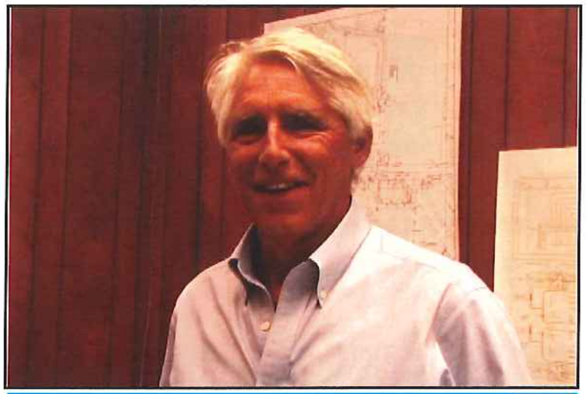
Chapter 1

INTRODUCTION

1.1 What is Asset Management?



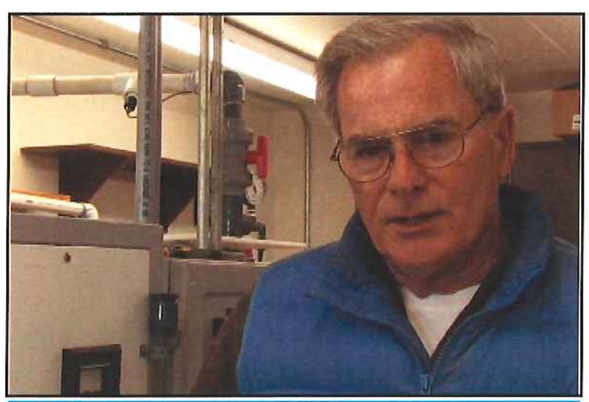
It's not a software program.
--Jim Smith, Louisville, KY IN-1

In the simplest terms, Asset Management can be thought of as applied common sense. Asset Management is designed to help people decide how and where to spend their money to achieve the desired results. Such a process is needed when there are competing priorities for limited funding.

As an analogy, think of your car. If you are driving your car and it gets a flat tire, what will you do? Will you fix the car or buy a new car? Because tires are inexpensive compared to the overall cost of a car, the most likely response is to repair the tire or put a new tire on the car. Think about what factors would go into a decision like this: the cost of the tire, value of the car, reliability of the car, and whether the flat tire caused any other damage to the car. However, in general, deciding what to do in this case is pretty simple.

What if instead of a flat tire, your car has a cracked engine block. Now what will you do? Will you fix the engine, put a new engine in the car, or buy a new or used car? Is it more difficult to decide what to do in this case? Why? Probably factors like cost of repair, cost of new engine, value of existing car, cost of a new or used car, reliability of existing car, value of existing car, current operation and maintenance cost, and many others would enter into the decision. This decision would involve collecting data and examining all the options over time.

If all of your decisions were like the tire example, you wouldn't need a formal program to help you make them. Unfortunately, you will have many decisions that are more like the cracked engine block. Funds are limited and there are many competing priorities for those limited dollars. Therefore, a program that will help you collect the data you need and provide a framework for making these decisions is very beneficial. Asset Management is designed to be this type of program.



Will you have enough money, by the time it fails, to fix it?
--Mike Daley, Gallup, NM IN-2

Asset Management is maintaining a desired level of service (what you want your assets to provide) at the lowest life cycle cost (best appropriate cost - not no cost.) Asset Management provides a set of tools and practices that can assist a utility in operating, maintaining, and managing assets in a cost-effective, sustainable fashion. The reasons a utility may wish to operate in this fashion include:

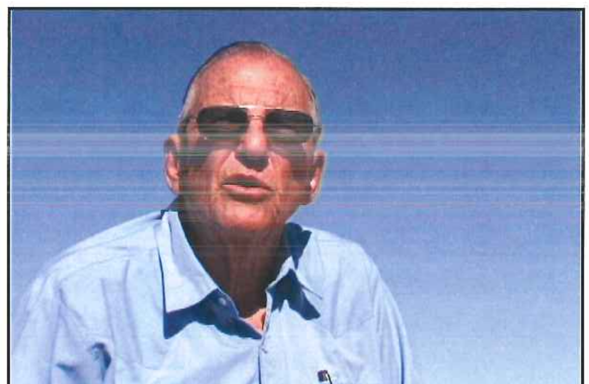
1) Water and wastewater assets represent a major public or private investment. In small communities, these assets may be the largest investment.
2) Well-run and efficient infrastructure is important to economic development.
3) Proper operation and maintenance of a utility is essential for public health and safety.
4) Utility assets provide an essential customer service.

There are five core components of Asset Management:

- What is the Current State of the Assets
- What is the Desired Level of Service
- Which Assets are Critical to Sustained Performance
- What is the Best Life Cycle Cost
- What is the Long-Term Funding Strategy

Each of these core components is described in detail in Chapters 3 through 7. Information regarding implementing Asset Management, the human aspects of Asset Management, and resources to assist utilities is also included in the guidebook.

Additionally, this guidebook includes considerations of energy efficiency throughout each of the components. The process of Energy Efficiency Management follows a similar framework to Asset Management, so following this guidebook will provide the utility with the tools to develop a comprehensive program of managing its assets in a cost-effective, environmentally- sound and energy-efficient manner.



It's mostly using common sense.
--Larry Covington, Picacho, NM IN-3

The Asset Management program described in this guidebook is compatible with the Environmental Protection Agency's Advanced Asset Management Training and current international practice in Asset Management. Further information on EPA's training can be found at the following web site: http://water.epa.gov/type/watersheds/wastewater/index.cfm
The international approach can be found in the International Infrastructure Management Manual prepared by the NAMS Group in New Zealand.

1.2 Benefits of Asset Management

The intent of Asset Management is to ensure the long-term sustainability of the water or wastewater utility. By helping a utility manager understand what assets the utility owns in order to make better decisions on when it is most appropriate to repair, replace, or rehabilitate particular assets and by developing a long-term funding strategy, Asset Management can assist the utility in ensuring its ability to deliver the required level of service far into the future.

There are many positive benefits of Asset Management. Utilities that fully embrace Asset Management principles may achieve many or all of these benefits. Some benefits may be achieved just by initiating Asset Management activities.

Some of the potential benefits of Asset Management are listed below and discussed in the following short videos. However, the type and extent of benefits that can be realized through implementing an Asset Management program are unique to each utility and community. The benefits that you achieve in your utility will depend on which aspects of the program are most important to you, where you focus your efforts, and the needs of your community.

IN-4  **Better operational decisions**

IN-5  **Improved emergency response**

IN-6  **Greater ability to plan and pay for future repairs and replacements**

IN-7  **Increased knowledge of your assets**

IN-8  **Increased ability to justify needs and prioritize decisions**

IN-9  **More efficient operation**

IN-10  **Better communication with customers**

IN-11  **Better communication with governing body**

IN-12  **Increased acceptance of rates**

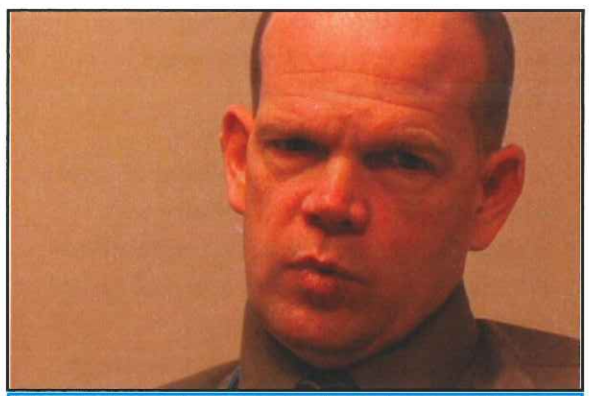
IN-13  **Capital improvement projects that meet the true needs of the utility**

1.3 Energy Efficiency

A utility has the responsibility to its customers to deliver service at the lowest possible cost and with the least impact to the environment. Water and wastewater utilities require large amounts of energy to operate, and energy represents the largest controllable cost in a utility's budget. An enhanced, comprehensive Asset Management program that incorporates energy efficiency and greenhouse gas or carbon footprint reduction goals will be a much more effective tool than either an Asset Management Program or Energy Efficiency Management by themselves. Including energy efficiency objectives within an Asset Management program makes sounds business sense, is environmentally responsible, and contributes to the sustainability of the community.

... starting an Asset Management Program, I would definitely try to correlate energy management into that program.
--Russell Batzel, St. Peters, MO
IN-14

A complete inventory of each asset and its respective functionality, including its energy use and environmental impacts, will allow the utility to make operational decisions based not just on asset life-cycle but also on that asset's impact on the utility's overall energy efficiency plan. An asset that is not performing optimally will almost always have a negative impact on energy efficiency. While energy efficiency programs generally focus on utility components that are connected to a power source, a comprehensive Asset Management program considers the total cost and energy impact of asset use. This will include assets that, through under-performance, may waste energy in ways that are not directly measured at the power meter. For example, a leaking pipe that wastes water is also wasting the energy used to pump and treat that water prior to entering the pipe. And whatever wastes energy will likely waste money, and increasingly so as energy costs inevitably rise.



When we have the opportunity to incorporate energy efficiency, we wanted to do that.
--Steve Hunt, Columbia, MO
IN-15

With the growing emphasis on energy conservation and environmental impact, it is crucial for utilities to incorporate these important factors into operational strategies. Incorporating energy evaluations and energy efficiency measures into the Asset Management plan from the outset is an efficient and effective way to take responsible action for energy efficiency as well as operational and financial efficiency.

1.4 Intended Audience

This guide to Asset Management can be used by any water and wastewater utility, but it is geared primarily toward small to medium-sized utilities. For utilities that wish to have a more robust Asset Management program, there are other guides, resources and consulting services that can help implement a more sophisticated program.
This guidebook contains all the basic elements of Asset Management, and discusses implementation as well as the human aspects of Asset Management. Utility employees at all levels should be able to use this guidebook, including operations or management personnel, elected officials or board members.

1.5 Asset Management IQ

This guidebook includes a self evaluation tool, called the Asset Management IQ. This tool will help assess progress in Asset Management activities. The tool has a total of 30 questions: 5 general questions (at the end of this chapter) and 5 questions for each of the 5 core components (chapters 3, 4, 5, 6, and 7). These questions are designed as a review of the important concepts of each of these components. Each question has a description of 6 possible levels of completion or practice. Reviewing these questions and the answers will help you understand where you need to focus your efforts toward implementing an Asset Management Plan and will prepare you for taking the full IQ test in Appendix F.

The IQ test in Appendix F can be taken electronically or printed out and score manually on paper.

If the user completes the entire Asset Management IQ tool (all 30 questions) before starting Asset Management, it will provide a baseline evaluation at the beginning of Asset Management. Comparing the scores of each of the six sections will show which areas have the biggest gaps in terms of Asset Management activities. These scores may provide information about where efforts should be focused. You may wish to start with areas that are the weakest, offering a large improvement with a little effort, or with areas that are already strong, which would offer a chance to get started in a familiar area.

As the utility progresses, the Asset Management IQ can be repeated and the scores compared to previous scores. At a minimum, you may wish to repeat the Asset Management IQ every year.

It should be noted that a total score of 150 would represent best practice in all areas of Asset Management. Not all utilities will be committed to achieving this goal. The utility should set its own target levels. The tool is meant to help utilities gauge their progress over time.

Asset Management IQ

Section I: General Asset Management

A. Is Asset Management terminology understood throughout the organization?

	No one within the organization understands terminology nor has any knowledge of Asset Management concepts.
	One person within organization understands Asset Management concepts and terminology.
	Less than 50% of the organization's personnel (a few key people within the organization) understand Asset Management concepts and terminology.
	More than 50% of the organization's personnel understand Asset Management concepts and terminology.
	All[1] of the organization's personnel understand Asset Management concepts and terminology.
	Throughout the entire organization personnel would be able to state what Asset Management is and understand Asset Management concepts and terminology.

[1]All refers to greater than 90% of the organization's personnel.

B. Does the organization have a clearly defined Asset Management Plan?

	The organization does not have a written Asset Management Plan nor a concept of what the plan would include.
	The organization has a concept of the plan but has not written the plan.
	The organization has written less than 50% of the plan.
	The organization has written more than 50% of the plan.
	The organization has a written plan but has not distributed it within the organization.
	The organization has a written plan and it is distributed throughout the organization.

C. Is Asset Management fully embraced by the elected officials or governing body of the organization?

	The governing body opposes Asset Management.
	The governing body does not understand Asset Management, but is not opposing it.
	The governing body is aware of Asset Management, but is not yet ready to provide support.
	The governing body supports Asset Management in general but has not mandated it for the organization in any way.
	The governing body has passed a resolution or has otherwise mandated asset Management and provides some support for the organization's Asset Management efforts, but has not provided sufficient funding for Asset Management and/or is not yet making decisions using Asset Management principals.
	The governing body has passed a resolution or has otherwise mandated asset management and fully supports the organization's Asset Management efforts, including providing the funding for Asset Management and making decisions using Asset Management principals.

D. Does the organization have a strategy for communicating the Asset Management strategy throughout the organization?

	The organization has no strategy for communicating Asset Management throughout the organization.
	The organization has some ideas for communicating Asset Management but has not documented or implemented any of them.
	The organization has a written strategy and has implemented less than 50% of the communication strategies.
	The organization has a written strategy and has implemented more than 50% of the communication strategies.
	The organization has a written communication strategy to share information with all levels of staff and it is fully implemented.
	The organization has a written communication strategy to share information with all levels of staff, it is fully implemented and feedback has been received.

E. Does the organization have an overarching goal or mission statement for Asset Management?

	The organization does not have an overarching goal or mission statement.
	The organization recognizes the need for an overarching goal or mission statement but has not yet begun working on it.
	The organization is working on an overarching goal or mission statement.
	The organization has an overarching goal or mission statement for Asset Management that is accepted by the governing body, but it is not known at all levels of the organization, and is not clearly communicated to the public.
	The organization has an overarching goal or mission statement for Asset Management that is accepted by the governing body, and is known at all levels of the organization, but it is not clearly communicated to the public.
	The organization has an overarching goal or mission statement for Asset Management that is accepted by the governing body, known at all levels of the organization, and it is clearly communicated to the public.

Chapter 2

ASSET MANAGEMENT
THE WAY TO DO BUSINESS

2.1 The Way to Do Business

Asset Management must become the way a utility does business. It cannot be something the utility does on the side as one of its many activities. Asset management thinking must underlie every activity, every action, and every decision that the utility undertakes. The Asset Management Plan must not be a theoretical document that overlays "business as usual" or a top-down decree that the utility staff views as an unnecessary burden. Nor can it be a methodology used by middle managers that is unknown to or unsupported by the governing body. It must be the paradigm from which all personnel, from elected officials or board members to managers, administrative staff, and operators, think about how they do their job.

What we call Asset Management...is just something that they take for granted.
--Kevin Campanella, Columbus, OH
WB-1

This is kind of our life blood right here, and that's why we do it.
--Dave Allen, Portsmouth, NH
WB-2

2.2 Achieving "Buy-In"

We're gonna do everything we can.
--Dan Scherer, O'Fallon, MO
WB-3

Having Asset Management underlie all of the utility's activities means that there must be "buy in" for the Asset Management concepts at all levels of the utility from the field staff to elected officials or owners. Every employee should understand that Asset Management is important to the overall function of the utility. If there is insufficient acceptance of Asset

Management, the plan will be much less successful or may not succeed at all.

You really have to listen from the bottom up and the top down
--Stan Allred, Albuquerque, NM

WB-4

One way to obtain acceptance of Asset Management is to explain the overall goal of the utility's Asset Management strategy to each employee or volunteer and how that particular employee will participate in the process. When Asset Management is adopted as the way of doing business, each employee's input, knowledge and expertise is important to the process and all are crucial to the successful implementation.

Each activity that is undertaken must have Asset Management thinking at its core. For example, when working on the water utility to fix a break, the operator should have a map of the utility and indicate on it the exact location of the break. The operator should note all information pertinent to the Asset Management program, such as: location of break, type of break, type of pipe, type of repair, length of time from report of leak to response to scene, length of time to repair the pipe, materials used, and difficulties encountered. This information can then be used in many ways. Did the same pipe break multiple times? Has the utility experienced more breaks on one type of pipe than another? Did the operator respond in a timely manner? Did the repair get fixed in a timely manner? By tracking this type of data a utility manager can begin to develop a more comprehensive picture of the overall utility and its operation.

Another example is a customer complaint. When the utility receives a customer complaint, it should track various items such as: What routine maintenance or operational activities were taking place in the time frame before the complaint? Is there any unusual condition that would cause this type of problem? Has this complaint been made before? Is there a pattern of complaints of this type (same area, same source, etc.)? Has an operator been dispatched to check out this type of complaint? How long did it take to respond?

Throughout the entire utility – whether it has 3 employees or 300 – every employee or volunteer should be considering how their activities impact the overall operation of the utility and how their activities fit within the broader structure of the Asset Management and energy use plan.


WB-5


WB-6


WB-7

One of the best approaches to receiving buy-in or acceptability of the Asset Management program at the water or wastewater utility is to demonstrate successes using the Asset Management techniques. There are many small successes that the program may demonstrate that can be used to convince even reluctant employees or volunteers that the efforts will benefit the utility. As an example, producing a map showing the utility's assets in a visual format can be of great benefit to the utility, especially if there has never before been a comprehensive map showing these assets.

2.3 Obstacles

Because implementing Asset Management requires changing the way the entire utility does business, it requires that employees change the way they think about their jobs and their relationship to the rest of the organization. This can be difficult for many people. Some employees may be reluctant to change methods that have worked in the past. Others may be anxious about the security of their jobs.


WB-8


WB-9


WB-10

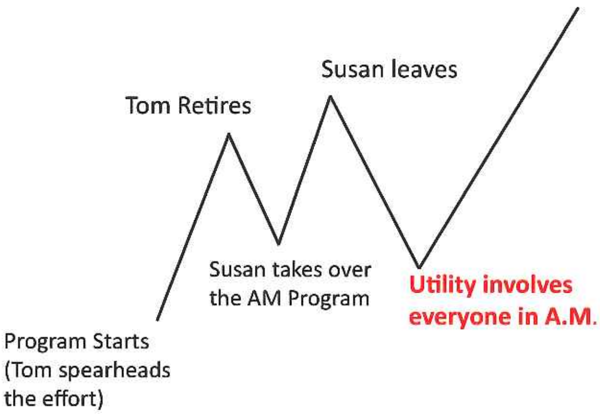
Some may not understand the concepts, or view it as just another management fad or gimmick. Still others may be afraid they will be assigned extra duties to overload their already-full work schedule, or feel overwhelmed by its scope. Elected officials may be wary of extra cost.


WB-11


WB-12


WB-13

Because any new way of doing business is bound to encounter obstacles, it is important that those in charge of the implementation process develop ways to overcome those obstacles and ensure the buy-in of all concerned. If this is not successful, the utility may experience what is known as the "saw-tooth effect" *(Ross Waugh, 2010)* in which the utility makes great strides in the beginning because of the enthusiasm and dedication of one or a few individuals . But when those individuals leave the utility through retirement or for other reasons, or if they grow tired of carrying the full load of implementation, the utility may experience a severe drop in the progress made in Asset Management. There may be a subsequent increase in interest when others take up the effort, but this up and down movement is inefficient and wastes valuable resources that could be put to good use to further progress towards the goals of efficiency and sustainability.



It hasn't embedded in the culture of the organization, so as soon as they lose that resource or that particular individual, the practice drops right back down again WB-14
--Ross Waugh, New Zealand

It is therefore extremely important to ensure every member of the organization is familiar with and accepts the goals of the program. This can be done with presentations, videos, trainings, posters, or any other informational method that reaches the employees. The best way to overcome these obstacles and secure buy-in is to involve every member of the organization in the implementation. When people are involved and have a voice in decision-making, they feel a sense of ownership. When their ideas are heard and considered, they will support the final product, even if their specific ideas are not included in the final plan. In addition, the synthesis of many ideas will create a more robust program than top-down decrees from management personnel who may not be fully aware of the issues faced by field personnel.

If you want support, involve people. WB-15
--Robert Moore, Webb, NY

2.4 Work Smarter Not Harder

Asset Management may first appear to be the type of program that will require personnel to take on more work and be overtaxed and it may seem as though there is no way to ever fit these extra duties into an already tight schedule. Asset Management is not meant to be a burdensome activity. It is actually quite the opposite. It should provide tools that change what you do and how you do it so that you become more efficient and effective, have more planned activities and less reactionary activities, and make better decisions. Asset Management is designed to allow you to work smarter not harder.

There may be times in the short term that Asset Management activities require a little additional time or effort to allow you to transition from the "old way" of doing things to an Asset Management way of doing things, but the time spent will be worth it in the long run.

The single biggest factor that will make you successful in your Asset Management endeavors is to open your mind to a new way of thinking about your assets and how you manage them. Changing your thinking, alone, will have a big impact on how you operate and manage your utility.

It ultimately changes the way you do business. You tend to become a lot more holistic and integrated.
--Ross Waugh, New Zealand

WB-16

What are the Obstacles to "Buy-In" in Your Utility?

______ **It's too expensive.**

______ **It takes too much time.**

______ **It's too complicated.**

______ **It won't work here.**

______ **We're too small to do this.**

______ **We're too big to do this.**

______ **It's just one more management fad.**

______ **I already have too much to do.**

______ **The Council will never approve it.**

______ **Our customers don't want us wasting our time this way.**

Chapter 3

CURRENT STATE OF THE ASSETS

3.1 Introduction

The first core component of Asset Management is assessing the current state of the assets. This component is probably the most straightforward. It is also, arguably, the most important as it underlies all other aspects of Asset Management. This step is critical to improving the water or wastewater utility's understanding of its system. Completing this step alone can greatly improve the overall operations and management of a utility.

This core component involves gathering information on the following basic questions:

- What assets do I own?
- Where are they?
- What condition are they in?
- What is their remaining useful life?
- What is their value?
- What type and amount of energy do they use?

Get a handle on what you have.
--Eric Saylor, Cincinnati, OH
IV-1

After the key information on assets is gathered, it is important to create an asset inventory to store the data. This inventory will need to be maintained to ensure it is kept up to date and accurate. The utility may also want to establish a work order system that is tied to the asset inventory to manage asset maintenance and repairs and to track the costs of these activities over time.

3.2 What Do I Own?

The most fundamental question a utility owner, manager, or operator can ask, is what assets does the utility own? It is absolutely critical to understand what you own. It is hard to manage something effectively if you don't know what that "something" consists of. Although "what do I own" is a seemingly straightforward question, it is not always easy to answer. The difficulties arise from several factors. Some of the assets are underground and can't be seen; assets are put in over a long period of time; records regarding assets may be old, incomplete, inaccurate, or missing; and staff turnover in operations and management may limit historical knowledge of utility assets. Given these difficulties, it may not be possible to immediately create a complete inventory of all the assets in the utility. It is important to recognize that the goal is to create the best inventory possible given the resources (personnel and financial) and capabilities of the utility and to develop an approach to adding to or improving the inventory over time.

In determining the answer to the

question, "What do I own?" consideration must be given to how to specifically define an asset. In general terms, assets are anything that you own that has value. However, this definition must be refined for a given utility. Some utilities may want to define assets in terms of dollar amounts. An asset could be defined as anything above $1,000 or $2,000 or any other amount that makes sense for the utility. In selecting this value consideration should be given to the total number of assets owned by the utility and the ability of the utility to track the number of assets that will result from the selected dollar amount. For example, defining an asset as anything with value over $500 may result in 2,000 assets for the utility, while selecting a value of $3,000 may result in 400 assets for the utility. Both choices are equally valid options, but it may be too difficult to track 2,000 assets for a utility with a small staff, or it may not provide sufficient benefit to the utility to track assets with such a low dollar value.

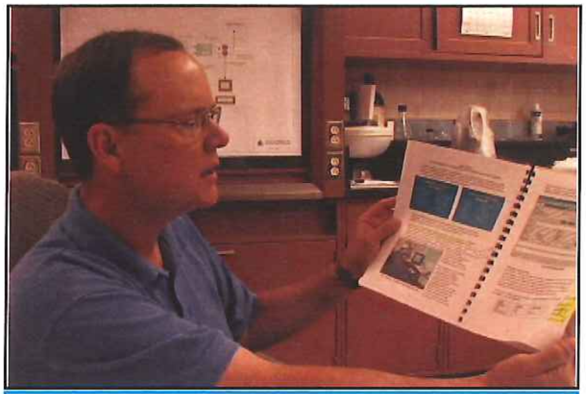
You don't want everything in there. IV-2
--Stacy Gallick, Johnson County, KS

On the other hand, choosing $3,000 may leave important assets out of the inventory or may not provide detailed enough information to manage the utility effectively. A value in between these two amounts may provide sufficient detail without being unduly burdensome.

Another way to answer the question of what defines an asset, is to define an asset as anything the utility would write a work order for. For example, if the utility would write a work order on a pump impeller if that part needed repair or replacement, then the impeller itself can be defined as an asset in addition to the pump it is a part of. If the utility would only write a work order for the pump, but not the impeller, then the impeller is not considered a separate asset.

These two approaches – dollar value or work order – or some combination of the two are the most common methods of establishing what defines an asset. Each entity should establish its preferred method of defining an asset. The main considerations include ability to handle the number of assets that results from the chosen option and being able to consistently apply the approach. The selected approach can be modified over time if it does not meet the needs of the utility.

Consider the example of Old Forge, NY. This utility selected a dollar amount of $500 to define an asset and then determined that this approach resulted in more assets than they could effectively track. For this utility, assets of that value could be replaced within the operating budget and did not need to be tracked. There was insufficient benefit for the utility to track assets at this dollar amount. Old Forge subsequently raised the dollar amount to define assets as anything valued over $1,000.



We soon realized that was not realistic.--Ted Riehle, Old Forge, NY IV-3

3.3 Where Are My Assets?

Once you know what assets you own, it is important to know where they are located. This component involves mapping the assets that are in the field and recording the location in the inventory file.

The most important factor in mapping is having a visual picture of the asset locations, especially for buried assets. The map can be as simple (hand drawn) or as complex (Geographic Information System) as the utility is capable of. The inventory map can help operators, managers, elected officials, and owners conceptualize the utility as a whole.

The most important considerations in selecting the type of approach to use for mapping are:

- Ensuring that the map is comprehensive (covers all the known assets)
- Having the ability to keep the map updated over time
- Establishing a process to correct any inaccurate or incorrect data on the map
- Being able to track asset failures or other relevant data on the map

A utility should choose the type of mapping system that best meets the needs, capabilities, and resources of the utility. Choosing a more sophisticated computerized mapping system, like GIS (geographic information system), has the benefits of being able to more easily sort and evaluate data, linking asset attribute data (size, type, condition) to the map, enabling remote use, and more accurately representing the data. However, this type of system can be expensive to create and maintain and the utility may not have the personnel to handle this task. A more simplistic approach of a hand-drawn map or a hand drawn map based on a free base map from an internet site (e.g. Google, MapQuest, Bing maps or similar), has the advantages of being extremely low cost and easy to generate. But this type of map is much less portable, less comprehensive in terms of asset data, and less accurate. The key is to balance the needs of the utility, the benefits the utility wishes to achieve, and the resources available for the task. A utility can also start with simpler maps and move to a more sophisticated approach later.

When thinking about mapping, a utility should also think very creatively for potential reduced cost options to access computer mapping expertise. Potential options include community college, university, or high school students who have taken courses on GIS mapping who may be willing to work as an intern to gain experience in mapping. Or perhaps a college or high school class would consider taking on a utility map as a class project. County, city, or state governmental agencies may offer free base maps or they may be able to assist with developing a map.

Data on locations can be gained by using a global positioning system (GPS) device. Simple versions of these devices can be purchased at many retail stores for very little cost and they are designed to be user friendly and simple to operate. These types of devices can be used to gather point data for visible assets (such as hydrants, manholes, valves, wells, storage tanks, pump stations, storm drains) and line data for water or sewer pipes. The accuracy of the simple devices is sufficient to create a reasonably accurate picture of the utility and can be adequate for most smaller utilities. A larger utility may wish to have higher accuracy GPS readings and could invest in more sophisticated GPS equipment or hire outside consultants to compile this information.

It gives you a picture of how your structure is laid out.
--Scot Jaynes, Tucumcari, NM

IV-4

In terms of gathering data for the map, it is best to start with what is already known about the utility from any maps – hand drawn or otherwise – that the utility has. The utility may have "as-built" drawings or maps that show assets that were installed during construction projects. These maps are intended to provide accurate information regarding the assets that were installed during the project. However, they may be limited in terms of scope in that they may show only the newly installed assets and not a comprehensive view of all the assets in the utility, and they may not be entirely accurate. Current operators and managers and retired operators or managers can work to fill in as many gaps in the information as possible. Additional gaps might be filled in by residents who were living in the area when the utility was built, or by engineers or construction contractors involved in the design or installation of the utility.

IV-5

IV-6

IV-7

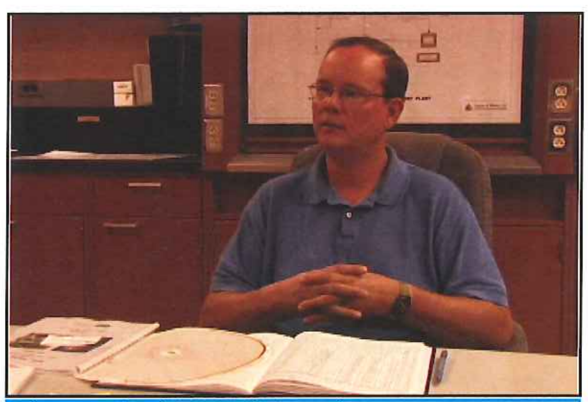
It is important to remember that no map will ever be completely accurate, especially in the initial stages. You should strive to make as good a map as possible the first time, within the limits of the information available, and then improve upon it. A good time to make any changes to a map is after assets have been dug up for a repair. At that time, any inaccuracies in location can be corrected. In addition, whenever new assets are installed, accurate locations can be obtained and added to the map. It is not recommended that assets be dug up for the sole purpose of locating them, unless there is a very compelling reason to do so. Instead, take your best guess at locations and revise as you learn more to keep the map as up to date and accurate as possible.

Additional information regarding internet-based mapping options can be found in Appendix A.

Some assets, such as pipes, will be mapped as described above while others, such as assets located in buildings, may not be mapped. In either case, the asset location should be added to the inventory file. Generally, the location will be a street name, street address, or building location such as pump house or treatment building. The addresses should be as specific as possible so that assets can be grouped together based on their location. It is important to be able to group assets by their category (i.e., all valves, all hydrants) and by their location (all assets on Main Street.) In this manner, the utility can answer various questions about its assets, such as: "If I replace the pipe on main street, what other assets are associated with that pipe that will also have to be replaced?" "If I replace a component in the treatment building, what other assets might be impacted?" Methods of including data in an inventory are discussed further in Section 3.8.

3.4 What is the Condition of My Assets?

After the assets are identified and located on a map, it is important to know their condition. A condition assessment can be completed in many different ways, depending on the capability and resources of the utility. The simplest approach is to gather people who have current or historical knowledge of the assets in a room. The group can then select a condition rating approach (0 through 5, A through F, Excellent through Unacceptable, etc.). The group then considers the list of assets and rates each one using the selected methodology. This approach relies on the best information available but does not require utilities to gather additional data in order to rate the assets. Any condition rating system that is understood by the utility and that is consistently applied is acceptable. A condition rating system should be agreed upon before rankings are made and a pilot project can be performed using a small subset of assets to test the effectiveness of the chosen ranking system. Each asset in the pilot project is ranked based on condition, and then everyone can examine the results to determine whether they make intuitive sense and if the selected approach was easy to use. If needed, the condition rating system can be revised and the pilot repeated. Once the condition rating system is selected it should be used consistently throughout the utility. Examples of ranking systems are presented in Appendix A.



When you look at condition...the more people you have involved, the better
--Ted Riehle, Old Forge, NY

IV-8

At a higher level or as a next step after the initial ratings of the assets, utilities can gather data on asset condition through more sophisticated means and re-rate the assets. For example, a sewer pipe can be examined with cameras to determine the interior pipe condition. Water pipes can be evaluated using leak detection technology. A rating system as described above may still be used in combination with this higher-level data, or a more sophisticated numbering system can be used.

We have a numbering system.
They're almost all 1 to 5.
--Stacy Gallick, Johnson County, KS
IV-9

Asset condition will change over time as assets age and as they are used during normal operations. Therefore, the asset condition must be continuously updated to keep the data current. The time interval between updates may vary from utility to utility, but generally annually is a good time to revisit the condition assessment. In addition, as assets receive routine, preventative, or corrective maintenance, condition can be re-assessed and the resulting condition rating can be revised in the inventory.

Examples of the types of condition monitoring approaches that can be used to assess asset condition is presented in a table in Appendix A.

3.5 What is the Remaining Life of My Assets?

All assets will eventually reach the end of their useful life. Some will reach this point sooner than others. In addition, depending on the type of asset, it will either reach that point through amount of use or length of service. For example, a pump will wear out sooner if it is used more and will last longer if it is used less. The actual age of the pump is not as important as the amount of work the pump has done. On the other hand, the life expectancy of pipe assets is based more on the length of time in the ground. If a pipe is in the ground for decades, it has had considerable time to contact the soil around it and the water within it and may start to corrode. There are many additional factors that will affect how much life a given asset has. Factors such as poor installation, defective materials, poor maintenance, and corrosive environment will shorten an asset's life, while factors such as good installation practices, high quality materials, proper routine and preventative maintenance, and non-corrosive environment will tend to lengthen an asset's life. Because of these site-specific characteristics, asset life must be viewed within the local context and the particular conditions of that utility. Cast Iron pipe may last 100 years at one facility and 60 years at another. It is best to make judgments on asset life based on past experience, utility knowledge, existing and future conditions, prior and future operation and maintenance, and similar factors in determining useful life. In the absence of any better information, a utility can use standard default values as a starting point. These default values can be obtained from manufacturers and industry guides. However, over time, the utility should use its own experiences to refine the useful lives.

It's challenging at times. IV-10
--Bill Boulanger, Dover, NH

For example, if a given water utility routinely replaced its chlorinator every 5 years because that was as long as that asset lasted, then 5 years should be used as chlorinator life, instead of a standard default value. However, if the utility has had its pipe in the ground for only 20 years and has no knowledge of how long it could be expected to last, it could use a standard default value of 50 to 75 years. However, as time goes on, if the utility did not notice any reduction in the integrity of the pipe after 40 years, the useful life could be increased from 50 years to 75 or 100 years. If the utility started seeing a reduction in the pipe integrity (numerous breaks due to corrosion) at 40 years, it would keep the useful life closer to 50.

Additional information regarding estimated default values for useful lives is contained in Appendix A.

3.6 What is the Value of the Assets?

Generally, when utilities consider the value of assets, they think about the cost of initially installing the assets. This cost has importance as historical information or it can be used by a utility to depreciate the costs of assets over time. It can also be useful to determine the total costs of operating an asset over its life span. However, the installation cost does not have a direct bearing on what it will cost to replace that asset when it has reached the end of its useful life. The asset may not be replaced by the same type of asset (e.g., cast iron pipe may be replaced by PVC pipe) or it may be replaced by a different technology entirely (e.g., a chlorination system replaced by an ultraviolet disinfection facility). Furthermore, costs of various assets may change drastically over time, so that the cost of installing ductile iron pipe in 1965 may have no relationship to the cost of installing PVC pipe 50 years later in 2015.

The value of the assets that should be recorded in the asset inventory, then, is the cost to replace the assets using the expected technology that will replace them. If the utility has asbestos cement pipe now, but would replace it with PVC pipe, the replacement value of that asset is the cost of replacement using PVC and the installation costs associated with PVC.

Although the idea behind valuing assets is relatively simple, obtaining costs for the asset replacement may not be so easy. Small utilities may not have the expertise to estimate replacement costs. In these cases, the utility should either estimate in the best manner possible or leave this portion of the inventory blank for the initial stages of the asset inventory. This information can be added later as the utility gathers additional information or expertise.

You need to come up with an average replacement cost.
Ross Waugh, New Zealand
IV-11

If estimation is done, the possible approaches include:

- If the utility has had recent improvements, such as pipe replacement, information regarding the cost per linear foot can be used.
- If a similar neighboring utility has had work done, costs incurred in their project may be used.
- Organizations that complete a large number of construction projects per year may be able to provide estimates.
- Some organizations, such as large cities, periodically publish unit costs for construction. These costs can be used as a starting point and revised as necessary to cover costs in other areas. If costs are typically higher in a particular area than the published guide, they can be increased. If costs are typically lower, the prices can be decreased.

Over time, as more utilities begin completing Asset Management strategies, it might be useful to form users' groups that would allow water or wastewater utilities to share information, such as unit costs/replacement costs, with each other.

3.7 What is the Energy Use of My Assets?

In addition to the information considered thus far, it is important to consider the energy use of your assets. This question involves a consideration of the asset's overall energy consumption, the type of energy used, and whether the energy consumption contributes to greenhouse gases. This assessment is important because energy usage is a significant portion of a utility's expenses, sometimes accounting for as much as 50 to 75% of the total operating costs. Therefore, optimizing energy consumption can have a significant impact on the cost of operating a water or wastewater facility. In order to determine the potential to reduce energy use, energy usage data should be collected for the assets in the inventory. As the assets are being inventoried, data on energy use, such as the following should be collected, to the extent possible:

- Type of energy used
- Horsepower
- Variable or constant speed
- Design specifications
- Operating status and practices
- Hours of operation per year

- Average equipment run times
- Measured power consumption
- Peak energy demands
- Total kilowatt-hours (kWh) of electrical consumption

The best method of gathering information about energy use by an individual asset is actual metered energy usage. However, most utilities don't have energy meters on each piece of equipment that uses energy and some utilities may only have one master energy meter that indicates overall energy use. In these cases, estimates will have to be made of asset energy use based on load, performance factors, equipment efficiencies, operator experiences, manufacturer's data, and reference guides. A particular reference guide that may be helpful is EPA's Energy Star Program.

That's the one of the things we've found is a limitation....at the water plant, there is one master meter.
--Barry Kirchhoff, Columbia, MO IV-12

In considering overall energy use, it is important to look beyond those assets that are easy to identify as energy consumers, such as pumps, motors, blowers, and drives, to those assets that have a less obvious effect on energy use. For example, leaking pipes have an impact on energy use because they result in more water being pumped and treated than is needed by the customers. Other energy use may come from "assets" that are not included in the inventory, such as light fixtures or heating units in buildings or pump stations or the gasoline or diesel usage of the utility's fleet of vehicles. It is important to have a method of capturing this type of energy use in your overall baseline assessment of total energy usage.

There are multiple areas of energy use.
--Russell Batzel, St. Peters, MO IV-13

Appendix A contains forms that can be used to gather information of energy usage of assets.

3.8 Developing An Asset Inventory

Once the answers to the questions in the previous sections are determined (what do I own, where is it, what condition is it in, what's its useful life, what's its value, what type and how much energy does it use) the information must be organized in an asset inventory. This step is important, but it should not be allowed to become all-consuming and utilities should not get "bogged down" in this step. The utility should complete this step to the extent possible in a reasonable amount of time and then move on. Alternatively, the utility could do the inventory a little bit at a time while working on the rest of the Asset Management program.

There are a number of systematic approaches to developing the asset inventory, such as collecting data one type of asset at a time (e.g., all the pumps, then all the hydrants, then all the valves), collecting data on one portion of the utility at a time (e.g., pre-treatment, then treatment, then solids handling), collecting the data linearly from one side to the other, collecting newer assets first (where there's likely to be more readily available information) followed by older assets, or collecting the data based on year of installation or based on major construction projects (this approach could be based on as-built drawings the utility has of each of its major construction efforts). Any of these approaches or any other approach that works for the utility is fine.

During the initial data collection effort, it is highly likely – and expected – that there will be gaps in the data. Some information may be missing, such as the manufacturer or the installation date or the value of the asset. During the initial inventory process, care should be taken to ensure that the best data possible is put into the inventory and reasonable estimates can be made for items that are missing. For example, if the installation year for pipe is unknown, the installation date of surrounding pipe may be used or if the construction date for a neighborhood served by the pipe is known, that date can be used. If no other data is available for installation an estimate of the oldest time of installation or an average date of installation may be used. The main point is to collect the best and highest quality data given the available resources of personnel, time, records, and technology during the initial survey. and then allow data quality to improve later.

The sophistication of the asset inventory can be increased over time. The utility may start out with a simple approach and improve upon that as resources become more available. The most important thing is to just get started with the inventory. Anything the utility does towards cataloguing what it owns in a systematic fashion will improve overall management of the assets and decision making.

3.8.1 Collecting Data on Assets

To develop the initial inventory, several approaches can be used and these are listed below. However, the utility should be as creative as possible with other approaches to obtaining this information.

- Determine who operated, managed and/or owned the utility at the time of the major construction periods (when a large number of assets were put in.) Interview these individuals and gather as much information as possible regarding their recollections of what assets were installed and where they were installed. If there are maps of the utility, these can be used during the discussions.
- Examine any as-built or other engineering drawings of the utility.
- Perform visual observations of above-

ground or visible assets (e.g., hydrants, pumps, manholes, treatment works).

- Use a digital camera to take pictures of the assets that are visible.
- Interview community residents who may have lived in the area during construction and who are familiar with the construction activities (especially helpful in very small towns in which the residents were actively involved in developing the utility).
- Interview contractors or engineers that were involved with construction.
- Estimate buried assets using above ground assets as a guide (e.g., using manholes to estimate locations, size, and type of pipe between the manholes; using isolation valve locations to estimate buried water pipe locations).
- Examine photographs of the utility taken during construction, repair, etc.
- Consult USGS Topographic Maps and other non-utility generated maps.
- Examine aerial photographs – both recent and historical.
- Use existing inventories (fire hydrants, meters, valves, etc.).
- Use metal detectors to locate buried assets.
- Consult utility records: billing, repair, maintenance, inspection, O&M manuals, sampling, operator's log/notebook, etc.
- Consult state and/or federal records, databases, or employees for information such as well depths, drill dates, discharge information, etc.

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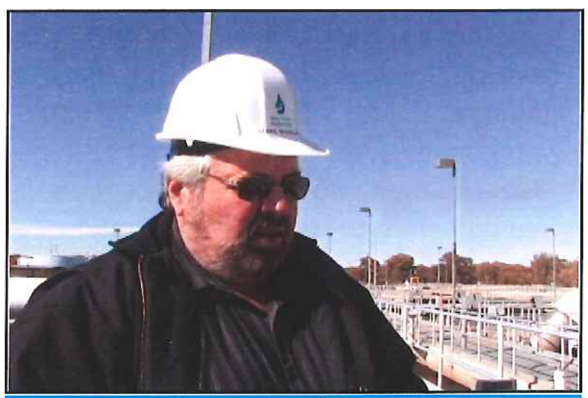
Several approaches may be necessary to get a good start on the asset inventory. A utility should use as many approaches as it deems necessary to get the best initial inventory of assets.

An obvious question when gathering data for an asset inventory is how much time will it take to gather the asset data? The answer will vary from utility to utility based on the overall number of assets, the number of utility staff, the overall area covered by the assets (size of community for water or wastewater pipes), and the quantity of data being collected on each asset. Gathering data can be a time consuming activity, but it is manageable if it is done in a systematic way or completed in phases.



We could actually speed up the process... if we just came out and took a picture.
Mark Winslow, Albuquerque, NM
IV-17

The easiest time to collect data is when assets are newly installed. If the new assets are installed as part of a large construction project or upgrade, the utility can direct the consultant or construction contractor to provide the data on the new assets. However, the consultant or construction contractor Request for Proposal (RFP) must state that there is an expectation that at the end of the project, the data on the assets will be provided to the utility. The RFP should also specify the format in which the data should be provided (Microsoft Excel spreadsheet, Microsoft Access database, other) and this format should be compatible with the format the utility is using for its asset inventory. If the RFP does not include this provision, the contractor may ask for additional money in order to collect the data. In addition, the requested data should match the quantity and type of data currently included in the asset inventory.

3.8.2 Asset ID Numbering

In developing an asset inventory, it is critical to develop a unique asset identification number (Asset ID) for each and every asset in the inventory. This number can be anything, as long as it is unique; however, it is preferable to use a "smart" numbering system. The smart numbering system can contain identification information for location, equipment type, equipment function, and specific piece of equipment. The numbering system should be consistent throughout a facility and should be easily and quickly recognized by facility personnel.

The numbering scheme should be developed by the individuals who will have to use it most, or at least should be developed with input from these individuals. In some facilities, a small number of individuals will need to be familiar with the ID numbering scheme or understand it, while in larger facilities, multiple people or departments will need to understand and use the scheme.

The task of developing an asset ID numbering system can seem simple, but in practice can be quite complex. It may be necessary to revise the system a few times before it is satisfactory. The best approach is to think about what should be accomplished with the numbering system, discuss different approaches, select an approach, and then do a pilot project to see if it will work properly. The pilot project should include a small subset of the overall assets from different parts of the facility to determine if the numbering system that was selected will work. If the numbering scheme does not perform adequately, it can be modified to solve the issues and the pilot can be repeated.


IV-18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An example of a potential numbering scheme is shown below. Additional examples are contained in Appendix A.

Example 1:
A BCD EFG 1

A = Water (W) or Wastewater (WW)
BCD = facility name (i.e., abbreviation for pump station, well house, treatment building)
EFG = Equipment name (i.e., abbreviation for name of equipment)
1 = Equipment number (i.e., number for that particular piece of equipment)

For Example:
WMPSPMP1 = Water System Main Street Pump Station Pump 1

W = Water System
MPS = Main Street Pump Station

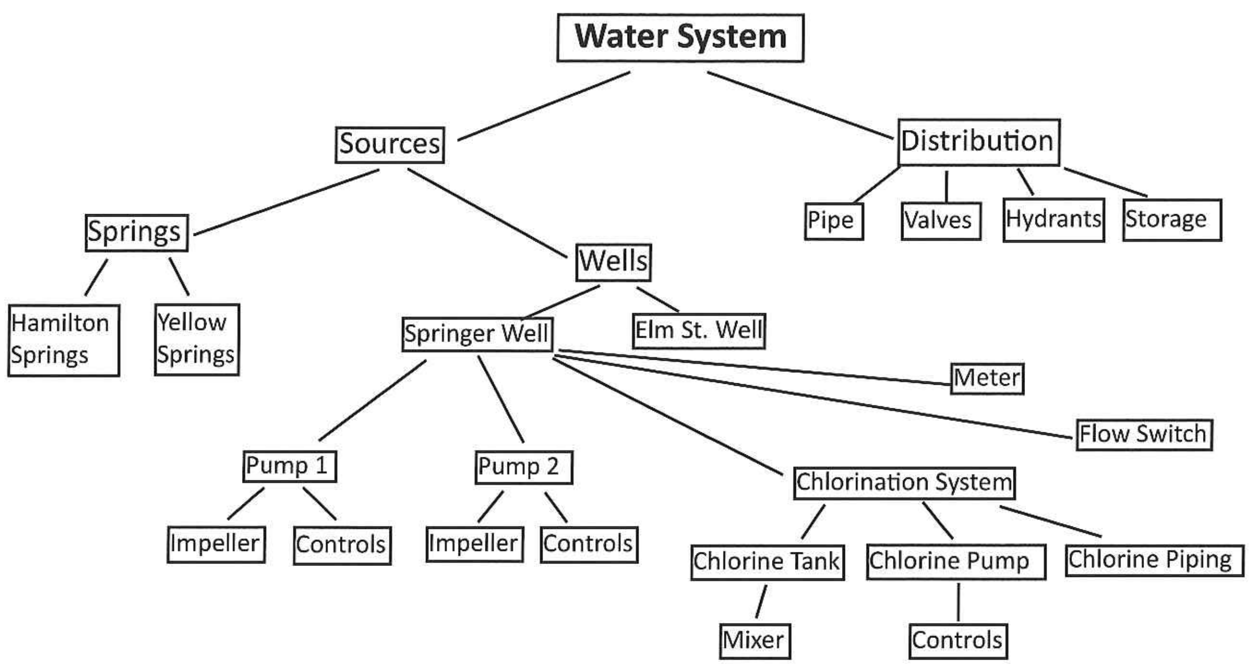
PMP = Pump
1 = Number 1 Pump

Any numbering system that provides location and equipment identification and that is unique for each asset can work. The system chosen should be one that best fits the particular utility. It is worthwhile to examine approaches used by other utilities in selecting a numbering scheme, but the system must be modified to suit the individual needs of the utility.

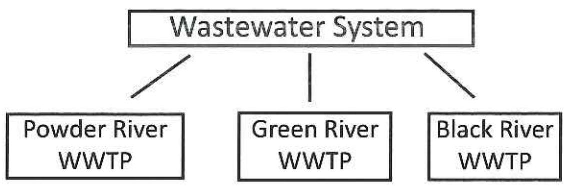
Once asset IDs are established, ID tags can be placed on visible equipment (pumps, valves, hydrants, blowers, etc.) The tags should be durable and attached in a semi-permanent way. If tags become warn or knocked off the equipment, they should be replaced.

3.8.3 Asset Hierarchy: Which Assets Go Together

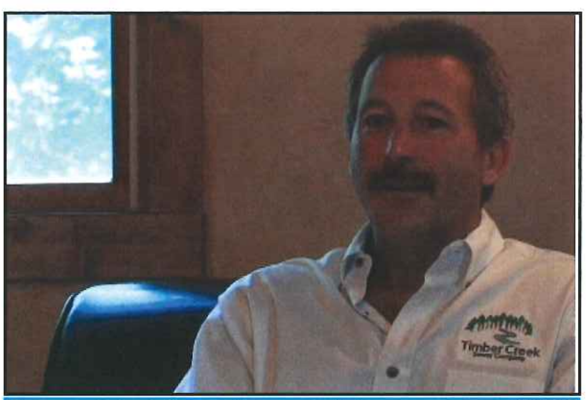
Within a water or wastewater utility, there are natural groupings of assets. One asset is typically a component of a larger system of assets. If assets are entered into the asset inventory in such a way that these groupings are recognized, it is a lot easier to examine asset data and make decisions about asset repairs and replacements. This type of grouping is called an asset hierarchy. The hierarchy can also be thought of as a tree structure or a parent, child, grandchild structure. An example of a portion of the hierarchy of a water utility is presented below.



The asset at the top of the list is the parent asset, the next level is the child asset, the next is the grandchild asset and so on. If you start at the bottom, assets can be "rolled" up into higher and higher categories until the final level is all of the assets in the water utility (or wastewater utility.) If you have multiple water or wastewater facilities that are completely independent of each other, each one of those can be a parent asset category or the parent can be water (or wastewater) with the child asset the name of each of the independent systems as shown below.



Then all of the assets for each plant can be associated with the individual treatment facilities.



It was a lot of discussion and dialogue IV-21
--Dereck Sherry, Platte City, MO

The benefits to an asset hierarchy are to be able to develop costs for groups of assets, such as the total cost of pre-treatment, the total cost of well #1 or the total cost of all wells. If the costs associated with individual assets associated with wells are collected, then the costs of these assets can be rolled up to obtain the cost of an individual well or all wells.

3.8.4 Data: How Much and At What Cost?

There is almost an unlimited amount of data that can be collected on assets. Clearly, it is neither possible nor cost-effective to collect every piece of data that could be collected on an asset. How much data and what type of data to collect on the assets should be determined based on a consideration of the following:

- How will the data be used?
- What data is important to upper management/elected officials?
- What resources are available to collect the data?
- Can the level of data be kept up over time?
- Can the accuracy and quality of the data be ensured?

Of these, the most important consideration is the use of the data. Collecting data for data's sake is not helpful to the utility and spends precious resources in the wrong area. Alternatively, not collecting data that is needed to support good decision-making is equally inefficient and effective.

One of the first steps in the process should be to decide what data will be useful to everyone within the utility, how it will be used, how much it would cost (time and other resources) to collect the data, what the quality needs to be, how easy it would be to collect the data, when the data would be collected and how it would be maintained in the future. This type of discussion should include all levels of the organization from operators to elected officials. The goal should be to collect the data that will be beneficial in asset operation and maintenance and in making management decisions and no more or less data than that. If the data is used, it is more likely to be collected in a high quality manner. If the data is not used by anyone, it is unlikely to be kept up over time or it may not be put in the inventory at a high quality.

The trick is not to collect too little information...but not to collect too much. Ross Waugh, New Zealand IV-22

The amount of data collected can be adjusted over time if the utility determines that another type of data is needed for operations or decision-making, or if it is determined that some of the collected data is not useful.

3.8.5: Collecting and Storing Cost Data on Assets

In order to make better management decisions about assets – when to continue to repair an asset versus when to replace an asset – cost data on an individual asset basis is needed. This data could include initial cost (if known,) operation and maintenance costs, repair costs, and rehabilitation costs. Additional costs such as fines or legal fees associated with an asset failure can be included if they are known and the inventory program is sophisticated enough to contain this data.

If the utility is using a very simple inventory program such as Microsoft Access or Microsoft Excel, there can be a cost data column or entry that contains the total cost for that asset per year. This could be done by adding new costs to the number that was there and entering the new amount. This approach would not provide a cost history, but it could provide cost information. For example, in October $200 was spent on Blower #1. $200 is entered into the O&M cost entry on the Access database. Then in December an additional $100 is spent on O&M. Now the $200 could be changed to $300 so there is only one entry for cost. Alternatively the utility could add cost columns to a spreadsheet inventory program and have multiple cost entries that can be totaled to determine the overall cost of the asset. For some assets, this approach could result in an extremely large spreadsheet.

A utility can also invest in a more advanced asset inventory program that tracks costs through a work order system or one that has more options regarding how to collect costs.

I was able to track all the costs for that. IV-23
--Brianne St. Pierre, Somersworth, NH

3.8.6 Types of Programs for Data Storage

There are many options regarding how to manage the asset inventory data. Specific options include:

- Commercially available software for asset inventories
- Generic database software
- Spreadsheet software
- Hand written inventory

The best option is a specifically designed Asset Management software program. This type of program provides the greatest level of flexibility in terms of use and is already programmed to contain asset inventory data. However, this type of program is expensive and may require a robust computer system to make it accessible to all operational and management personnel.

Since this type of software is written specifically for Asset Management, it is designed to allow the input data to be searched and printed, has pre-designed reports, can track budgets, and provide a lot of other useful information. There is a wide variety of programs of this type in a full range of pricing options from free (EPA's CUPSS program) to extremely expensive. Which program is chosen depends on the features desired and the cost.

The next option, generic database software, is much less expensive but will require a time commitment on the part of someone within the utility to set up the database and input the data. This option will allow the utility to sort the information. Creating a database using generic database software is not typically self-explanatory. However, there are courses available for learning about databases at most colleges or community colleges. Many of these are relatively short and inexpensive. In addition, communities may have a student or someone with database knowledge who would be willing to assist with this project. Once the database is created and tested, maintaining and updating the data can be accomplished by a staff member of the utility who has the time, skills and inclination to do it. Some examples of database software that are readily available include MySQL, Microsoft Access, Oracle, FoxPro, and OpenOfficeBase. This option is recommended for smaller utilities that cannot afford commercial software.

Another method of cataloging an inventory is to create a spreadsheet that lists every asset in the utility's inventory.

Spreadsheet software is standard on most computers. However, there are disadvantages to using a spreadsheet. Spreadsheets have very limited searching capabilities. Creating a spreadsheet inventory will essentially create a list of assets that can be printed. Although spreadsheets have some sorting capabilities, queries such as "Provide me a list of all pipes installed in 1950 that are cast iron that have had at least 1 break in the last 10 years" are very difficult to perform. This list can be obtained in a matter of moments with a database.

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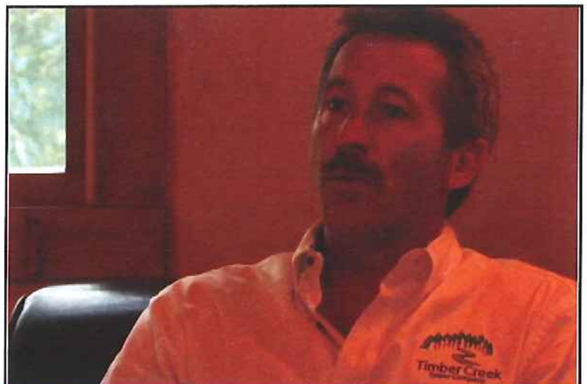
IV-26

If software and computers are not readily available, the utility should have a written inventory of all the assets it owns. This handwritten list should be edited as the utility grows and changes. A handwritten inventory is the least desirable inventory option, but is better than no inventory at all and should be used if this is the only option available to a utility. This method can also be used as an interim option while a utility works toward a computerized system. One option to consider with a hand written asset inventory is to put each asset on an index card so that they can be sorted in a file box.

The key to a useful asset inventory is to structure it to provide the information the utility needs in an easy to retrieve fashion. If the data is not easily accessible, the utility will not use it and the inventory ceases to have as much value as it could.

Appendix A contains an inventory form that can be used as a guide for a handwritten inventory or as a field worksheet to gather inventory data.



...it was just the investment of our time in getting the development done.
--Derek Sherry, Platte City, MO

IV-27

3.9 Updating and Maintaining the Asset Inventory

It is crucial that the asset inventory be routinely updated and consistently maintained. New assets must be added to the inventory as soon as they are installed. Newly discovered assets (such as a pipe that is found during a road construction project or a valve that was paved over that is found in a construction project) should also be added to the inventory. Data on condition, useful life, and value will change over time as the asset ages, is maintained, repaired, or rehabilitated. These changes need to be reflected in the inventory.

Assets that are repaired or rehabilitated through the normal operation process can be revised within the inventory files throughout the year. Other assets that have not been examined, should be revised every year or two to make sure the asset inventory remains up to date and accurate.

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IV-30

If maintaining the inventory becomes such a burden that the quality and quantity of data can not be kept up to date, the utility has a few choices:

1) increase resources (personnel or money) to allow for the additional data collection
2) reexamine the definition of an asset to reduce the overall number of assets
3) reduce the overall amount of data that will be in the inventory (see Section 3.8.4).

The most important consideration is that the data in the inventory be of high quality and be beneficial to the utility, so having less data is better than more data, if the data is of higher quality.

3.10 Work Order Systems

A major function of a water or wastewater utility is to assign operators operation and maintenance tasks and repair orders. A system that describes these tasks is called a work order system. If this type of system is computerized it is called a computerized maintenance management system or CMMS. A work order system – computerized or otherwise – can be a valuable tool for a water or wastewater utility. Very small utilities may find it difficult to manage a computerized system or may not see sufficient benefit to doing so. For all others, a computerized work order system may be highly beneficial in scheduling work, tracking costs, ensuring maintenance is performed on schedule, and determining what parts were used during the repairs.

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IV-33

A work order system can be tied to an Asset Management inventory program so that the information put onto the work order comes from the asset inventory and so that following the completion of the work order, the information from the repair goes back into the asset inventory. These systems can be relatively simple or highly complex. Costs of these types of programs also vary widely. If a utility is considering purchasing an asset inventory software, some consideration should also be given as to whether the utility wishes to buy software that integrates a work order system with the asset inventory.

I am linking it to the asset that it relates to.
--Brianne St. Pierre, Somersworth, NH

IV-34

Asset Management IQ

Section II: Current State of the Assets

A. Does the organization have an asset inventory?

	There is no inventory of the assets of any kind.
	There is a limited asset inventory with no plans to complete the inventory.
	The organization is working towards a complete asset inventory with less than 50% of assets presently included.
	The organization is working towards a complete asset inventory with more than 50% of assets presently included.
	There is a complete[1] asset inventory of the organization's assets and it is used throughout the organization. The asset inventory is not done in a hierarchical structure or the inventory does not include the basic minimum attributes for the majority of the assets - asset ID, asset name, location, condition, useful life, replacement value, energy usage (if any,) probability of failure rating, and consequence of failure rating.
	There is a complete[1] asset inventory of the organization's assets and it is used throughout the organization. The asset inventory is done in a hierarchical structure. The asset inventory includes the following minimum attributes for the majority of the assets: asset ID, asset name, location, condition, useful life, replacement value, energy usage (if any,) probability of failure rating, and consequence of failure rating.

[1]*Complete refers to greater than 90% of the assets*

B. Does the organization have a map of asset locations?

	The organization does not have any type of map of asset locations.
	The organization has some limited mapping with no plans to produce a complete systems map.
	The organization is working towards a complete map of the system with less than 50% of the current system presently mapped.
	The organization is working towards a complete map of the system with more than 50% of the system presently mapped.
	The organization has a comprehensive map of the entire system. It is not linked to the asset inventory data.
	The organization has a comprehensive map of the entire system. It is in a GIS system that is linked to the asset inventory data.

C. Does the organization have a process for condition assessment?

	The organization has no process to assess the condition of the assets.
	The organization has a process to assess the condition of the assets, but has not yet begun the process.
	The organization has assessed the condition of less than 50% of the assets.
	The organization has assessed the condition of more than 50% of the assets but has not recorded the information as part of the asset inventory.
	The organization has assessed the condition of more than 50% of the assets and the condition results are recorded in the inventory system.
	The organization has assessed the condition of every[1] asset in the inventory and has recorded these condition results along with the asset inventory.

[1]Every refers to greater than 90% of the assets

D. Does the organization have a means of estimating useful life?

	The organization has no means to estimate the useful life of assets.
	The organization has developed a process to establish the useful life of the assets, but has not yet begun to use the process.
	The organization has established the useful life of less than 50% of the assets.
	The organization has established the useful life of more than 50% of the assets but has not recorded the information as part of the asset inventory.
	The organization has established the useful life of more than 50% of the assets and has recorded the information as part of the asset inventory.
	The organization has established the useful life of every[1] asset in the inventory and has recorded these results along with the asset inventory.

[1] *Every refers to greater than 90% of the assets*

E. Has the organization determined asset replacement values?

	The organization has not determined any asset replacement values.
	The organization has developed an approach for determining replacement values but has not yet implemented it.
	The organization has estimated the asset replacement values for less than 50% of the assets.
	The organization has established the replacement value of more than 50% of the assets but has not recorded the information as part of the asset inventory.(3 points)
	The organization has established the replacement value of more than 50% of the assets and has recorded the information as part of the asset inventory.
	The organization has established the replacement value of every[1] asset in the inventory and has recorded these results along with the asset inventory.

[1] *Every refers to greater than 90% of the assets*

Chapter 4

LEVEL OF SERVICE

4.1 Introduction

Customers are not just an important part of your business, they *are* your business. Without them you have no reason to exist. Not only do you need customers, but you need customers who are willing to pay a fair price to enable you to provide a sustainable service.

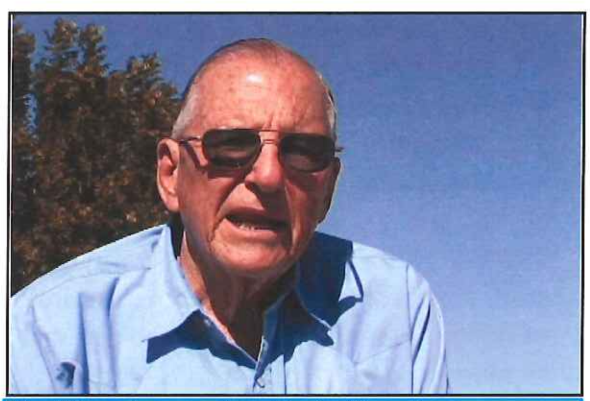
We should really be worried about what the customer would think.
--Kevin Campanella, Columbus, OH
LS-1

Broadly defined, water utilities are in the business of providing safe, reliable drinking water at an acceptable pressure. Wastewater utilities are in the business of treating and discharging wastewater in an environmentally sound manner. Within these broad missions, utilities must determine specifically how they will operate and maintain the assets to meet customer expectations. Determining how to operate the facility to meet customer expectations is called the Level of Service (LOS.)

Level of Service (LOS) defines what you want your assets to provide and how you want them to perform. The LOS can include any components the utility and customers decide, as long as all regulatory requirements are met and the components are within the capabilities of the assets. The document that lists the levels of service, the Level of Service Agreement, will become a fundamental part of how the utility is operated and managed.

The Level of Service Agreement has many benefits.

- It communicates the utility's operation to the customers.
- It assists in identifying critical assets.
- It provides a means of assessing overall utility performance.
- It provides a direct link between costs and service.
- It serves as an internal guide for utility management and operations staff.
- It communicates energy efficiency and water conservation goals.



It's all based on service. That will pretty much determine your whole program.
--Larry Covington, Picacho, NM
LS-2

The LOS Agreement will also allow the

utility to track its performance and determine how well it is meeting its goals. This performance can be communicated to the customers to reinforce how the fees they pay are related to the service they receive.

4.2 Developing the LOS Agreement

The first step in developing a Level of Service Agreement is determining the goals of your utility. Goals can be in any of the following areas:

- Energy Efficiency
- Water Efficiency/Conservation
- Social Considerations
- Environmental Considerations
- Customer Service
- Regulatory Requirements

The goals will be a combination of internally set goals and externally set goals. Internally set goals are those goals that define utility operations, but are not easily understood by utility customers. Examples of these types of goals include:

- Maintenance Scheduling
- Energy Efficiency
- Number of pipe breaks per mile
- Unaccounted for water

Internally set goals can be set by utility staff. It is best to involve a cross-section of utility personnel from elected officials to management to operations when setting goals to ensure that the goals are feasible and reasonable. In a small utility, goals may be set by the utility board with input from the operator. Alternatively, the board president may work with the operator to set goals, which can then be approved by the entire board.

External goals are items that directly impact customers. Examples of these types of goals are:

- Response time for water outages or sewer back ups
- Response time for customer complaints
- Water savings from water conservation
- Minimum water pressure


LS-3


LS-4


LS-5

The basic question a utility should ask itself when trying to set external goals is "What do my customers want?" This question can only be answered effectively by engaging in a conversation with the customers. This type of conversation can be conducted in any way that is feasible and practical for the utility and its customers. For example, a small utility with less than 100 customers may be able to go door to door and ask for feedback. A utility that holds annual meetings may be able to get feedback from an annual meeting. A larger utility may wish to hold focus groups with randomly selected customers. Surveys can be included with utility bills or can be mailed out. Communities that have more access to technology may wish to use internet based polls or ask for feedback on a social networking website. If a customer call/complaint log is kept at the utility,

the information obtained from these phone calls can be examined. The main objective is to change the dynamic of standard customer communications from adversarial to one in which the customers are engaged as partners or collaborators.

In setting goals for the LOS, the initial starting point is defined by the utility's regulatory requirements at the federal, state, and local level. The federal regulations are generally specified in the Safe Drinking Water Act and Clean Water Act. The State of Kansas Department of Health and the Environment (KDHE) has adopted and administers these regulations. In addition, KDHE has its own regulations that go beyond these acts. At the local level, counties, cities or utility boards may adopt ordinances or other types of regulations that they want the utility to follow.

Because there are many regulations, it is not necessary for the utility to list compliance with each and every regulation on its LOS Agreement. Rather, a broad statement such as "the utility will comply with all applicable state, local and federal regulations" should suffice. Alternatively, the Agreement may include statements that describe categories of compliance such as, "will conform to all water quality requirements," "will conform to all operator certification requirements," or "will meet all requirements of the open meetings act." In this case, the LOS Agreement may also need a summary statement to the effect that "the utility will conform to all other applicable federal, state and local regulations" to ensure that nothing has been omitted.

The next aspect the utility must consider is the fact that assets have physical limitations. Assets can not deliver services beyond these limitations. For example, if a water utility wishes to include the provision of fire flow in its LOS Agreement, but it has only 2 and 4 inch lines with no fire hydrants, it is not possible to provide fire flow. You may include the provision of fire flow in your long-range Capital Improvement Plan and seek funding, but until the assets for fire flow are in place, fire flow provision should not be included in the LOS Agreement.

The regulatory requirements and physical capabilities provide boundaries for the LOS. In between these boundaries, the utility will specify the internal and external goals of the utility. The utility should keep the LOS Agreement very simple, especially at the beginning. As an initial starting point, the Agreement should contain 8 to 12 items of importance to the customers and the utility. As the utility progresses in Asset Management, it may be desirable to add to the Agreement, but starting simple is best.

The goals must be written in such a way that they are measurable. In selecting a goal, you should ask yourself the following questions:

- Can I measure this goal?
- How will I measure it?
- What data do I need to measure it?
- Do we have the data readily available to measure it or will we have to develop a process to get it?
- Will the results of measuring this particular goal help us serve our

customers better or make better operational or managerial decisions?

The answers to these questions will guide your development process. If you can't measure the goal, it needs to be revised so that you can. If you are not able to figure out how to measure the goal, you don't have sufficient data to measure it, or the data is not readily available, you may need to either revise the goal or postpone implementation of that goal until the data is available.

The last question regarding how the goal will help the utility is fundamental. If you can't say that having this goal and tracking how well you're meeting this goal will have a positive effect on serving your customers or on operating or managing the utility it is not a goal worth having and it should be eliminated.

An example of a well written goal is the following:

The XYZ Water Treatment Plant will provide a minimum pressure of 50 psi at all locations in the service area 98% of the time.

This goal can be measured. How? By taking pressure readings. What data will you need? Pressure readings at various locations throughout the distribution system on a routine basis. Is this data readily available? Let's assume that XYZ Water Plant takes readings monthly. Therefore, this data is available on a monthly basis. No additional effort will be needed to measure this goal. The final question of whether it will help XYZ serve its customers, can be answered "Yes" if XYZ has asked its customers for feedback and determined that this was their desire or if XYZ has determined that this is an optimal operating pressure to balance customer needs with operational concerns, such as leakage. You might note that this goal has a caveat of 98% included in it. This caveat is there to ensure that customers understand that there may be times when breaks occur and pressure drops. As a practical matter, customers should not expect perfection, because utility assets will fail. It should be acceptable to most customers that pressure may be low on rare occasions as repairs are made.

An example of a poorly written goal is the following:

"The QRS Wastewater Plant will work on odors."

Can this be measured? Not really. This goal is too vague and would be hard to measure or determine how well you are doing against this goal.

How could a goal like this be rewritten?

"The QRS Wastewater Plant will have no more than 4 odor complaints per month."
This goal can be measured using data from a customer complaint log.

The key factors to keep in mind in developing the LOS Agreement are:

- Keep it simple
- Make sure the goals are important
- Make sure the goals are measurable
- Make sure the goals are within the capabilities of your existing assets
- Set internal and external goals

- Engage utility staff in the process of setting internal goals
- Engage utility customers in setting external goals

It is much easier to operate or manage a utility when both the operations staff and the management staff understand the goals of the operation. These goals allow the operations staff to have a better understanding of what is required of them. The management will have a better understanding of how to allocate staff and other resources more efficiently and effectively. Examples of a Level of Service Agreement and a form that can be used to develop an LOS Agreement can be found in Appendix B.

4.3 Balancing the LOS Agreement and Cost

There is a direct link between the level of service provided and the cost to the customer. When a higher level of service is provided, the costs to the customers will likely increase. This relationship provides an opportunity for the utility to have an open dialogue with its customers regarding the level of service desired and the amount the customers are willing to pay for this level of service. For example, customers may complain about contaminants that cause taste, odor, or color issues in the water, but are not health concerns. The water utility could install treatment to remove these contaminants but the cost of this treatment will have to be passed on to the customer. The water utility can have a dialogue with the customers to explain what the treatment would entail, what the finished water quality would be, and how much it would cost the customers. Following the discussions, the customers could decide whether or not they are willing to pay for the additional treatment.


LS-6


LS-7


LS-8

4.4 Measuring and Adjusting the LOS Agreement

As discussed previously, the LOS goals should be written such that they are measurable and so that progress towards meeting these goals can be tracked over time. This process of measuring how well the utility has met the goals should be manageable and kept at the level a utility can handle. For example, progress towards goals can be tracked monthly for some goals, quarterly for others, or annually for goals that are time consuming to track. The most important aspect is to track the goals on some routine basis and report the results of this tracking to both the elected officials/upper management and the customers.

The measurement and tracking of goals should also use a process that is easy to implement. Tracking can be done on a simple spreadsheet or even on a piece of paper in the case of very small utilities. Tracking simply entails comparing actual data to the LOS goal to see if the goal was met. Goals can be tracked on different frequencies, depending on what the goal is and whether it is an internal or external goal.

It can become overwhelming, but it doesn't really need to be that way.
--Kevin Campanella, Columbus, OH

LS-9

In determining how often to track a particular goal, the following questions should be considered:

- How frequent will the data I need be available?
- How much time will it take to get the data for tracking?
- How often do I need to report this type of information to elected officials or the board?
- How often do I need to communicate with my customers on meeting this goal?
- How often will it be possible to make adjustments if I find I'm not meeting the goal?

The frequency with which you track an individual goal should match the frequency of data availability. For example, if you want to track water pressure throughout the distribution system on a monthly basis, but operators only measure the pressure once a quarter, something has to change. Either the utility needs to change the way it operates and take monthly readings or the goal should be evaluated quarterly as data become available. If it will take considerable time to collect data for tracking a goal, the frequency should probably be less to reduce costs. If elected officials want information regarding a particular goal for every board meeting or on some routine basis, such as semi-annually, the frequency of tracking can be set to match the need for the information. Similarly, the frequency of communication to customers can also be used to set the time frame for tracking a goal. If the utility has an annual meeting with its members, then the goal can be communicated annually and maybe it doesn't need to be tracked more often than that. If the utility has a quarterly newsletter, then the goal may be tracked on a quarterly basis to provide information to the newsletter. Lastly, the utility should consider how often it is possible to make adjustments to the goal in determining how often to measure it. If adjustments can only be made on a quarterly basis, then collecting data on a monthly basis is too frequent. Similarly, collecting on an annual basis is too infrequent. An example of this type of situation is the following. Assume the utility has set a goal of responding to breaks within 6 hours during normal business hours. The utility has a contract with an operator to respond to breaks. The utility can only change the contract on an annual basis. In this scenario, even if the utility finds that one contract operator can not meet the goal of 6 hours after the first quarter, it won't be able to make an adjustment until the end of the year when it comes time to renew the contract. In this case, measuring annually, or semi-annually will make more sense than measuring monthly.

The main point regarding frequency of measuring progress towards meeting goals is that there should be a balance between the amount of resources it takes to get the data (time and money) and measure progress, and the importance of having the data.

An example of goals and tracking to see if goals are met, is shown below.

Goal	Target Level	Measuring Frequency	Actual Experience	Met (Y or N)	Comments
Less than 3 odor complaints per month	3	monthly	2	Y	
Fewer than 4 sewer backups per quarter	4	quarterly	5	N	Unusual wet weather conditions caused extra backups

Once this data is examined on a monthly, quarterly, semi-annually, or annual basis, the utility can decide how well they are doing in meeting the goals of the LOS Agreement. There are several responses a utility can take after examining the goals:

- Keep the goal the same
- Raise the goal target level
- Lower the goal target level
- Eliminate the goal entirely
- Revise the goal

If the goal was met, the costs of meeting the goal were within the normal operations, and customers were satisfied with the goal, the goal can be kept the same.

Goal target levels can be adjusted upward if it appears that the utility can consistently meet a higher level of service without additional cost and customers want this higher level. Goal target levels can be adjusted downward if the utility will have to hire more staff or otherwise increase costs to meet the goal and the customers would rather have a reduced level of service than pay the higher cost. Adjustments to external goals should be made in the context of customer dialogue, conversation, or feedback. Adjustments to internal goals can be made through discussions between management and operations staff with approval by the governing body.

If the utility determined that the particular goal provided very little benefit to the operations or management of the utility and was not of particular interest to customers, the goal can be eliminated. If the goal was reasonable, but not properly stated or not clearly understood, the goal can be adjusted.

At a minimum, a review of all goals, including consideration of adjusting the goals or target levels should be undertaken on an annual basis. An example of a chart showing goals and progress towards those goals is contained in Appendix B. This example is from Johnson County, Kansas.

We send out monthly reports and quarterly manager reports.
--Stacy Gallick, Johnson County, KS

LS10

4.5 Energy Efficiency and Level of Service

Energy efficiency goals should be included in the Level of Service. These goals may be internal goals because customers may not fully understand all of the ramifications of energy usage or a single goal of reducing energy use by some percentage may be set as an external goal. Because energy costs can account for such a large portion of the utility's overall costs, these goals are particularly important to the operations of the utility.

In order to determine potential costs savings that may result from reducing energy usage, the current energy use and its associated cost must be determined. This is known as developing a baseline. In order to develop this baseline, historical energy use will be needed. At a minimum, one year of energy use data should be collected and analyzed. This data can be collected from an existing accounting system, utility billing records, supervisory control and data acquisition (SCADA) system records, operations and maintenance records, and equipment or motor lists that include horsepower and load information. (As a side note, if a SCADA is in place, add as many data loggers as possible at different phases of the process to determine if any of the equipment has large energy spikes.) Because there may be a lot of data to analyze, graphs and charts can be developed to aid in understanding the data. Along with the historical use data, it is also important to understand the energy rate structure from the energy company. The price of energy and the energy rate structure affect total energy costs. It is also important to understand the hydraulic loading data (flow data) and then compare it to the energy use data. Understanding the rate structure and the link between flow and energy use will help with making energy management decisions.

Once the baseline is established, the utility can monitor energy use to determine how well it is doing on reducing energy use and it associated costs. The utility can also benchmark itself against other utilities of similar size.

LS-11

LS-12

LS-13

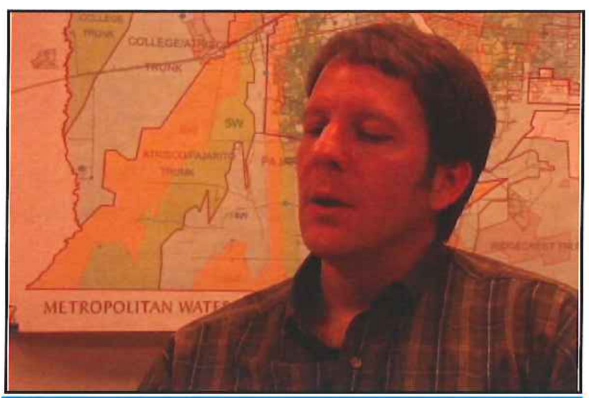
The most obvious energy goal is a decrease in overall energy usage as discussed above, but the utility can also set goals related to other aspects of energy usage. For example, the utility can set a goal to switch its fleet vehicles to hybrid cars or reduce overall miles traveled. The utility can set goals to reduce the carbon footprint of the plant or change the type of energy used. Goals specifically related to reduction in greenhouse gas emissions may also be set.

4.6 Communicating the Level of Service Agreement

It is critical for the LOS Agreement and the results of tracking progress towards meeting the level of service goals to be communicated to customers. The communication should focus on the external goals – those goals with direct impacts to customers. The goals and progress towards meeting the goals can be communicated to the customers via newsletters, public meetings, billing inserts, posting in a public place (such as a library or city hall), web site, or other approaches the utility thinks will reach its customers. Publicizing how well you are doing toward delivering the services customers want can be extremely valuable in getting support for the rates and fees you charge. It can also open up a dialog regarding changes that will be needed within the utility to meet goals that customers may want, but may not be possible under the current rate structure. This communication to the public should be at least an annually.

Communicating the Level of Service creates a transparency for the utility which can seem somewhat daunting at first but can lead to very positive outcomes. Customers are much more willing to support what they know and understand than what they don't know. The more transparent the operation is, the more likely you are to get customer support and remove suspicion and doubt.

Customer communication should also involve a feedback mechanism so that the utility can receive information back from customers regarding how well they think the utility is doing or regarding how important particular goals are. This feedback can be in the form of customer surveys, input at public meetings, phone calls to random customers, focus groups, or other approaches. The feedback can be used in the process of revising goals as discussed in Section 4.4.



We do customer opinion surveys...and include questions related to levels of service
--Frank Roth, Albuquerque, NM

LS-14

Asset Management IQ

Section III: Level of Service

A. Does the organization have a means of communicating to the customers, including communicating the goals of the Level of Service?

	The organization does not communicate with the customers.
	The organization communicates through notices on billing statements, but does not inform the public of the Level of Service goals.
	The organization has done surveys or sought public input about Asset Management in general, but has not informed the public of the Level of Service goals or progress towards meeting those goals.
	The organization has a minimal program to inform customers of the Level of Service goals, but does not inform the public of progress towards meeting those goals.
	The organization has an active program to inform customers of the Level of Service goals and progress towards meeting those goals, but has no feedback mechanism for the customers to provide information to the organization.
	The organization has an active program to inform customers of the Level of Service goals and progress towards meeting those goals, and has a feedback mechanism for the customers to provide information to the organization.

B. Does the organization have clearly defined Level of Service goals and are they aligned with customer expectations/desires?

	The organization does not have specific goals.
	The organization has goals but they are not written.
	The organization has some written goals but this process is not fully complete. Goals were not aligned with customer expectations/desires.
	The organization has clearly defined, written goals for the organization. They are well-known throughout the organization. They were not aligned with customer expectations.
	The organization has clearly defined, written goals for the organization. They are well-known throughout the organization. One or two goals were aligned with customer expectations.
	The organization has clearly defined, written goals for the organization. They are well-known throughout the organization. All goals were aligned with customer expectations.

C. Does the organization meet current regulatory requirements and, if not, does it have a plan to meet these requirements in the future? Does the organization anticipate future regulatory requirements and their impact on operations and infrastructure needs?

	The organization does not meet current regulatory requirements and currently has no plan to meet them in the future.
	The organization does not meet current regulatory requirements, but has a plan to meet them in the future.
	The organization meets current regulatory requirements or has a plan to meet these requirements and has just begun to investigate future regulatory requirements.
	The organization meets current regulatory requirements or has a plan to meet these requirements and knows which and how future regulatory requirements are likely to impact the organization.
	The organization meets current regulatory requirements or has implemented a plan to meet these requirements. The organization has a clear plan to address the infrastructure and operational impacts of future regulatory requirements.
	The organization meets current regulatory requirements and has a clear plan to address the infrastructure and operational impacts of future regulatory requirements.

D. Does the organization measure progress towards meeting the goals of the Level of Service?

	The organization does not have specific goals.
	The organization has a written set of Level of Service goals but does not measure progress towards meeting the goals.
	The organization has a written set of Level of Service goals and measures progress towards the goals on an ad-hoc or non-routine basis.
	The organization has a written set of Level of Service goals and measures progress towards goals on a defined, routine, periodic basis. There is no regular process to adjust the goals, make improvements or otherwise address the lack of meeting the goals.
	The organization has a written set of Level of Service goals and measures progress towards goals on a defined, routine, periodic basis. There is a process in place to regularly adjust the goals, make improvements or otherwise address the lack of meeting the goals. The progress towards goals is not communicated to the governing body of the organization.
	The organization has a written set of Level of Service goals and measures progress towards all goals on a defined, routine, periodic basis. The measurements are used to adjust goals, make improvements, and determine the progress of the organization. Progress towards goals is communicated to the governing body of the organization, who uses this information in decision-making processes.

E. Does the organization analyze current and anticipated customer demands, including planning for future growth or population decline?

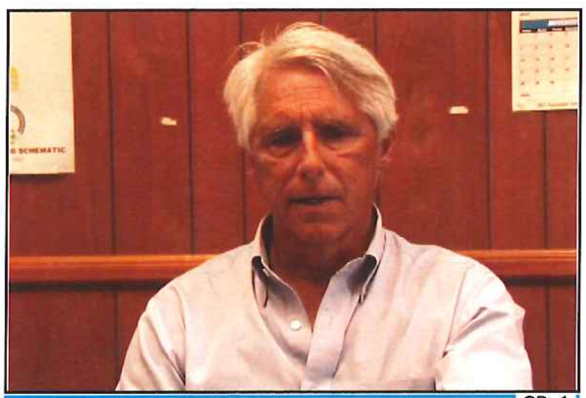
	The organization does not analyze current or anticipated customer demands.
	The organization analyzes current demands but not anticipated demands.
	The organization analyzes current and future demands, and uses the information to plan infrastructure investments to accommodate future growth or population decline. Planning is for less than a 5 year horizon.
	The organization analyzes current and future demands, and uses the information to plan infrastructure investments to accommodate future growth or population decline. Planning is for a 5 to 9 year horizon.
	The organization analyzes current and future demands, and uses the information to plan infrastructure investments to accommodate future growth or population decline. Planning is for a 10 – 19 year horizon.
	The organization analyzes current and future demands, and uses the information to plan infrastructure investments to accommodate future growth or population decline. Planning is for a 20 year or longer horizon.

Chapter 5

CRITICAL ASSETS

5.1 Introduction

Not all assets are equally important to the utility's operation. Some assets are highly critical to operations and others are not critical. Furthermore, the criticality of assets is completely utility specific. Certain assets or types of assets may be critical in one location but not critical in another. For example, a utility may have only one well that serves the entire community so that well may be a critical asset. Another utility's well may not be a critical asset because it has multiple wells and a large storage tank with capacity to store enough water for several days. A utility must examine its own assets very carefully to determine which assets are critical and why.



Does it feed a critical customer? CR-1
--Jim Smith, Louisville, KY

In determining criticality, two questions are important:

1) How likely is the asset to fail?
2) What is the consequence if it does ?

Criticality has several important functions, such as allowing a utility to manage its risk and aiding in determining the balance between expenditures for operations and maintenance, and capital projects.

5.2 Probability of Failure

The first step in determining criticality is determining how likely an asset is to fail (or the probability of failure for a given asset.) There are four modes by which an asset can fail.

- Mortality – the asset physically fails either through collapse, rupture, or some other mechanism
- Financial Inefficiency – the asset is costing so much to operate and maintain that it is no longer economical to keep it in operation
- Capacity – the asset is still operational, but is unable to provide the capacity needed
- Level of Service – the asset is still operational, but is unable to meet the level of service required

Mortality (when an asset is unable to perform its function) is the mode most commonly considered when thinking about failure. When Asset Management approaches are adopted, the other three modes also become important. When costs of operation and maintenance activities, as well as repairs, are cosidered on an individual asset basis, it is possible to determine the point at which it no longer makes economic sense to keep the asset in service. This is the point at which it is actually cheaper to replace the asset than to continue to operate and maintain it. The final two failure mechanisms occur in assets that may be functioning properly. However, they are no longer providing either the capacity needed or the service level desired.

In thinking about how each individual asset might fail, all four mechanisms need to be considered. However, the first two modes are the most likely for the majority of assets. At the beginning of an Asset Management program it is unlikely that historical data on operation and maintenance will be available on an individual asset basis and it may take time to get a program in place to track this data. For this reason, the focus of this discussion will be on the physical mortality failure mode.


CR-2


CR-3


CR-4

To determine the likehood of failure of an asset based on physical mortality, factors such as age, condition, repair history, operation and maintenance history, historical knowledge, experience with similar assets, and knowledge of factors affecting physical mortality, should be considered. An asset that is nearing the end of its useful life, is in poor condition, has a long history of repairs, and a poor history of maintenance is highly likely to fail. On the other hand, an asset that is relatively new, has no repair history, is in good condition, has had routine and preventative maintenance, is unlikely to fail. The factors that affect the probability of failure for an asset are described in more detail below. No single factor should be the sole predictor of likelihood of failure. Rather, all the factors about the asset should be taken collectively in determining probability of failure.

- **Asset Age:** Over time, assets deteriorate, either from use or from physical conditions such as interaction with water or soil. There is no "magic age" at which an asset can be expected to fail. An asset's useful life is highly related to the conditions of use, the amount of maintenance, the original construction techniques, and the type of material used in construction. A piece of ductile iron or cast iron pipe may last 75 to 100 years in one application, 150 years in another, and 50 years in yet another.

If age is the only issue with an asset, the probability of failure can still be relatively low even if the asset is quite old. For example, if the utility has cast iron pipe in the ground that was installed properly, made with good manufacturing techniques, and has never had a history of failure, it does not necessarily have a high probability of failure, even though it is 75 years old.

In order to use age as one measure of probability of failure some knowledge of potential useful life is necessary. This concept was discussed in Chapter 3. Each asset or type of asset should be assigned a useful life or life expectancy so that the actual age can be compared to the useful life. In this manner, it is possible to determine how much of the asset's life is "used up." The closer the asset gets to the end of its life, the more likely the asset is to fail. For example, a 35-year-old concrete interceptor that is expected to last 70 years has only reached the mid-point of its life expectancy and would not be likely to fail. If its useful life was only 40 years, 88% of its life is used up, so it is more likely to fail. As discussed in Chapter 3, the useful life values can be adjusted up or down if actual experience shows that the assets average more or less life expectancy than your initial estimate.

- **Asset Condition:** Another important factor in determining an asset's probability of failure is the condition of the asset. As the asset's condition deteriorates, it will be more likely to fail. It is important, therefore, to make the best possible attempt to give the assets a reasonable condition assessment. Obviously, assets given a poor or fair condition rating are more likely to fail than those given an excellent or good rating.

The condition assessment should be updated periodically, so that the criticality can also be updated.

- **Repair History:** It is important to monitor repairs resulting from some type of failure and record the type of event that occurred. This information should be as specific as possible to assist the utility in understanding its failure modes. Systems should track when the asset failed (or at least when the failure was discovered), how the failure was determined (customer report, operator observation, lack of service in that part of the utility, etc.), type of failure (e.g., rupture, mechanical failure, small leak), specific location of failure, and any field observations that may help explain the failure (e.g., lack of bedding sand, subsidence of soil, overheating, etc.) Failure history should be tracked on all asset categories.

Past failure is not completely predictive of future failure, but it can provide some indication of the probability of future failure, especially if detailed information on the past failures is collected and reviewed. If the asset failed because its construction or condition was poor, it is likely to fail again unless some action was taken to correct the problem. If the asset failed because of some action or incident unrelated to its condition or operation (e.g., a construction crew ruptured a pipe or a car hit a fire hydrant), it is not likely to fail again after the condition is corrected. If a pipe has failed several times in the past few years, it will be more likely to fail. If the pipe has never failed, it will be less likely to fail in the future.

- **Operation and Maintenance History:** Knowledge of how the asset was operated and maintained will provide information about how likely the asset is to fail. The lack of adequate maintenance is likely to shorten an asset's useful life and cause premature failure.

- **Historical Knowledge:** If the utility has any additional knowledge regarding the asset, it should be considered in the analysis of probability of failure. This type of information may include knowledge of construction or manufacturing practices used at the time the asset was installed or knowledge of materials used in the utility.

- **Experience with Similar Assets:**

Although probability of failure is asset and site specific, some guidance regarding probability of failure can be gained by examining experience with similar assets at your facility or other facilities. For example, if there is a history of a certain type of pump failing frequently after 2 years of use, and a utility has that type of pump and it is currently 18 months old, the asset should be given a higher probability of failure than it would if there was no general experience of this type.

- **Knowledge of Factors Affecting Physical Mortality:** There are two types of assets in water and wastewater utilities – vertical or active assets and horizontal or passive assets. Vertical assets are typically visible plant assets, and include assets such as pumps, blowers, mixers, diffusers, and chlorinators. Horizontal assets are field assets, generally buried, and include pipe, valves, manholes, meters, and service lines. It's important to know the difference between the two types because different factors affect their physical mortality.

In vertical assets, the asset usually has moving parts so the asset fails with use rather than age. Failure is related to overall run time, frequency of starting and stopping, quantity and type of routine and preventative maintenance, conditions of exposure (corrosive environment, extreme heat or cold, severe weather,) improper alignment, and lubrication.

In horizontal assets, the assets are passively providing service. These types of assets fail with age because they are in constant service. Failure is related to soil characteristics, saturation level of soil, physical loads, bedding conditions, asset material and related attributes, construction conditions, exposure to weather, and quantity of internal and external corrosion.

It is important to consider all of the relevant factors when assessing an asset or class of assets' probability of failure. The factors taken together provide an overall assessment of the asset's likelihood of failure due to mortality. If, however, a given asset is more likely to fail based on one of the other modes of failure (financial inefficiency, capacity, or level of service) before it fails due to mortality, the probability of failure should match that mode of failure instead.

The assets should be assigned a probability of failure rating based on how likely the asset is to fail on a scale of 1 to 5 or 1 to 10 or some other scale of the utility's choosing. An example rating using 1 to 5 is shown below.

1	Very Low
2	Low
3	Moderate
4	High
5	Very High

The ratings can be developed by a team of people who are knowledgeable about the assets, gathered together in a room to decide how the assets should be ranked. This ranking does not have to be a long, time-consuming activity. A small utility should be able to complete this process by meeting a few times for a few

hours. A larger utility may take a little longer.
An important consideration is the fact that the assets should be ranked relative to each other. The rankings should not be compared to other utilities; this system is meant as an internal tool only. The goal is to determine which of your assets are more likely to fail than other assets in your utility.

Once the assets are ranked according to the chosen scale, the results can be reviewed to see if they make sense. If you believe the assets that are ranked highest in terms of probability of failure are the ones most likely to fail, then the results are fine for a starting point. If not, then adjustments can be made until the rankings make sense.

A more sophisticated approach can be used, but a simple ranking like 1 to 5 works very well and will not take a lot of time to accomplish.

5.3 Consequence of Failure

After you determine the likelihood of failure of each asset, it is important to determine how bad a failure would be. This determination of consequence of failure involves the consideration of several tangible and intangible factors:

- Cost of repair/replacement
- Social impacts or costs
- Environmental impacts or costs
- Costs or impacts related to collateral damage caused by the failure
- Legal costs associated with asset failure
- Public health impacts or costs
- Reduction in Level of Service
- Any other costs or impacts related to the asset failure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The consequence of failure can be high if any of these costs or impacts are significant or if there are several of these factors that might occur with a failure. Further discussion of each of these factors is presented below.

- **Financial Cost of Repair:**

When an asset fails, it will be necessary to repair or replace the asset. Depending on the type of asset and the extent of the failure, repair may be simple or extensive. A small leak in a pipe can be repaired with a clamp. A chlorine pump can be replaced with a spare pump or perhaps the parts can be replaced inside the pump. The failure of a well may be much more involved and may require much more extensive repair efforts. Some failures may be so severe, or repairs may be so expensive that asset replacement is required. The financial cost of the repair or replacement of the failed asset must be considered in the analysis of the consequence of failure. If the asset can be repaired easily and without a tremendous cost, then there is a lower consequence. If the cost of repair is higher, then the consequence of the failure is also greater.

- **Social Impacts or Costs:**

When an asset fails, there may be an inconvenience to the customer. In some cases, this inconvenience may be minor,

while in others it may be much higher. If a pipe must be repaired in a residential area, there may be a few customers who are out of water for a short period of time. This outage would constitute an inconvenience, but would not be a severe situation. On the other hand, if the utility has very few isolation valves so that any repair requires the whole utility to be shut down, the inconvenience to the customers is much greater. In the first case (simple repair in residential area that shuts off a few customers), the consequence of failure related to the social impact is low. In the second case where the whole utility must be shut down to make any repair, the social impact is much higher. When framed in terms of inconvenience, social costs appear insignificant, but to your customers, the inconvenience may be extremely important and may impact how they feel about the utility in general. If customers have a negative impression of the utility, it can impact the ability to raise revenue.
Social impacts may be hard to quantify in dollar terms, but they need to be included in the analysis of consequence of failure in some way, either quantitative or qualitative.

- **Costs or Impacts Related to Collateral Damage Caused by the Failure:**
In some cases, when an asset fails, damage may be caused to other assets within the utility or to assets unrelated to the water or wastewater utility. An example of this type of damage might include a water line failure causing a sinkhole which causes major sections of a road to collapse or damages the foundation of a building. In addition, cars may be damaged in the sinkhole. The damage from the pipe failure without the sinkhole would be fairly minimal. With the sinkhole, there is collateral damage including the road, the building, or cars. Another example would be a sewer pipe failure that leaks sewage into a home or yard or onto a schoolyard or playground. In this case, a significant amount of cleaning will be required to restore the property. The utility will be held responsible for this collateral damage, so the costs related to this type of failure need to be considered in the assessment of costs of failure. Collateral damage may also occur within a utility. If a sewer collapses, debris may be delivered to the wastewater treatment plant which may damage motors or other moving parts.

- **Legal Costs Associated with Failure**:
In some cases, individuals or businesses may sue the utility for damages or injuries caused by an asset failure. These costs would be in addition to the costs of repairing and replacing damaged property or other assets. For example, imagine a driver is driving down the road and his car falls into a sinkhole caused by a water line failure, and the driver sustains an injury. The driver may sue the utility to cover the costs associated with the injury and loss of work time. Utilities may also be sued for causing significant environmental damage.

- **Environmental Impacts or Costs:**
Some types of asset failure can cause environmental impacts. The costs related to these impacts may not always be easy to assess in monetary terms. However, some attempt should be made to assign some type of quantitative or qualitative value to the environmental consequences. An example of an environmental cost related to a failure

would be a sewer pipe that leaked sewage into a waterway or onto public or private land. A value, either monetary or qualitative, would need to be placed on this type of consequence. If the leakage could result in a regulatory fine, the cost of the fine could be included. The cost of other environmental damage can be assessed qualitatively or a dollar amount can be estimated. A failure that could result in raw sewage being discharged into a major waterway should be given a high consequence rating; a failure that would have the potential to cause a more limited environmental impact could be given a medium rating; and a failure that would cause no environmental impact could be given a low rating.

- **Public Health Impacts or Costs:**
Some types of asset failures can negatively impact public health and safety. As with environmental costs, the costs related to these impacts may not always be easy to assess in monetary terms. However, some attempt should be made to assign some type of monetary or qualitative value to the consequences.

You have to renew that equipment so that it's meeting the new types of tests that are required.
Louis Martinez, Albuquerque, NM
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- **Reduction in Level of Service:**
The assets must be in working order to deliver the level of service desired by the water utility and its customers. If the assets fail, the ability to deliver the desired level of service may be compromised. An asset that has a major impact on the ability to meet the level of service would be considered more critical to the utility than an asset whose failure would not have a significant impact on level of service.

- **Other Costs Associated with Failure or Loss of Asset:**
The costs in this category are any other costs that can be associated with an asset failure that are not adequately defined within the categories above. An example of a cost that may be included in this category is loss of confidence in the water or wastewater utility or loss of the utility's image. Certain types of failures may negatively impact the public's confidence in the water or wastewater utility and this may have a cost to the utility. Other examples include loss of income related to the inability to provide service for a period of time, loss of the service itself, or health or safety impacts to workers.

In assessing the overall consequences of asset failure, the utility should consider all the costs associated with the categories above. The assessment can be a simple ranking of the consequences from 1 to 5 or 1 to 10. In this type of structure, the assets can be ranked against each other, but a specific monetary amount does not need to be calculated for the failure of each asset. For example, a major distribution line that has the potential to cause major failures and social and collateral damage and legal consequences might be ranked "5" while a small valve serving a residential area that has low costs of repair and essentially little or no social or environmental consequence would be given a ranking of "1." In this way, there is a qualitative assessment of which assets have a greater consequence than others, but no specific quantitative assessment is performed.

An example of a rating scale using 1 to 5 is shown below.

1	Very Low
2	Low
3	Moderate
4	High
5	Very High

Similar to probability of failure ratings, the consequence ratings can be developed by gathering people who are knowledgeable about the assets together in a room to determine the potential consequences of asset failure. This ranking does not have to be a long, time-consuming activity. A small utility should be able to complete this process by meeting a few times for a few hours. A larger utility may take a little longer.

Again, it is important to remember that the assets should be ranked relative to each other. The rankings should not be compared to other utilities; this ranking is meant as an internal tool only. The goal is to determine which of your assets will result in serious consequences for the utility if they fail.

Once the assets are ranked according to the chosen scale, the results can be reviewed to see if they make sense. If you believe the assets that are ranked highest in terms of consequence of failure are the ones for which the consequence is the greatest, then the results are fine for a starting point. If not, then adjustments can be made until the rankings make sense.

A more sophisticated approach can be used, but a simple ranking like 1 to 5 works very well and will not take a lot of time to accomplish. From an implementation perspective, it may be easiest to use the same scale for both consequence and probability of failure, but it is not necessary to do it this way. If the utility wishes to use a 1 to 5 ranking for probability of failure and a 1 to 10 ranking for consequence of failure, or vice versa, that is fine.

5.4 Redundancy

In some cases, there should be redundant assets in a utility. If an asset fails, there is another asset that can operate in its place. If there is total redundancy (i.e., the redundant asset can perform the function of the failed asset completely) then the consequence of the initial asset failing is greatly reduced. The probability of failure is not affected because the asset still has the same likelihood of failure, but its consequence is much less. The consequence does not fall to zero, however, because the asset would still need to be repaired; the redundant asset must be able to perform; and when the redundant asset is put into service, there is no redundancy until the failed asset is returned to service or replaced. In general, the more redundancy, the lower the consequence of failure.


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Operating water and wastewater utility assets is inherently risky. Chemicals are used in treatment and pipes are placed under major roads and waterways. Redundancy offers one way to reduce risk. Redundancy can be a very good risk reduction strategy – consider the fact that an airplane can fly on one engine – but it can also be an expensive way to operate, so this strategy should be used judiciously.

Redundancy can be incorporated into the risk assessment process in two ways. It can be built into the determination of consequence of failure so that the ranking given to the asset takes into account that there is partial or total redundancy. For example, if the asset without redundancy would be given a consequence of 5, the asset with redundancy might be given a consequence of 1 or 2. Another method of considering redundancy in the process is to multiply the redundancy factor times the overall risk score. This method will be explained in the next section.

5.5 Assessing Criticality – Risk Analysis

Criticality is a risk-based process. The risk is determined by the probability of failure and the consequence of failure.

The assets that have the greatest probability of failure and the greatest consequences associated with failure will be the assets that are the highest risk and therefore most critical. The next most critical assets will fall into three main categories:

- Assets that have a very high probability of failure with low consequence
- Assets that have a low probability of failure with a very high consequence
- Assets that have a medium probability and medium consequence of failure

The assets that have low probability and low consequence will be the least critical assets.

A technique such as the ranking table presented below can be a good place to start in assessing criticality. Appendix C contains copies of this table for use in criticality analyses at your utility.
To use this table, estimate the probability of failure for a specific asset from 1 to 5, with 5 being very high probability of failure and 1 being a very low probability of failure. Then assess the consequence of failure from 1 to 5 in the same manner. Using the number for probability of failure, move across the row until the column associated with the number for consequence of failure is reached. Locate the number that is in the box where the row and column intersect. That is the criticality score for that asset.

Consequence (Cost) of Failure	**5**	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
Multiplied		**1**	**2**	**3**	**4**	**5**
	Probability of Failure					

1 Very Low	**2** Low	**3** Moderate	**4** High	**5** Very High

Consider the following scenario.

Asset: 10 inch Cast Iron pipe; constructed in 1950, (61 years old in 2011)

Service History: Numerous breaks in the past 5 years

Service Area: Serves 3 major subdivisions, but there are loop lines available and only residential customers are served

Probability of failure: 4 – because pipe has broken many times, but when repaired it was still in reasonable condition

Consequence of failure: 2 – because there are loop lines so not all customers will be out of water. Repair costs are moderate. Line isn't in a critical roadway so repair is relatively easy.

Using the chart, move across the row for 2, until the column for 4 is reached. The number in the box is 8. Therefore, 8 is the criticality factor for this asset. (See the table below.)

Consequence (Cost) of Failure	**5**	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
Multiplied		**1**	**2**	**3**	**4**	**5**
	Probability of Failure					

As another example, look at the following scenario.

<u>Asset:</u> Chlorine pump
Utility uses hypochlorite so liquid chlorine solution is pumped into the utility for disinfection. Utility has both spare parts and a spare pump. Chlorine pump has failed due to many factors several times in the past 10 years. Chlorine is checked once per week

<u>Probability of failure: 4</u> – because pump has failed many times

<u>Consequence of failure: 4</u> – because a failure in a chlorine pump has the potential to be a major consequence. The consequence is mitigated by the presence of a spare pump and spare parts. However, because the pump may fail for a significant period of time before the failure is known (up to 1 week because the levels are only checked once per week), the consequence is not substantially reduced by the spare parts and pump.

Using the chart, move across the row for 4, until the column for 4 is reached. The number in the box is 16. Therefore, 16 is the criticality factor for this asset. (See the table below.)

Consequence (Cost) of Failure	**5**	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
Multiplied		**1**	**2**	**3**	**4**	**5**
		Probability of Failure				

In looking at these two assets for this utility, the chlorinator is much more critical than the piece of pipe. If all assets are viewed in this way, an analysis can be done to determine the criticality number for each asset and then the results can be compared to see which assets are more critical than others.

Once an analysis of this type is done, the results can be reviewed to determine if they make sense to the utility. If the utility personnel do not believe the results for a particular asset make sense (i.e., the asset seems to have the wrong relative ranking), a re-evaluation can be completed until reasonable results are achieved.

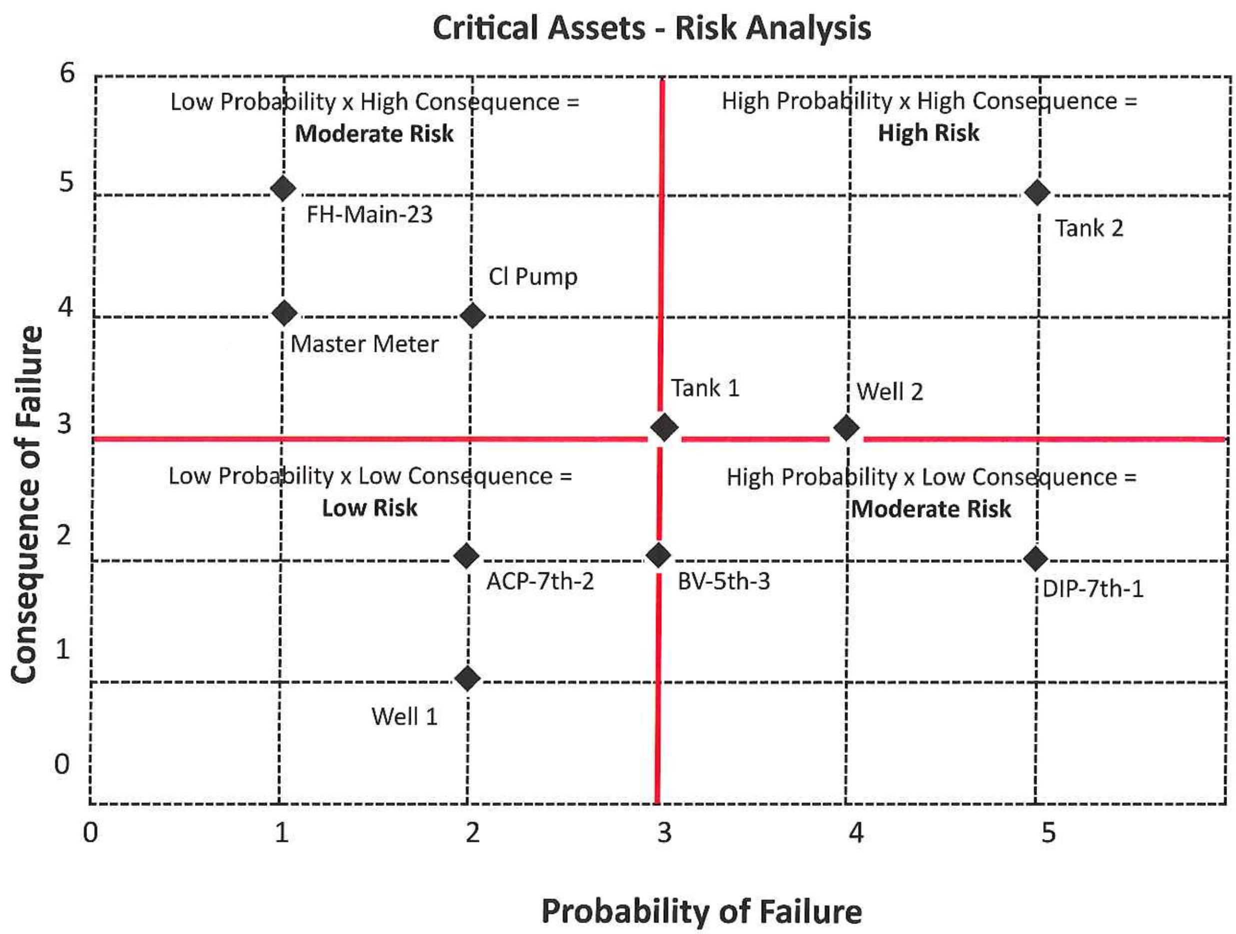
When the risk assessment for each asset has been completed, a graph showing the risk for each asset is a useful tool to quickly see which of the assets is most critical. Plotting the risk number on a graph with probability of failure on one axis and consequence of failure on the other axis is the easiest way to accomplish this. The graph can be divided into four categories of risk, as shown on the risk matrix (or "quad chart") below.

Risk Matrix

Consequence of Failure		
	Low Probability x High Consequence = **Moderate Risk**	High Probability x High Consequence = **High Risk**
	Low Probability x Low Consequence = **Low Risk**	High Probability x Low Consequence = **Moderate Risk**

Probability of Failure

The highest risk numbers will fall in the box in the upper right-hand corner, making it easy to compare assets and determine which of the assets are most critical. An example is shown below that includes asset in each of the quadrants of the chart. This example assumes that redundancy has been taken into account in the consequence of failure rating. A blank quad chart is included in Appendix C.



There is another way to consider redundancy. In this approach, the probability score is multiplied by the consequence score and then by a redundancy factor. The redundancy factor is based on how much redundancy there is for the asset. For example, if there are three pumps and two are needed to operate at a time, the utility has a 50 percent redundancy in pumps. If there are four pumps and three are needed, the utility has 33% redundancy. If there are two pumps and only one is needed, there is 100% redundancy. If there are three pumps and only one is needed, there is 200% redundancy.

An example of how to calculate the risk ranking using this approach follows.

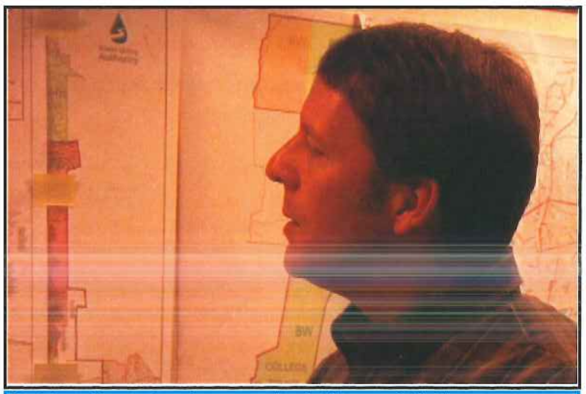
A pump is rated 4 for probability of failure and 4 for consequence of failure There are 3 pumps and 2 must be operating at any one time. (50% redundancy)

Criticality = (probability rating) times (consequence rating) times (1 minus redundancy factor expressed as a decimal)

Criticality = 4 X 4 X (1 - 0.5) = 8

Note that without redundancy, the asset would have had a score of 16.

If the redundancy is 100% or more, the equation would give an answer of 0 or negative risk. However, this does not represent the true risk, because even with redundant assets, there is still some risk related to the asset because the redundant assets must perform as expected. Therefore, for any asset that has a redundancy of 100% or more, a consequence rating of 1 should be used.



Criticality...is the probability of failure and the consequence of failure.
--Frank Roth, Albuquerque, NM CR-12

5.6 Criticality Related to Energy Use

Another component to consider when assessing which assets are critical to the process is energy use. If the asset is a high energy user, there is an operational cost associated with that energy use. Ranking assets according to energy use in a manner similar to the condition and consequence rankings will allow energy to be a consideration in the overall process of criticality.

There are many factors to consider when assessing criticality related to energy efficiency. Most of these factors fall within two major headings: the asset's impact on energy use, and the feasibility of addressing the energy use of the asset through installing a new asset or some other method. Discussed below are criteria that can be considered.

When an asset uses energy – either directly or indirectly – its impact on energy use and energy efficiency goals should be considered. The following criteria describe some of these considerations.

- **Meets Energy Efficiency Goals:**
When determining criticality for energy purposes, it is important to discuss whether the asset currently contributes to meeting the utility's energy goals or whether it is a factor in not meeting the goals. If the asset is allowing the utility to meet its energy goals, it should be given a low score (i.e., low criticality) and if it is not meeting the energy efficiency goals it should be given a high criticality score.

- **Energy Use:**
If an asset uses large amounts of energy, there may be a potential for significant energy use reductions related to installing a more energy efficient asset. If the asset uses very little energy or the asset is already as energy efficient as practical, there may be little potential for reducing the energy use. Assets that have a high energy usage should be given a higher rating than assets that have a low energy use. This evaluation should use actual energy use data when available.

- **Renewable Source of Energy:**
When considering energy use, understanding how the energy source

impacts the environment may be an important part of the energy criticality evaluation. If an asset is a significant contributor to greenhouse gas emissions it may be given a higher rating. If an asset uses a renewable energy source, it would be given a lower ranking.

A table showing a 1 to 5 ranking system is presented below.

1	Very Low Energy Use
2	Low Energy Use
3	Moderate Energy Use
4	High Energy Use
5	Very High Energy Use

The second aspect of the criticality discussion for assets that use energy is the feasibility of addressing the energy use. For the utility to be able to address the energy use of an asset, there must be a feasible alternative to the current asset, or a more efficient way to operate it, or a different energy source. The more feasible the project is, the higher the ranking should be. The less feasible, the lower the ranking.

- **Potential Alternatives:**

When deciding if the asset's energy usage can be reduced, consideration must be given to whether there are potential alternatives to the current asset. For example, an asset may be 65% efficient and the utility may desire it to be 75% efficient, but this increase is not possible if there is not a replacement asset on the market with that efficiency rating. Consideration must also be given to operational changes that may be required by the alternative. The more feasible a potential alternative is, the higher the criticality ranking score.

- **Costs:**

There may be alternatives to the asset as described above, but both capital and operational costs of the alternative(s) must be considered. Additionally, any cost savings that will result from the reduction in energy usage should be taken into consideration. The operational cost savings can be compared to the capital cost to determine how long it would take in savings to pay for the capital. The shorter the period, the better the project. The energy source of the original asset and any potential alternatives should be considered as well. When converting from one source of energy to another (i.e. electricity to natural gas) the operational costs may be significantly impacted. Any non-monetary costs – either positive or negative – should also be considered, such as social and environmental costs. The lower the costs or the greater the energy savings, the higher the criticality ranking.

- **Availability of Funding, Financing or Rebates:**

The question must be asked, How can the potential energy reduction alternative be paid for? If funding is available or if there are specific rebates or other incentives in the funding for the alternative, the project criticality ranking is higher.

- **Operability:**

Is it possible for the alternative to be operated with current staff upon completion? If the answer to this question is yes the ranking should be higher and if the answer is no, the ranking should be lower.

- **Regulatory Requirements:**
If an alternative is required to meet new or existing state or federal regulations or to address non-compliance, it should be given a higher ranking.

1	Very Low Feasibility
2	Low Feasibility
3	Moderate Feasibility
4	High Feasibility
5	Very High Feasibility

Similar to the approach with probability of failure and consequence of failure the assets can be ranked according to energy usage and ability to address the energy usage. The assets can be given a score of 1 to 5 for energy usage and a score of 1 to 5 for the potential to address the energy usage. The assets with the highest scores would be those that have both high energy usage and high ability to do something about it. These assets would be "critical" from the standpoint that if the asset were replaced or rehabilitated in some way related to energy, the utility would benefit.

When the factors for energy use and feasibility have been considered, a matrix similar to the one in section 5.5 can be constructed.

Prioritization Matrix

Feasibility of Addressing		
	Low Energy Use x High Feasibility **= Medium Priority**	High Energy Use x High Feasibility **= High Priority**
	Low Energy Use x Low Feasibility **= Low Priority**	High Energy Use x Low Feasibility **= Medium Priority**

Energy Use

The same ranking tables and graph from above can be used with energy projects.

Consider the following example.

Asset: A Sewage Lift Station Pump

Energy Usage: Uses a large amount of energy, representing 20% of the total energy usage for the utility. It is causing difficulties for the utility in terms of meeting its goal of 10% overall energy reduction. The pump is 15 years old and there are more efficient pumps available.

Energy Use Rating: 4

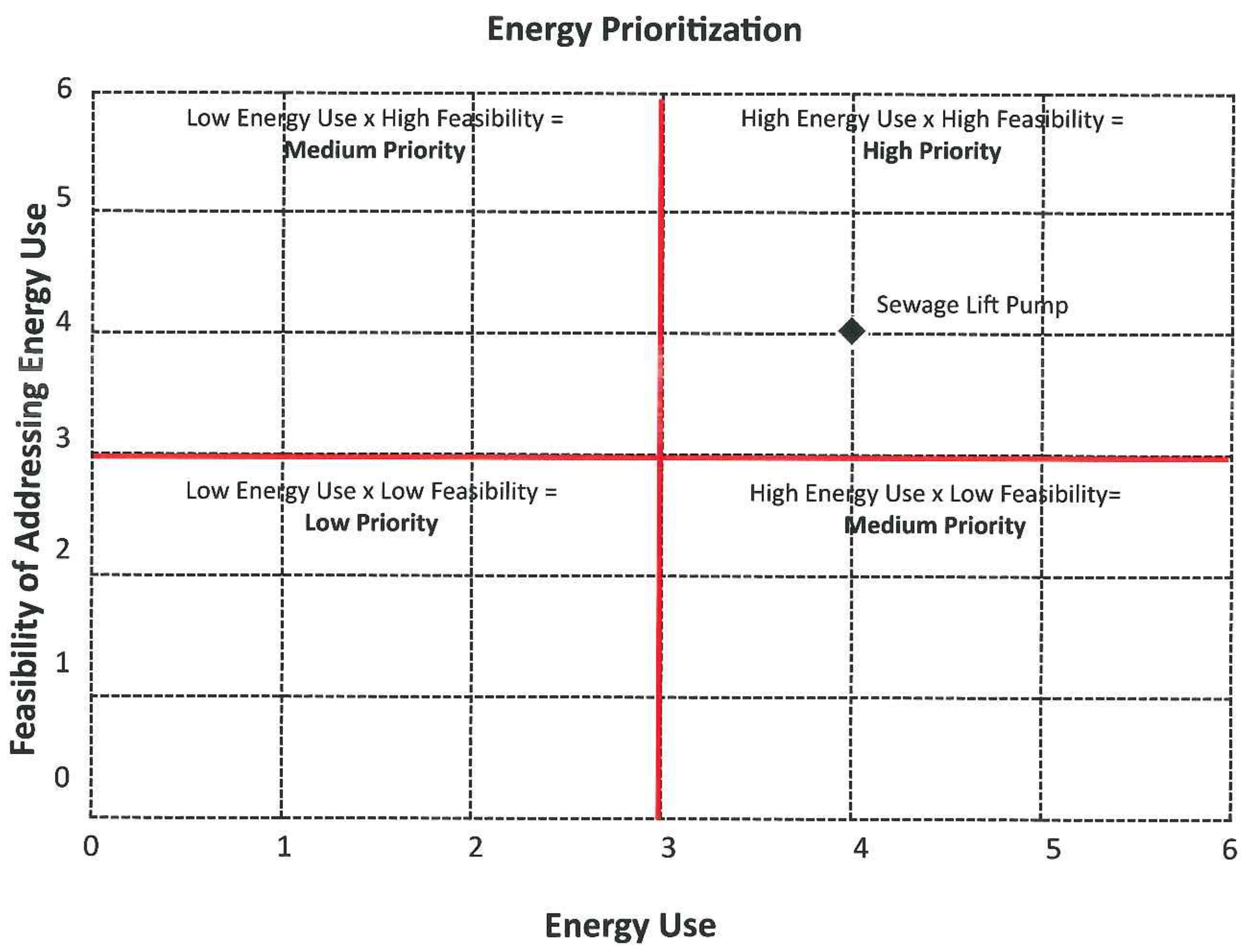
Feasibility: The reduction in energy use will offset the cost of the new pump in 6 years. The new pump will be easy to operate by the existing operator. There are funds available that include a grant portion to do this project.

Feasibility Rating: 4

As can be seen on the table, the total energy risk or criticality is 16. That number means that the project is a critical project to consider because it will reduce energy use, save money, and it is feasible. A copy of the table is included in Appendix C.

Feasibility of Addressing Energy Usage	**5**	5	10	15	20	25
	4	4	8	12	(16)	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
Multiplied		**1**	**2**	**3**	**4**	**5**
	Energy Usage Ranking					

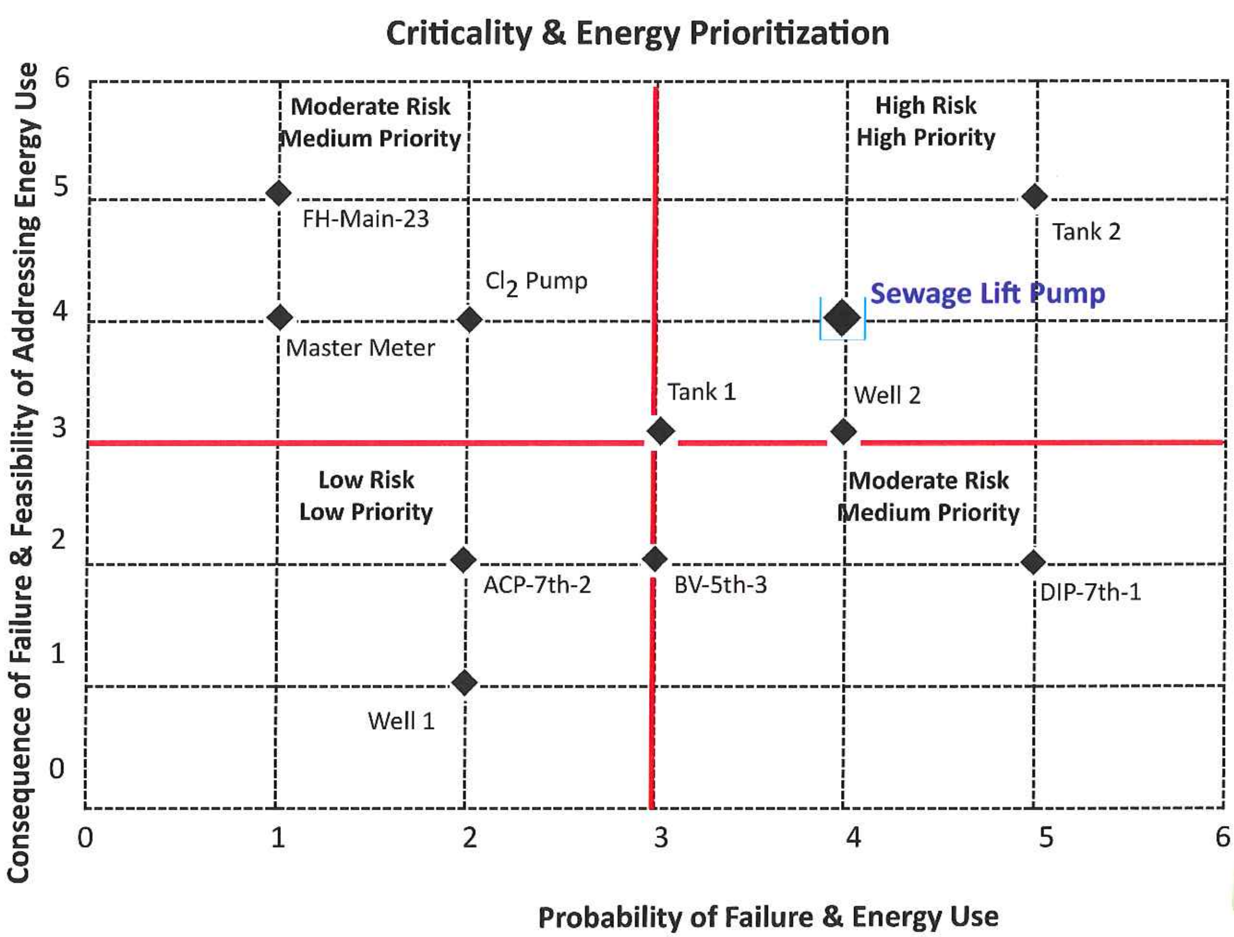
The Energy Use Ranking and the Feasibility of Addressing Energy Use of an asset can be plotted onto a quad chart along with other assets to show the relative merits of addressing the energy issues with each asset. A quad chart for this example is shown below.



The energy criticality can be overlain on top of the asset overall criticality as shown on the Criticality and Energy Prioritization Chart. If the Sewage Lift Pump was also a high risk asset based on probability of failure and consequence of failure, it would be an extremely critical item for the utility to consider. If it appears critical only based on the energy considerations, it should be included within the context of all highly critical assets.

Overlaying the criticality of assets based on probability and consequence with energy criticality can identify assets that may be high in both categories. These assets would be extremely critical to the utility in terms of replacement. A discussion of decision making based on criticality is presented in Chapter 6.

Both of the energy-related quad charts are available in Appendix C.



5.7 Criticality Analysis Over Time

The condition of the assets will change over time affecting the probability of failure. Costs of repair may increase, the community may grow, new roads may be built, rehabilitation may be completed or similar factors may occur that cause the consequence of failure to change. Therefore, it is necessary to periodically review the criticality analysis and make adjustments to account for changes in the probability of failure and the consequence of failure.

The criticality analysis must be reviewed and updated periodically to ensure that the utility is spending its time and resources on the appropriate assets. This operational and managerial approach is the heart of Asset Management. Ways to implement this approach are discussed in the next chapter. The update must also incorporate replacement of assets. If an asset that was critical primarily due to its probability of failure is replaced with a new asset, the criticality number will go down since the probability of failure is much less. The update must also take into account any changes in redundancy - positive or negative. If a new asset was installed to create redundancy, the consequence ranking will go down. If a redundant asset has failed and has not been repaired or replaced, the redundancy has decreased and the consequence ranking of the asset may increase.

You do your interventions and your asset replacements based on your ability to live with the risk.
--Ross Waugh, New Zealand

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Section IV: Assets Critical To Sustained Performance

A. Does the organization have a process to assess the probability of failure of assets?

	The organization has no process to assess the probability of failure of assets.
	The organization has developed a process for establishing the probability of failure but has not yet begun to use it.
	The organization has established the probability of failure for less than 50% of the assets.
	The organization has established the probability of failure for more than 50% of the assets.
	The organization has established the probability of failure for all1 of the assets.
	The organization has established the probability of failure for all[1] of the assets and uses the information in operating and managing the system.

[1]All refers to greater than 90% of the assets

B. Does the organization have a process to assess the consequence of asset failure?

	The organization has no process to assess the consequence of failure of the assets.
	The organization has developed a process for establishing the consequence of failure but has not yet begun to use it.
	The organization has established the consequence of failure for less than 50% of the assets.
	The organization has established the consequence of failure for more than 50% of the assets.
	The organization has established the consequence of failure for all[1] of the assets.
	The organization has established the consequence of failure for all[1] of the assets and uses the information in operating and managing the system.

[1]All refers to greater than 90% of the assets

C. Does the organization have a process to rank assets according to the likelihood and consequences of asset failure (i.e. according to "overall risk")?

	The organization has no process to rank assets according to overall risk.
	The organization has some limited ranking of assets according to overall risk with no plans to put in place a system for ranking all assets.
	The organization has developed a process to rank assets according to risk and is working towards ranking all assets with less than 50% of them presently ranked.
	The organization has developed a process to rank assets according to risk and is working towards ranking all assets with more than 50% of them presently ranked.
	The organization has ranked all[1] of the assets according to risk but is not yet using this information in the process of operating and managing the system.
	The organization has ranked all[1] of the assets according to risk and using this information in operating and managing the system.

[1]All refers to greater than 90% of the assets

D. Do the likelihood and consequences of asset failure (i.e. the "overall risk") drive asset investment decisions?

	The organization does not use risk to drive investment decisions.
	The organization is in the discussion stages regarding whether to use overall risk to drive asset investment decisions but has not yet started any activities in this area.
	The organization is developing an approach in which risk will drive asset investment decisions.
	The organization has completed development of a program for overall risk to drive asset investment decisions, but has not yet implemented it.
	The organization has a plan for how overall risk drives asset investment decisions and it is implemented. The risk ranking only plays a small role in the asset investment decision-making process for the organization.
	The organization has a plan for how overall risk drives asset investment decisions and it is implemented. The risk ranking process is fully integrated into the asset investment decision-making process and overall risk plays a key role in the process.

E. Does overall risk drive asset operation and maintenance (O&M) decisions?

	The concept of overall risk is not used to drive O&M decisions.
	The organization is considering using overall risk to drive O&M decisions.
	The organization is developing an approach in which risk will drive asset O&M decisions.
	The organization has completed development of a program for overall risk to drive asset O&M decisions, but has not yet implemented it.
	The organization has a plan for how overall risk drives asset O&M decisions and it is implemented. Not all decisions are yet based on this approach.
	The organization has a plan for how overall risk drives asset O&M decisions and it is implemented. All decisions are based on this approach.

Chapter 6

LIFE CYCLE COSTING

6.1 Introduction

Life cycle costing is the heart of Asset Management. Knowing exactly how much and what type of maintenance to do on an asset during its life and the correct point to replace the asset would optimize operational and capital expenditures. If you knew this information for each and every asset in your utility, you would know that every dollar spent was absolutely necessary and was being spent at the right time for the right reason. Consider a pump installed in June 1998. Assume you knew that the pump would fail completely in June 2012. You could replace the pump in May 2012. This would use the maximum life of the pump while allowing you to replace it before it became an emergency. We can add another dimension to the analysis by considering maintenance activities. What if you knew exactly what maintenance needed to be done, no more, no less, to have the pump last until 2012? You would need to perform only those particular activities on the pump to achieve its maximum life.

In theory, then, life cycle costing is relatively simple: do only as much maintenance as necessary to get the maximum asset life and replace the asset right before it fails. Unfortunately, the reality of life cycle costing is a bit more complex. It is almost impossible to predict with certainty when an asset is going to fail and it can be difficult to determine exactly how much and what type of maintenance is optimal for each asset.

The Holy Grail of Asset Management is being able to understand when assets are going to fail.
--Kevin Campanella, Columbus, OH

LC-1

Because of the complexities, a simpler method of deciding what to do in terms of asset replacement and operation and maintenance needs to be developed. This approach is based on risk as discussed in Chapter 5. Simply stated, assets with higher risk are replaced sooner than the end of their predicted or estimated useful lives and those assets with lower risk are replaced after they fail. Operation and maintenance activities are focused on high risk assets and greatly reduced on low risk assets.

This approach is used all the time in the case of vehicles, even though we might not think of it in these terms. The types of parts replaced on a car before they fail are those components that carry a high risk of catastrophic failure – the brakes, the timing belt, the tires. The parts that are allowed to fail are those that carry a low risk – the radio, the automatic door locks, the cup holders. Medium risk components have the potential to leave you stranded on the side of the road, but probably don't put your life at risk. These assets are parts like the water pump or radiator hoses. These assets may be allowed to fail or may be replaced before failure, depending on the owner's risk tolerance. The maintenance activities done on a car are also related to risk. Since changing the oil keeps the engine in working condition, it is done routinely. Very little maintenance, if any, is done on low risk assets in the car. It is unlikely that anything will be done to maintain parts like the radio or door locks.

As in the car example, risk is the main factor that will help utilities make decisions on water and wastewater assets for both operation and maintenance and capital expenses.

6.2 Life Cycle Cost Components

In order to improve decisions regarding the management of assets, it is necessary to know the costs of the various components of the life cycle of an individual asset. These costs include:

- initial cost of installation
- operations and maintenance expenses
- repairs costs
- rehabilitation costs
- disposal cost
- legal, environmental, or social costs


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At the beginning of an Asset Management program, it is often difficult to find historical cost information for individual assets. Instead, information is usually in an aggregate form. The utility may know total expenditures for operations and maintenance, but not how much of that cost was spent on a particular pump or well or blower. The lack of this type of specific information makes it more difficult to determine the optimal time to replace assets. If you don't know that of the $40,000 you spent on O&M at the wastewater plant, $5,000 was spent maintaining a clarifier drive this year and an additional $3,000 the prior year on the same drive, you won't be able to see that it would be more cost effective to buy a new drive at $7,000 than continuing to maintain the old asset.

Aggregate data also makes it harder to determine the overall quality of the utility. For example, suppose maintenance costs are $70,000 per year for a water utility. It would be helpful to know if that cost is uniformly spread out between field assets (pipe, valves, meters) and plant assets (wells, treatment, storage) or whether a single asset or asset class makes up most of that cost. If costs are spread across asset classes such as the following:

- $10,000 on pipe repair and maintenance
- $5,000 on meter and service line replacement
- $20,000 on well maintenance
- $15,000 on treatment related expenses
- $15,000 on storage tank maintenance
- $5,000 on fire hydrant repair and replacement

the utility can see that no one asset class accounts for most of the expenditures. However, if the costs of the $70,000 are distributed in the following way:

- $60,000 on pipe repair and maintenance
- $5,000 on meter and service line replacement
- $2,000 on well maintenance
- $1,000 on treatment related expenses
- $1,000 on storage tank maintenance
- $1,000 on fire hydrant repair and replacement

it is clear that the bulk of the costs are related to one asset class, pipes. In this latter case, the information shows that the utility needs to spend time and effort evaluating pipe to determine why costs are so high in this area compared to the rest of the operation. Addressing pipe issues might significantly decrease the overall cost of operating and maintaining the utility. Even though total expenditures were the same in both examples, the profile of expenditures presents a very different view of what should be done to address the costs.

A deeper analysis can provide even more information about how to address operation and maintenance expenditures. If you take one particular asset class, such as water pipe, and look more closely at how the costs break down between types of pipe, more information can be obtained to aid in decision-making.

In the second example, total pipe expenditures were $60,000 and these expenditures accounted for most of the total cost of operation and maintenance. Further examination of these costs can help to determine which specific assets are driving this cost. Suppose the costs break down as follows:

- Cast Iron pipe <12 inches $40,000
- Cast Iron pipe >12 inches $5,000
- PVC Pipe <12 inches $5,000
- PVC Pipe >12 inches $2,000
- Asbestos Cement (AC) Pipe <12 inches $7,000
- AC Pipe >12 inches $1,000

This type of breakdown would show that cast iron pipe less than 12 inches has the highest expenditures. Further examination of all cast iron pipe that is less than 12 inches would reveal which pieces of cast iron pipe were the most problematic. This data could be examined based on location, age, or some other method. For example, if the pipe was examined based on the decade of installation, the data might look similar to the following:

Install Date	
1930s	$2,000
1940s	$5,000
1950s	$20,000
1960s	$3,000
1970s	$5,000
1980s	$5,000

This data indicates that the majority of the problem is in cast iron pipe installed in the 1950s. Perhaps this pipe was not manufactured well or was installed incorrectly or was installed in an area with harsh soil conditions.

This type of detailed analysis of operational data is only possible if data is collected on an individual asset basis or at least by asset class. The more detailed the data, the more advanced and detailed the analysis of costs can be.

This type of data collection will be easier if the data is stored electronically, but data on work orders can also be kept on paper. If the total time for repairs, parts used, and personnel and vehicles involved are kept on the work order, along with information regarding the specific asset on which the work was performed, an estimate can be made of the cost for each type of activity completed on the asset. The work orders can then be sorted by asset and associated asset costs can be tracked. The work orders can also be sorted by asset class (i.e., pipe, hydrants, wells) to determine costs by class. If the utility has very few assets and a limited number of work orders per year, this method can work well. The more assets and work orders you have, the more important it is to keep an electronic version of the data or at least examine the data more frequently to prevent data review from being overwhelming.

Beyond operation and maintenance costs, there are other types of cost data to collect on assets: initial capital cost, costs related to energy use, repair costs not included on work orders, and any other costs associated with the asset (environmental, social, legal). Initial capital cost can be obtained at the time the asset was installed, or the cost information may come from historical records. If no other data is available costs can be estimated. Costs related to energy can be obtained from estimates of energy use as discussed in Chapter 3. The Energy Inventory forms in Appendix A can also be used for this purpose.

Records of all of these costs should be kept on the individual assets in the most sophisticated system available to the utility, be it hard copy or electronic. The more asset-specific the cost data is, the easier it will be to make good decisions on the management of the assets.

6.3 Operation and Maintenance Costs

The basic functions of keeping a water or wastewater facility running fall under the category of operation and maintenance. These two types of actions are often lumped together as one, but in this section, they will be separated into two distinct activities.

Operations, or operational activities, can be classified into three categories: standard operating procedures, alternate operating procedures, and emergency operating procedures. During the normal course of operations of a water or wastewater facility, standard operating procedures should be used. Standard operating procedures represent those activities that operators perform on a routine basis to keep the plant functional and to ensure that all permit conditions or regulatory requirements are met. These activities include opening and closing valves, turning on and off pumps, filling chemical tanks, taking chlorine residual readings, conducting a jar test, and putting fuel in vehicles.

Standard operating procedures will be used most of the time. However, conditions may change. Perhaps a piece of equipment is taken off line for maintenance or repair or for scheduled shut-downs. Under these conditions, the utility should follow alternative operating procedures. When severe conditions occur, such as natural disasters (flooding, tornadoes, fire) or the sudden failure of a critical asset, the utility needs to follow emergency operating procedures.

The key to efficient operations, whether standard, alternate, or emergency, is to ensure that all personnel are familiar with the procedures. Standard and alternate operating procedures should be captured in an operations and maintenance manual. For a small utility, the manual does not need to be lengthy or excessively detailed. It needs to clearly state what procedures should be followed during normal conditions and how those procedures might be modified in circumstances that call for alternate operating procedures, and it should specify the conditions that require alternate operating procedures. The document should be in a format that is easy to understand, and, above all, should be available to utility personnel. The document should be easy to modify if new procedures are adopted or conditions change.

Emergency procedures can be included in the operations and maintenance manual as a separate section or they can be specified in a special emergency procedures document. These procedures must be kept in an accessible place at all times – a place that will be available to any employee during an emergency. It is a good idea for emergency procedures to be kept in multiple places and in hard copy to ensure accessibility, including in the event of a power failure preventing access to electronic files. Emergency procedures should be coordinated – in advance – with first responder personnel, such as police, fire, hazardous materials response teams, and medical facilities. The emergency procedures should consider all types of potential emergencies at the facility and specify responses to each of these emergencies. Responses should also be practiced in advance to ensure that everyone knows what actions to take, who to call, and how to coordinate with other agencies. EPA has a free tool called Tabletop Exercise Tool for Water Systems, that can be used to practice an emergency scenario. The tool also includes many resources to assist utilities with emergency preparedness procedures and planning.

Maintenance involves those activities that help keep the assets in good working order so that it will operate smoothly. These activities include such things as: changing the oil, flushing water lines, cleaning out a sewer, and lubricating moving parts. Maintenance falls into the broad categories listed below.

- Routine Maintenance
- Planned Maintenance
- Preventative Maintenance
- Warranty-Related Maintenance
- Corrective Maintenance

Routine maintenance represents those activities done on a regular schedule, such as quarterly oil changes or monthly lubrication. These activities are necessary to ensure that the asset will perform properly and can be performed with minimal to no impact on the utility operations.

Planned maintenance is any work that is done on the asset in a planned and predictive way, rather than as a response to a failure or crisis. An example of this type of activity is a planned sewer cleaning program. The utility may decide to clean 1 mile of sewer every month, and a plan can be developed to move through the sewer utility to get this work performed.


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Preventative maintenance is similar to planned maintenance, but it involves actions specifically taken to prevent a failure. For example, if the utility examines a sewer with a camera and it shows significant corrosion of a concrete pipe, the utility may wish to add a chemical to reduce sewer gas build up. Another example is a pump that is showing signs of wear in the bearings. The utility can replace the bearings before they fail so that the work may be performed when it is advantageous for the utility (e.g., during business hours, when an operator is on duty, and when spare parts can be ordered ahead of time).

Warranty-related maintenance is any action required by a manufacturer to ensure that the warranty remains in effect. If a manufacturer's warranty on a particular asset requires specific maintenance, this maintenance needs to be completed on the appropriate schedule and documented to make sure the warranty is not voided.


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Corrective maintenance is the work performed after an asset fails in some way. It might be a small failure that requires very little effort to fix or it might be a major failure. A utility should strive to minimize this type of maintenance in order to reduce costs, keep the facility operational, and the levels of service met.

A companion activity to maintenance is monitoring. Monitoring should be done to determine when maintenance should be performed. Monitoring can be permanent and on-going with continuous read equipment or it can be intermittent. An example of continuous monitoring is a dissolved oxygen meter. This meter can show whether the aeration equipment is functioning properly. An example of intermittent monitoring is televising sewer lines. The data from the camera can indicate if there is root intrusion, corrosion, sediment build up or other conditions in the sewer that might lead to a problem within the utility. Another example is leak detection on water pipes

All operations and maintenance activities and monitoring require time and money, which are finite resources, particularly at a small utility. Therefore, it is extremely important that a utility carefully consider the following questions:

- What maintenance am I currently

doing that I need to continue?

- What maintenance am I currently doing that I need to discontinue?
- What maintenance am I *not* doing that I need to start doing?
- What maintenance am I *not* doing that should stay that way?

Chances are the utility has activities in all of these categories. It is highly likely that the maintenance currently performed involves more reactive maintenance and less proactive maintenance than is optimal. The goal for utilities that follow Asset Management principles is a ratio of 80 percent planned maintenance (including the categories of planned, preventative, and warranty-related) and 20 percent reactionary (corrective) maintenance. The more the utility does in a planned, predictive manner, the more efficient the overall operation. Planned maintenance helps to forestall failures, lengthens the life of assets, and saves money by avoiding overtime for repair activities and allowing sufficient time for obtaining spare parts on a non-emergency basis. When the maintenance activities are mostly corrective, it is an indication that not enough planned and preventative maintenance is being performed.

Once a utility decides to move to more planned maintenance, the next question is which maintenance activities should be performed and how often. Just as reactionary maintenance is more expensive than planned maintenance, doing the wrong type or frequency of planned maintenance is also inefficient and wastes money. Furthermore, doing inappropriate activities takes time away from doing the activities that are most likely to prevent failures. For example, although the oil in a car could be replaced every month, doing so does not extend its life more than changing the oil every 3 months or changing the oil based on usage.

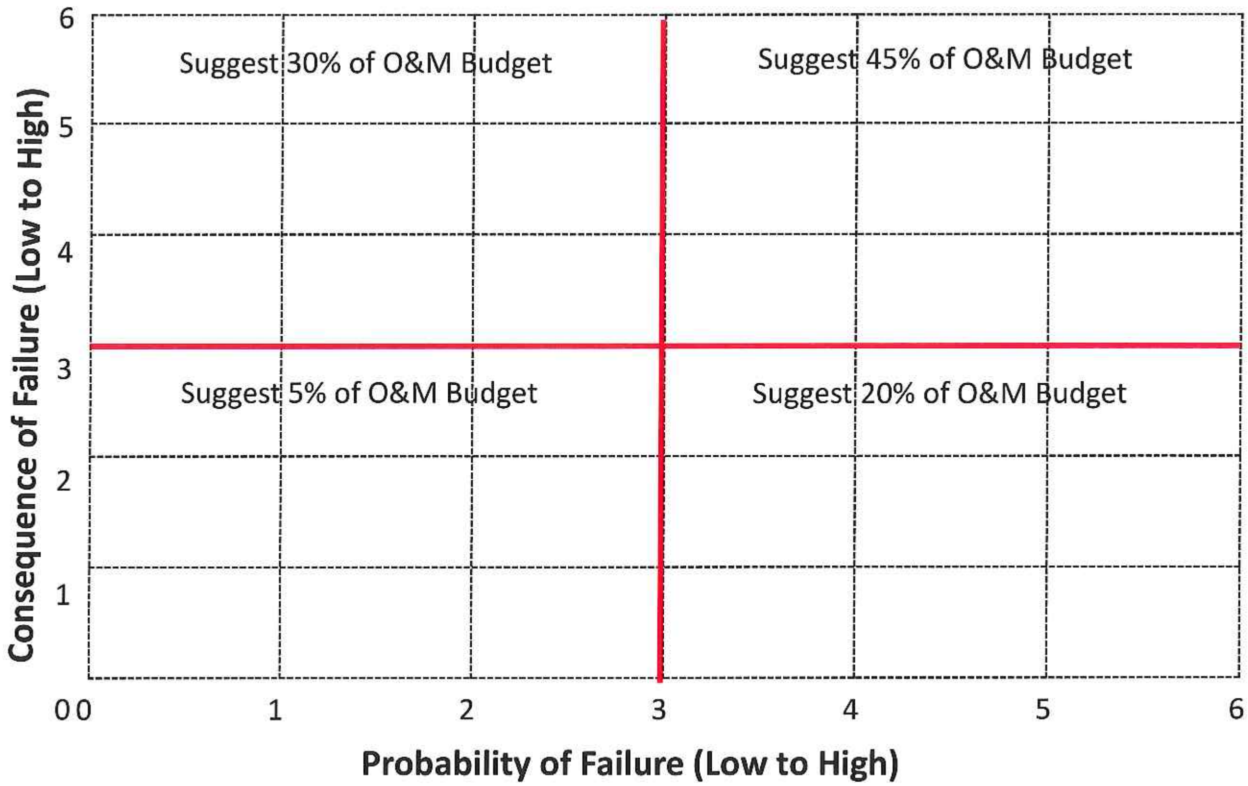
The question of which maintenance to perform and how often relates to the discussion of criticality in Chapter 5. The more critical an asset is, the more important preventative maintenance is. If an asset is likely to fail and the consequence is high if it does fail (the high criticality box on the quad chart,) then a utility would be wise to put a lot of resources and effort into making sure the failure doesn't occur. If, on the other hand, an asset is unlikely to fail and even if it does, the consequences are very low, the utility shouldn't be spending much on trying to prevent the failure. In fact, in the case of low criticality assets, letting the asset "run to failure" may be the most advantageous way to operate. This concept will be explained in more detail in Section 6.4.

Examining the assets that are in the high criticality category is a good starting point for deciding what maintenance to perform. Each class and type of asset has different types of maintenance that can help prevent a failure. A cleaning program can help prevent sewer pipe failures. A flushing and inspection program can help prevent fire hydrant failures. A valve exercising program can help prevent valve failure. A pump cleaning program can help prevent chemical feed pump failures. The first step is to determine the types of assets in the high risk category and the types of maintenance that can be performed to help forestall the failure. The next step is to determine if the utility has the tools and expertise to perform the maintenance. If it is not possible to perform maintenance to forestall a failure, another option, such as replacement, rehabilitation or providing a redundant asset to reduce the risk may be chosen.

As with operational procedures, maintenance activities need to be documented in some way. There are several options. A utility could have a written program, a generic computer-based program, or a computerized maintenance management system (CMMS.) EPA's CUPSS program includes a maintenance component to help small utilities identify routine maintenance activities. Any type of written or electronic maintenance program needs to include a mechanism to document that the work has been completed, so that managers can track maintenance activities and cost on an individual asset basis.

For most utilities, prior to initiating an Asset Management program, maintenance is usually spread out relatively evenly across assets. Following Asset Management principles changes this spread of maintenance tasks to one that is much more heavily oriented towards high risk assets. The criticality quad chart in Chapter 5 can be used to show how maintenance expenditures should be distributed across the four boxes. Most of the expenditures should be in the high risk box and very little should be in the low risk box. A quad chart showing a potential split of maintenance tasks by criticality is presented below.

Relationship Between Probability of Failure and Consequence of Failure



The following table summarizes the information regarding expenditures on O&M and related expenditures for condition assessment or monitoring.

Summary of O&M Expenditures and Criticality

Risk	Probability of Failure	Consequence of Failure	Relative Amount Spent on O&M	Relative Amount Spent on Condition Assessment	Example of an Asset That Could be in This Category
Low	Low	Low	Low	Low	4-yr old PVC pipe in a residential area
Medium	High	Low	Moderate	Moderate	60-yr old steel pipe in a residential area
Medium	Low	High	Moderate	Moderate	Encased pipe under a railroad track
High	High	High	High	High	60-yr old steel pipe under a major arterial road

Similar to maintenance expenditures, expenditures on condition assessment and monitoring should match risk. The greater the risk, the more worthwhile expenditures on condition assessment or monitoring. There is very little value in monitoring the condition of assets that have little risk of failure, particularly when the utility will probably take no action to prevent these failures.

Maintenance activities are an important part of preventing asset failures. However, it is never possible, even with the best maintenance program, to prevent all failures. At some point, the asset may have deteriorated or aged to the point that it is no longer feasible to forestall failure; or continued maintenance may be so expensive relative to the cost of a new asset that maintenance may no longer be the best option. In these cases, the asset should be replaced or rehabilitated through the capital improvement plan.

6.4 Run to Failure

For low risk assets, the most economical option may be to allow the asset to fail. This allows the full life span of the asset to be achieved. This management strategy is called "run to failure." You are choosing to let the asset run until it fails, at which time you will repair, rehabilitate, or replace it.

There are two categories of medium risk assets. The first category is high probability of failure but low consequence of failure and the second is low probability of failure but high consequence of failure. In the first case, these assets can be run to failure because the consequence is low. Since these assets are likely to fail, in the process of managed failure, the utility should be prepared for the repair or replacement of the asset. In the second case, the asset failure has high consequences. These assets are not generally ones that should be run to failure. Failures should be prevented if possible through maintenance activities or early replacement.
The final risk category – high risk – are those assets that are very likely to fail and they have serious consequences if they do. You would not want to use a managed, run to failure option for these assets; the risk of serious consequences is too great. In addition, replacing these assets sooner can prevent other serious consequences.

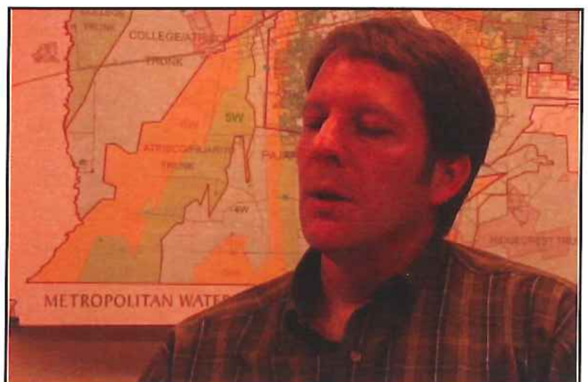
...when you properly prioritize your assets...you can't fix everything.
--Eric Saylor, Cincinnatic, OH
LC-11

6.5 Repair, Rehabilitate, or Replace: How to Decide?

When an asset failure occurs, the choices for how to respond include:

- Repair
- Rehabilitate
- Replace

In some cases, an asset can be repaired. The repair will not bring the asset back to its original condition, but it can keep the asset operational for a period of time. The condition of the asset at the time of the repair is an important consideration. If the asset retains a reasonable amount of structural integrity, a repair makes sense because the asset will still perform effectively. If, however, the asset shows significant deterioration, a repair makes less sense. One of the other options, rehabilitation or replacement, should be followed in this case.



We were spending about half our time on only 5% of our assets.
--Frank Roth, Albuquerque, NM

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Sometimes, an asset can be rehabilitated to bring it close to its original condition and extend its useful life. Rehabilitation can be done before an asset fails, or in some cases, after failure. Rehabilitation is generally less expensive than installing a new asset, but more expensive than repairing the asset. Rehabilitation can be used effectively if the additional useful life is enough to justify the cost. An example of rehabilitating an asset is lining sewer pipe. If the pipe has some structural integrity left, lining the pipe can bring it to an almost new condition and give the pipe an additional 50 years or more. The lining also eliminates the need to dig up the pipe and replace it, which reduces the cost.

The last option is replacement. The asset can be replaced with a similar technology, a completely new technology, or a more efficient technology. The replacement should be one that makes sense for the utility from a capital and operational standpoint and should fit with the level of service goals and the long-term plans for operation.

The selection of repair, rehabilitation or replacement involves a consideration of: the feasibility of the options; the condition of the existing asset; the capital cost of each option; the operations and maintenance cost after the repair, rehabilitation, or replacement; the remaining useful life in each case; the decay pattern; asset criticality; energy use; and the impact on level of service.

• Feasibility of the Options: Not all of the options will be available in all cases. There may be cases in which the asset is too badly damaged to be repaired. There may be limited rehabilitation options for many of the assets or the asset may have been too badly damaged to enable this option.

• Condition of Existing Asset: If the asset condition is fair or higher, repair may be a good option as long as the repair is relatively inexpensive compared to the cost of a new asset. In the case of a poor condition asset or an asset whose repair costs are high, replacement or rehabilitation may be better options.

• Capital Cost of Repair, Rehabilitation, or Replacement: The capital costs of each option should be determined.

• Operation and Maintenance Costs: Different options lead to different costs of operation and maintenance. The costs of maintaining an asset that has been repaired could be different than the costs related to an asset that has been rehabilitated or replaced. If the asset is one that uses energy, a cost difference may occur if a more energy efficient asset is installed to replace the asset or if the new asset has a different energy source.


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• Remaining Useful Life: If the asset is repaired, the useful life will probably remain the same as before, although the initial failure could cause some decrease. If the asset is rehabilitated, the useful life can be extended to almost as long as the original asset. If the asset is replaced, the asset life will be the life span of the new asset. As an example, if an existing asset had a useful life of 40 years and was 30 years into its life at the time of the failure, repairing the asset will likely keep the 10 year remaining life; rehabilitating the asset may result in an additional 30 years of life (for a total of 60 years from installation to replacement); and replacing the asset might provide an additional 40 years of life for a total of 70 years of life for the two assets together. In this example, replacement only provides an additional 10 years, compared to rehabilitation. To make this option attractive, the cost of replacement would have to be close to the cost of rehabilitation. Otherwise, rehabilitation may be a better option than replacement.

• Decay Pattern: After an asset is installed, it will start to decay or deteriorate at some rate over the course of its useful life. In some cases the decay may be very slow at first and then start to increase until it increases very rapidly as it gets closer to the end of its life. In other cases, the decay may be more evenly distributed over the asset's life. Each asset or asset class has a different type of decay pattern or curve. If the decay pattern was known for the various assets or asset classes, it would be easier to make decisions about what to do when the asset failed. If the asset was in the beginning of its decay curve, repairing a failure would make sense. If the asset was at the point where it was decaying at a very rapid rate, it would make more sense to replace rather than repair the asset. It is difficult to know the exact decay curve for each asset, but the utility's experience with various asset classes can help determine how the asset will respond to failures. If the utility notices that a type of asset usually lasts 10 years before its first repair, then has a few repairs over the next 5 years, then seems to break constantly, a decay pattern can be established. This example asset has a slow decay rate for 10 years, then an increasing rate for 5 years, followed by a rapidly increasing decay rate, until the asset ultimately replaced. In this scenario, an asset should be repaired if it is in the first 15 years, and replaced within the next few repairs after that time. It will not be possible to know the decay pattern of all the asset classes, but it may be possible to know some of them, particularly assets that have shorter lives. Any historical knowledge you can gather to help define the decay patterns, will help you make a better determination of how to respond to an asset failure.

• Asset Criticality: When a high risk asset has failed, it may be more advantageous to replace or rehabilitate the asset, than to repair it. The risk of the asset failing again may be too great to allow for a repair.


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• Energy Usage: If the asset is high priority from an energy standpoint (the asset is uses a lot of energy and it is highly feasible to do something about it) it should be replaced with a more energy efficient asset. Alternatively, if the level of service includes a goal to reduce green house gas emissions and the asset can be replaced by an asset that uses a "green" source of energy, replacement of the asset may be a good idea, even if this option is not the cheapest alternative. (There are resources, such as Portfolio Manager, that can help a utility determine energy usage and these resources are included in Chapter 10. Also, a table is included in Appendix D to assist utilities in the determination of potential energy savings projects.)

• Impact on Level of Service: Some options may have an impact, positive or negative, on the level of service. This impact must be taken into consideration in the evaluation of how to decide which option to choose.


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All of these factors play a role in determining whether to repair, rehabilitate or replace the asset. The cost factors (capital and O&M) together with the information on useful lives provide good information regarding overall life cycle cost, while the condition, feasibility, level of service, and decay pattern provide insight into other reasons to pick one option over another. The overall risk of the asset may also drive the decision to replace or rehabilitate over repair. Some decisions may be obvious, while others may be much less so.

Thus far, the discussion has been focused on assets that have failed. Some high risk assets will need to be replaced or rehabilitated to prevent failure. Some medium risk assets, those with high consequences of failure, may also be replaced prior to failure. These replacement or rehabilitation projects can be done as planned activities and the costs can be included in the capital improvement planning process.

6.6 Capital Improvement Planning

A utility will have many reasons to install new assets or rehabilitate existing assets. The most common reasons are listed below.

• Replacement or Rehabilitation of High Risk Assets: As discussed in Section 6.5, some high risk assets will need to be replaced or rehabilitated on a planned schedule.

• Assets Related to Future/Upcoming Regulations: New rules at the state or federal level may require water or wastewater utilities to install new assets to meet the requirements. For example, when EPA lowers the Maximum Contaminant Levels (MCLs) of primary contaminants or begins regulating a new contaminant, the utility may need to add treatment technologies or make some other changes, such as developing a new water source, to meet the new regulation. It is important for utilities to be aware of upcoming regulations and consider how they may impact the capital needs of the utility.

• Assets Required for Growth: A utility's service area may expand requiring new infrastructure to reach additional customers, or population growth may occur within the existing utility boundaries requiring expansion of capacity. This growth may result in the need for additional water resources, water and wastewater piping, treatment facilities or storage tanks.

• Assets Related to Utility Consolidation or Regionalization: Some utilities may find it advantageous to consolidate or regionalize with other nearby utilities. When this consolidation or regionalization includes a physical connection between the utilities, new assets may be required.

• Asset Replacement Related to Improved Technology or Energy Efficiency: In some cases, a utility may wish to replace an asset with a new asset that uses a different technology. The new technology may result in better operation or improved energy efficiency. Newer assets are often more energy efficient than older assets, so there may be opportunities for significant cost savings if an asset is replaced with a more energy efficient asset. In other cases, assets may be replaced by technologies that improve customer service or enhance operational efficiencies. Examples of this type of asset replacement include automatic metering of water utilities or a SCADA system that electronically controls the utility's operations.

Projects needed to address any of the issues described above should be compiled into a Capital Improvements Plan. The plan, at a minimum, should cover 5 years, but a time horizon of at least 20 years is preferable. Although projects in years 15 through 20 are more speculative in nature than those in the first 5 to 10 years, this long range projection helps the utility plan for and fund its future capital needs.

The capital improvements plan should specify project priorities and the anticipated funding source for each one. The projects should be listed by the year in which they are planned. At a minimum, the capital improvement plan or CIP should include the following information:

- Description of the project
- Need for and benefits of the project
- Estimate of project cost
- Estimate of O&M including reductions in energy costs for projects that address energy efficiency
- Funding source(s)

It is important to note that the funding source can be internal or external. If the utility desires to track projects separately based on whether it will use internal or external funding sources, it can separate the projects between a CIP (projects funded by outside sources) and a Replacement Schedule (projects funded by internal sources) otherwise all the projects can be listed together on the CIP.

Appendix D contains a copy of a Capital Improvement Plan and Repair and Replacement Schedule.

The CIP needs to be updated annually so that it always covers the same length of time. As projects are completed, they should be removed from the list. Projects listed for the current year that were not completed should be moved to a later year. If no projects are anticipated for a given year, the CIP should reflect this. Appendix D contains an example table that can be used to develop the CIP. There is also an example table for a Repair and Replacement Schedule.

Capital Project Validation

Deciding to replace an asset does not fully address the question of how it should be done. Because capital projects can be such a significant expense for a utility, it is critical that the projects be validated to make sure the project is necessary, all potential alternatives are considered and the best alternative is selected. To address these concerns, a business case evaluation should be performed that includes the following type of information:

- Project Description
- Need for Project
- Benefits as a Result of the Project
- Risk of Not Doing Project
- Current Asset Condition
- Estimated Useful Life of the Existing Asset
- Estimated Useful Life of the New Asset
- Probability and Consequence of Failure
- Current O&M
- Capital Cost of Proposed Project
- O&M of Proposed Project
- Options for O&M to forestall the capital project
- Alternatives to Proposed Project, Including Non-Asset Alternatives

We're able to document a long-term savings of over $10 million.
--Kevin Campanella, Columbus, OH
LC-22

Many of the items are self-explanatory. The remaining items are explained below. One of the items on the business case evaluation is the options for using O&M to forestall a capital project. In some cases, there may be opportunities for O&M interventions that can keep the asset in service for some additional time period to delay the capital project. These options, as well as the cost of the option and the number of years gained in useful life, need to be documented.

No matter what the proposed project, there are almost always alternatives. There may be alternatives with different combinations of capital and O&M costs that can be compared to determine whether a project with higher capital cost and lower O&M cost is more advantageous than a project with lower capital and higher O&M cost. There may be alternatives more closely match community values or alternatives that are more comfortable for the current operators. It is absolutely critical that a thorough analysis of all the alternatives be completed and that the analysis is done objectively. All reasonable alternatives should be clearly presented, along with cost information.

A specific type of alternative that should be included, when feasible, is a non-asset solution. Non-asset solutions are alternatives that address a need without actually installing assets. For example, consider a utility that maintains a fleet of vehicles and has a vehicle maintenance yard that is in disrepair and needs rehabilitation or replacement. Perhaps it will cost $500,000 to do the maintenance yard repairs, but it turns out that the utility needs its vehicles infrequently. Instead of rehabilitating the maintenance facility, it may be possible to enter into a sharing arrangement with a neighboring utility and pay for the use of vehicles on an as-needed basis. This type of solution may cost more on a per-mile basis than owning the vehicles outright, but since they are not needed constantly and the maintenance yard would no longer be needed, the overall cost of operation might be much lower.


LC-23


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LC-25

When done correctly, a business case evaluation can take time to complete. Therefore, it may be a good idea to use this process only for projects above a certain dollar amount. Different utilities will set different limits depending on the size of the facility. A smaller utility will probably set a lower dollar amount than a larger utility. Each utility should select a dollar amount that allows most major expenditures to go through the process, while not overly burdening the personnel.

A business case evaluation can have several possible outcomes. These outcomes include:

- Project should go forward in current year's CIP
- Project should be delayed until a future year's CIP
- Insufficient information was presented in the business case; project should be re-submitted with additional information

- Alternatives should be investigated and the project should be re-submitted with the additional information
- A different alternative than the one selected should be chosen
- Additional O&M is recommended; the project should be delayed for some number of years
- Project should not go forward

Projects should proceed only if the most appropriate alternative has been selected and both the need and benefit are clearly shown. If these conditions are not met, one of the other options as outlined above should be selected. If more information is needed, the project can be re-evaluated and re-submitted.

Because capital expenditures account for such a large portion of the overall budget of most utilities, a good capital project validation process can provide significant cost savings for even small utilities. As an example, Arenas Valley, a small utility included in this manual, was contemplating a capital project that included replacement of much of their water distribution system. This project would have cost approximately $5 million dollars. A validation process showed that the project was not needed. Instead, the utility would benefit from looped lines, isolation valves, and a limited pipe replacement project. This project was completed at a fraction of the cost of the original project and increased the level of service for the customers.

A business case evaluation form is included in Appendix D.

6.7 The Data and Decision-Making Cycle

Making good decisions relies on knowledge. Knowledge comes from data but is not equal to it. A utility can have a lot of data and very little knowledge if the data is incomplete, of poor quality, inaccessible, or of the wrong type. For example, a utility may have 2,000 repair records for their main line pipes for the past 10 years. The records are scattered around an office and many of them are incomplete. There is no consistency between the records, so it isn't easy to tell what work was done. Information such as pipe type and size is missing from the records. Clearly, the utility has a lot of data. What it doesn't have is knowledge. This utility would not be able to determine which type of pipe was breaking nor could it comfortably rely on the data due to the poor quality. It would also be hard to use the data because it is in paper form and scattered throughout the office.

When they reach a point where it's breaking at twice our average break rate...is when we would start to proactively replacing that pipe.
--Kevin Campanella, Columbus, OH

LC-26

Instead, utilities need to determine what data they need to collect to gain the knowledge to make good, sound decisions about the management of the assets. Once this determination is made, the need to ensure good quality and thorough record keeping must be passed on to all of the staff.

At the beginning of an Asset Management program, it is highly unlikely that a utility collects all of the data it needs at a sufficient quality, organized in an accessible manner. Most likely, the utility will need to figure out what data it wants in order to improve decision-making. It will also have to establish parameters for the data quality and determine the best method to store the data.

The utility should consider data gathering and decision-making to be a cyclical process. Data will be collected and analyzed to gain knowledge and inform the decision-making process. This analysis will also point out weaknesses in the data, data quality, or data storage system. These weaknesses can be addressed and the process can be repeated. For the first several years of the cycle, considerable gains will be made in the ability to make decisions about the right way to manage the assets each time through the cycle. After that, the utility will still make gains, but the increments will be smaller.

Just as there may be data that is needed and is not collected, there may be data that is collected but not needed. If data is not useful for operations, maintenance, or capital decision-making and there is no other compelling reason to obtain the data, it should no longer be collected. Data should not be collected for data's sake; the collection of data takes time and resources and should only be done if there is a need for it.

...for our highly critical assets, we'll do frequent condition monitoring.... LC-27
--Scott Maring, Cincinnati, OH

An example of the data and decision-making cycle is the following. A wastewater utility wishes to determine if something can be done to address sewer back ups. The initial data available is the number, but not location, of customer complaints. The utility doesn't have enough information to proceed, so it can decide to start collecting more information on each sewer back up. It develops a process to collect data on each back-up on a written form that is filled out in the field. The field data is then input into a simple computer spreadsheet. The data includes date, time, location, pipe type and size, and nature of the problem. Using this data, the utility begins a sewer cleaning program. The utility examines data for sewer back-ups for a year after the cleaning program is initiated to determine the effect. The utility notices that in one part of the utility, there was a significant improvement in the number of back-ups, but in another part of the utility, there was no improvement. Now the utility needs additional data on the sewer lines that are still experiencing back-ups. The utility decides to televise these sewer lines. The televised data show that several lines have severe root intrusion in the sewer. The utility begins a program to remove the roots. Data on sewer back-ups is analyzed for a year following the root removal to determine the impact. The utility determines that the cleaning program and root removal efforts have made a significant decrease in the number of sewer back-ups.

The business case showed that this was the way to go.
--Eric Saylor, Cincinnati, OH
LC-28

A data decision-making cycle that includes data collection, data analysis, decision-making, and action followed by data collection, data analysis, revised decision, and action can be used to address many operational and managerial concerns within a utility.

6.8 Balancing O&M and CIP Costs

Utilities should strive to achieve a balance between operation and maintenance costs and capital expenditures. Spending more in one area can impact the expenditures in the other. For example, spending more on maintenance can extend the life of an asset and forestall a capital expenditure for a period of time. Alternatively, if assets are replaced frequently, these capital expenditures reduce the need for maintenance. Consider the example of a car. A car can be kept in service for 15 years or more if regular and preventative maintenance is performed. In this case, the expenditures on maintenance would be high but the expenditures on capital would be very low. The opposite mode of managing the car would be to purchase a new car every 2 years. In this case, there is very little need to do any maintenance at all, even oil changes. Besides adding gas, the car would likely run for two years without maintenance. In this case, the expenses for maintenance would be minimal, but the expenses for capital would be extremely high. Consider the expenses associated with each type of operation as shown below:

Example 1: Maintaining Car for a 15 Year Life

- Initial Cost of Car: $18,000
- Maintenance Cost
  * Average $100/month years 1 to 5
  * Average $200/month years 6 to 10
  * Average $300/month years 11 to 15

Total cost/year on average for 15 years = $3,600/year

Example 2: Buying a new car every 2 years.

- Initial Cost of Car: $18,000
- New Car every two years at $18,000/each

- Maintenance Cost: Average $5/month

Total cost/year on average for 15 years = $9,060/year

Although these two modes of managing the car represent extremes, they are illustrative of the point that, generally, spending more on operation and maintenance and less on capital is the least cost method of managing assets. However, the risk of failure is somewhat higher with this type of management.

Where do we spend those revenue dollars? Do we spend more on capital projects...or do we spend more on operations?
--Stan Allred, Albuquerque, NM

LC-29

This risk is one reason to shift the balance in one direction or the other. When an asset is extremely high risk (high criticality,) the risk associated with the failure may be so great that the asset needs to be replaced sooner and the potential to keep it in service with maintenance may be reduced.

Another factor affecting the balancing between capital and O&M is the ability of the utility staff to manage the maintenance required to keep the asset in service.

6.9 Managing Risk

The main consideration with all operation and maintenance activities and capital expenditures is how much risk the utility is willing to tolerate. The utility can spend less if it is willing to accept more risk (i.e., increased failures of high and medium risk assets) and more if it is willing to accept less risk (i.e., intervening to prevent failures for high and some medium risk assets.) The utility should invest money to reduce the failures it feels cannot be tolerated. This investment should be made in both operation and maintenance expenses and capital expenditures. Money should not be spent to prevent failures of low risk assets. These assets should be replaced after they fail.

LC-30

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As a starting point, a utility can ask itself the following questions:

- Did we experience bad consequences from failures last year?
- How bad were they for customers?
- Did customers complain about the consequences of any of the failures?
- Did we incur additional costs from fines or legal expenses because of severe consequences?

If the utility can say that there were few really severe consequences from failures, then perhaps the utility is appropriately managing its risk from asset failures. If the utility had a lot of negative consequences from failures and the customers are expressing concerns about failures, then perhaps the risk level is not well-managed. In that case, the next questions the utility should ask include:

- Are we doing enough to prevent high risk assets from failing?
- Are the maintenance activities focused on the high risk assets?
- Have we properly identified the high risk assets?
- Will our customers be willing to pay more to reduce the risk in the facility?

All of the techniques and tools in this chapter should help the utility manage its risk at the appropriate level.

When I cannot bear the risk of that asset failing, I will replace it.
--Ross Waugh, New Zealand

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Asset Management IQ

Section V: Life Cycle Cost

A. Is the organization moving from reactive maintenance to planned or predictive maintenance?

	The organization does not assess reactive vs. planned maintenance in any way.
	The organization is developing a process to track reactive versus planned maintenance.
	The organization is currently implementing a process to track reactive versus planned maintenance.
	The organization's reactive versus planned predictive maintenance is currently being tracked. There is insufficient data to determine if there have been any improvements.
	The organization's reactive versus planned predictive maintenance is tracked. Improvement in the ratio of reactive to planned maintenance has occurred. However, it is not yet in line with the industry best practice of 80% planned/predictive maintenance and 20% reactive maintenance.
	The organization's reactive versus planned predictive maintenance is tracked and it is in line with the industry best practice of 80% planned/predictive maintenance and 20% reactive maintenance.

B. Does the organization have a program to fully consider all aspects of Life Cycle Costing when making infrastructure investment decisions, including initial capital cost, operation and maintenance, repair, and disposal?

	The organization only considers capital cost when making infrastructure investment decisions.
	The organization sometimes considers Life Cycle Costs when making infrastructure investment decisions. Doing so is not part of a standard process.
	The organization is developing a process to consider Life Cycle Costs but has not yet implemented it.
	The organization has developed a process to fully consider all aspects of Life Cycle Costing and has tested it on a few asset investment decisions.
	The organization is implementing a process to fully consider all1 aspects of Life Cycle Costing on all[1] asset investment decisions. The process is not yet used for all[1] investment decisions.
	All1 asset investment decisions are made using a process that fully considers all[1] aspects of Life Cycle Costing.

[1]All refers to greater than 90%

C. Does the organization have a long-term Capital Improvement Plan?

	The organization does not have a long-term Capital Improvement Plan.
	The organization has a Capital Improvement Plan for the current year only.
	The organization has a Capital Improvement Plan that covers less than5 years of future needs.
	The organization has a long-term Capital Improvement Plan that covers 5 to 9 years of future needs.
	The organization has a long-term Capital Improvement Plan that covers 10-19 years of future needs.
	The organization has a long-term Capital Improvement Plan that covers 20 years or longer of future needs.

D. Does the organization have a validation[1] process for its capital projects that includes consideration of non-asset solutions as well as non-traditional approaches (i.e., green infra-structure, decentralized treatment, water conservation to reduce need for new sources)?

	The organization does not have a validation process and does not consider non-asset solutions nor non-traditional approaches.
	The organization sometimes investigates non-asset solutions or non-traditional approaches when evaluating capital projects. Doing so is not part of a standard validation process.
	The organization is developing a validation process for capital projects, but has not yet implemented it.
	The organization has developed a validation process for capital projects including the consideration of non-asset solutions or non-traditional approaches when evaluating capital projects. The process has been tested on a few capital projects.
	The organization is implementing a validation process that includes the consideration of non-asset solutions and non-traditional approaches. The validation process is notyet used for all capital projects.
	All capital projects (or all projects greater than a set cost threshold) undergo a validation process that includes the consideration of non-asset solutions and non-traditional approaches.

[1]Validation means objectively looking at capital projects to determine if the proposed capital project is necessary, cost effective, and the appropriate solution. This process involves documenting potential operation and maintenance activities that could forestall the need for a capital project, examining a wide range of alternative approaches, and ensuring that the scope of the proposed project is appropriate.

E. Does the organization have a program to analyze the use of operation and maintenance processes to extend the life of the existing assets?

	The organization has no program to analyze the use of operation and maintenance processes to extend the life of the existing assets.
	The organization is currently developing a program to analyze the use of operation and maintenance processes to extend the life of the assets.
	The organization has a simple program to analyze the use of operation and maintenance processes to extend the life of existing assets. The organization has not yet used operation and maintenance practices to extend the life of assets.
	The organization has a simple program to analyze the use of operation and maintenance processes to extend the life of existing assets. The organization has used operation and maintenance practices to extend the life of assets when appropriate.
	The organization has a robust program to analyze the use of operation and maintenance processes to extend the life of existing assets. The organization has not yet used operation and maintenance practices to extend the life of assets.
	The organization has a robust program to analyze the use of operation and maintenance processes to extend the life of existing assets. The organization has used operation and maintenance practices to extend the life of assets when appropriate.

Chapter 7

LONG-TERM FUNDING STRATEGY

7.1 Introduction

In order to manage and operate the utility at the desired level of service and at the appropriate cost to your customers, you will need to have a sustainable funding strategy. You will need to determine if you are funding the operation and maintenance, repair, rehabilitation, and replacement of assets at the appropriate level. Your utility has both internal and external sources of revenue. In both cases, you should think about the revenue as "public money" whether it comes directly from your customers or through federal or state loans or grants. It is important that utilities be responsible stewards of public money.

External funding for capital projects comes from loan and grant programs and from bonds. Most federal and state loan and grant programs fund only capital projects and the utility is responsible for the overall operations and maintenance. When your utility applies for funding from state and federal agencies for capital expenses, you are more likely to be successful if you demonstrate that your rates are sufficient to cover the cost of service and that you have incorporated additional operational costs that the new project might incur.

Internal funding for day-to-day operations comes from utility rates and fees. These rates and fees should be sufficient to recover the cost of operations. Besides customer rates, a utility may have other fees such as connection fees, stand-by fees, reconnection fees, and developer impact fees.

The rating agencies really like the idea of Asset Management.
Stan Allred, Albuquerque, NM

FS-1

7.2 External Funding for Capital Improvements

Much of the funding for capital projects comes from external sources or non-utility revenues. These sources typically include governmental or commercial loans, governmental grants, and bonds. A utility reserve account may be used to pay for part of a project or may serve as a local match, when required by a funding agency.

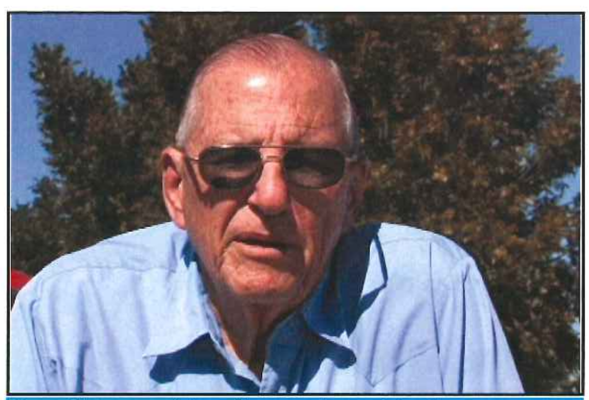
Government loans typically involve relatively low transaction costs, and interest rates may be subsidized, particularly for small communities. Each state and federal loan program has specific application procedures, eligibility requirements, and deadlines. For example, in some cases the applicant must prove a benefit for low to moderate income residents in order to be eligible for funding. Commercial loans are more flexible than government loans, but are typically more expensive for public borrowers. Commercial loans may be one of the few available options for privately-owned utilities.

We were a whole step ahead of the grant-writing process.
Chris Jacobs, Somersworth, NH
FS-2

Although utilities may regard grants as a more desirable option than loans, these funds may be very competitive, and their availability is diminishing. Many grants also require a loan in addition to the grant in order to fund an entire project. Each state and federal grant program has specific application procedures, eligibility requirements, and deadlines.

In its simplest form, a bond is a written promise to repay borrowed money on a definite schedule and usually at a fixed rate of interest for the life of the bond. Some types of bonds are tax exempt to the purchaser of the bond, making them somewhat more attractive. Bonds can represent a large source of capital for a utility, but the utility must have the authority to issue bonds. It can be a complex and more expensive way to borrow money due to legal and other fees and administrative time. In some cases voter approval is required. A Revenue bond is a bond on which the debt service is payable from revenue generated through the utility. These bonds may be issued by state and local governments, or an authority or special district for the purpose of facility construction. General obligation bonds require that the entity has taxing authority and don't require voter approval. Utility revenues are obligated to cover the debt payment.

Due to the current economic climate, government funding has decreased and the process has become more competitive. This new reality requires utilities to think about using more customer generated sources of funding for future projects and to plan more long term funding to pay for capital expenses. For example, if the utility knows it wants to drill a new well in 10 years and it will cost $400,000 to drill the well, the utility could consider collecting additional revenue at $40,000 per year in order to have sufficient funds to pay for the new well. As discussed in Chapter 6, the utility must carefully examine all capital projects to make sure they are necessary and that the best alternative was selected.



Our alliance got together and went to the legislature and got a grant.
Larry Covington, Picacho, NM
FS-3

Utilities may also wish to seriously consider funding projects in phases to reduce the immediate costs of the project and create more time to acquire the needed revenue. Some phases of the project may be paid for with external funds, while others might be financed with internal funds.

To assist utilities with funding options, the Kansas Interagency Coordinating (KAIC) Committee, composed of Kansas Department of Health and Environment, Kansas Department of Commerce, and Rural Development, typically meets once a month to discuss the best mix of potential loan and grant funding available for applicants. Appendix E provides a list of funding sources available for Kansas utilities.

7.3 Internal Funding: Rate/Fee Structures

A rate/fee structure is simply an allocation of the costs of operating and maintaining the utility to the customers. Two questions naturally arise when thinking about such a structure:

(1) What are those costs?
(2) How should they be allocated?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In order to set an effective rate/fee structure, a utility should adopt a full-cost pricing strategy. Full-cost pricing seeks to cover *all* current and future costs that are not covered by external sources of revenue (grants, loans, bonds, etc). A rate/fee structure based on full-cost pricing needs to provide adequate revenue for four major areas.

Operation and Maintenance Costs
There generally are no outside funding sources for routine operation and maintenance of a water or wastewater utility. Utilities must fund operations and maintenance from internal revenue sources.

Routine Repairs and Replacements
Every utility manager knows that, despite the best maintenance plan, equipment fails and needs to be repaired or replaced. In fact, the core of Asset Management is a system for making decisions about when to do those repairs or replacements. But knowing is only the first step. You have to have the money to do it. Once you have built a schedule for routine repairs and replacements, you will need to "save" money for those events. This is the function of the repair and replacement reserve fund.

Capital Improvements
A Capital Improvement Plan generally includes a plan for obtaining funding for capital projects. However, many grants or grant/loan combinations require a portion of the funding to be provided by the utility. A capital improvement reserve fund is intended to provide those funds.

Debt Service
Few utilities will be able to finance capital improvements without incurring some debt. Your rate/fee structure must provide funds for the repayment of debt. Setting those funds aside in a debt

service reserve fund will ensure that the utility can meet its debt obligations.

Emergency Operating Reserves
Some utilities may want to set funds aside to deal with emergencies. This fund may not be a necessity for utilities whose general operating fund is adequate to cover emergencies. Smaller utilities whose day-to-day operations do not leave much surplus will probably want to build a reserve for emergencies.


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A "good" rate/fee structure will accomplish the following:

- Meet *all* operating and maintenance expenses
- Provide reserve funds for capital improvements, repairs and replacements, debt service and emergencies
- Provide revenue stability
- Be fair and equitable
- Be affordable for the majority of customers
- Encourage responsible water use
- Provide for future incremental increases

Many utilities struggle with rate-setting and with gaining public acceptance for rates and fees. Rates are often determined by a political process that is not based on business reality. Such rates will inevitably lead to under-investment in infrastructure and perhaps even an inability to meet current operating expenses.

Political expediency often results in a "willingness to charge" problem in which officials and managers become over-sensitized to their customers' desires to keep rates low or general unwillingness to pay for services. However, willingness to pay is not the same as ability to pay. For this reason, it is important to assess your customers actual ability to pay. This can be done with census data on annual median household income (AMHI) in your area. If data is not available for your area or is not specific enough to your customers, you may need to conduct your own income survey or base your assessment on other knowledge of the economic condition of your customers. When ability to pay is assessed objectively, it may be necessary for the utility to develop programs to assist low-income customers. Some may see this as unfair, but setting a rate structure geared to the customers with the lowest income will often result in insufficient revenue and may not be in the best interests of the community as a whole. If rates are set too low to cover all of your costs, everyone suffers in the long run. It is essential to find a way to set a rate/fee structure that is adequate to cover expenses. For many utilities that may mean devising a program to assist low-income customers.


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When a utility adopts Asset Management practices, the rate/fee structure may need to increase. This will occur if the utility must move from being under-funded (i.e., collecting insufficient revenues to cover all expenses) to being properly funded. Understanding your customers' ability to pay will help you defend your rates and fees and to make decisions about whether certain income groups may need to be subsidized. A solid Asset Management program will give you the tools to defend the rates you set. Asset Management brings transparency to the process so that the basis for rates is clear. The more clearly the rates can be defended, the more likely they are to be accepted by the public. The more you inform and involve your customers in understanding how you provide the benefits and services they are receiving, the more they will support you. Generally, once people understand what they are getting and see that their money is being spent responsibly, they will support the rates. This support, in turn, will give elected officials a higher willingness to charge.

A good rate analysis must start with good data on costs and future plans. It is therefore imperative that the utility have a budget and a good record-keeping system for tracking costs. Without good information about your current costs, you will not be able to project future costs with any confidence.

Listed below are 10 suggested steps for an effective rate-setting process. These steps are not meant to be definitive, but rather suggest issues that need to be considered and data that needs to be gathered.

(1) Determine your costs. Your budget and record-keeping system should track costs in meaningful categories. It is helpful to separate operations costs into fixed (those costs that don't change with the amount of water produced or treated) and variable (those costs that go up when you produce more water or treat more wastewater)

(2) Determine your revenues. It is helpful to understand how much of your revenue comes from usage rates vs. other fees.

(3) Determine your reserve needs. You will consult your capital improvement plan, your repair and replacement schedule and your debt obligations for this information.

(4) Determine your current financial position. Do you have a deficit? If you have not met expenses in the past, you will have to correct for this in your new rates.

(5) Determine revenue required for the next 5 years. This will be based on your past costs, but don't forget to take into account future growth and inflation.

(6) Gather information about your customers. This information is at the heart of any rate-setting process. Knowing how many customers fall into various usage categories will make it possible for you to set a rate/fee structure that maximizes your revenue, while making sure that the cost is spread equitably among the customers. For example, if you find that 90% of your customers use below 4,000 gallons per month, it will not gain you much revenue to include 4000 gallons in your base fee and start charging incrementally above 4000 gallons.

(7) *Gather information about production and use.* These data will tell you whether you are "losing" water due to leakage or theft. Or you may simply be providing water to community buildings without charge. In any case, this water costs money to produce and must be paid for by your customers. If your utility does not have meters, you cannot set a meaningful rate.

(8) *Design a rate/fee structure.* There are as many different structures as there are people with imagination designing them. However, an effective rate will cover all costs; will spread the cost of operations equitably across all classes of customers; and will encourage conservation.

(9) *Implement the rate.* Do not under-estimate the importance of "selling" the new rate/fee structure to your customers. If you have already involved your customers in your Level of Service Agreement, it is a natural step to let them know what the services will cost.

(10) *Review your rates regularly.* Rates should be reviewed annually.

If you manage your assets related to the fact that they are truly community assets,...you can build rate capacity.
--Jim Smith, Louisville, KY

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There are many sources of rate setting assistance, including trainings and free rate setting programs. Any approach that includes all costs of operation; reserve accounts for capital improvement, debt service, repairs and replacements, and emergencies; and considers conservation or other utility goals is acceptable. Appendix E lists some resources for assistance with rate-setting.

7.4 Funding for Energy Efficiency

In the case of energy efficiency projects, there are additional options for funding projects beyond those available for "normal" operation and maintenance and capital projects. These projects have the potential to reduce energy costs and therefore have different criteria and potential for funding.

One consideration in terms of funding is the amount of potential cost savings. If the cost savings are great compared to the cost of the capital expenditure, the investment will pay for itself in a short time. If the cost savings is small relative to the capital expenditure, it may take a long time to pay for the project. This concept is called Return on Investment or ROI. As an example, consider changing a constant speed pump to a variable speed pump. Suppose the new pump cost $40,000 and the expected energy cost savings was estimated to be $5,000 per year. In 8 years, the energy savings would equal the cost of the investment, so the pump would pay for itself in 8 years. If the expected life of the pump was longer than 8 years, it would be worth doing this project because everything after 8 years would represent a cost savings to the utility. If the expected life of the pump was less than 8 years, the project would not be worth doing because it would cost the utility more money than it would save.


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Another consideration is when to make an investment in a more energy efficient piece of equipment. If an asset has reached the end of its useful life, the decision to make the investment in a more energy efficient asset may be fairly simple. The asset has to be replaced anyway, so even if the more energy efficient asset has a long pay-back period, it may make sense to do this project. If an asset has not reached the end of its useful life, but a new, energy efficient asset will pay for itself in a short amount of time, the utility may decide to replace the asset immediately instead of waiting until the asset fails or reaches the end of its life. For example, a wastewater plant may have a very inefficient blower that costs $5,000 per year in energy costs and $4,000 per year in O&M costs. Its remaining useful life is 15 years. Suppose a new blower costs $30,000 to install, will cost $3,000 per year for energy usage, and $2,500 per year for O&M. The savings in energy and operational costs are $3,500 per year. In 10 years the savings will be $35,000, which is more than the cost of the new blower. The blower will pay for itself before the old blower would reach the end of its useful life. In this example, it is beneficial to remove the existing inefficient blower and replace it with a new blower right away, rather than waiting until the old blower has served its full expected life.


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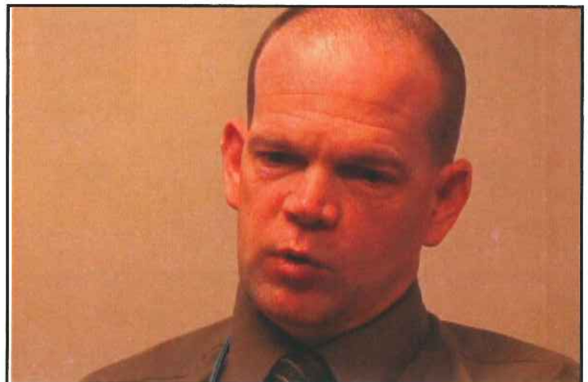
Another option available for utilities related to energy savings is the potential to use an energy service company (ESCO.) An ESCO is a commercial business that will analyze the utility's current energy use and determine the potential for energy savings. The ESCO will prepare a plan for energy saving projects and suggest the highest priority projects to accomplish. There are many ways that the ESCO can be used, but generally the ESCO pays to install the equipment and the utility pays the ESCO the normal utility bill for some amount of time, which would be longer than the pay-back (ROI) on that equipment. Because the new equipment is more energy efficient, the ESCO will use the reduction in energy cost to pay for the equipment it installed. The advantage to the utility comes from the capital cost being provided by the ESCO, saving the utility the time and expense of securing other funding. In addition, ESCOs often guarantee energy savings and have to pay the utility if these energy savings are not realized, so the risk to the utility is reduced. A disadvantage is that in the long run, the utility will pay more for the project because it will be a longer period of time before the utility itself starts to reap the benefits of the reduced energy costs. Another disadvantage is that the ESCO will probably be focused on assets that consume large amounts of energy where cost savings will be significant and may miss opportunities within the utility to save smaller amounts of energy (e.g., changing light fixtures and bulbs.) Therefore, the utility may need to have additional activities in energy efficiency to address these smaller incremental savings, and to address assets that indirectly use energy (e.g., leaking pipes.) There are many ESCOs available. If a utility wishes to follow this route to pay for energy projects, a Request for Proposals can be done.

Another funding source that applies to the energy efficiency projects is the "Green Reserve" of the State Revolving Fund (SRF.) This money is specifically meant for "green" projects and this definition includes projects that address energy efficiency, reductions in greenhouse gases, water use efficiency improvement, and treated wastewater effluent non-potable re-use.

Thus far, the discussion has focused on how energy use reductions will save the utility money and therefore, it is easy – or easier – to justify this type of project. However, there may be cases when a utility might wish to subsidize a project because it addresses energy goals in the Level of Service, such as a reduction in carbon footprint or greenhouse gas emissions. Elected officials or boards may decide to go forward with a project, even though it may be more expensive in the long term or have an insufficient ROI, because they are trying to reach an energy goal.

For the most part, energy efficiency projects will result in cost savings and each dollar saved can be spent on something else, such as employee salaries, preventative maintenance, training, or equipment purchase.



Advice...would be to look long-term and not worry so much about what's the cheapest equipment today.
--Steve Hunt, Columbia, MO

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7.5 Comprehensive Funding Strategies

Utilities need to develop a comprehensive funding strategy that clearly defines the sources of funding for all the utility's current and future needs, both operational and capital. At a minimum, the funding plan should look 5 years into the future. However, the funding plan should tie very closely to the capital improvement plan, and since capital projects require long-range planning, this portion of the funding strategy will need to encompass the next 10 years at least and ideally would extend even further. If the community has a business plan, the funding strategy might be a part of that plan.


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However the utility decides to structure the strategy, it should have the following components:

- It should clearly demonstrate the source and adequacy of revenue for day-to-day operations.
- It should specify the anticipated source of funding for capital projects, from design to implementation (including demolition and/or disposal of existing facilities) and clearly define any portion that needs to be met with internal sources of revenue.
- It should include repayment of debt that might be incurred for capital projects, including interest.
- It should anticipate any increased operational costs resulting from capital projects and define the source of revenue for those costs.


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- It should account for inflation.
- It should anticipate steeply rising energy costs and incorporate energy efficiency measures and funding options.
- It should balance operational costs with the costs of future projects, keeping in mind the current financial position, and the community's needs and desires and its ability and willingness to bear those costs. Nothing burdens a community so much as being saddled with paying for an expensive facility they neither needed nor wanted.
- It should move the community towards a sustainable future.

One of the things key with Asset Management, it's telling use where we need to spend our dollars.
--Stan Allred, Albuquerque, NM

FS-27

Asset Management IQ

Section VI: Financing

A. Does the organization maintain reserve funds/accounts?

	The organization maintains no reserve accounts.
	The organization maintains one reserve account but it is not adequately funded.
	The organization maintains one reserve account and it is adequately funded for the purpose for which it was established.
	The organization maintains 2 reserve accounts (or a reserve account that satisfies 2 needs) and the reserve accounts are adequately funded.
	The organization maintains 3 reserve accounts (or a reserve account that satisfies 3 needs) and the reserve accounts are adequately funded.
	The organization maintains reserve accounts for: repairs and replacement, emergencies, debt repayment, and capital improvements. All accounts are adequately funded and monies are used from the funds as required.

B. Does the organization have a plan to fund capital improvements for the long term?

	The organization has no plan to fund capital improvements over the long term.
	The organization recognizes the need for a plan to fund long term capital improvements, but has not yet begun to work on it.
	The organization is working on a plan to fund long term capital improvements, but it is not complete.
	The organization has a plan that considers funding needed for capital improvements over the next 5 to 9 years. The plan includes all sources of funding necessary.
	The organization has a plan that considers funding needed for capital improvements over the next 10 to 19 years. The plan includes all sources of funding necessary.
	The organization has a plan that considers funding needed for capital improvements over 20 years or more. The plan includes all sources of funding necessary.

C. Does the organization target its rates and other revenue streams to adequately fund all long term costs, including both operations and maintenance (O&M) and capital investment/capital debt needs?

	The organization's rates and other revenue streams are not set based on anticipated expenses.
	The organization's rate structure and other revenue streams are set to cover ongoing operation and maintenance expenses, but do not take other expenses into account.
	The organization's rate structure and other revenue streams are set to cover ongoing operation and maintenance expenses, as well as some extra revenue that is used for reserves and/or capital projects. The extent of revenue that is above O&M expenses is not tied to specific goals for funding reserves or capital projects.
	The organization's rate structure and other revenue streams are set to cover ongoing operation and maintenance expenses, as well as a targeted amount above that for funding reserves or capital projects. The target is not based on an assessment of long term asset investment needs.
	The organization's rate structure and other revenue streams are set to cover ongoing operation and maintenance expenses, as well as a targeted amount above that for funding reserves or capital projects. The target is based on an assessment of asset investment needs for the next 5 years or less.
	The organization's rate structure and other revenue streams are set to cover ongoing operation and maintenance expenses, as well as a targeted amount above that for funding reserves or capital projects. The target is based on an assessment of asset investment needs longer than the next 5 years.

D. Is investment in assets prioritized based on overall business risk?

	Investments in assets are not based on overall business risk.
	The organization recognizes the need to make asset investments based on overall business risk, but has not yet begun to develop a process to implement this process.
	The organization is developing a process to make asset investments based on overall business risk.
	Some asset investments are prioritized based on the overall business risk to the organization.
	The majority of asset investments are prioritized based on the overall business risk to the organization.
	All asset investments are prioritized based on the overall business risk to the organization.

E. Does the organization provide a program for disadvantaged customers so that adequate rates are possible

	The organization does not provide any programs for disadvantaged customers.
	The organization is conducting an analysis to determine the need for a disadvantaged customer program.
	The organization has completed an analysis of the need for a disadvantaged program but has not developed the program.
	The organization is in the process of developing a program for disadvantaged customers.
	The organization has a program to provide for disadvantaged customers, but it has not yet been communicated to the customers.
	The organization has a program to provide for disadvantaged customers, customers are fully aware of the program, and the organization provides outreach to help customers take advantage of the program.

Chapter 8

IMPLEMENTATION

8.1 The "Just Do It" Philosophy

The best way to implement Asset Management is to "just do it." There is no need to worry about getting it wrong. Asset Management is a way of thinking about managing assets in a more efficient and customer-centric way but it is not about the one right way to do this. There are as many acceptable approaches as there are utilities that engage in Asset Management, as long as the 5 core concepts form the basis of the program. Asset Management is also self-educating and self-correcting. You will learn how to do Asset Management better by doing Asset Management. The more you implement, the more you will learn. Also, if you've implemented one part of the program in a way that doesn't meet your needs or doesn't accomplish what you want, you can change it. It is completely expected that your program will look different in five years than it does when you begin. Asset Management is meant to be cyclical and no one expects a utility to have a "perfect" Asset Management program right away. In fact, perfection is not the goal. The goal is to manage your utility in a better way today and tomorrow than you did yesterday.

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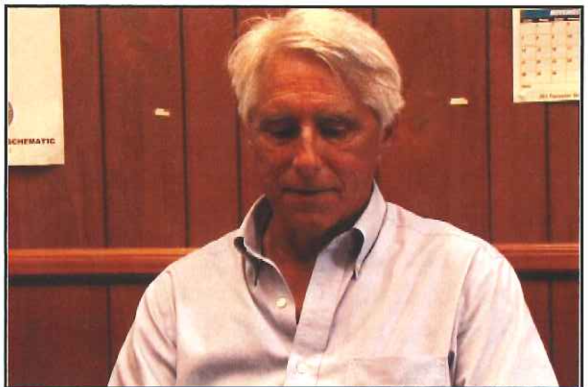
Asset Management is firmly rooted in common sense and good business practices. Whatever you do in Asset Management should seem like the right way for you to do business. You should be able to start working on some of the components of Asset Management right away without a lot of preparation or resources. In fact, you may very well find that you are already using some Asset Management principles and techniques in the way you already do business. You should start the activities at a level that is comfortable to the utility operators, management, and elected officials. The level of sophistication can increase over time as the utility grows more comfortable with Asset Management in general and some of the specific practices. Starting out simple and working towards higher levels as the utility's internal expertise and resources allow will keep the implementation from seeming too daunting. For instance, a utility can complete an asset inventory in a simple spreadsheet, or even on paper if there are very few assets, and then decide to move towards a specialized software program designed for asset inventories and work orders a few years down the road.

The most important thing is to "just do it" because your volume of work will never go away, your assets will only increase, and things aren't going to get better on their own. Just start and be flexible enough to adjust and adapt as you move along and accept that data quality may not be high initially, but will improve over time.



Just do it. Any little bit you do, you'll see great a amount of benefit.
--Jim Smith, Louisville, KY

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8.2 Getting started

Either an individual or a team of individuals at your organization will need to take the initiative to start Asset Management. The initial starting point can be educating yourself, your staff and elected officials about Asset Management. This guide and the videos are good tools to use in this process but there are other tools available that can be found in the resource section of this guide.

Having a "champion" in the organization who can explain the terminology as well as the benefits of Asset Management and who is willing to take a lead role in the development of an Asset Management program for the organization can aid implementation efforts. However, it is important that the knowledge, interest, and expertise not reside solely with the champion. As explained in Chapter 2, Section 2.3, Asset Management thinking and practice needs to imbed throughout the organization to prevent the sawtooth effect (practice increases, then the person leaves, the practice drops until it is picked up again.)

Asset Management requires a culture change – a different way of thinking about your utility and the services you provide. It involves accepting more transparency, acknowledging that the utility's main function is customer service, and making management decisions on an individual asset basis. It is important to work with and support utility employees through this culture change.

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There may be resistance initially to adopting Asset Management if employees or elected officials perceive that it is nothing more than extra work or the latest management fad. Most likely, people and financial resources are already stretched thin and people resent additional work if they don't understand why they are being asked to do it or how it will benefit them. There should be benefits at all levels of the organization. It is also important that the employees and elected officials view Asset Management as the way business should be done and not just a passing fad. Asset Management has been in practice for almost two decades across the world and in that time, its prominence has only strengthened.

Building upon the pieces of Asset Management that are already in place can help start the implementation process. For example, you may have part of an asset inventory or some type of mapping. You may have a user rate or financial plan. Starting with what you already have will help you gain buy-in from the employees and it may also help you in achieving "quick wins." A quick win is anything that can easily demonstrate value to employees, management, or the governing body. A quick win can be a comprehensive map of the utility where non existed previously, or a savings in capital projects from completing a validation exercise, or a customer survey that shows that customers want a different level of service than you are currently providing and the new service will be easier or cheaper. The utility should look for internal and external "wins" and look at all levels within the organization. The more people see the value in Asset Management and what it means for their job, the more they will embrace the concept. When people truly understand and embrace Asset Management, their thinking will become more creative and the utility will benefit.

It is also important to share your successes with your customers. They will be more supportive if they understand that the utility is working towards improving services and is making the best use of the money they pay in rates and fees.

8.2.1 Who to Involve

Asset Management is not just one person's job; it is everyone's job from the field staff to management to the governing board. In a very small utility, the total staff may be 1 or 2 people and a governing body. In slightly larger utilities, there may be an operator, a clerk, a manager, and a governing body. As the size of a utility increases, there will be more people and there may even be separate departments for various functions. It is desirable to form an implementation team of some type. In a small utility, this team may only be two people. As the utility size grows, the team can be made up of a few individuals or many individuals. It is not important how many people are involved in the Asset Management team as long as all the functions (such as operations, maintenance, budgeting, capital improvements, customer service, and financing) are represented, and as long as you find a way to gain buy-in from everybody. In smaller utilities, multiple functions may be the responsibility of the same person, so the team may be smaller.

The team can be called an Asset Management Steering Committee or some other name that shows the rest of the utility that the organization values this function and that there is a purpose to the team. In organizations that have both water and wastewater utilities, the team can be made up of individuals from both utilities. One of the first steps for the steering committee can be to develop a mission statement and goals for how they will implement the process and how they will share information with the rest of the organization and the governing body.

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A steering committee does not need to be a major time commitment. The group can meet periodically, such as every other week or once a month, for an hour or two. The meetings can be a little longer to start the process and then shorten once the implementation is firmly established. The most important thing is to pick a day, time, and frequency that is feasible for your utility to make sure you get consistent participation. Serving on the steering committee should be considered a priority and the governing body needs to support this participation. The steering committee should become part of the on-going Asset Management program, so it should not be thought of as a temporary group. The frequency of meeting may lengthen after the initial implementation, but it will still need to meet.

In addition to current utility staff, a lot of knowledge about your utility resides in the heads of former operators, managers, board members, or clerks. If at all possible, the knowledge of these individuals should be captured in the implementation process. In very small systems, it may even be worthwhile to contact long-term customers who may have knowledge of past construction or operations practices. It is important to think creatively about who should be involved in the implementation process to ensure access to the maximum amount of historical information.

8.2.2 Consultants vs. Do it yourself

No one knows your utility better than you and no one is more familiar with your assets. It is better for your utility to have a simple Asset Management plan that you develop yourself that represents your values and priorities than a more sophisticated plan that was developed by someone else who may not share these values or may not understand your capabilities and limitations. If the plan sits on the shelf, it doesn't matter how good it is, it is a failure. The point of an Asset Management plan is to implement it and start operating and maintaining the facility using Asset Management principles. If you don't understand your plan because someone else wrote it without much input from you, then it is not useful and your money was not well-spent. This guide is intended to help you through the steps of Asset Management and to encourage you to do as much as possible yourself.

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In some cases, a utility may desire outside assistance to get started, to help organize the effort, to provide encouragement, or to help complete a particular task. There are two types of assistance that may be possible: an assistance provider or a consultant. An assistance provider is generally free or low cost to the utility and will serve mostly in an advisory or training role for the utility. A consultant will be paid by the utility and may either be in an advisory role, or they may be asked to complete a particular task. The most important thing, in either case, is to be very clear about what you want from the outside assistance and to define the roles of your staff and the outside provider/consultant clearly. It is important to make sure that the outside assistance is done *with* you, not *for* you. No matter who does it, it is still your plan and that must be understood. If contract is made for outside assistance, it is important to make sure the Request for Proposals (RFP) clearly defines tasks and deliverables. This is especially important for smaller utilities with limited funds.

8.2.3 Resources - Tools, Time and People

There are resources available to assist you in your efforts to implement an Asset Management Plan. Specific resources related to tools, time, and people are presented below.

Tools

There are many tools that are available to assist in Asset Management. These tools can be asset inventory programs, guides such as this one, or methods of completing particular aspects of Asset Management. Many of these tools are available on the Web. Some examples are Energy Star, Portfolio Manager, or EPA's CUPSS program. Other tools may be available from other utilities who have implemented Asset Management. Many of these utilities are willing to share what they have developed.

Find out what makes sense for your size and scale.
--Derek Sherry, Platte City, MO
IM-14

Time

Asset Management is not "doing more," it is "doing differently." Therefore, in the long run, it should not represent an increase in workload. In the short term, there may be additional work related to gathering data for the inventory, evaluating asset risk or in conducting business case evaluations for capital projects, but in the long term, work should be more efficient as it moves towards more planned and less reactionary. Asset Management is not something you will implement overnight. It will take months or years to get the initial Asset Management plan in place. It is best to accept this reality at the very beginning and not get discouraged about how long the process takes. It is important to remember that even in the initial stages, before you've fully developed your Asset Management program, things are improving at the utility and your customers are benefitting from your efforts.

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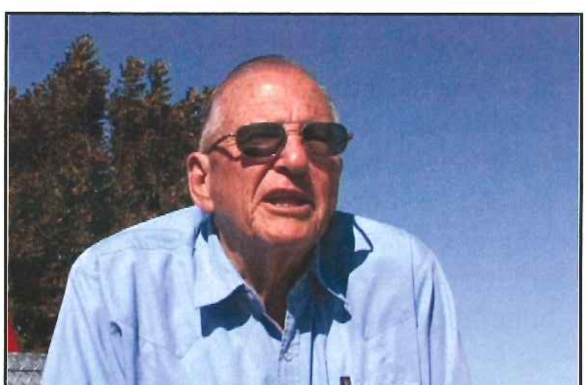
People

Other chapters and sections of this guide discuss the importance of your staff in the process. In this section, it is important to think of other resources that are available to you beyond your staff and governing body. Other utilities that have initiated or implemented Asset Management can be a resource. Call them, e-mail them, or meet with them to gain knowledge about what worked for them or how they overcame challenges. State agency personnel, such as the KDHE capacity development staff, can also be a resource. Attending conferences that include an Asset Management component can also expose you to people who are trainers or practitioners. You may also want to form an Asset Management Users Group to allow you to meet regularly with other utilities who are engaged, or want to engage, in Asset Management. The users group can include individuals from a variety of utility sizes and types very effectively. This type of sharing network can provide support and expose you to new tools, additional resources, or examples of how to address challenges.



There's a lot of information around... different people you can call on....
--Larry Covington, Picacho, NM
IM-18

8.3 The Asset Management Plan

An Asset Management plan does not have to be complicated or lengthy to be useful.

You will achieve 80% of your gains for 20% of your effort.
--Ross Waugh, New Zealand
IM-19

It can be a very simple document written in such a way that everyone within the utility can understand it. It should not be a document that is completed, put on a shelf, and never looked at again. The Asset Management Plan should be thought of as a "road map" to explain how the utility is going to address and implement each component and how the utility will continue with Asset Management over the long-term. It should not be thought of as "the answer," but rather a guide explaining how the utility intends to do business. The Asset Management Plan should also be written in such a way that all levels of the organization can use it. It should be readily available to all members of the organization and distributed freely. It can also be made available on the web to customers; it should not be a secretive document that only employees or the governing body can access. It is equally important, however, that customers understand that the document is not to be viewed as an absolute or law. It is a living breathing document and the utility will make changes and adjustments to it over time. While it establishes levels of service, it is not a contract and should not be thought of that way. The document provides information to the customers regarding how the utility operates and what services they can expect. Viewed in this way it should serve to create more confidence in the utility and more support for the rates that are charged.

Increasingly, Asset Management is becoming either a requirement of funding or an activity that can provide additional points or a higher ranking on a funding application for a particular project. Consequently, having an Asset Management Plan that includes all of the core components can allow your utility to meet this requirement or receive a more favorable rating. Funding agencies may wish to review your Asset Management Plan or they may wish to use the AM IQ to determine the adequacy of your plan or Asset Management activities. The AM IQ can be found throughout this document and a complete AM IQ can be found in Appendix F.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The Asset Management Plan should include the following, at a minimum:

- **Introduction:** The overall goal of the plan, how it was developed, who was involved (See Chapters 1, 2, and 8 in this guide)

- **Current State of the Assets:** The methodology used to gather asset data, how assets were defined, total number of assets, the type of data gathered for each asset or asset class, the type of inventory program, the type of mapping completed, and the location of the asset inventory. If there are a small number of utility assets, the listing of the asset inventory can be included in an appendix or as an attachment. If there are many assets, the actual data on the assets does not need to be included in the document, but it should be clear where this data resides (i.e., on a computer or in a notebook) and how you would get access to the data. (See Chapter 3 of this guide)

- **Level of Service:** The Level of Service goals, including target levels, how the goals will be measured, where the data will come from, how frequently the goals will be measured and how the results of the measurements will be communicated to the governing body and customers should be included. (See Chapter 4 of this guide)

- **Criticality:** The methodology used to evaluate criticality, including how probability of failure and consequence of failure were determined, should be included. If there are not many assets, a graph showing the relative risk of assets can be included in the document. If there are many assets, a listing of highly critical assets can be included, and how to locate this information can be referenced in the document. (See Chapter 5 of this guide)

- **Life Cycle Costing:** The approach used to determine how much operation and maintenance will be done on assets, by whom, and how frequently should be explained in this section. The actual maintenance tasks do not need to be explained, but a reference to where these tasks are explained should be included. For example, if there is a computer program that identifies who should do what and when, that program should be referenced. If there is a book that lists maintenance tasks, the book can be referenced. The process used to determine when assets will be repaired, rehabilitated or replaced should be explained along with the process used for capital validation. (See Chapter 6 of this guide)

- **Financial Plan:** The approach the utility will use to obtain the necessary funding now and in the future should be explained. (See Chapter 7 of this guide)

- **Updating the Plan:** The frequency by which the Plan will be reviewed and revised as well as who will do the revision should be included in this section. (See Section 8.4 of this guide)

The plan should specify how the utility will accomplish the various components, as discussed above, but does not need to include all the data that went into the plan (all the assets, or all the maintenance tasks). It can be as specific in these areas as the utility desires and the amount of specificity will depend on the number of assets or amount of data involved.

8.4 Asset Management Plan Review and Updates

The plan is meant to be a dynamic document, so having an electronic version of the document in a format that can be easily revised is a good idea. The plan should be reviewed each year and updated as necessary to address portions that did not provide the desired results or did not meet the needs of the utility. Because the plan will not contain the actual operational data, it does not need to be updated each time a work order is completed or condition is assessed. This continual updating should be occurring within the inventory or work order system used by the utility. The plan should be revised when changes such as the following occur: level of service goals are revised, a new approach to data collection is established, a new method of business case evaluations is developed or new approaches to funding are incorporated. A plan should be established for who will do the review of the Plan and make the updates. This may be accomplished by the Asset Management Steering Committee, if the utility has one, or by the individuals who are doing the implementation if there is not a committee.

Steal ruthlessly from other utilities. You really don't need to re-invent the wheel.
--Kevin Campanella, Columbus, OH

IM-23

8.5 Coordinating and Integrating Asset Management

Asset Management can be extremely helpful for coordination of activities within departments or between different departments of a larger municipal entity. Coordination can, and should, be done with other city departments to ensure that construction and repair activities are managed efficiently. A typical example is the case of road repairs. Customers do not like to see a road that has recently been paved torn up to replace a water or sewer line. A good working relationship between the two departments can prevent this type of event. Money will be saved and both departments will benefit from the customer satisfaction that will result from better communication and coordination. To successfully use Asset Management to coordinate different activities across departments, a well-managed inventory, including a history of repairs and a work order system that can be accessed by different departments is helpful. However, expensive software is not a pre-requisite. Communication is the key to coordination and good communication is the result of shared vision and a common commitment.

Because Asset Management is a way of doing business, it should not be thought of as a separate or stand-alone activity. In addition to the integration of Asset Management with activities specifically related to your assets, like energy efficiency, Asset Management should be integrated with other planning activities that relate to the community as a whole. These community planning activities will involve the utility in some way, either peripherally or directly, and may include comprehensive planning, master planning, capital planning and sustainability planning.

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Any good comprehensive plan or visioning effort should be based on the community's goals and values and developed with the involvement of community members. It generally includes physical, social, and economic aspects of the community. If the comprehensive plan is truly developed by the community and reflects their values, it will provide general guidelines for utilities to consider for expansion and rehabilitation.

A master plan establishes specific long-range directions for the community and may include the utility. The Asset

Management plan must integrate the goals articulated in the master plan to ensure that the two are compatible and reflect the same vision of the utility's future operations, expansions, or changes. This is equally important whether the community wants to encourage growth or whether it wishes to preserve a quality of life that the citizens value.

A community capital improvement plan should identify those projects that have been identified as high priority for the utility. The capital improvement plan must be coordinated with the Asset Management plan to ensure that the community seeks appropriate funding for the projects for which a clear business case has been established.

Sustainability initiatives focus on the economic, social, and environmental well-being of a community in order to ensure its continued existence and preserve its values. It is particularly important for the Asset Management plan to reflect these values, as determined by the community. Doing so will ensure an Asset Management plan that is workable and has the support of the community.

Anybody that looks at that master plan knows I have issues with that old pipe.
--Bill Boulanger, Dover, NH

IM-27

Chapter 9

The Human Aspect of Asset Management

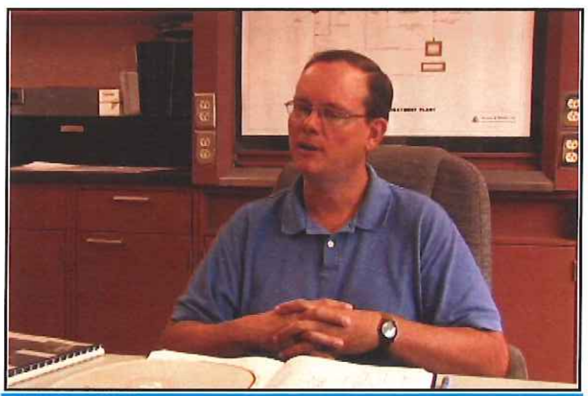
9.1 Introduction

Of all the assets your utility manages, the people, or human assets, are by far the most valuable. All the data, information and procedures in the world will not be helpful without the people to make sense of the data, communicate the information and implement the procedures. As we saw in Chapter 2, it is extremely important to get "buy-in" from everyone involved, from elected officials to the field staff, and including your customers. In this chapter, we will look at some of the most important considerations involving communication, knowledge management, training, leadership, and community involvement. This discussion is designed to help you achieve the kind of "big view" that will help your efforts succeed beyond just gathering data and implementing programs.

It requires a culture change. You need to be ready to focus on the people aspects of it.
--Kevin Campanella, Columbus, OH
HU-1

9.2 Communication

We all know that good communication is the key to success in everything we are trying to accomplish. But how do we make it effective? Anthony Robbins (self-help author and success coach) said *"to effectively communicate, we must realize that we are all different in the way we perceive the world and use this understanding as a guide to our communication with others."*



With any public education plan, the place to start is with the kids.
--Ted Riehle, Old Forge, NY
HU-2

Tailoring your communication to the listening of your audience is the key to effective communication. It is very important to understand that others may perceive the world differently than you do; that their understanding of what is happening may be different from yours; and, most importantly, that what is meaningful and important to them may be very different from what is meaningful and important to you. Communication based on this principle establishes a partnership between the speaker and the listener.

If it can be said that communication is the key to success, then it can also be said that lack of communication is often the reason for lack of success. In the case of Asset Management, the real key to success is the involvement and enrollment of everyone who has a stake in the process, be it the Mayor, the meter reader, or the customer at the farthest end of the line. And the key to this "buy-in" is *effective* communication.

There are two basic types of communication that you should address-internal and external-and each of these corresponds to different audiences and different needs.

Internal communications are communications up and down the chain of command within your organization and across different departments within the utility. Internal communication is often direct and informal and usually contains very specific and detailed information. However, communication with governing bodies may take on the character of external communication since these people are usually not concerned with the details of day-to-day operations. The City Council will be interested in the fact that you are saving money by implementing a preventative maintenance plan. The operator needs to know the specific details of the plan such as the actual schedule for changing the oil in a pump. Thus, they are being given different levels of information about the same program. This is not just a difference in the *amount* of information that is being given, but also a difference in the *kind* of information.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External communications are communications with your customers and stakeholders and with the entire community served by your utility. These communications will be usually more general and often take on the character of "PR" or advertising. This is not a negative connotation. Most of your customers are not versed in the inner workings of your organization and will need to have important ideas and facts conveyed in terms that are meaningful to them. It is not important for your customers to understand the specifications for new sewer lines. It is important for them to understand the need for the lines, the impact of the project on their rates and how the installation will affect them.


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What is important to understand about the distinction between these two types of communication is that not only will you want to communicate different kinds of information externally than you communicate internally, but you may want to use different *methods* of communication. For instance, you may publish a brochure to communicate with your customers, but use a memo or meeting to communicate with your operators. This is not to say that you might not use the same methods for both audiences, but that it is important to consider not just the information you want to communicate, but also what might be the most effective way to communicate it.

Some of the methods of communication that the utilities interviewed for this manual have found effective for external communication with customers and stakeholders are:

- Brochures
- Door Hangers
- Plant tours
- Water fairs and sustainability fairs
- Public meetings
- Telephone surveys
- Articles in newspapers


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Some of the methods useful for internal communications are:

- Emails
- Phone calls
- Brochures
- Posters
- Memos
- Staff meetings

No one can tell you what will work in your community. You know your employees and your customers better than any outside entity providing advice to you. The only limit is your creativity and that creativity is inspired by your desire to make your utility efficient and your community a better place to live.

9.3 Knowledge Management

Knowledge Management comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organizational processes or practice. (*from Wikipedia*)


...collect all the information that these folks have in their heads and try and put it in one spot. HU-12
--Stacy Gallick, Johnson County, KS

The ability of an organization to manage its knowledge can be another key to the successful implementation of an Asset Management program. Often we find that the knowledge present in the organization is either inaccessible because it is buried in layers of paper or computer data or it resides only in the minds of individuals. Knowledge management can be as simple as up-to-date maintenance manuals or as complex as cross-training all employees in all aspects of operations. What kinds of techniques you employ will be determined by the size of your utility, your resources, and your determination to create a robust and independent knowledge base.

Knowledge is an asset, no less important than the physical assets you own. And, just as with any asset you own, it is important to classify your knowledge assets. Generally, knowledge can be said to be one of two types: explicit and tacit. It might also be helpful to classify this distinction as external and internal. Explicit (or external) knowledge is generally data-based. That is, it consists of facts, figures, procedures, business plans, financial information, customer lists, even your Asset Management plan itself. These kinds of things can, and should, be written down, kept up-to-date, and made accessible to everyone in your organization. This "writing" can be in paper form or electronic, but must be accessible.

Make it a priority and make everything else aligned to that.
--Biju George, Cincinnati, OH
HU-13

In terms of external knowledge, your knowledge management plan should consist, at a minimum, of the following:

- A complete inventory of assets
- Maps showing the exact location of all assets
- Your Level of Service Agreement
- Maintenance manuals on assets you own
- Operating Procedures--standard, alternate and emergency
- Maintenance schedules and procedures
- Procedures for updating all of the above
- A history of maintenance on all assets (to the extent that it is known)
- A written Capital Improvement Plan
- A written Repair and Replacement Schedule
- Your rate schedule and the basis and rationale for the rates

Internal (sometimes referred to as tacit) knowledge is a lot harder to manage. This is all that knowledge that resides in the minds of your employees. The statement that your employees are your most valuable assets encompasses the understanding that some of this value lies in the knowledge that they possess. However, having this be the *only* place valuable knowledge resides is risky and inefficient. Employees retire, move away, seek other jobs, get sick, die. When one of these inevitable events occurs, the organization can be left without the crucial information it needs to operate. It is therefore very important that utilities develop strategies and practices that capture all the knowledge that is needed to continue efficient operation. Needless to say, turning internal knowledge into external knowledge--i.e. getting all that information out of people's heads and onto paper or computers or video tape--is one of the best ways to manage a lot of this risk, and every utility should strive to do that as much as possible.

However, some of the knowledge your employees carry around with them does not lend itself to this kind of externalization. This kind of tacit knowledge is based on judgement and experience. This is the ability of an operator with 30 years of experience to just *hear* when a pump is having problems or the "gut feeling" that something should be checked.
This is your meter reader knowing that the gate will be locked on Tuesdays or your billing clerk understanding that Mrs. Jones doesn't get her check until the 15th and that she will always pay her bill on the 16th, so it is a waste of money to send a past due notice.

You need to keep the human factor in there.
--Stacy Gallick, Johnson County, KS HU-14

This is *people* knowledge and it is extremely important. This kind of knowledge, by its very nature, is difficult to capture, but there are some techniques that can be employed to help organizations make future use of this kind of knowledge.
Cross-training builds redundancy of employee skills into your utility and can be extremely helpful in the event of sudden illness or departure of employees.
Job-sharing is similar to cross-training, but has the advantage that 2 or more employees actually share duties and knowledge on a continuing basis, as opposed to one-time or occasional trainings that are characteristic of most cross-training programs.
Mentoring is a long-term, complex process in which an experienced employee seeks to impart his or her knowledge and wisdom to a less experienced employee in order to ensure continuation of that knowledge within the organization.
Shadowing is similar to mentoring, or may be a component of mentoring. In this process, the less experienced employee or "protege" may spend only portions of his or her time with the "expert" or may do so only on a few occasions.
Joint problem-solving may incorporate aspects of all of the above techniques and is generally an ongoing feature of an organization's mode of operation. In some ways, joint problem-solving is the most effective and the most difficult to implement of all the strategies to manage the risks inherent in internal knowledge.

However an organization decides to manage its knowledge, an effective program should help the organization accomplish the following:

- Foster innovation by encouraging the free flow of ideas
- Improve customer service by increasing operator knowledge
- Enhance employee retention rates by recognizing the value of employees' knowledge and rewarding them for it
- Streamline operations and reduce costs by eliminating redundant or

unnecessary processes
- Stabilize operations by ensuring smooth transitions when employees leave the organization
- Cut costs related to loss of employees and training of new employees
- Cut costs related to loss of ability to operate smoothly in the event of unexpected employee absences or departures

9.4 Training

Training programs are at the heart of the implementation of any new program, as well as the orientation of new employees to existing programs.

...to give them a very high level overview on how what they do is critical to Asset Management.
--Stacy Gallick, Johnson County, KS
HU-15

Since Asset Management, as a formal program, is unfamiliar to most utility employees, it is imperative that the utility establish robust training programs for all employees. There will likely be new software to be learned, new procedures to be mastered and new concepts to be incorporated.

...a way for operators to...go into their training with the idea that they would try to maximize energy savings.
--Russell Batzel, St. Peters, MO
HU-16

It is important to stress, however, that Asset Management is a common sense approach to doing business and that many of its techniques are already in place in a well-run utility, even though they may not be in a structured formalized program. In addition, Asset Management is a scalable process, so that it may be implemented in small increments. Understanding these two points is important in the determining what types of training programs will be needed, as well as in allaying fears and the natural resistance to new programs or activities. If training programs are put in place from the beginning at appropriate levels and if all employees are given a chance to participate in decisions, the process of implementing Asset Management is likely to proceed smoothly.

9.5 Leadership

Leadership: The art of getting someone else to do something you want done because he wants to do it.
(Dwight D. Eisenhower, 34th President of the United States)

We let them know as an organization that they do matter. Asset Management stems from the employees more than anything else.
--Stan Allred, Albuquerque, NM
HU-17

Most of us do not like to be told what to do, but we don't mind being shown a better way to do things. Every organization has leaders; some of them are at the top of the organization and some are not. The implementation of an Asset Management program utilizes leadership at all levels, but it is extremely important that top levels of management understand and support the program. Without the endorsement of the Board or Council or other governing entity, the implementation can flounder for lack of funds or the inability of employees to see the importance of the program. On the other hand, a top-down mandate can generate resistance.


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For these reasons, top level buy-in is critical. Total participation throughout all levels of the organization might be gained gradually. As the process gains momentum, and success is achieved, and as people receive training, buy-in will increase at all levels. People will come on board as they see the benefits. This is where true leadership comes in. A good leader can help people understand their role in the overall process without forcing their participation.

9.6 Community Involvement

Many water and wastewater utilities seem to operate in a vacuum. They are invisible to everyone but themselves. We turn the tap and water comes out. We flush the toilet and all is well. But most citizens know very little about what keeps these processes going. It's not that they don't want to know; they often just don't have much opportunity to learn. This is where the utility has an opportunity to tap a huge resource of support.


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Simply informing your customers can go a long way toward gaining support for your programs. The experience of the utilities interviewed for this manual, as well as many others worldwide, bears this out. In several of the utilities we interviewed, people responded in overwhelming numbers to campaigns to inform them about their water and wastewater utilities. In other areas, large numbers of community members have participated in drafting master plans and sustainability plans for their communities. Such involvement gives people a sense of belonging and pride in their communities.

If the people feel that they have participated...they are going to be more willing to move forward. HU-24
--Jim Noucas, Portsmouth, NH

Just as you will have greater success by involving all your employees, you will compound those successes even further by involving the entire community in your plans. For larger communities, this involvement is vital to gaining support for rate increases and capital improvement plans that might require voter approval. For extremely small utilities with limited resources, involvement of community members can mean the difference between being able to implement your Asset Management plan and never getting off the ground.

It's all a volunteer-driven effort. HU-25
--Peter Britz, Portsmouth, NH

Small communities are full of individual people with different valuable skills. Some of these people may be retired, semi-retired or underemployed. This is a resource that can be tapped for various aspects of the implementation of the Asset Management plan--e.g. mapping or creating databases.

It has been said that two heads are better than one. Surely 500 heads can be used to better advantage than 5. Thinking of your customers as allies and collaborators can reap significant benefits.

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9.7 The Triple Bottom Line

The concept of the Triple Bottom Line is gaining acceptance around the world, as communities begin to examine their quality of life and consider the environmental consequences of their actions. Triple Bottom Line (also known as "people, planet, profit" or "the three pillars") considers an expanded spectrum of criteria for measuring the success of any organization. These criteria are typically economic, social and environmental. Triple bottom line accounting expands the traditional reporting framework to take into account ecological and social performance in addition to financial performance.


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This approach also uses all three criteria to structure total business case evaluations for proposed projects that take into account the three types of capital needed to complete a project (financial, human and natural) as well as the three types of impacts of the project.


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The ultimate goal of the triple bottom line approach is sustainability. But for most people and most communities, true sustainability is a nebulous concept whose realization is beyond our reach. That, however, should not prevent us from working toward that goal. Every step in that direction enhances our future and that of our children and grandchildren.

That's the ultimate goal--we want to protect our rivers and waters.
--Ted Riehle, Old Forge, NY

HU-35