Seattle Public Utilities Takes Aim at Critical Assets Using Risk-Based Decision Making and Strategic Asset Management Plans

What does asset failure mean to your utility? For Seattle Public Utilities (SPU), unanticipated asset failure is something that they hope will be a thing of the past. A sudden sewer collapse back in 2002 has been one of the motivators for organizational and practice changes that have led to the development of a world-class asset management program.

Terry Martin, Wastewater and Drainage Lead in the Office of Strategic Asset Management at SPU, notes that not only was the repair costly, but a nearby hospital was entitled to financial compensation as well (Martin, 2005, p.14). The last time the pipe had been inspected was in 1992. Since SPU used a time interval-based condition inspection program, the routines in place at SPU did not have the pipe scheduled for re-inspection for another 20 years. In retrospect, the long period between pipe inspections made little sense since this particular pipe formed a portion of one of the oldest sets of infrastructure in the city of Seattle, was subject to high combined sewer and stormwater flows, and was adjacent to a hospital.

SPU has since implemented a comprehensive asset management program to help anticipate future failures before and the degree of damage that will be caused by them before they occur. The program has focused on establishing levels of service, understanding business risk, and developing business cases for asset investment. They have looked to some of the world’s best asset managers to help develop their asset management program. This case study describes some of the key elements of the organizational and practice changes that have taken place at SPU in support of their chosen asset management path.

Seattle, WA – The Emerald City

Located in the State of Washington, approximately 113 miles south of the US-Canadian border, the city of Seattle is situated at sea level between Puget Sound and Lake Washington. As the largest city in the Pacific Northwest, Seattle is often called “the Emerald City,” referring to the lush trees found within the city. Surrounded by water, Seattle is 142 sq. mi., of which 40%, or 58.6 miles, is actually
water. The highest point of elevation in the city reaches 520 feet.

The city of Seattle has two utility departments. Seattle City Light provides electric power, and Seattle Public Utilities (SPU) provides water, sewer, stormwater, and solid waste services. SPU also provides drinking water services to several neighboring communities and manages its own internal engineering services to support SPU-related projects and activities.

SPU operates and maintains a variety of assets including, but not limited to, the following for provision of clean water (Kelly, January, 2008):

- Four dams and two headworks facilities
- 175 miles of large diameter transmission pipelines
- 1,700 miles of water mains
- 175,000 metered services
- 17,000 valves
- 29 water pumping plants
- 16 reservoirs
- 16 elevated tanks/standpipes

SPU also owns two major drinking water treatment facilities. These are operated and maintained by private contractors. In addition, there are more than a dozen small water chlorination facilities throughout the city.

In the stormwater and wastewater arenas, SPU is responsible for maintaining the assets listed below (2005-2010 Adopted Capital Improvement Program, p.457 and Input from Elizabeth Kelly, January, 2008). Note that wastewater treatment services are provided by King County:

- 582 miles of sewage system pipelines
- 482 miles of drainage system pipelines
- 905 miles of combined system pipelines
- 68 pump stations
- 92 combined sewer and pump station outfalls
- 38 combined sewer overflow control detention tanks/pipes
- 140 miles of ditches and culverts

SPU also manages assets related to providing solid waste management services.
In total, the annual operating budget of SPU is approximately $600 million with assets totaling approximately $4.5 billion (Kelly, Commitment to Customer Service January/February, 2008).

The main goal of SPU is to meet the service expectations of their customers (Seattle Public Utilities 2007-2008 Strategic Business Plan, p.2, 2007). At the same time, the utility strives to balance the provision of value with life cycle costs while considering financial, environmental, and social factors. These three factors form the basis of what is known as “Triple Bottom Line,” a concept that is gaining popularity due to public interest in sustainable practices. In order to achieve their vision, SPU recognizes the importance of a world-class Asset Management (AM) program and has gone to great lengths to establish a program that incorporates the values and goals of the organization as part of the decision-making process.

This case study focuses on Seattle's journey in asset management toward a more strategic focus, with particular emphasis on the incorporation of a risk management-based approach. Using the management of sewer pipe assets as an example, the case study illustrates how SPU uses a risk-based decision process to determine which assets are most important in sustaining levels of service.

**Asset Management Background**

Providing water utility services is very infrastructure intensive. The challenges include rate pressure, public scrutiny, an aging infrastructure, and environmental sensitivity, which all become part of public service delivery (SPU Asset Management Framework, 2007, p.3). In 2002, SPU began planning and implementing a strategic asset management program. As explained in SPU’s Asset Management Framework, “quick wins” are attributed to the initial approach SPU chose for asset management development. Instead of implementing a complex asset management program at the outset, executives at SPU instead decided to adopt an “early gains approach.” This decision resulted in the development of a core AM philosophy, implementation of key AM elements, and a focus on early gains to build staff understanding and confidence. This has proven to work very well.

**Asset Management – An Evolutionary Path**

Development of the asset management program in use today by SPU represents five years of effort including realignment, modifications, trial and error, piloting, review, data acquisition and scrubbing, analysis, collaboration, and more. A great degree of effort has been devoted to:

- Creation of a formal asset management document that identifies the overall framework
- Implementation of an organizational model that distinguishes Specifiers from Service Providers (see below for explanation)

- Establishment of an Asset Management Committee (AMC) and other decision-making groups

- Development of a process for analyzing and documenting strategies for management of assets (Strategic Asset Management Plans, or SAMPs)

- Development of the Project Development Plan (PDP) process and the Project Development Plan Guidebook called the “Quick Start Guide” to explain the PDP process

- Documentation of the Triple Bottom Line process (wherein they consider social, environmental, as well as financial costs, benefits, and risks) in a Triple Bottom Line (TBL) Guidebook

- Establishment of agreed-to service levels

- Establishment of a corporate wide risk management framework

- Establishment of a quarterly Performance Indicator Report that helps SPU understand how well they’re doing in the provision of service and helps to focus improvement efforts

As part of the asset management development process, concepts were transferred from Australia to SPU by having utility managers from these locations work directly with SPU staff as part of a staff exchange program. With the Australians assisting, SPU was challenged to “think outside the box” and develop a unique program that would better prepare SPU for the future. A component of this was establishment of the Specifier-Provider model.

Specifiers at SPU are accountable for proposing service levels, ensuring that the organization meets service levels, negotiating and meeting regulatory requirements, developing business cases for investments, and determining the best balance between capital expenditures and maintenance activities. Service Providers are responsible for implementation of various capital, operational, and maintenance programs, including the day-to-day activities of equipment maintenance and operations. Service providers become very good at achieving results in their specific area, and their opinions and perspectives are very valuable to specifiers. Service providers also have a critical role in customer interface.

**SPU Strives for a Customer-Centric Approach**

In recent times at SPU, there has been even greater awareness to adopt a customer-centric approach to asset management rather than focusing totally on asset
condition. Liz Kelly, Director of the Office of Strategic Asset Management for SPU, explains:

*SPU is creating a new paradigm for how staff and management make decisions. SPU employees routinely ask: What is the best way we can meet the needs of our customers? What would our customers think about this decision? Are we providing equitable services across all of our communities?*

Commitment to Customer Service January/February, 2008

The models and guides that form part of SPU’s asset management program encourage these types of customer considerations when making decisions (See Project Development Process Quick Start Guide, p.14).

For SPU and many other utilities, the driver for project initiation and implementation hinges on maintaining customer service levels and keeping within regulations. It is important, therefore, to ensure customer service levels are set accurately and with care. To facilitate the proper assessment and determination of service levels, SPU created an interim Service Level Project Team and a Service Level Steering Committee. Members of these teams met regularly to review near-term and long-term service level and performance indicator work.

The results of the Service Level Project Team and Steering Committee not only provided information on customer satisfaction but also provided data regarding customer willingness to pay.

**The Strategic Asset Management Plan (SAMP)**

SPU’s approach to determining which assets are critical to sustain performance is very structured – it is planned, documented, and put through an iterative process of refinement. There is less emphasis on critical assets and more emphasis on risk-based decision making. In order to consolidate the asset management information, strategy and approach for a group of assets, SPU has a specialized team responsible for crafting Strategic Asset Management Plans (a.k.a. SAMPs) for various categories of assets. SAMPs are created by a small group of about six experienced individuals who have been practicing SAMP development for several years.

The current definition of a SAMP as approved by the SPU Asset Management Committee (AMC) is as follows:

*A Strategic Asset Management Plan (or, SAMP) is a short term planning document that guides our management of a category of assets to meet defined objectives. Management of assets in this sense incorporates operations, maintenance, and capital activities and investments. SAMPs assess the current status of a category of assets by 1) characterizing asset attributes such as type, size, material, and age, 2) listing relative service*
levels and regulations, 3) describing current operations, maintenance, and rehab/replacement strategies, and 4) characterizing the risk associated with SPU’s operation and ownership of the assets. SAMPs then characterize our risk tolerance for the asset category and define our program for controlling risks associated with ownership and operation of assets. Once approved by the Asset Management Committee (AMC), SAMPs become guiding documents that may feed into our data management strategies, our condition assessment strategies, our operations strategies, our maintenance plans and strategies, our renewal and replacement strategies, and our CIP planning processes. Such strategies are referred to as Tactical Plans and are an integral component of SAMPs. SAMPs also have a secondary value in centralizing information related to an asset category and creating transparency regarding maintenance, operations, and renewal/rehab strategies. SAMPs have “owners” (i.e., individuals responsible for their preparation and updating), but are developed in a collaborative manner among Corporate Asset Management (CAM), Resource Planning, Strategic Ops, and others as appropriate. SAMPs and comprehensive plans function collectively to set the strategic framework for SPU’s management of assets.

**SAMP Definition, Approved by AMC on Dec 15, 2004**

A list of SAMPs that have been completed by SPU includes the following asset categories:

- Wastewater and Water Pump Stations
- Wastewater Collection Pipes
- Wastewater Structures including:
  - Combined overflow structures
  - Underground detention valves
  - Hydrobrakes
  - Tide gates
- Drainage Collection Pipes
- Water Distribution Pipes
- Water Service Pipes
- Water Pump Stations
- Water Reservoirs and Tanks
- Water Valves
How SPU Makes Well-Informed, Risk-Based Decisions

In order to make informed risk-based decisions, SPU calculates the annual Risk Cost of Failure. The formula used to determine this is:

\[ \text{Risk Cost of Failure} = \text{Consequence of Failure} \times \text{Probability of Failure} \]

Terry Martin of SPU describes the process of determining both sides of this equation in detail as it relates to the practices followed by SPU for wastewater collection pipes (2005, p.14 & 16). He also explains how SPU discerns pipes of greatest concern with the use of risk-based decision making tools.

Consequence of Failure

SPU has divided the consequence of failure into three main subgroups:

1. **Baseline generic financial costs for repair of an asset failure**: This refers to the “hard” cost of repairing an asset. In order to arrive at these estimated costs, SPU uses historical cost information for similar assets and asset attributes (i.e. diameter of pipe, material of construction, and depth to pipe) to extrapolate an approximate cost.

2. **Location-specific factors which increase the financial cost of an asset failure**: Depending where the asset is located, specific factors can be accounted for that will increase the financial cost of performing repair work for a given asset failure. This might include location under a bridge, location under railroad tracks, location under a body of water, etc.

3. **Location-specific factors which increase the environmental and social costs of an asset failure**: Location-specific factors not only can increase the financial cost of an asset failure but can also increase the environmental and social costs. For instance, an asset failure located in the heart of the city will not only increase the repair cost due to traffic control but will also cause social disruption. Martin discusses other “intangible” (i.e. non-financial) costs which come into consideration including potential damage to public health, environmental damage potential, unfavorable publicity potential, and property damage potential.
### Probability of Failure

SPU has developed a model for predicting the probability of failure that uses a two-pronged approach. The first consideration is location-specific cost multipliers that will increase the probability of failure. For wastewater collection pipes, such factors might include:

- steep slope (H2S generation causing material degradation)
- proximity to industrial, commercial and institutional (ICI) facilities, which release substances that may affect the life of a pipe

SPU has taken the initiative to create a program that interfaces with the city’s GIS system to apply an appropriate factor of failure probability based on such location-specific cost multipliers.

The second way the probability of failure is determined is based on the age of each asset and susceptibility to material degradation. SPU has created predictive failure curves that identify the expected failure rate of a pipe, for instance, based on its material composition and age. Martin explains that this in-house model is capable of applying a unique failure curve to each pipe that is identified in the system. As more empirical information becomes available, SPU continues to update the model.

### Calculating Annual Risk Cost

Once the unique consequence of failure and the unique probability of failure are known for a given asset, SPU defines the product of these as the total risk cost of failure.

When considering which assets are of highest risk, there are a few other factors that need to be considered, according to Martin. One factor is the cost to perform a condition assessment. Therefore, the life-cycle cost of the condition assessment is calculated and taken into account. Another factor might be the cycle time required to perform a condition assessment. For pipe assets, SPU has estimated the cycle time for a CCTV assessment to be approximately five years.

Determining which assets are high risk is done by comparing the calculated risk cost of an emergency failure repair for a given asset versus the Net Present Value (NPV) of a scheduled repair plus the life cycle cost to perform condition assessment. If the risk cost of an emergency failure repair is greater (i.e. the benefit/cost ratio is greater than one), then the asset is deemed “high risk” and an initial condition assessment (i.e. CCTV video inspection) is performed on the asset.
Advice to Other Utilities Seeking to Implement an Asset Management Program

When asked what advice he would pass along to other utilities that are trying to develop an asset management program, Terry Martin offers the following thoughts (phone interview held 18 February, 2008):

The first relates to data management. Asset management helps to obtain better data. Strategic Asset Management requires reliable asset data. In order to implement a good asset management program, a great deal of effort must be put forth to get existing data organized and accurate and to ensure new data is accurate and it is captured properly. A GIS system has proven to be invaluable for SPU in acquiring accurate asset data. However, existing GIS data at the outset had numerous errors which required correction.

An important aspect of asset management is change. Martin specifically addressed the difficulty associated with encouraging a culture of change within SPU. According to Martin, asset management challenges many people within the organization to do things differently than what they are used to doing, and it is likely that not everyone in the organization will be on-board with the changes that need to happen. Some just do not want to change. An example is documentation. Asset management involves documenting how things are done. For some employees, this is seen as a threat to job security.

Finally, Martin suggests that utilities consider asset risk rather than criticality. By shifting one’s way of thinking more to the apparent level of risk rather than criticality, Martin has found that some “sneaky things” tend to become apparent that were otherwise not realized. A very simple example of this is as follows:

A fire hydrant is a critical asset. It must be located in certain areas within the city in case of fire. From a criticality perspective, you will consider the locations where the hydrant needs to be located to mitigate risk. However, from the same perspective, you may not consider the risk associated with a fire hydrant that is not painted properly. Risk-based decisions may take into account that the hydrant will degrade sooner, may not be suitable for its intended use and may need to be replaced earlier than the anticipated life expectancy period dictates. It will also address the importance of repainting the hydrants over time.
Conclusion – The Benefits of Asset Management for SPU

After reviewing the information presented by Seattle Public Utilities with regard to the overall asset management program, it is clear that a very concise and well thought-out program is taking shape. In fact, as an exercise, it is interesting to note the many advantages that arise from the program in use today. These include the following:

1. Better understanding of the cost of doing business. This results in more informed Capital Improvement Project (CIP) decisions.

2. An opportunity to include rate-payer input when making CIP decisions since the cost of business is better defined. Approximate rate increases for a given level of service can then be proposed to rate-payers, for instance.

3. Assets of greatest risk become better defined and targeted as the main areas of focus. This allows for efficient allocation of asset management resources (i.e. maintenance staff).

4. As more empirical data becomes available in future, SPU continually improves and refines assumptions, information, models and data that form part of the decision making process.

5. An asset management program that encourages a customer-centric mentality and approach to decision-making with the use of models, guides, agreed-to service levels and culture changes.

6. Greater accuracy in predicting asset failure before failure occurs.

7. Decisions that are made with consideration of Triple Bottom Line (i.e. considering Social, Environmental, and Economic factors). Many utilities still have not formally embraced TBL as part of their decision making process.

8. Various initiatives that can be integrated to foster sound decision making. As an example, SPU leverages its geospatial data to produce risk-based charts and graphs for assets management purposes.

9. Information and processes required to make a decision are well-documented and available to all staff as user-friendly models, often with associated templates and guidebooks.
BIBLIOGRAPHY


