces based on acceptable system architecture. System integration also provides the platform where business intelligence software can enable performance management and allow decision makers to leverage data for value creation. This will help MMSD achieve the goal of becoming both data and knowledge rich.

6.2 SAM Information Technology Considerations

As part of the March 2015 workshops, a discussion with IT stakeholders at MMSD was conducted to better understand SAM IT considerations for implementation. The following is a summary of this discussion, which is also presented in the minutes included in Appendix B.

The project team used the Five Core Questions in the discussion to identify the IT solution needs for MMSD Asset Management Program.

Question 1 – What is the current state of my assets?
• Need a better process for adding and retiring assets in WAM (including commissioning).
• Need a tool(s) to collect condition assessment data at the plant/facility. Identifying a data storage process is key for others to be able to access the data. There is also a need to translate PACP/MACP to a standard Condition Rating System.
• Need to collect PCS/DARC data into the WAM. (DARC pulls PCS data and then summarizes those data according to procedures created within DARC. WAM then pulls summarized data. I am mentioning this because issues with DARC data stewardship are currently resulting blocks to getting good data into WAM. Efforts needed to improve data management and processing would be helpful in generating good data for the related assets.)
• Need to have improved processes for asset management data such as physical effective life, failure cause, remaining life, decay curve, and replacement costs.
• Access to asset data is needed through the GIS platform.
• There needs to be availability and easy access to asset record documentation (e.g., as-built drawings, O&M manuals, easements).
• Reporting functionality needs to include exportability of the content and flexible format configuration to match needed output objectives
• Training for new and updated processes is needed.

Question 2 – What are my required levels of service?
• Important metrics needs to be reported out via a dashboard.
• Within Level of Service Data Management, there needs to be the ability to identify the data sources that contribute to the LOS and there needs to be consistent processes for updating data.

**Question 3 – Which assets are critical to sustainable performance?**

• A COF scoring tool (BI) and data management for COF attributes are needed.
• Spatial analysis tools (GIS) are needed.
• Risk BI/ tool is needed.

**Question 4 – What are our best O&M and Capital Strategies?**

• A planning level renewal, replacement, and forecasting tool is needed that has what-if analysis capability.
• A business case evaluation tool is needed
• A project packaging and prioritization/ rating tool is needed.

**Question 5 – What are our funding requirements?**

• There needs to be an efficient way of presenting and reporting on financial requirements.
• The ability to forecast operational and not just capital costs is needed.
• The ability to aggregate data into Nessie Curves is needed.

The above IT solution needs will be considered in the development of the AMIS requirements document and should be an input into the development of the IT and GIS Strategic Plans.
Appendices
Appendix A – Sustainable Asset Management Policy

Sustainable Asset Management Policy
The Madison Metropolitan Sewerage District (MMSD)’s guiding principles for sustainable asset management are the following:

1. Understand and manage the current state of our assets, including condition and remaining life.
   • Know what assets MMSD owns and for which assets we have responsibility or legal liability. MMSD will record these assets in an asset register down to a maintenance-managed item (MMI) level.
   • Monitor the condition, performance, use and cost of infrastructure assets down to the appropriate level and against prescribed service levels and regulatory requirements.

2. Understand and manage our level of service (LoS) to our customers.
   • Understand and record the current levels of service with which we provide our customers. We will define target future levels of service required in order to continue to serve our customers for the long term.
   • Understand customer expectations including the regulatory (e.g., compliance, water quality, public health, etc.) and non-regulatory aspects of our business (e.g., noise, customer service, appearance, cleanliness, customer outreach).

3. Understand and manage our business risk exposure (BRE).
   • Focus emphasis on those infrastructure assets that are critical to our service levels and prioritize their management to prevent their failure. (This is not to imply that non-critical assets are ignored.)
   • Identify, understand, and manage the risks associated with running the utility.

4. Prepare asset management plans for capital and operational strategies.
   • Prepare an asset management plan for the Nine Springs WWTP and an asset management plan for the Collection System. Together, these two asset management plans will constitute the asset management plan for the organization.
   • Create the asset management plans as living, active documents. Investment projections from the asset management plans should be reviewed and validated on an annual basis. The asset management plan is intended to be updated as needed on a periodic basis every 5 to 10 years.
   • Understand the total cost of service delivery, including financial, social and environmental costs.

5. Embed sustainable asset management practices throughout the organization and develop a long-term sustainable funding strategy
   • Develop funding strategies to sustainably manage the utility. MMSD will monitor and report in Triple Bottom Line terms (financial, environmental, social/community/organizational).
   • Link MMSD’s organizational and asset management strategic goals to asset related investments and action plans.
   • Use validation processes to evaluate planned investment in capital projects, maintenance programs, operations and associated support services, as well as their impact on rates (including business cases, decision support systems, etc.).
   • Establish an appropriate governance model with defined roles and responsibilities to sustain asset management practices.
   • Provide information technology (IT) and data management support.
   • Review progress to continuously improve our asset management performance.
   • Allocate resources to effect the continued development and implementation of an asset management program.
   • Provide training as needed on asset management processes and procedures.
## Appendix B - (Envision™ Rating Tables)

### RA2.1 REDUCE ENERGY CONSUMPTION

**INTENT:**
Conserve energy by reducing overall operation and maintenance energy consumption throughout the project life cycle.

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<td>(3) 10% to 30%. During the planning and design phases of the project, the owner and the project team conduct one or more planning or design reviews to identify and analyze options for reducing energy consumption in the operation and maintenance of the constructed works. Operational energy reductions are estimated at 10% to 30% as compared to industry norms. (A, C)</td>
<td>(7) 31% to 50%. During the planning and design phases of the project, the owner and the project team conduct one or more planning or design reviews to identify and analyze options for reducing energy consumption in the operation and maintenance of the constructed works. Operational energy reductions are estimated at 31% to 50% as compared to industry norms. (A, B, C)</td>
<td>(12) 51% to 70%. During the planning and design phases of the project, the owner and the project team conduct one or more planning or design reviews to identify and analyze options for reducing energy consumption in the operation and maintenance of the constructed works. Operational energy reductions are estimated at 51% to 70% as compared to industry norms. (A, B, C)</td>
<td>(18) Greater than 70%. During the planning and design phases of the project, the owner and the project team conduct one or more planning or design reviews to identify and analyze options for reducing energy consumption in the operation and maintenance of the constructed works. Operational energy reductions are estimated at greater than 70% as compared to industry norms. (A, B, C)</td>
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### RA3.1 PROTECT FRESH WATER AVAILABILITY

**INTENT:**
Reduce the negative net impact on fresh water availability, quantity and quality.

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<td>(2) No immediate negatives. The design team determines how much fresh water will be used by the project both during construction and operations. Look for opportunities for reuse, and its effects on local surface water and groundwater including groundwater flow and quality. Consider peaks in short term usage. Some strategies regarding long term impacts, but mostly extrapolation of current estimated usage. (A, B)</td>
<td>(4) Good water management. Design the project to access and control water usage over average maximum conditions, with plans to offset peak withdrawals during lower water need periods. Influent water meets minimum standards with chemical and physical conditions maintained during lower water need periods. Meets the requirements of aquatic species and sensitive aquatic species. (A, B, C)</td>
<td>(9) Wise water management. Design the project to access and control water usage over average maximum conditions, with plans to offset peak withdrawals during lower water need periods. Meets the requirements of aquatic species and sensitive aquatic species. (A, B, C)</td>
<td>(17) Total water management. Design delivery and operations maintained such that there is no net impact on water supply volumes, including managing runoff to recharge local groundwater and surface water supplies in a manner that offsets withdraws. Freshwater and surface water supplies are replenished in excess. Discharges to receiving waters meet quality and quantity requirements of historic high value aquatic species. Methods may include closed loop recycling of water within the project. (A, B, C)</td>
<td>(21) Positive impact. Replenishes the quantity and quality of fresh water surface and groundwater supplies to an extent that ecosystem condition, retirement and development potential is not reduced. Discharges to receiving waters of freshwater after use, meets historic pre-development seasonal cycles of quality and quantity, including temperature. (A, B, C, D)</td>
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CR1.2 REDUCE AIR POLLUTANT EMISSIONS

INTENT:
Reduce the emission of six criteria pollutants; particulate matter (including dust), ground level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, lead, and noxious odors.

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<td>(2) Improved air quality standards. California standards are more stringent than NAAQS, and address additional pollutants beyond the six common air pollutants. Meet CAAQS standards for all project activities. Create a maintenance program to ensure that these standards remain met throughout the life of the project. (A)</td>
<td>(6) Enhanced air quality standards. Meet SCIAQS rules in section XI and XIV, as applicable, for Source Specific Standards and Toxic and Other Non-Criteria Pollutants. (B)</td>
<td>(12) Negligible air quality impact. Project has only negligible air pollution impacts or no zero impacts from criteria pollutants. (C)</td>
<td>(15) Air quality improvement. Project not only achieves zero net production of criteria pollutants but implements measures to improve existing air quality to a level higher than pre-development. (C)</td>
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LD1.4 PROVIDE FOR STAKEHOLDER INVOLVEMENT

INTENT:
Establish sound and meaningful programs for stakeholder identification, engagement and involvement in project decision making.

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<td>(1) Information transfers. A limited program established for stakeholder communication and information transfer. Programs provide a basic exchange of information about the project. Lines of communication established. Some limited community involvement. Feedback to the community; but essentially a summary of community input. Some planning and commitment to action, actions taken based on input received. (A, B)</td>
<td>(5) Active engagement and dialogue. Communication with and feedback from project stakeholders and the affected public are important elements of the project. Lead persons work with the project group to understand communication needs, potential for involvement. Active engagement and dialogue is planned. Feedback received is compared against impacts to the project. Actions taken are based on practical project considerations and focused less on project disruption than community stakeholder feedback. (A, B)</td>
<td>(9) Open to a wider community. Engagements expand to a wider community, people and relevant groups that are affected by or have an interest in the project. Frequent communication with the public and stakeholders, through significant project phases. Feedback received through solid, credible programs for obtaining stakeholder and community feedback. Feedback is assessed and applied to project decisions. Actions taken are based on community/stakeholder feedback, modified by feasibility. Public and stakeholder groups are sufficient and credible opportunities for involvement in project decision-making. Demonstration to stakeholders and the public that the public participation process is transparent and that they have an opportunity to provide meaningful input. (A, B, C)</td>
<td>(13) Community relationship building. Communication programs and strategies are designed to develop relationships with the key stakeholders, involvement in the project decision-making processes. Solid, credible programs for soliciting feedback from the public and key stakeholders, regarding communications and public involvement in the project decision-making processes. Project can demonstrate specific and significant criteria by which changes were made based on feedback. Given the likely broad array of issues and positions, the project team focuses on not only obtaining meaningful input, but also buy-in that the process for making project decisions is fair and equitable. Built properly, these relationships can assist in breaking project logjams. Feedback programs are designed to give complete, credible feedback regarding the communications and public involvement processes. Project decisions incorporate fairness and equity. (A, B, C, D)</td>
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**LD2.1 PURSUE BY-PRODUCT SYNERGY OPPORTUNITIES**

**INTENT:**
Reduce waste, improve project performance and reduce project costs by identifying and pursuing opportunities to use unwanted by-products or discarded materials and resources from nearby operations.

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<td>(1) Casual search and diversion. Identification and characterization done on a limited set of nearby facilities, waste streams. Candidate facilities and by-product possibilities identified but little work done in assessing the potential. Availability of excess resources and energy unclear. Assessment done but limited in depth, and only if by-product synergy possibilities seem obvious. Mostly a paper assessment. Studies and assessments are made, but managers of nearby facilities may be contacted. However, identification and screening efforts are limited. (A, B)</td>
<td>(3) Affirmative program. Owner and project team management demonstrate an appetite and inclination to address by-product synergy opportunities. Efforts to identify candidate facilities and by-product possibilities are broad and reasonably comprehensive. More aggressive searching and screening of opportunities. Assessment done in some depth. Facilities and possibilities identified. Contacts with facility decision-makers to assess the potential are spotty. (A, B, C)</td>
<td>(5) Opportunity foresight and pursuit. Broader and comprehensive efforts to identify managers of facilities nearby who may have by-products or discarded materials that can be used on the project. Assessment done in sufficient depth to determine possibilities. Decision-makers contacted and pursued. Systematic assessment. Knowledge of the availability of excess resources and energy, other possible synergies is clearly identified. Research into region-by-region by-product synergy projects. Aggressive searching and screening of opportunities. (A, B, C)</td>
<td>(12) Opportunity pursuit and capture. Aggressive searching for by-product synergy possibilities is a significant project element. Owner and project team understand the principles of industrial ecology. Facility decision-makers identified and contacted to assess the potential. Relationships developed. Active discussions with managers of nearby facilities to pursue by-product synergy opportunities. Constructive discussions with regulatory agencies, policy or standards-setting organizations regarding potential conflicts with regulations, policies and standards. Considerations in forming relationships with nearby facility managers to implement industrial ecology practices, i.e., long term supply of facility by-products for use in the operation of the constructed works. One successful by-product synergy application. (A, B, C, D)</td>
<td>(15) Additional synergy opportunity captures. Successful negotiation with managers of nearby facilities for securing two or more of their unwanted by-product supplies. Material supplies can be for short-term project construction or for long-term operation of the constructed works. (A, B, C, D)</td>
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**QL2.1 ENHANCE PUBLIC HEALTH AND SAFETY**

**INTENT:**
Take into account the health and safety implications of using new materials, technologies or methodologies above and beyond meeting regulatory requirements.

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<td>(2) Assessment of new requirements. In addition to the health and safety plans and programs put in place as required by law and regulation, the owner and the project team identify, assess and include new standards, methods and procedures to address any additional risks and exposures created by the application of new technologies, materials, equipment and methodologies. Requirements are passed down to the construction contractor in the form of construction specifications. (A, B, C)</td>
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## QL2.2 MINIMIZE NOISE AND VIBRATION

### INTENT:

Minimize noise and vibration generated during construction and in the operation of the constructed works to maintain and improve community livability.

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<td>(1) Studies, predictions. Conduct baseline studies of existing levels of noise and vibration specified in the project for construction and operations. Predictions of levels of noise and vibration based on proposed project silting and design are produced. (A)</td>
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<td>(8) Achieving acceptable levels. Proposals for mitigation of airborne and ground-borne noise and vibration to acceptable levels in the affected community are created based on studies and determination of the noise goals of the affected communities. Proposals are presented, approved and incorporated into the project designs. Project team sets construction specifications for noise and vibration limits. Programs to monitor noise and vibration during operation are established. (A, B, C)</td>
<td>(11) Creating quieter communities. The project is designed in such a way as to reduce ambient noise in the area. As a result of the project and the completed works, noise levels in the community have been substantially reduced below previous levels, and at least to affected community noise objectives. Specifications set for noise and vibration during construction take into account community needs. (A, B, C)</td>
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