A tool to determine when it’s the right time in an asset’s life cycle to change the investment strategy

Case Study Application of Determining End of Physical Life Using Survival Analysis (INFR2R11a/ SAM1R06 Tool)

The Central Issue
Wastewater infrastructure systems are sizable investments for most communities. As plants and pipes across the country age, higher percentages of the asset base are failing and failures of the same asset or asset function occur more frequently. This is because many of the assets constituting the major components of both treatment and collection systems are now reaching the point in their life cycles where failures are accelerating. Many of these failures can pose significant consequences to the community.

The question then becomes, when is the right time in an asset’s life cycle to change the investment strategy, from operations, to maintenance, or capital investment? When utilities plan their schedules and budgets, there is a good chance that unforeseen circumstances may affect the plan. It is this uncertainty that challenges asset managers to integrate the right blend of operations, maintenance, and capital improvements. Much of this challenge is the capital component of the investment mix – which assets, and when in the life cycle to reinvest capital in the existing asset base. The key to managing the transition from operations to maintenance to capital investment is identifying the end of asset life because the goal of the strategy is to provide sustained system performance at an acceptable level of service, with the lowest ownership cost, and at a level of risk acceptable to their customers.

Context and Background
The End of Asset Life Reinvestment Tool (simplified to EoAL Tool) provides step-by-step process guidance for making those cyclical transitional decisions with a particular focus on the transition to capital reinvestment. It assists in determining which renewal strategy (maintenance/repair, refurbishment, replacement) is most cost effective and when in the life cycle of a given asset, given a set of user-established baseline conditions and assumptions, to transition from an operations and maintenance strategy to a capital reinvestment (renewal) strategy. Because the reinvestment decisions depend on end of asset life triggers, other tools in the SIMPLE toolbox are referenced.

Findings and Conclusions
The tool was pilot tested at two utilities, Metropolitan Sewer District of Greater Cincinnati (MSD) and Milwaukee Metropolitan Sewerage District (MMSD). To demonstrate the tools’ versatility, both buried assets (pipes), and pumps and motors (vertical assets) were tested.

The City of Cincinnati volunteered to test the logic and application of the tool on selected water and wastewater pipe. Water pipe data was provided by the Greater Cincinnati Water Works (GCWW), while sewer pipe data was supplied by the Metropolitan Sewer District of Greater Cincinnati (MSD). Senior staff from U.S. EPA and WERF joined the two-day application test team in applying the tool to Cincinnati’s data and business practices.

The Milwaukee MSD volunteered to test the tool on vertical assets (pumps and motors). Similar to Cincinnati, senior staff participated in a workshop to apply the tool to Milwaukee’s data and business practices. The data were not sufficient to develop survivor curves, but the review team was able to provide guidance on the data necessary to populate the datasets.

At both utilities, every step and task of the tool was discussed in the workshops as the research team introduced and tested the viability of the advanced concepts to determine the end of physical life. Determining the end of service level/capacity life and the end of economic life were also thoroughly discussed and reviewed.

Management and Policy Implications
Understanding the end of life trigger for service level/capacity in addition to the end of physical life allows a utility to have a much clearer picture for planning purposes. The availability of usable data may be an impediment to developing survivor curves initially, however, the tool also provides advanced guidance to help personnel make asset end of life decisions when there are limited data.
## Executive Summary

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### Related WERF Research

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<th>Project Title</th>
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| **SIMPLE: Sustainable Infrastructure Management Program Learning Environment (03CTS14)** | This online knowledge base enhances the ability to train personnel and provide guidance and tools to utilities of all types, sizes, and levels of practice in asset management. It contains tools, best practices, case studies, research reports, training aids, and an extensive body of knowledge to help set up an asset management program, take a program to the next level, and increase knowledge. ([www.werf.org](http://www.werf.org)) These tools are included in SIMPLE:  
- Asset Hierarchy/Registry  
- Condition Assessment Scoring  
- Condition Assessment Selection  
- Remaining Effective Life  
- Life Cycle Cost Projection  
- Level of Service  
- Business Risk Exposure  
- End of Asset Life Reinvestment  
- Business Case Analysis  
- Capital Improvement Project Validation/Prioritization  
- Asset Management Plan Template  
- SAM GAP |
| **Condition Assessment Strategies and Protocols for Water and Wastewater Utility Assets (03CTS20CO)** | Provides information on how to effectively use condition assessment tools and techniques to improve both long-term planning and day-to-day management of assets. The report is structured for two distinct audiences:  
1) Utility planning managers who want to use cost-effective condition and performance assessment programs to support long-term planning decisions.  
2) Engineering/maintenance managers who want to identify and understand the advantages and disadvantages of tools and techniques for measuring the condition and performance of utility assets to support daily maintenance and operation of assets. |
| **A Practitioner’s Guide to Economic Decision Making in Asset Management (SAM1R06b)** | Part I presents background concepts including drivers, approaches, decision support tools, and frameworks relevant to economic decision making in asset management and provides the basis for the guidance of Part II. Part II provides insights into the development of a decision support framework and methods such as strategic budget setting, changes in service levels, investment decisions, and benefit cost analyses. |
| **Remaining Asset Life: A State of the Art Review (SAM1R06d)** | Synthesizes the broad range of factors that influence remaining asset life. Covers the state of knowledge with respect to the estimation and prediction of remaining asset life, and if there is the capacity to translate between condition and performance data (e.g., the presence of significant defects) and the residual life of an asset. |
| **Towards an Economic Decision Methodology for Remaining Asset Life: Research Roadmap (SAM1R06g)** | Provides insights into an economic approach to decision making, applicable at multiple scales and in utilities of different levels of asset management sophistication. |

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