February 2015

FINAL
Asset Management Plan

Prepared for
Elk Grove Water District
9257 Elk Grove Blvd.
Elk Grove, CA 95624

K/J Project No. 1497014*00

Kennedy/Jenks Consultants

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List of Acronyms

ACP	Asbestos Concrete Pipe
AM	Asset Management
AMP	Asset Management Plan
BAP	Best Appropriate Practices
BRE	Business Risk Exposure
CAD	Computer Aided Design
C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution Pipe
C905	Polyvinyl Chloride (PVC) Pressure Pipe, 14 in through 24 in, Water Transmission and Distribution Pipe
CMMS	Computerized Maintenance Management System
CIP	Capital Improvement Plan
CoF	Consequence of Failure
DIP	Ductile Iron Pipe
EDC	Economic Development Corporation
EEL	Effective Economic Life
EGWD	Elk Grove Water District
FRCD	Florin Resource Conservation District
FSCD	Florin Soil Conservation District
GIS	Geographic Information Systems
HVWTP	Hampton Village Water Treatment Plant
KJ-IAM	Kennedy/Jenks Infrastructure Asset Manager
MMI	Maintenance Managed Item
MPL	Maximum Potential Life
O&M	Operations and Maintenance
ORDM	Optimized Renewal Decision Making
PEL	Physical Effective Life
PoF	Probability of Failure
RRWTP	Railroad Water Treatment Plant
SCADA	Supervisory Control and Data Acquisition
USEPA	United States Environmental Protection Agency

Executive Summary

Purpose

The purpose of this Asset Management Plan (AMP) is to document the current state of the assets for the Elk Grove Water District (EGWD). The AMP is a consolidation of the information currently available in regards to EGWD's infrastructure assets and service delivery programs. This long-range planning document will provide the EGWD with a rational framework for understanding its asset portfolio. This is a "first cut" asset management plan due to the limited data and asset knowledge available at this time, but can provide an understanding of what is needed to effectively manage the assets over the long term. In the future, this document can be enhanced as data quality is improved.

The AMP assists the EGWD in answering the following questions:

- What is the current state of the assets?
- What are the required levels of service?
- Which assets are critical to sustained performance?
- What are the needed operations and capital investment strategies to sustain asset performance?
- What is the best long-term funding strategy?

This document provides the first look at an organizational approach to managing assets, bringing together information about the asset portfolio from around the organization into a structured framework useful for short-term and long-term decision making.

Outcomes

The key outcomes from the development of the AMP are to:

- Document the current asset portfolio
- Establish value of assets
- Determine asset remaining useful life
- Understand the Business Risk Exposure of assets
- Long-range renewal forecasting
- Data for suggested 10-year CIP
- Future AMP recommendations.

Asset Portfolio

There are a total of 4,606 assets in the EGWD's asset portfolio. **Figure ES-1** presents the asset portfolio developed for the EGWD system of assets. Assets are organized under six major assets groups as shown below.

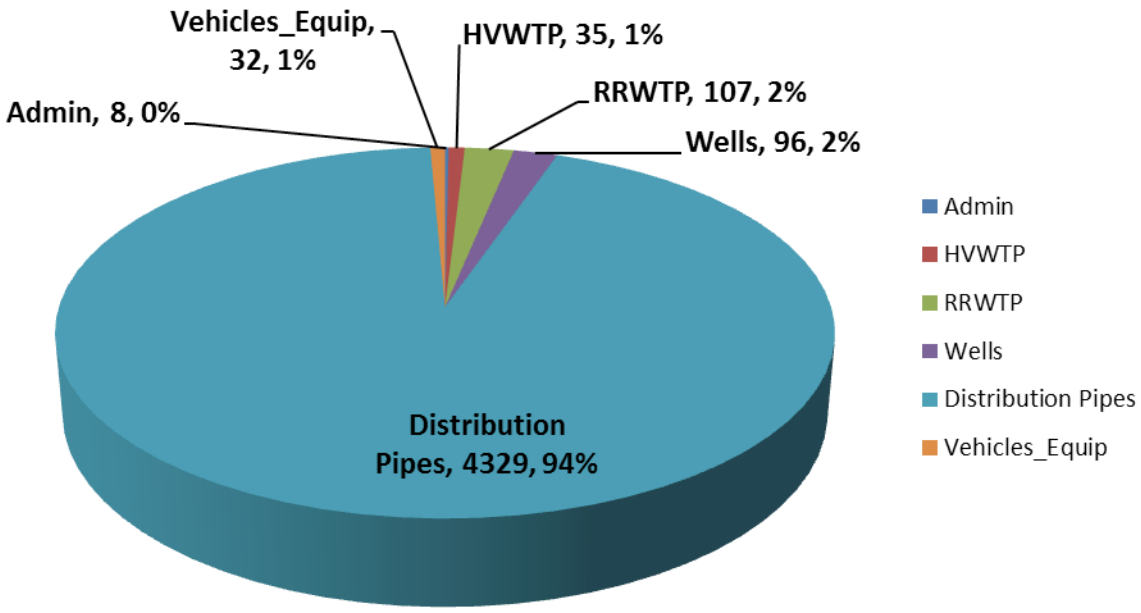

Figure ES-1: EGWD Asset Portfolio for this AMP

Value of Assets

A current replacement valuation for all EGWD assets has been generated. The replacement value represents the cost in 2014 dollars to completely replace all the assets to new condition. The approach used is looking from a bottom-up approach. This approach does not factor in the allied cost of design and construction as in the case of a top-down approach. The current bottom-up replacement value is estimated to be $140 million.

Figure ES-2 shows the distribution of EGWD assets by group based on replacement value.

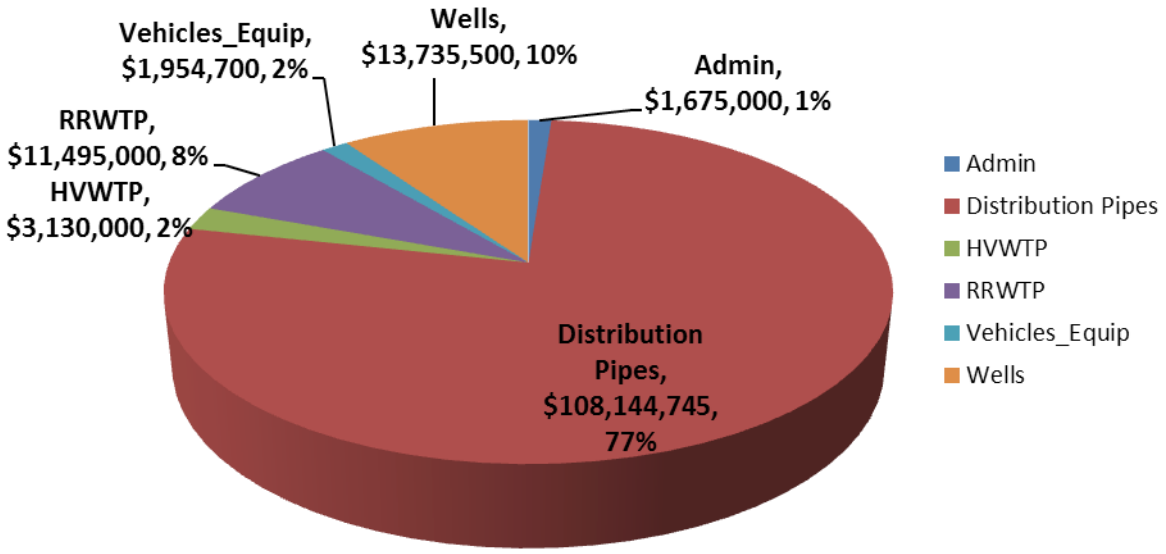

Figure ES-2: Replacement Value of EGWD Assets ($140 million)

Remaining Useful Life of Assets

The remaining useful life of several assets are coming due in the short term (the next 5 years) that exceed $4M as well as significant investment due approximately 30 years from now in the amount of $7M (current dollars) as shown in **Figure ES-3**.

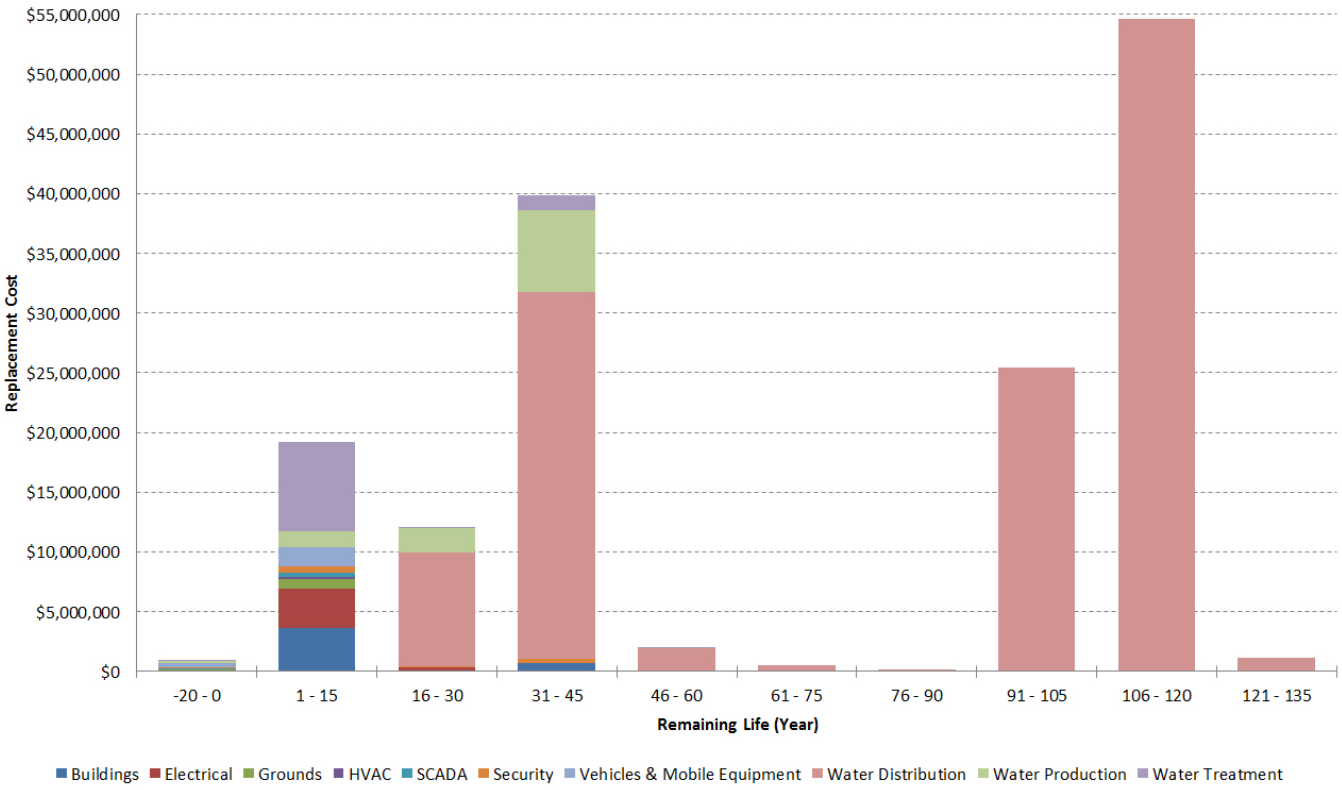

Figure ES-3: Remaining Life of EGWD Assets

This profile provides the EGWD with the overall knowledge of what portions of the assets are used up or are nearing the end of their useful lives.

Business Risk Exposure of Assets

Asset management involves understanding and balancing levels of service, cost, risk, and customer expectations. Understanding which assets or asset components are at risk and why helps an organization focus on critical investments. Business risk exposure is a measure used to estimate the relative risks individual assets present. **Figure ES-4** presents a risk plot for all EGWD assets. Assets outside the consequence threshold and tolerable risk level are the assets that present the greater risks to EGWD, and are the assets that should be evaluated immediately.

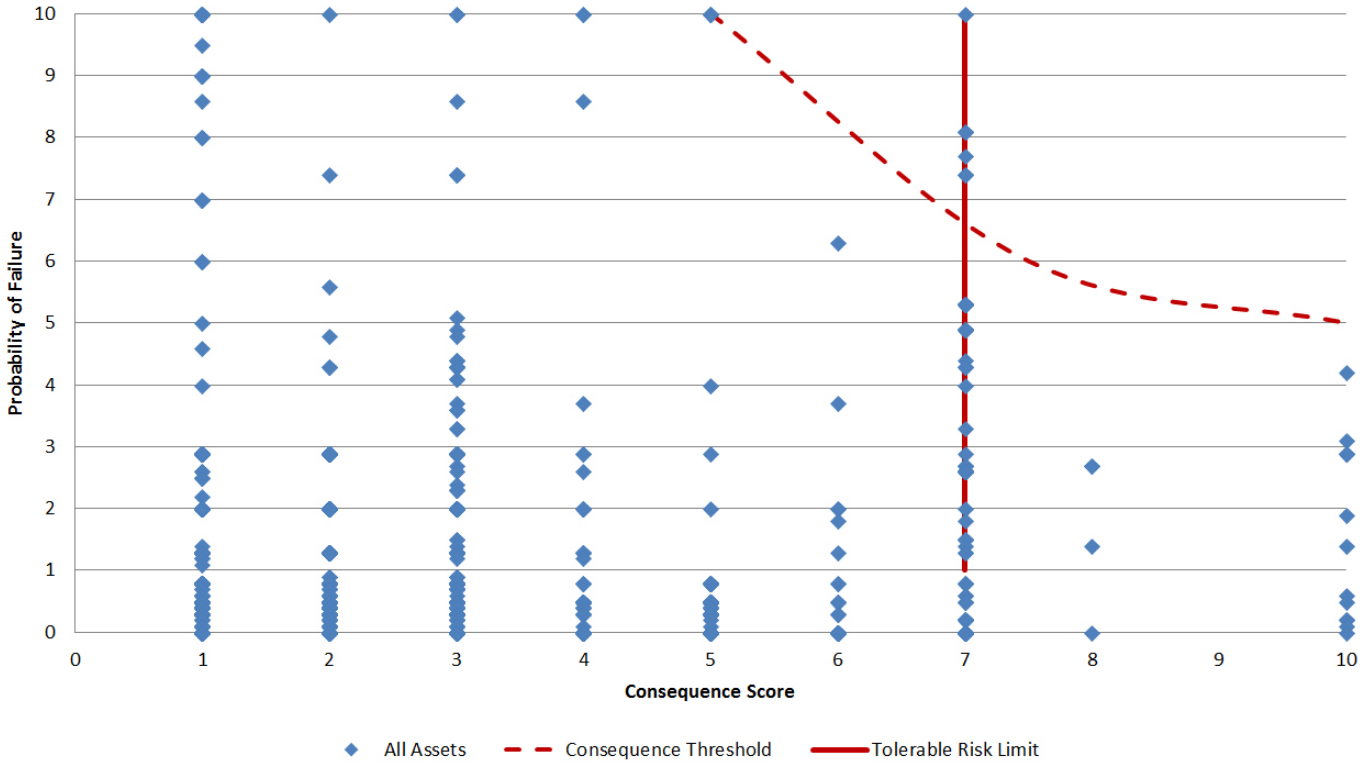

Figure ES-4: Business Risk of EGWD Assets

Long-Range Renewal Forecast

Figure ES-5 provides a 100-year renewal requirement projection for the total system. The projection estimates the EGWD will need to invest an average of approximately $1.9 million per year to meet the projected renewal needs (the projection estimates are based on 2014 dollars). Kennedy/Jenks recommends EGWD investigate the asset inventory and corresponding attribute data to ensure the accuracy of this forecast.

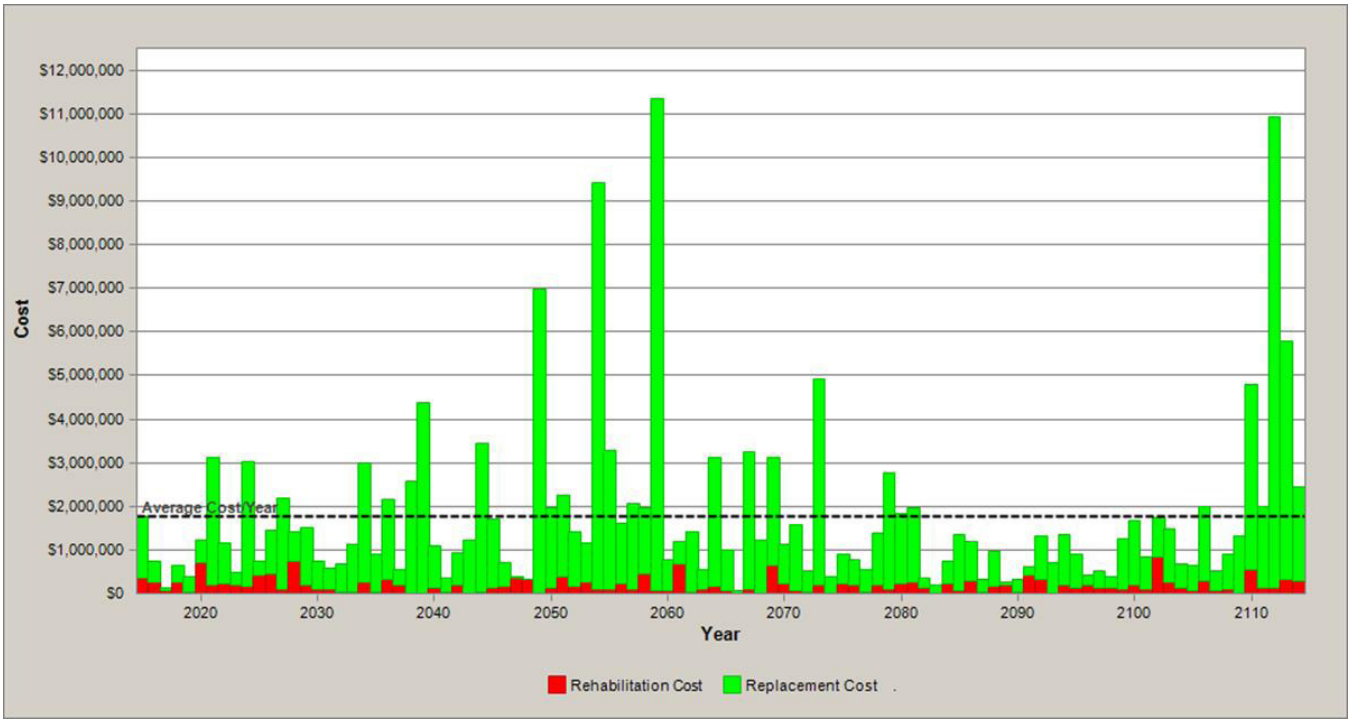

Figure ES-5: EGWD System Asset 100-year Renewal Forecast

Future AMP Improvements and Recommendations

This AMP has been built through the helpful insight from all levels of the EGWD, including management, administration, distribution, and technical staff. Input to this AMP included workshop contributions, data collection and review, revision of existing electronic data, and reviews of existing reports. Workshops and interviews provided insight into the asset registry, asset condition, asset management strategies, and associated business risks. Data analysis provided details of current status of the assets, and the likely requirements for future expenditure and revenue.

There are still opportunities for significant improvement of the data and the subsequent analysis going forward. The following are some recommendations for improving the asset management program:

- Review assets with the highest risk and determine if additional condition assessment investigations are necessary or to proceed with rehabilitation/replacement.
- Create condition assessment protocols to assist in determining the remaining useful life of assets.
- Develop failure codes by asset type to assist in determining when to intervene with appropriate levels of maintenance or rehabilitations.
- Identify assets where additional maintenance or rehabilitation would effectively extend lives.
- Develop a process for updating the asset management plan reflecting the results of implementing the recommendations.

Section 1: Introduction

1.1 Background

The EGWD wants to determine the adequacy of its funds to pay for future water system asset refurbishments and replacements. The EGWD employed the services of Kennedy/Jenks Consultants to assist in the preparation of an asset management plan to assist in its planning for the future.

EGWD is engaged in refining and strengthening its asset management processes and practices by progressing to the use of advanced asset management tools. This AMP was built around the United States Environmental Protection Agency (USEPA) 10-step asset management framework (**Figure 1-1**). The framework addresses the 5 core questions of infrastructure asset management:

1. What is the current state of the assets?
2. What is the required level of service?
3. Which assets are critical to sustained performance?
4. What are the best O&M and CIP investment strategies?
5. What is the best long-term funding strategy?

EGWD's initial AMP addresses 4 of the 5 core questions by:

- Identifying and organizing assets
- Determining remaining useful life
- Determining renewal and replacement requirements
- Assessing imminent and dominant breakdown modes
- Determining risk
- Projecting overhead, operations, maintenance and capital expenditure
- Developing funding strategies for the EGWD's infrastructure assets.

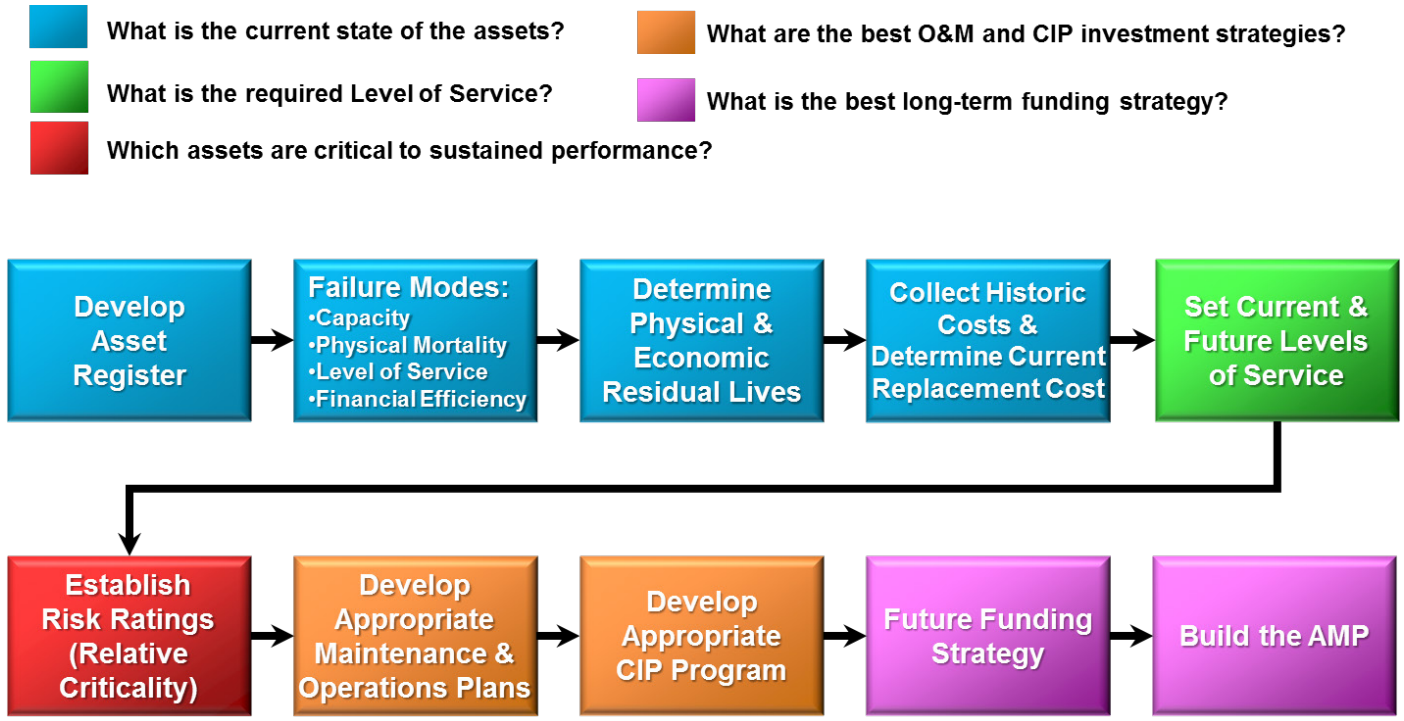

Figure 1-1: 10-Step Asset Management Process

This report documents and presents EGWD's current state of its asset management program. The asset management plan is a long-range planning document used to provide a rational framework for understanding the assets an organization owns, services it provides, risk exposure from assets, and financial investments it requires. The asset management plan was developed using available data from EGWD's GIS, City Works databases, and staff knowledge.

Working with the EGWD staff, the AMP was developed to provide a better understanding of the EGWD long-range asset renewal (rehabilitation and replacement) requirements and document current business practices related to its asset management practices. This will enable EGWD to make better infrastructure decisions.

As this is EGWD's first AMP, this document may not meet all of the long-range goals for a fully developed asset management plan. The AMP is intended to become a living document to be updated and continually refined by EGWD as part of an ongoing asset management and business improvement process.

1.2. History

Prior to World War II, the Florin area was well known for its grapes and strawberries. Almost all of the area now encompassed by the Florin Resource Conservation District (FRCD) boundaries was in agricultural production, including dairies, orchards, grain and other feed.

In the spring of 1950, the Florin Farm Center Committee for Organization of a Soil Conservation District, a committee of Florin farmers, submitted a proposal to the Sacramento County Board of Supervisors for the formation of the Florin Soil Conservation District and requested approval and submission of that proposal to the State Soil Conservation Commission. The specific intents of the new soil conservation district were efficient use of irrigation water, improved drainage, flood control, and other land improvements. With the necessary approvals, the committee met with other agricultural interests and local landowners until they had thoroughly identified all properties wanting to be within the District boundaries.

On June 23, 1953, a public election determined the establishment of the Florin Soil Conservation District (FSCD) and its first five member board of directors. Those directors were: George E. Carlisle, Thomas H. Young, John E. Mensch, Chris Feickert and J.E. Jensen. Perhaps portending the future FRCD's focus, the very first work plan, written in 1953, identified the importance of wise irrigation use and the necessity of not depleting the area's underground water supply. In 1954, the board executed a Memorandum of Understanding with the United States Department of Agriculture, beginning a long and productive partnership.

During the first years of the organization, two additions were made to the boundaries, a region around Franklin and the Waegell addition, a property near Florin Road, Grant Line and Sunrise Blvd. The Franklin addition expanded the District into Elk Grove. With grant money, equipment was purchased for water management projects, such as irrigation and drainage improvements. The FSCD also had a wildlife program, coordinating the sale of plants grown by the residents of the Preston School of Industry, Sacramento County's Boy's Ranch and Folsom Prison, and planting habitat for game birds and rabbits.

As Sacramento grew, the Florin area transitioned from a farm community into a Sacramento neighborhood. The FSCD transitioned too, moving its headquarters and its focus south to Elk Grove. Early FSCD documents describe Elk Grove as an area with orchards, dairy farms and a variety of crops, including alfalfa and other grains. In the early 1970s, because the District's activities included far more than just soil conservation, the Florin Soil Conservation District changed its name to the Florin Resource Conservation District (FRCD).

In 1893, after several fires threatened the small town of Elk Grove, local residents banded together to found the Elk Grove Water Company. The Jones family purchased the water company in 1906 and operated the utility as the Elk Grove Water Works for nearly 100 years.

In 1999, FRCD purchased the Elk Grove Water Works from J.B. Jones, changing the name first to "Elk Grove Water Service" and then to the "Elk Grove Water District." The FRCD and EGWD service area boundary is illustrated below with **Figure 1-2**.

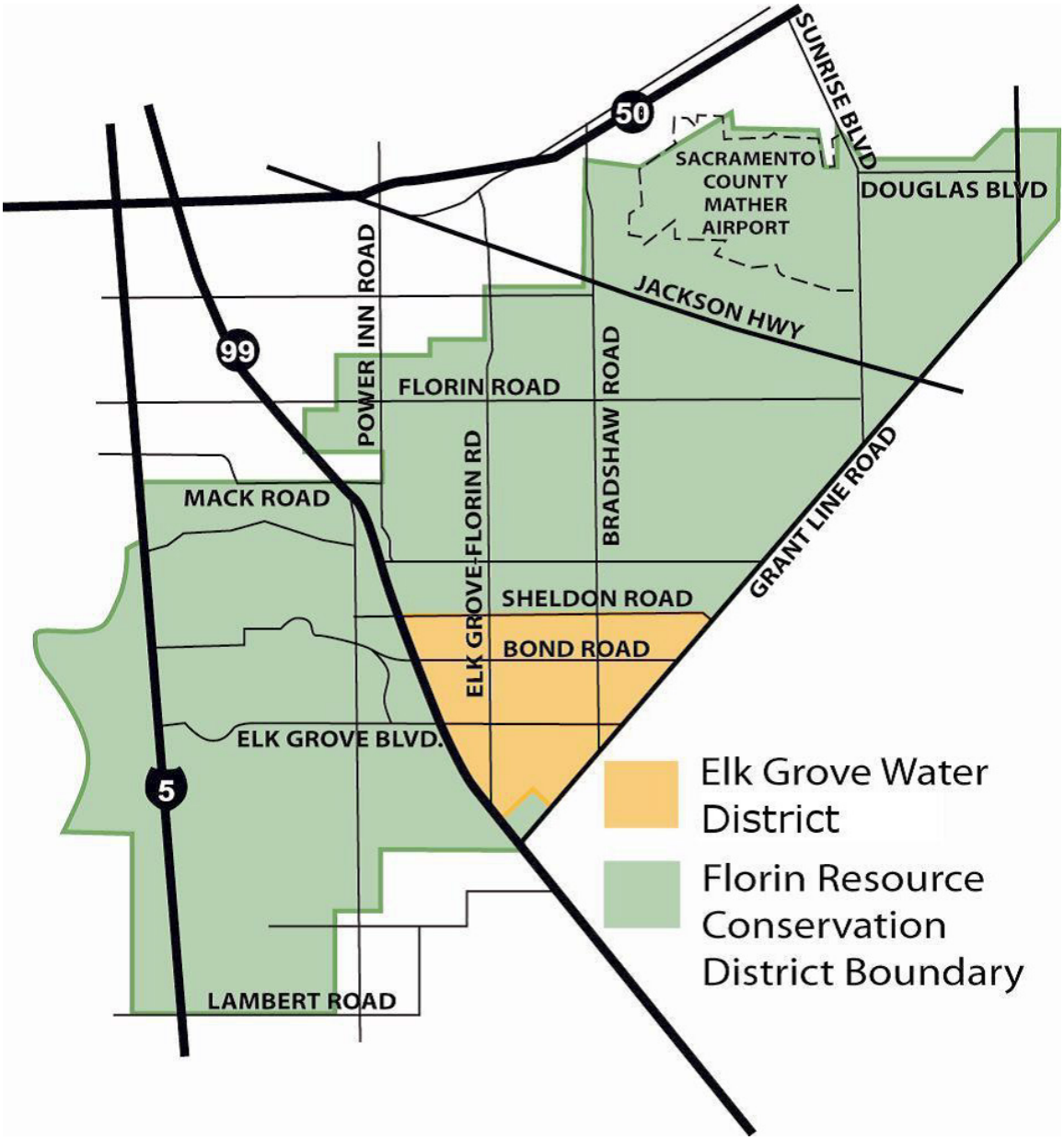

Figure 1-2: FRCD and EGWD Service Area Boundary

1.3 Asset Management Plan

The purpose of an AMP is to provide EGWD with a long-range planning document that EGWD can use to provide a rational framework for understanding the following:

- The assets that the EGWD owns and the services that it provides.
- The present and future demands on the infrastructure assets that are critical for delivering the organization's level of service to its customers and community.
- The current estimate of the short-term and long-term financial commitments necessary to maintain the assets and services that it provides.
- The business risk exposure associated with the potential failure of the assets to meet the expected levels of service.
- The organizational continuity that will transfer asset management knowledge between successive generations of utility managers.

This is EGWD's first version of an AMP and as such will not yet meet all of the long-range goals for a fully developed, high-data-confidence AMP. It is intended that the annual updates of the AMP will become a dynamic process and a living document that will be updated and continually refined as part of the ongoing asset management and business planning processes within EGWD.

This document has a long-term focus (100 years) and short-term focus (10 years) covering the full life cycle of the assets. It is based on a set of systematic planning activities to assess asset performance and demands, improve reliability of asset performance, improve forecasts for both capital and operational budgets based on asset performance and reliability needs, identify and quantify business risks and trends, formulate and evaluate both capital and operational options for meeting service levels, and plan continuous improvements related to delivering lowest life cycle cost service solutions.

The basic functional process for developing the information in the AMP is the following:

- Know the physical and functional characteristics of the assets.
- Determine the current condition and performance of the assets and the systems and facilities of which each asset forms a part.
- Determine the asset's likely breakdown modes and the probable timing of remaining useful life. The breakdown modes will include condition or structural malfunctions, physical mortality, under capacity, not meeting an established level of service, and no longer economically viable to own and operate.
- Determine the optimal solution to correct the effects of the breakdown mode based on a justified business case including costs and risk.
- Document these decisions in the AMP.

- Review the AMP against the organizations capacity and capability of completing the plan, including the amount of risk that the plan represents to the organization.
- Rationalize and document the trade-offs necessary to undertake implementation of the plan.
- Review the plan and update periodically.

The EGWD has developed this AMP to better understand its long-term business obligations related to the assets it currently owns and will own, and how the business decisions related to these assets will affect its ability to sustain asset performance and consequently sustain provision of economical services to its customers.

Section 2: Asset Portfolio

Determining the current state requires knowledge of the assets owned and managed by EGWD. This step starts with consolidating assets owned and managed in a central location (asset register). An asset register records all of the EGWD-managed assets and the associated attributes. As part of this initial AMP, working with EGWD staff, Kennedy/Jenks mapped out and collated data between all of EGWD's asset-related applications (e.g., GIS, CMMS, and KJ-IAM). Additionally, the newly created asset register can now be used to define the structure used by EGWD information systems going forward with the intent to enable the assessment of the assets as individual components, composite assets, or groups of assets.

The asset register forms the basis for the asset hierarchy, valuation, risk assessment, and long-range renewal forecasting. In order to develop the asset management plan, all data provided by EGWD was consolidated into one asset register (e.g., KJ-IAM).

2.1 Overview of Assets

The following list provides a summary of current EGWD assets organized by facilities and the water distribution system.

- Water System
  - Administrative Facilities
  - Distribution Pipes
  - Hampton Village Water Treatment Plant
  - Railroad Water Treatment Plant
  - Wells
  - Vehicles and Equipment.

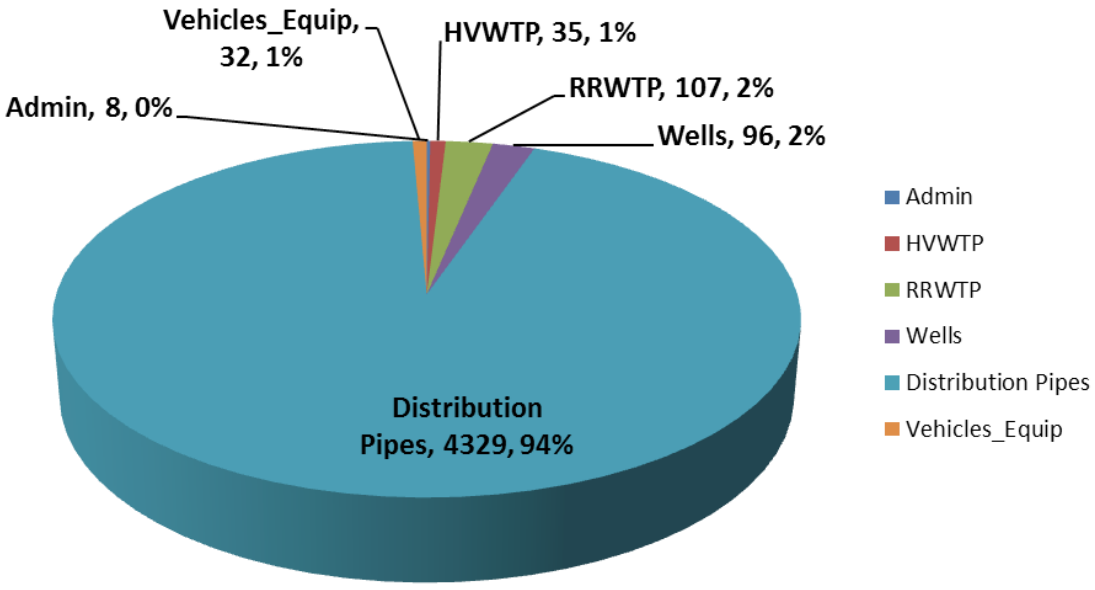

Figure 2-1: EGWD Asset Portfolio

Figure 2-2 shows the EGWD's administrative facility assets by type. The total number of assets is 8.

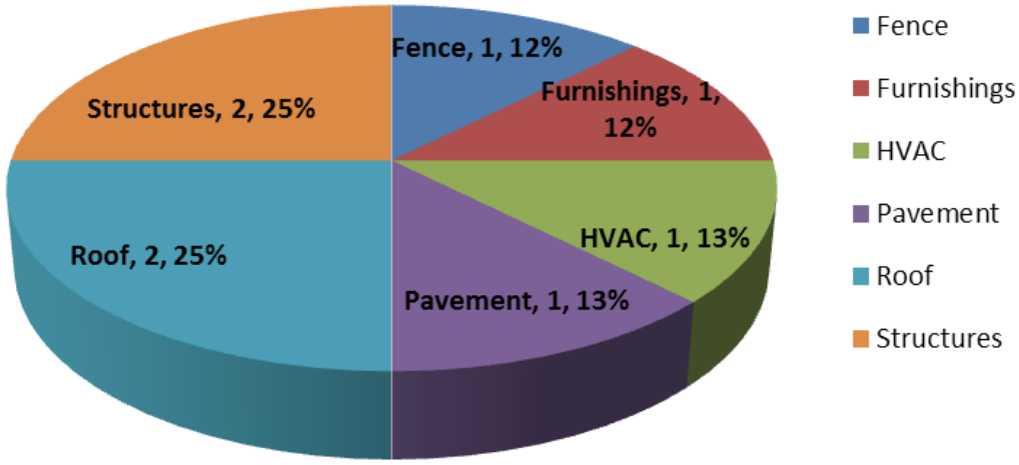

Figure 2-2: EGWD Administrative Assets by Type

Figure 2-3 summarizes the water distribution pipe data provided by EGWD. The total length of water pipe is 136 miles. Pipes were broken down by material type, with sizes ranging from 4 to 36 inches.

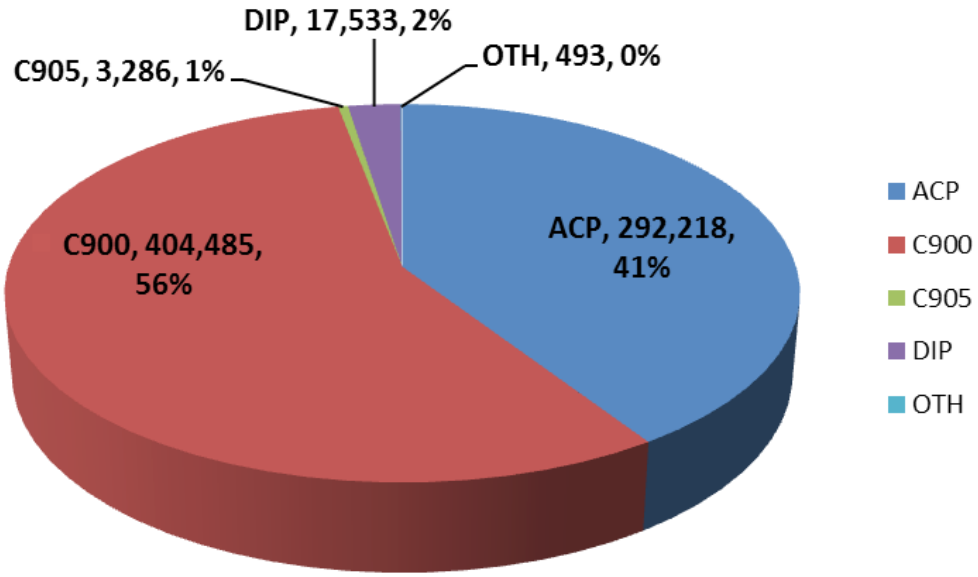

Figure 2-3: Distribution Pipe Assets by Type

Water Production and Treatment

Water production and treatment data contained at the Hampton Village Water Treatment Plant (HVWTP), the Railroad Water Treatment Plant (RRWTP), and eight water production wells is provided below. The data provided by EGWD is presented in **Figure 2-4**, **2-5**, and **2-6** by asset types for each.

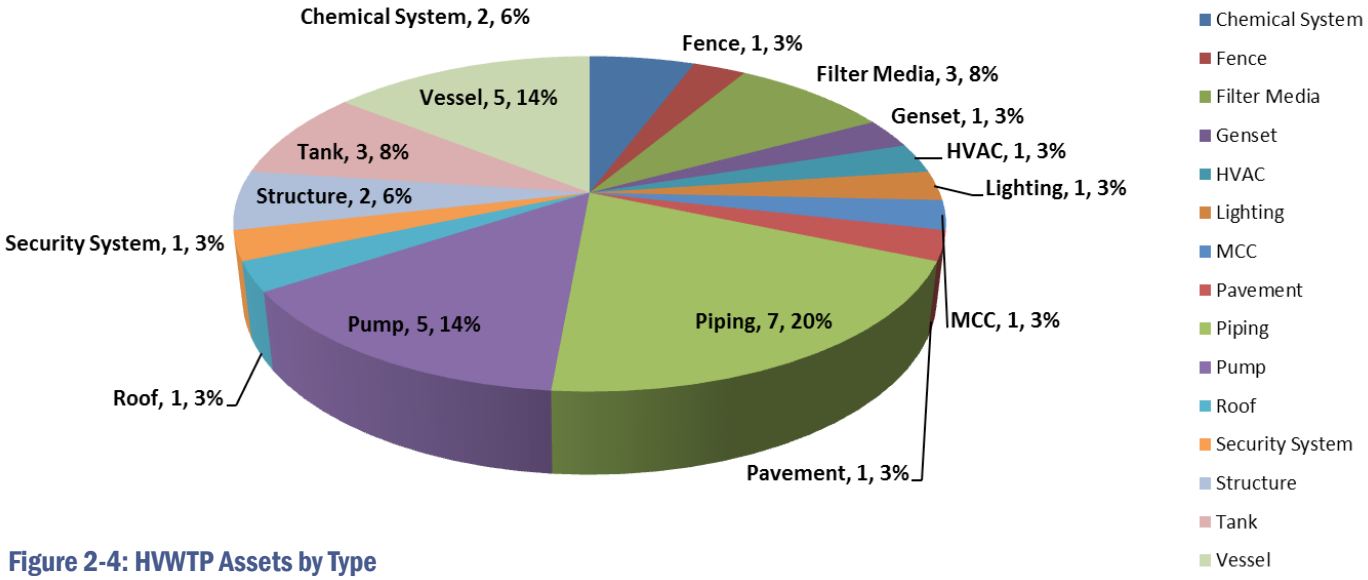

Figure 2-4: HVWTP Assets by Type

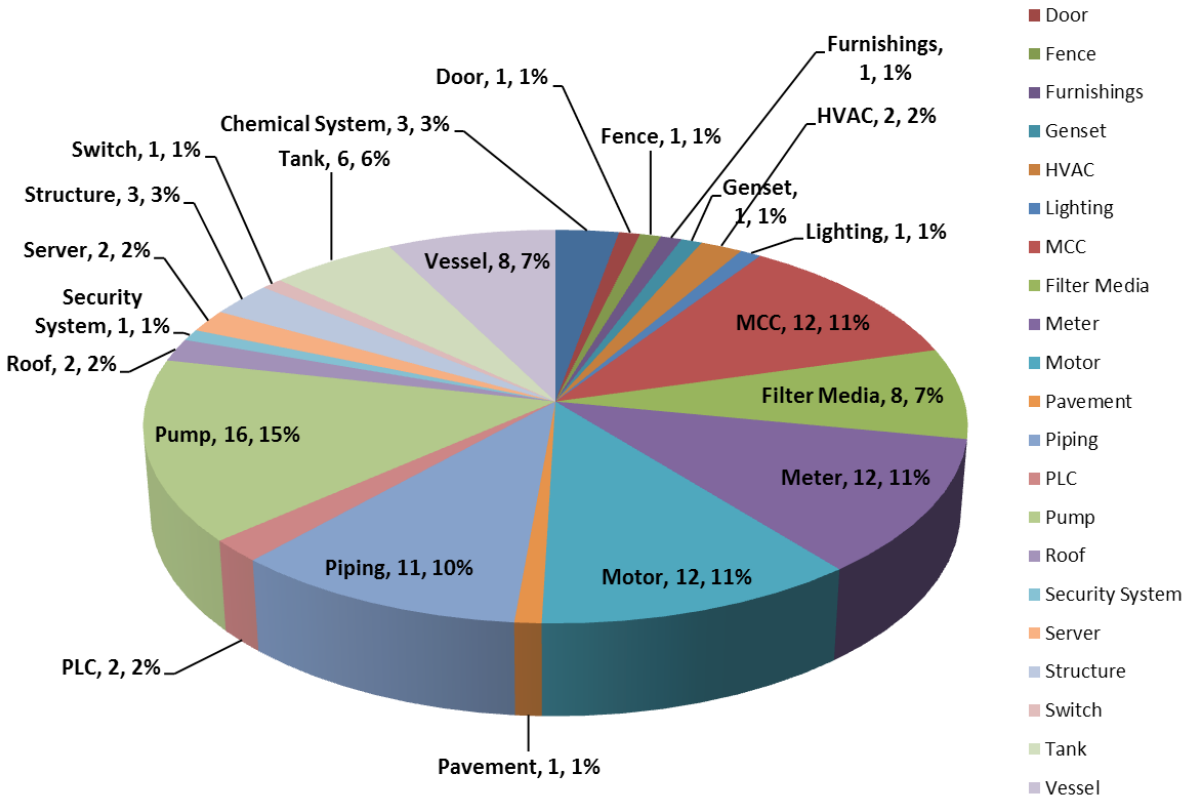

Figure 2-5: RRWTP Assets by Type

EGWD currently maintains and operates eight water production wells. The graph in **Figure 2-6** shows the total count of asset types for all wells.

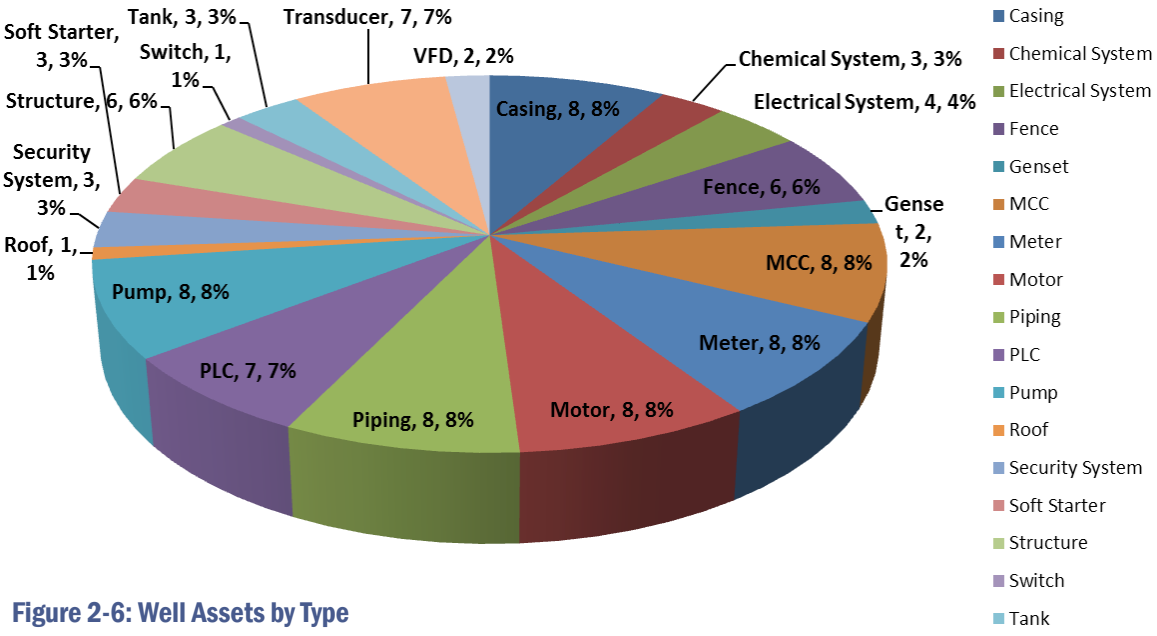

Figure 2-6: Well Assets by Type

The EGWD fleet consists of 32 vehicles and heavy equipment. Below in **Figure 2-7** is a representation of the vehicles and equipment by type.

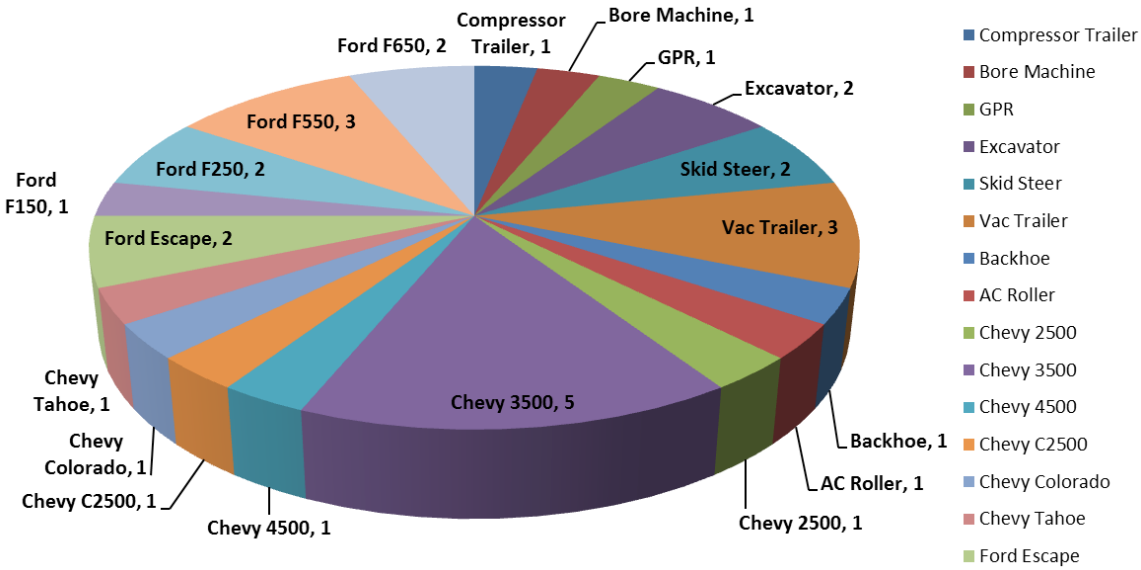

Figure 2-7: Vehicles and Equipment by Type

2.2 Hierarchy & Inventory of Assets

An asset hierarchy provides a structured framework for organizing the assets in the asset register. A hierarchy must have a structured relationship (e.g., grandparent-parent-child) allowing consistent roll-up/roll-down of data. Working with Kennedy/Jenks, EGWD now has a well-established asset hierarchy in KJ-IAM that will allow EGWD to easily locate an asset and integrate data (e.g., valuation, risk, remaining life) required to support asset management decisions.

Figure 2-8 presents the asset hierarchy developed for EGWD system of assets, which are organized in 6 major asset groups.

Figure 2-8: Water System Asset Hierarchy for this AMP

Assets are then organized under specific facilities and processes within each of the 6 major asset groups. The first major group is EGWD's Administrative assets. The Admin Buildings hierarchy is shown below in **Figure 2-9** in three major areas (e.g., Office, Site, and Warehouse).

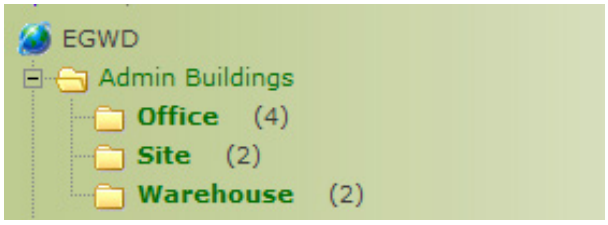

Figure 2-9: EGWD Admin Asset Hierarchy

The next grouping of assets shown in **Figure 2-10** is the Water Distribution System. The distribution system of assets is comprised of 4,329 segments of water main pipe segments of varying diameters, material types and sizes totaling 136 miles. For this initial version of the AMP, appurtenances such as valves, meters and hydrants were omitted from the asset hierarchy. Based on discussions with EGWD staff, it was decided that business decisions relating to repair or replacement of these assets would not be driven by the AMP. These decisions instead would be driven by daily operations and maintenance. Collectively, these assets represent a significant cost value to EGWD, however individually their values are not considered to be significant with respect to the AMP. Furthermore, adding all of these individual assets to the KJ-IAM asset registry would cause the KJ-IAM model to take hours to calculate results.

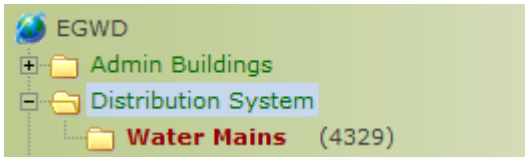

Figure 2-10: Water Distribution System

The following groups of assets in **Figure 2-11** and **2-12** are for the Hampton Village and Railroad Water Treatment Plants, respectively. The HVWTP is made up of 35 assets in 5 process areas, while the RRWTP consists of 107 assets in 8 process areas.

The EGWD's fleet of vehicles and mobile equipment consists of 32 assets of various trucks and heavy equipment, as shown in **Figure 2-13**.

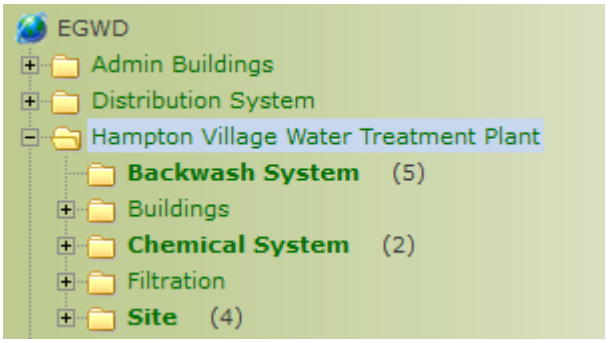

Figure 2-11: Hampton Village Water Treatment Plant

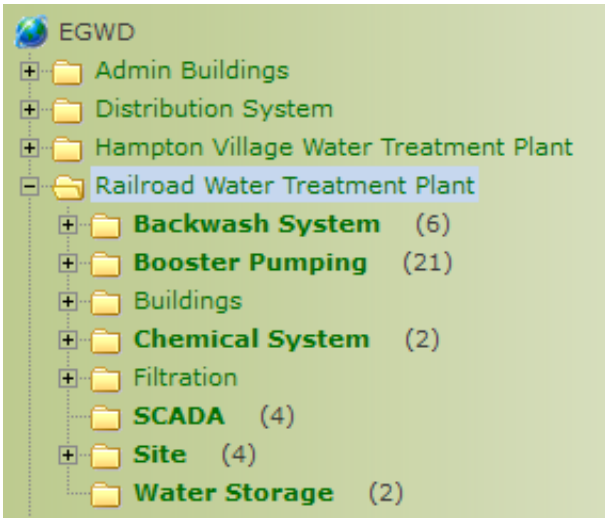

Figure 2-12: Railroad Water Treatment Plant

Figure 2-13: EGWD Vehicles and Mobile Equipment

The Wells asset portfolio is made-up of 8 wells that have 96 assets contained within 7 process areas. The individual wells are shown in **Figure 2-14**, while **Figure 2-15** shows Well 3 with its process areas as an example of the hierarchy structure developed for EGWD's wells.

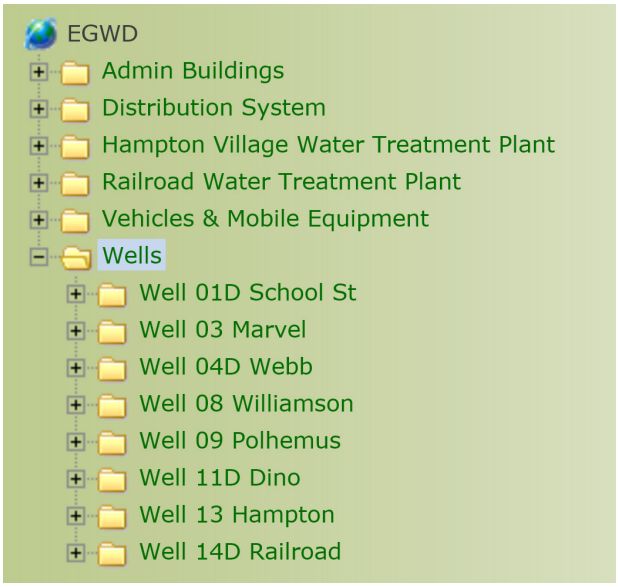

Figure 2-14: EGWD Wells

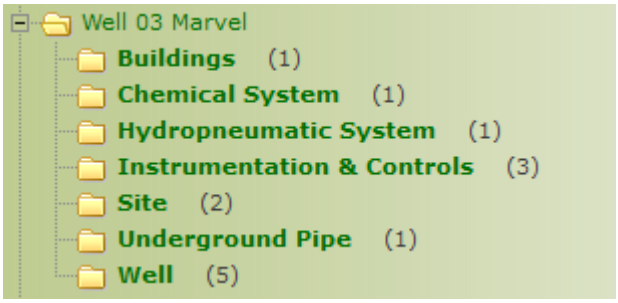

Figure 2-15: Well 3

2.3 Summary of EGWD Asset Portfolio Replacement Value

Asset valuations are an integral part of asset management. The valuation process provides asset managers with the necessary asset knowledge to make sound managerial decisions and to meet regulatory compliance. Additionally, asset valuation is a valuable management tool to assist in determining future budgets, allocating costs, and providing measurements for performance.

Asset valuation provides the following benefits:

- Optimized management decisions based on knowledge of assets
- Minimized life cycle ownership costs
- Forecasted replacement and rehabilitation requirements
- Determined budgets.

All assets in the asset register were assigned a replacement cost. The value was estimated based on what it might cost to replace the asset in today's dollars. For some assets, pricing attributes (e.g., size, type) were not available to determine valuation. Attribute assumptions were made to proceed with the valuation. Going forward, Kennedy/Jenks recommends that EGWD re-assess the valuations periodically (industry standard is every 2 years) as better data becomes available. The current year (2014) replacement estimates for each 'equipment" type asset class is summarized in **Appendix A**.

A summary of EGWD's asset valuation is provided below. Based on the assets provided and the estimated replacement costs, the total replacement cost for EGWD's asset portfolio is approximately $140 million. **Figure 2-16** provides a breakdown of valuation based on the 6 asset categories of Admin, Distribution Pipes, HVWTP, RRWTP, Vehicles and Equipment, and Wells. The estimated replacement values for each category are:

- **Admin** – $1,675,000
- **Distribution Pipes** – $108,144,745
- **HVWTP** – $3,130,000
- **RRWTP** – $11,495,000
- **Vehicles and Equipment** – $1,954,700
- **Wells** – $13,735,500.

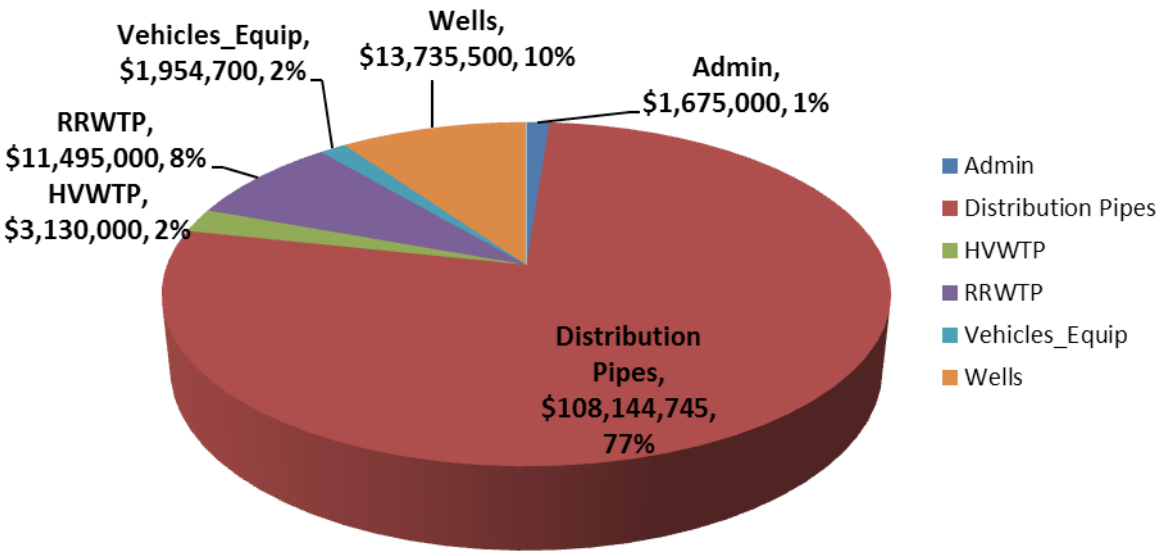

Figure 2-16: EGWD Asset Replacement Valuation

The total value of the administrative facility assets is approximately $1.7M. **Figure 2-17** shows the breakdown of replacement costs by asset by type.

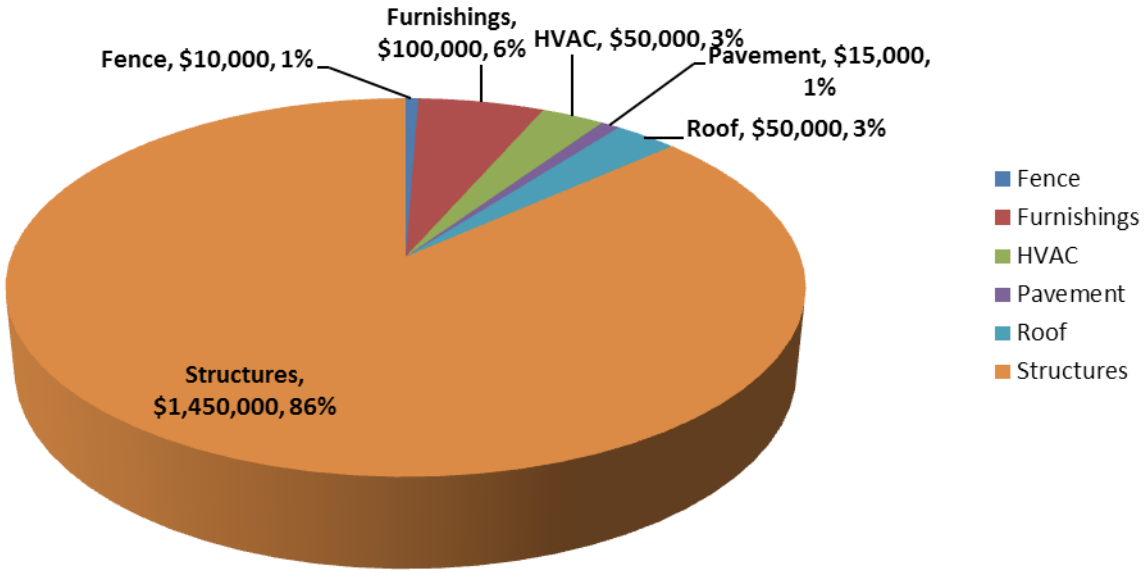

Figure 2-17: EGWD Administrative Asset Replacement Valuation

The total valuation, in current 2014 dollars, for water distribution pipe assets was estimated to be about $108M. The water distribution system consisted of 136 miles of pipe. The distribution pipes were broken down by the class of pipe. **Figure 2-18** provides a summary of these pipes based on the different asset classes.

The following equation was used for the "Water Mains" pipe replacement value:

Pipe replacement value = $20*in-diameter*lineal foot (so for 4" it would be $80/foot and for 20" it would be $400/foot).

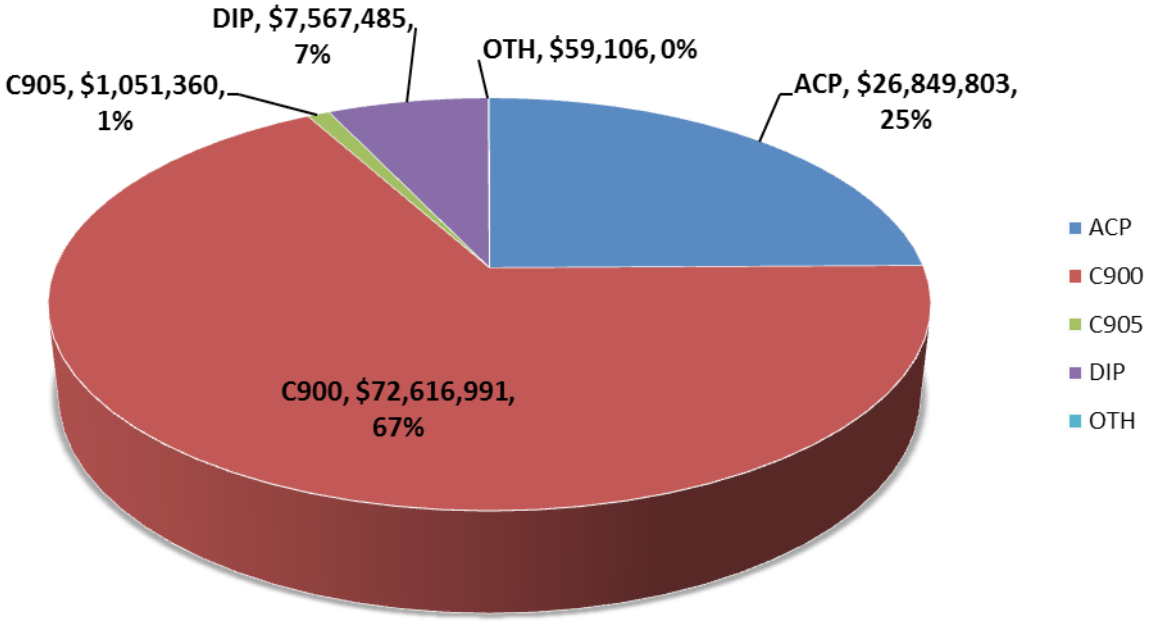

Figure 2-18: Distribution Pipes Replacement Valuation

Water production and treatment replacement valuations for the HVWTP, the RRWTP, and 8 water production wells is presented in **Figure 2-19**, **2-20**, and **2-21**. The total asset replacement value for each facility is:

- **HVWTP** – $3.1M
- **RRWTP** – $11.5M
- **Wells** – $13.7M.

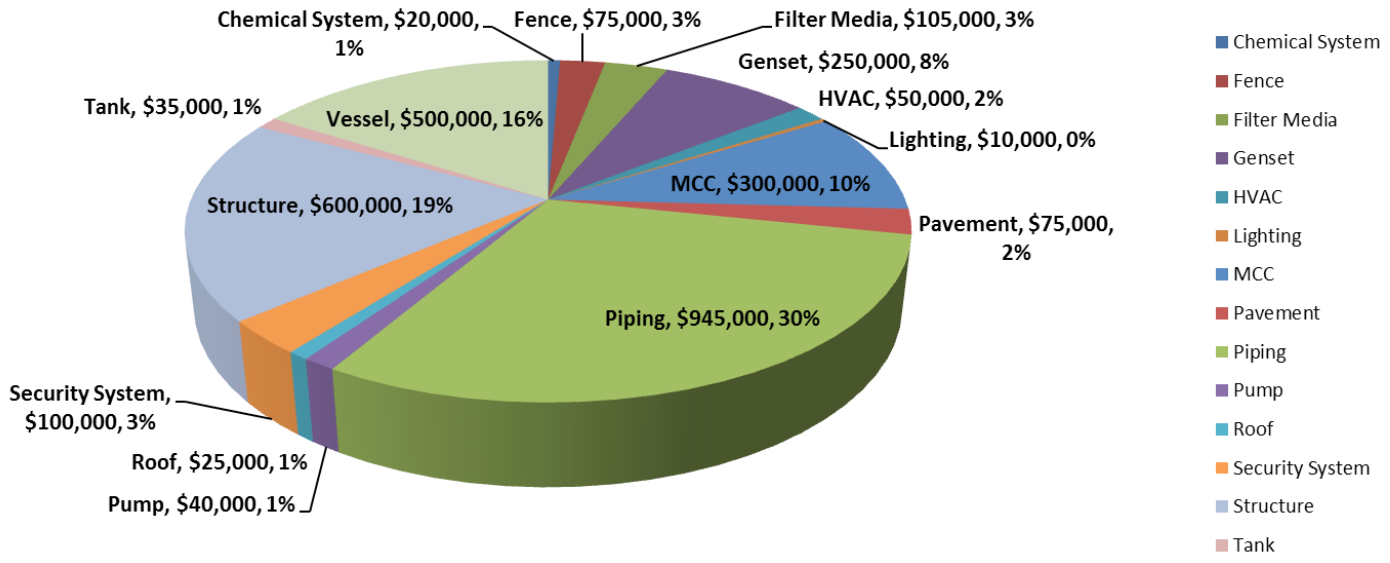

Figure 2-19: HVWTP Asset Replacement Valuation

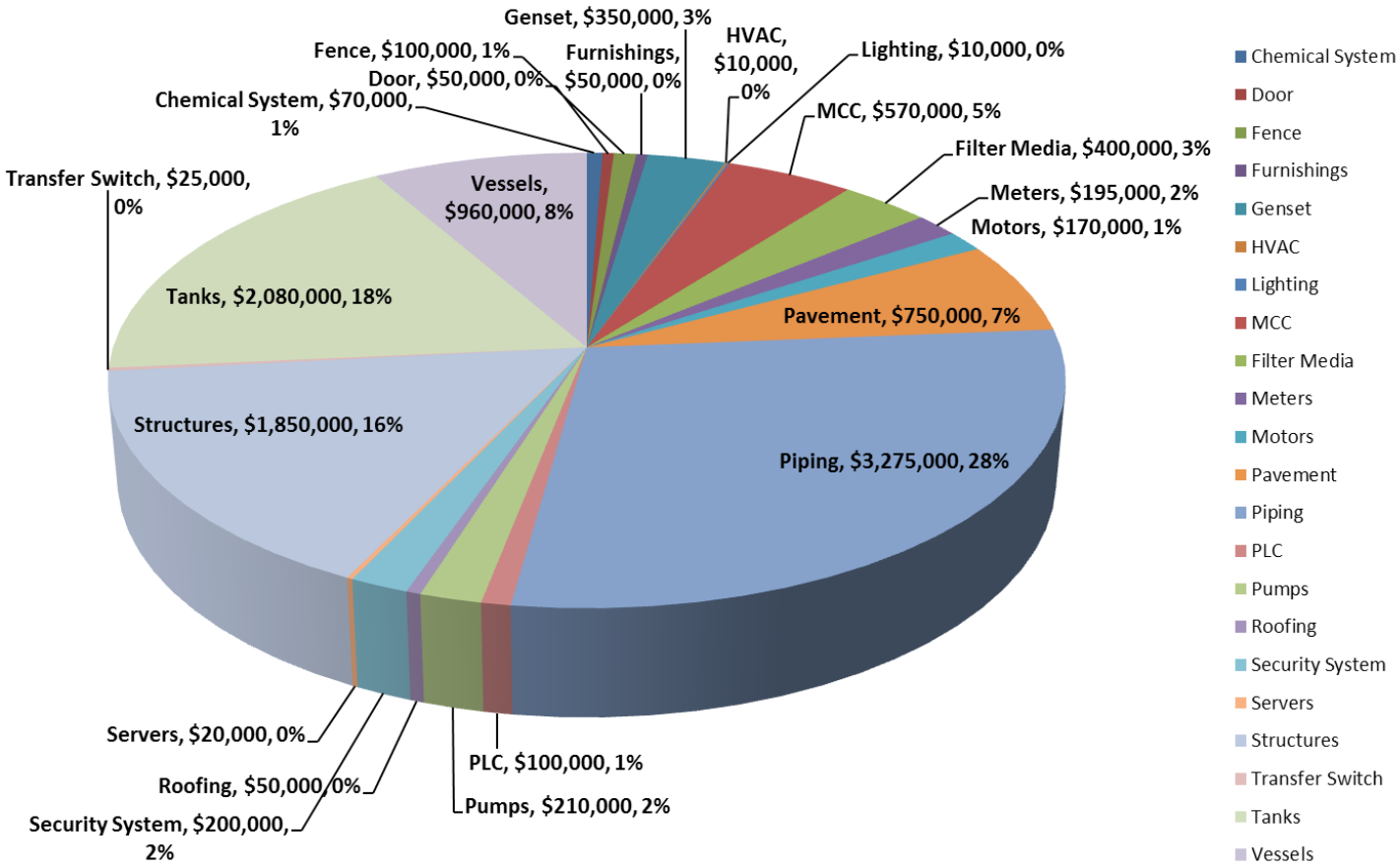

Figure 2-20: RRWTP Asset Replacement Valuation

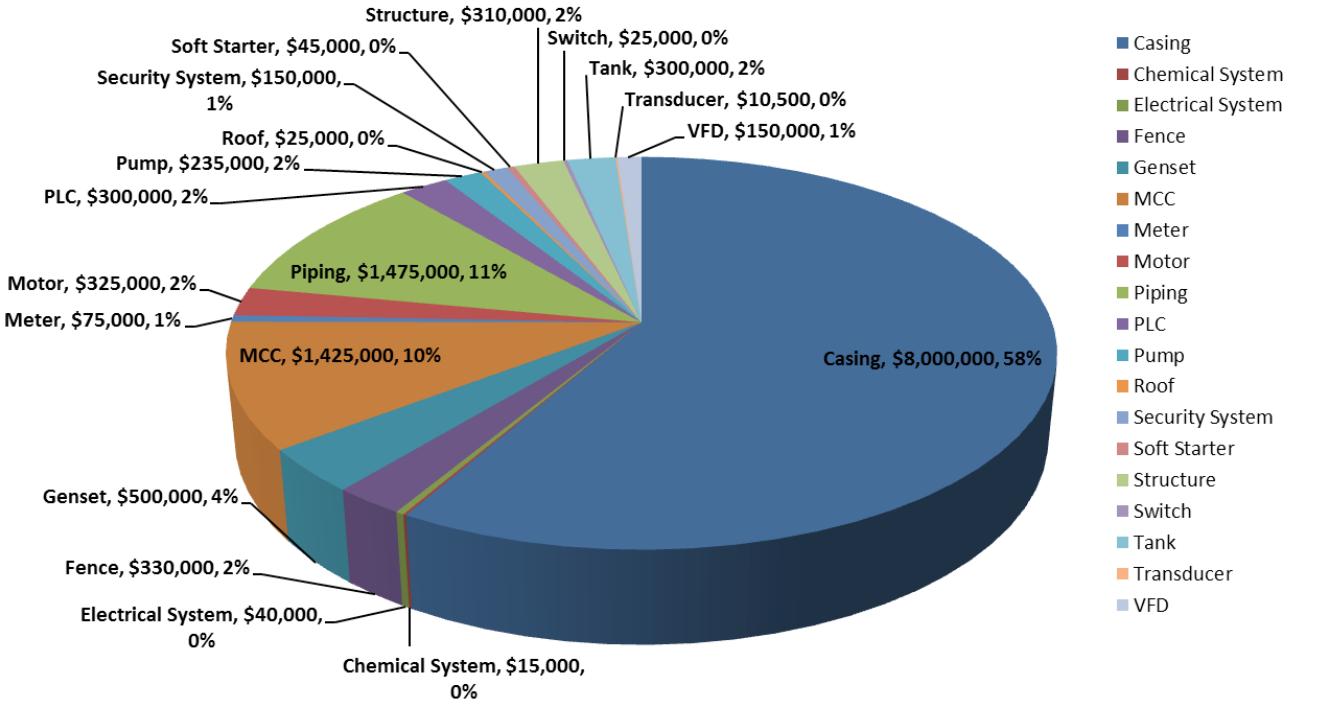

Figure 2-21: All EGWD Wells Asset Replacement Valuation

The total replacement valuation of EGWD's 32 vehicles and heavy equipment is $1.9M. **Figure 2-22** shows the valuations of vehicles and equipment by type.

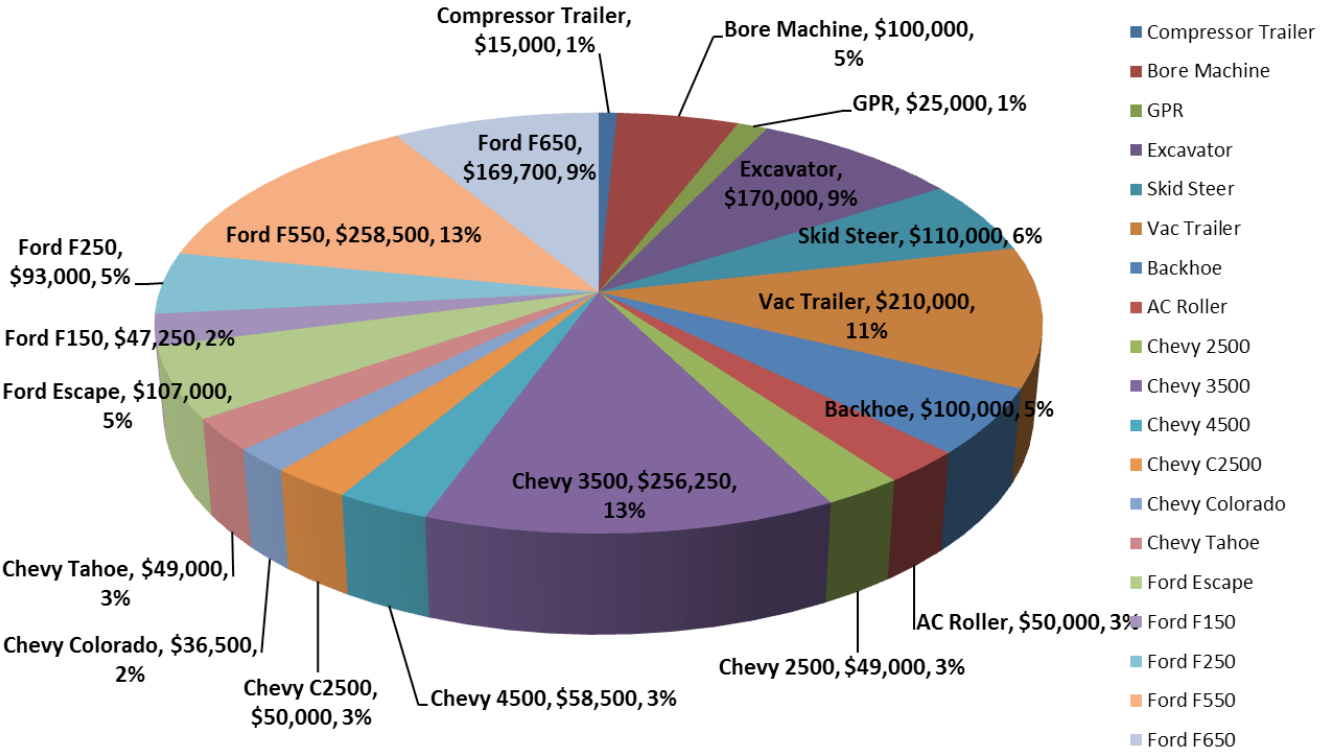

Figure 2-22: EGWD Vehicles and Equipment Replacement Valuation

2.4 Installation Profile of Assets

Figure 2-23 shows the historical installation profile of the entire EGWD asset portfolio.

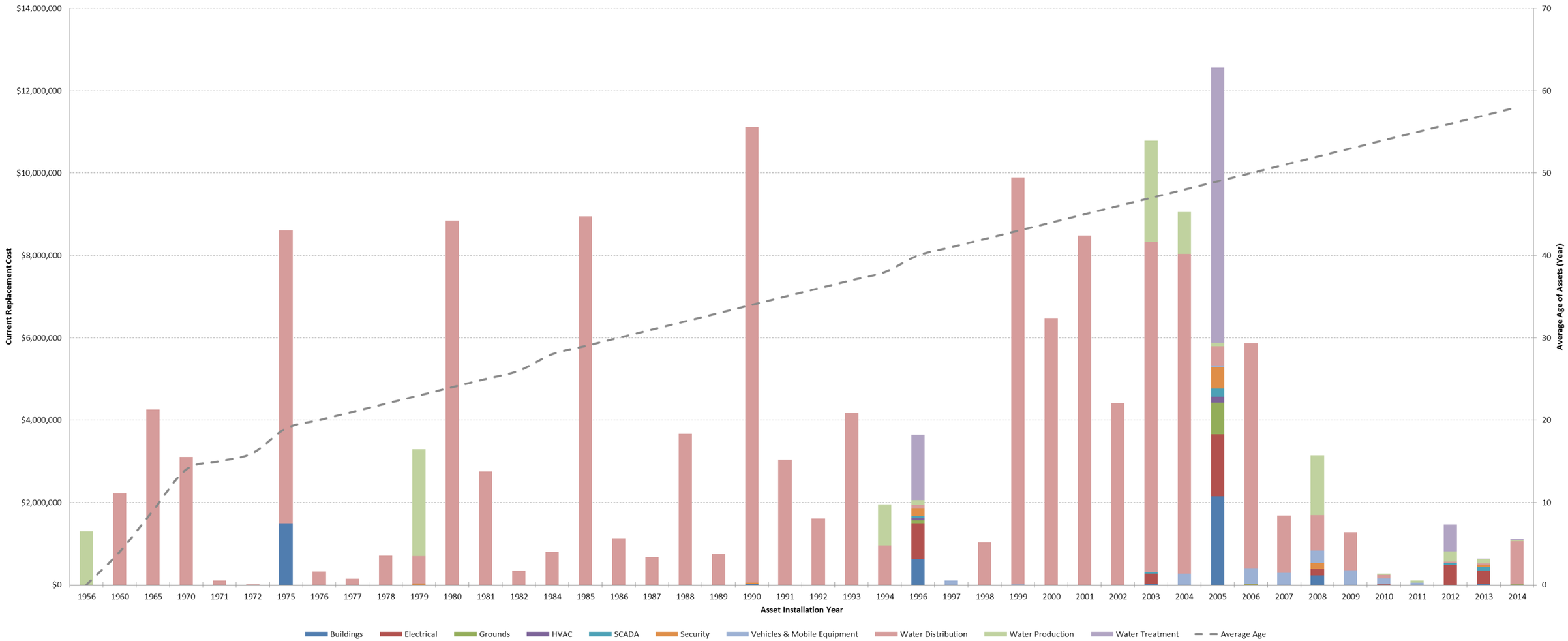

Figure 2-23: Historical Asset Installation Profile

2.5 Remaining Life of EGWD assets

Figure 2-24 shows the remaining life of the assets comprising the EGWD system, based on an age-based profile. In future AMPs, the confidence level rating for the AMP results can be significantly improved by substituting field condition data, performance and reliability information from SCADA, and/or utilization/ consumption data in lieu of an age-based approach. At this time, the District has some condition/consumption data (i.e., specific capacity for its wells), but can systematically build on this concept for assets that have high risks or appear (based on age) to be reaching the end of their useful life. **Table 2-1** shows the expected useful life used in these AMP calculations.

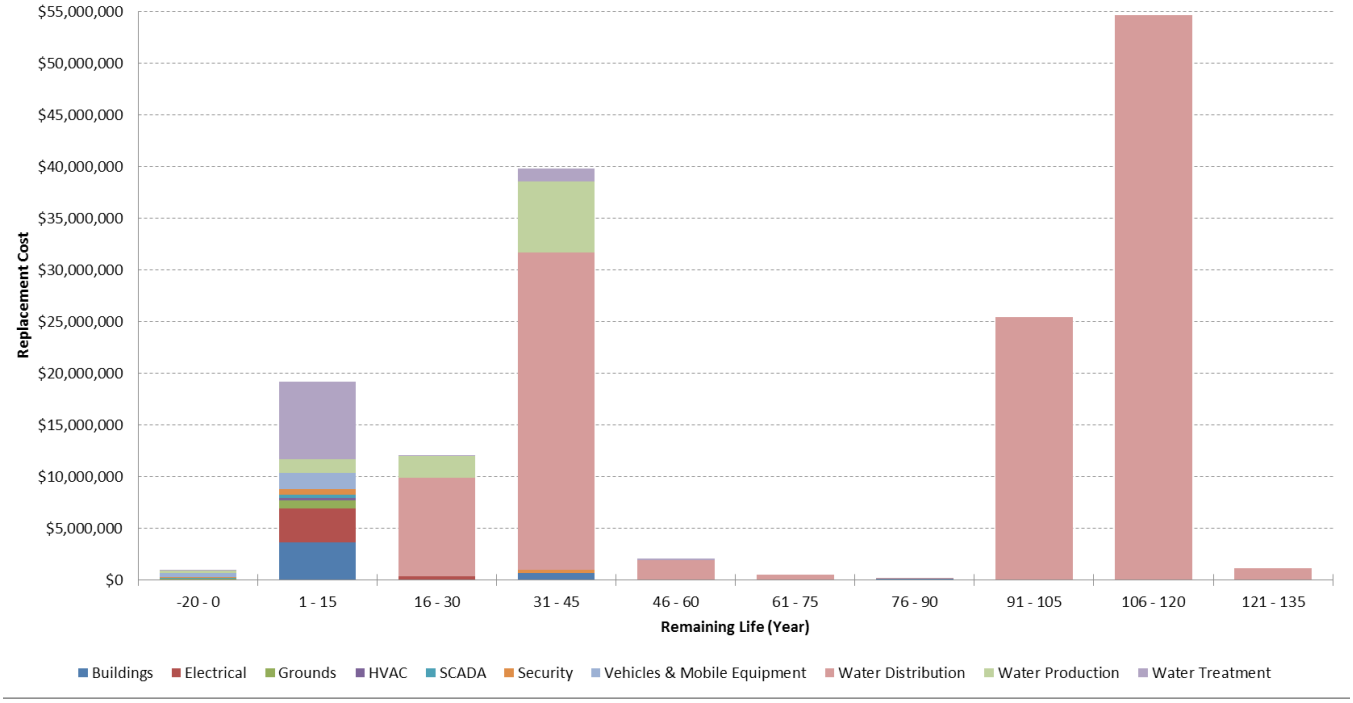

Figure 2-24: Remaining Life of EGWD Assets

Table 2-1: Useful Lives Assumed for Calculations in this AMP		
Asset Type	**Asset Subtype**	**Useful Life**
Casing	Well	40
Chemical System	ChlorTec	15
Chemical System	Coagulant Dosing	15
Chemical System	Polymer Dosing	15
Chemical System	Sodium Hypochlorite	15
Door	Roll-up	20
Electrical System		25
Fence		50
Furnishings		100
Genset		20
HVAC		20
Lighting		25
MCC		30
Media	Filter	20
Meter	Flow	20
Mobile Equipment	AC Roller	20
Mobile Equipment	Backhoe	20
Mobile Equipment	Bore Machine	5
Mobile Equipment	Compressor Trailer	5
Mobile Equipment	Excavator	20
Mobile Equipment	GPR	10
Mobile Equipment	Skid Steer	20
Mobile Equipment	Vac Trailer	20
Motor	Pump	25
Pavement		10
Piping		50
PLC		15

Table 2-1: Useful Lives Assumed for Calculations in this AMP		
Asset Type	**Asset Subtype**	**Useful Life**
Pump	Backwash	20
Pump	Booster	25
Pump	Sodium Hypochlorite	10
Pump	Well	15
Roof		20
Security System		15
Server	SCADA	10
Soft Starter		15
Structure	Building	50
Switch	Transfer	25
Tank	Backwash	20
Tank	Clear Well	25
Tank	Diesel Storage	25
Tank	Salt Brine	20
Tank	Sodium Hypochlorite	15
Tank	Surge	40
Transducer	Pressure	10
Vehicle		10
Vessel	Filter	20
Vessel	Reaction	25
VFD		15
Water Main	ACP	75
Water Main	C900, C905, DIP, OTHER	125

Section 3: Lifecycle Analysis

3.1 Overview

The intention of asset management is to deliver the intended level of service from an infrastructure portfolio, at the least lifecycle cost, and at an acceptable level of risk. To manage assets appropriately, a lifecycle management strategy for each asset type in the portfolio needs to be developed. This strategy answers the questions: "*What will I do to my assets? When? At what cost?*" The asset lifecycle management strategies used in this AMP for managing EGWD's assets are described in detail in Section 5. For many asset types, this strategy is "run to end of useful life" but for other asset types, a series of rehabilitation "interventions" are applied to reduce the overall cost of owning the asset over its life. For this AMP, current management strategies of EGWD were used in the modeling effort. It is expected that EGWD will continue to examine and optimize the management strategies in the future to reach an optimal management strategy for the entire asset portfolio.

3.2 End of Useful Life

The performance of an asset relates to its current ability to meet current and future demands. Assets can breakdown in 4 major ways, which is identified in this report as the "end of useful life" for an asset, and is used to determine the most appropriate investment strategies (i.e., intervention mode) relevant to the asset. The 4 primary breakdown modes are capacity, physical mortality, level of service, and financial efficiency:

- **Capacity:** the demand exceeds the capacity of the existing asset or network of assets (i.e., adding pipes to the network or upsizing due to growth in a particular grid)
- **Physical Mortality:** the structural condition of the asset is such that it has reached the end of its effective life (i.e., replacement with same size and function of asset such as replacing a deteriorated water main)
- **Level of Service:** the asset no longer performs reliably (i.e. pipe breaks frequently causing excessive customer complaints), safely or there is a change in drinking water regulations
- **Financial Efficiency:** the cost of the asset exceeds the economic return necessary to justify retention of the asset (i.e., replacing some of the electronics in a flow meter versus replacing the entire meter).

All decisions about the refurbishment and replacement of an asset and the timing of these activities should be based on a sound determination of the asset's breakdown modes. Risk is used in asset management to enable the asset manager to rank each asset's potential end of remaining life, based on likelihood (i.e., probability) of failure and criticality. Risk ranking will help EGWD focus on the assets remaining useful life and how it impacts EGWD's day-to-day business.

The remaining life of an asset is the period from the current point in time to the time that the asset needs to be replaced. Understanding asset end of useful life modes and determining remaining useful life leads to better decision-making because it allows effort to be focused on understanding the timing of intervention, criticality and resultant expected cost expenditure patterns in EGWD's infrastructure asset portfolio.

3.3 Lifecycle Analysis

The lifecycle of an asset can generally be described as shown in **Figure 3-1**.

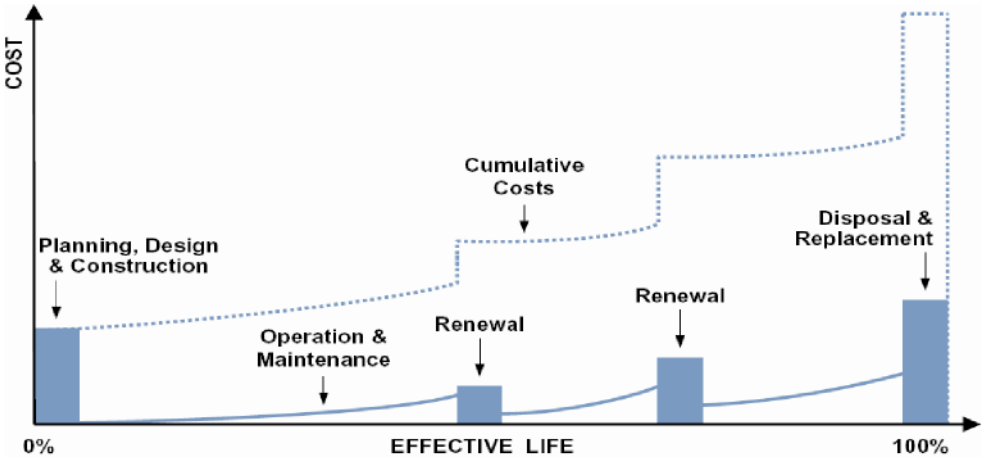

Figure 3-1: Generic Life Cycle Cost Model

Several definitions for the life of an asset were used in developing the management strategies in the lifecycle model for this AMP. **Figure 3-2** shows the definitions of the various lifecycle "intervention" points for an asset. Some assets may have no intervention points and are simply "run to end of useful life" at the maximum potential life (MPL) because that is the most cost-effective strategy for that asset. Other assets may have several technically feasible and cost effective interventions prior to replacement at the end of their life. The effective economic life (EEL) of an asset is defined as the time from when the asset is new until the first technically feasible intervention point. The physical effective life (PEL) or effective useful life is defined as the time from when an asset is new until the asset physically fails with no interventions. The lifecycle model for this round of modeling mainly considered MPL and PEL for all management strategies applied to assets in the EGWD's hierarchy.

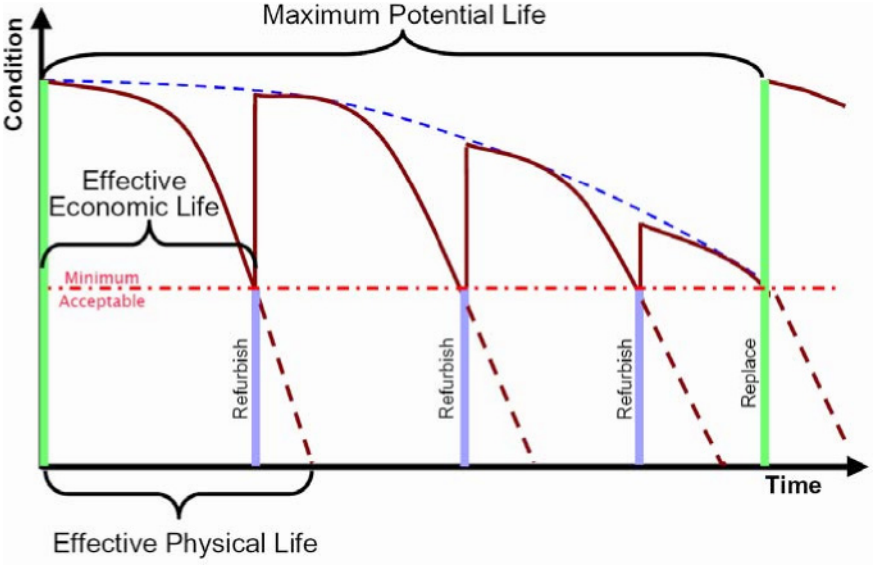

Figure 3-2: Definition of Asset Lives

3.4 Asset Consumption by Asset Type

Figure 3-3 and **3-4** illustrate where EGWD's system of assets are within their lifecycle and how much of them have been consumed as of 2014. These graphs reflect the estimated life of the various assets. **Figure 3-3** provides the overall remaining asset life profile, while **Figure 3-4** includes an assessment of EGWD's overall asset consumption profile.

These profiles provide EGWD with the overall knowledge of what portions of the assets are used up or are nearing the end of their useful lives. Overall, it can be concluded that EGWD assets have a lot of remaining useful life left. This also indicates there is not a significant backlog of work and EGWD should have a full contingent of tools to address the management of their assets going forward.

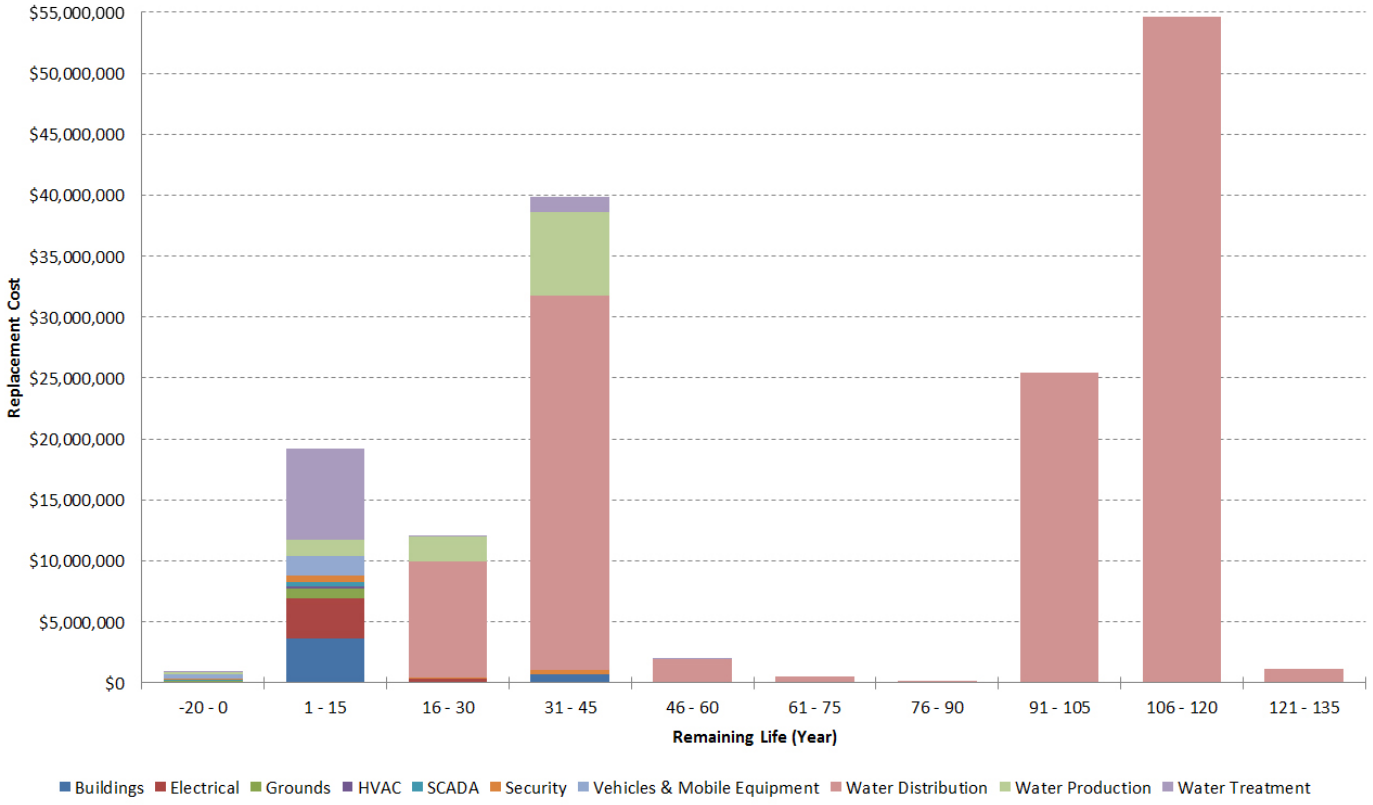

Figure 3-3: Remaining Life of EGWD Assets

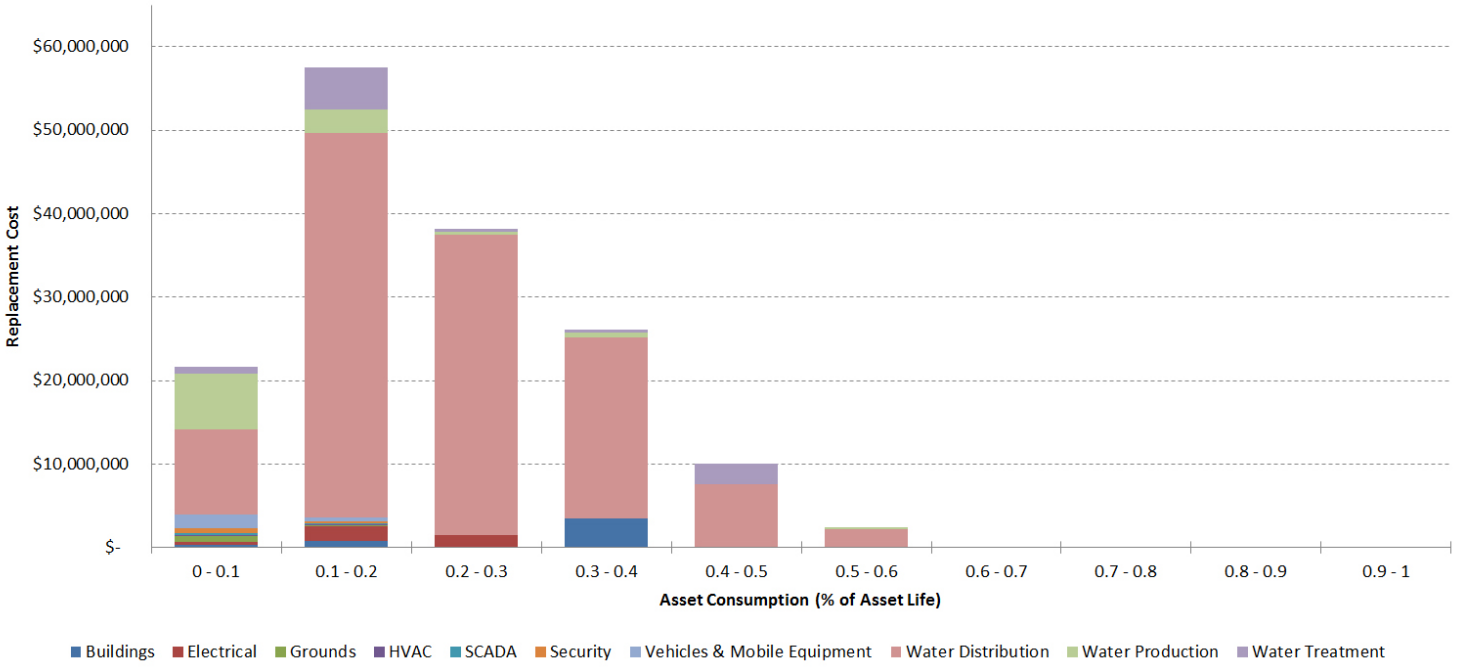

Figure 3-4: Consumption of EGWD Assets

Section 4: Risk Profile

4.1 Overview

Risk management is increasingly being viewed as an integral part of managing the lifecycle of major infrastructure assets. Any approach that an organization takes to the management and maintenance of its assets involves the acceptance of an inherent level of risk. There is usually never enough money in an organization to manage all risk to zero. Management of risk entails understanding the inherent risk profile in the asset portfolio and establishing strategies to manage the risk to acceptable levels. A common misconception of adequately managing a risk profile is to keep annual costs low or constant while unintentionally assuming more and more risk over time through deferred investments (normally deferred maintenance).

Risk management is increasingly being viewed as a core business function for water system managers to influence all decision-making, including infrastructure lifecycle management planning. Risk assessment is a valuable tool for asset investment prioritization and optimized renewal decision-making.

Asset risk arises from the potential for events or breakdowns to occur, and will vary depending on the location, capacity, age, and condition of the asset. Mitigation of risk occurs primarily through the level of initial investment and putting processes in place to ensure that maintenance and renewals (i.e., interventions) occur in an appropriate and timely manner.

For the purposes of this AMP, a risk score is derived from the multiplication of 3 factors. The first is the probability of failure (PoF), which is the likelihood or chance that an asset failure may occur at any given time. Condition may be used as a proxy for PoF, but for this AMP, condition information for all assets was not available, so a straight line relationship to remaining life was used to compute the PoF. The second factor is consequence of failure (CoF), which is the direct and indirect impact on EGWD if such an asset failure were to occur. The third is redundancy that may be available in the asset portfolio. Should a single asset fail, there may be the ability to still deliver the level of service through other assets or combinations of assets. This calculation is shown in **Figure 4-1** below. (Note: A high BRE number correlates to higher business risk exposure.)

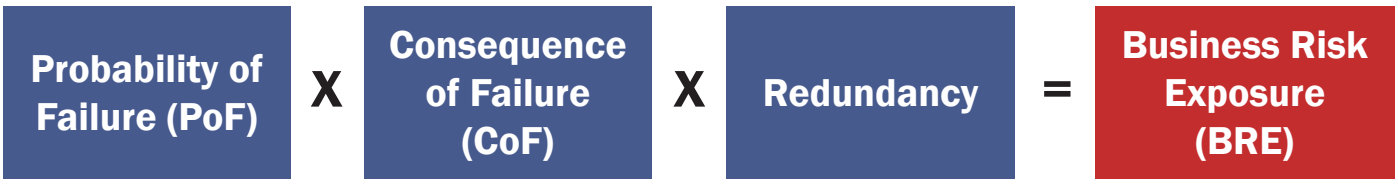

Figure 4-1: Risk Scoring Formula

A risk map is a graphic representation of probability and consequence of one or more risks related to a similar objective. After assessing the impact and likelihood of each risk, they are plotted on a graph, matrix, or map. Different colors on the risk map help to identify where and how to focus resources, time, effort, and/or dollars within an organization.

- Risks that appear in the red zones are significant to EGWD and therefore need to be actively managed and monitored in a more comprehensive manner than other risks.
- Risks that appear in the orange or yellow zone will also need to be actively managed depending on their nature.
- Risks that appear in the green zone are generally acceptable without significant mitigation strategies being implemented, although monitoring may still occur in some form.

Table 4-1 shows the CoF scoring factors for water mains. A separate set of factors was developed for vertical assets (above-ground assets) as shown in **Table 4-2**. **Table 4-3** and **Table 4-4** shows the methodology used in this AMP to assess the likelihood of failure.

Consequence of Failure Rating Methodology for Water Mains

1. GIS information is tagged based on location of pipe to the items identified.
2. CoF is the sum of the ratings based on diameter, roads, railroads, creeks, schools, hospitals, industrials, and shopping center categories.
3. The total sum is the CoF rating. In EGWD's case, CoF for water mains totaled up to a maximum of 7.0.

Table 4-1: Water Main CoF Scoring Factors

Spatial/Database Assignments	Score
Pipe Diameter <16	1
Pipe Diameter >= 16 and <24	2
Pipe Diameter >=24 and <48	4
Freeway (within 30 feet)	4
Highway (within 30 feet)	3
Primary Road (within 30 feet)	2
Secondary Road (within 30 feet)	1
Railroad (intersecting)	3
Creek (within 30 feet)	3
School (within 200 feet)	3
Hospital (within 200 feet)	3
Light Industrial (within 200 feet)	1
Heavy Industrial (within 200 feet)	2
Regional Shopping Center (within 200 feet)	2
Neighborhood Shopping Center (within 200 feet)	1

Table 4-2: Vertical Asset CoF Scoring Factors		
Asset Type	**Asset Subtype**	**CoF**
Casing	Well	10
Chemical System	ChlorTec	6
Chemical System	Coagulant Dosing	6
Chemical System	Polymer Dosing	6
Chemical System	Sodium Hypochlorite	6
Door	Roll-up	1
Electrical System		8
Fence		1
Furnishings		1
Genset		4
HVAC		1
Lighting		1
MCC		7
Media	Filter	7
Meter	Flow	2
Mobile Equipment	AC Roller	1
Mobile Equipment	Backhoe	1
Mobile Equipment	Bore Machine	1
Mobile Equipment	Compressor Trailer	1
Mobile Equipment	Excavator	1
Mobile Equipment	GPR	1
Mobile Equipment	Skid Steer	1
Mobile Equipment	Vac Trailer	1
Motor	Pump	7
Pavement		1
Piping		7
PLC		3
Pump	Backwash	7
Pump	Booster	7
Pump	Sodium Hypochlorite	5
Pump	Well	10
Roof		1
Security System		2
Server	SCADA	4
Soft Starter		3
Structure	Building	3
Switch	Transfer	3

Table 4-2: Vertical Asset CoF Scoring Factors		
Asset Type	**Asset Subtype**	**CoF**
Tank	Backwash	3
Tank	Clear Well	3
Tank	Diesel Storage	3
Tank	Salt Brine	3
Tank	Sodium Hypochlorite	3
Tank	Surge	3
Transducer	Pressure	1
Vehicle		1
Vessel	Filter	3
Vessel	Reaction	3
VFD		7

Table 4-3: Probability of Failure Factors
Probability of Failure Rating Methodology
1. Select asset life based on the pipe material or asset type.
2. Subtract the number of years the asset has been installed to get the remaining life.
3. Divide the years the asset has been installed by the asset life to get the probability of failure.

Table 4-4: Redundancy Factors	
Level of Redundancy	**Reduce PoF by:**
50% Backup	50%
100% Backup	90%
200% Backup	98%

4.2 Risk Rating by Asset Type

Asset management involves understanding and balancing levels of service, cost, risk, and customer expectations. Understanding which assets or asset components are critical and why, helps an organization focus efforts and investments on critical investments. Risk is a measure used to estimate the relative risks that EGWD's individual linear (underground piping) and vertical facility assets present.

Risk scores were calculated for all assets using a 1 to 10 scale for CoF and PoF scores. The risk score was calculated as a product of PoF, CoF, and Redundancy.

The risk model produced a ranked list of assets based on the risk calculations performed. The first analysis to perform on the results is to assess the assets by descending order of risk. That will indicate which assets represent the highest risk. Assets that appear in the red zone are considered to be significant to EGWD and therefore need to be actively managed and monitored in a more comprehensive manner than other risks.

Assets that appear in the yellow zone will also be actively managed depending on their nature. For example, an asset with a high PoF may be in need of rehabilitation or replacement but the timing of the activity depends on its criticality.

Assets that appear in the green zone are generally acceptable without significant mitigation strategies being implemented, although monitoring may still occur in some form.

Figure 4-2 and **Figure 4-3** illustrate the relative risk of individual assets. **Figure 4-4** shows some suggested actions based on the risk scores. Total refurbishment and replacement cost for the critical higher risk assets is estimated at $475,000. **Table 4-5** provides a list of the higher risk assets.

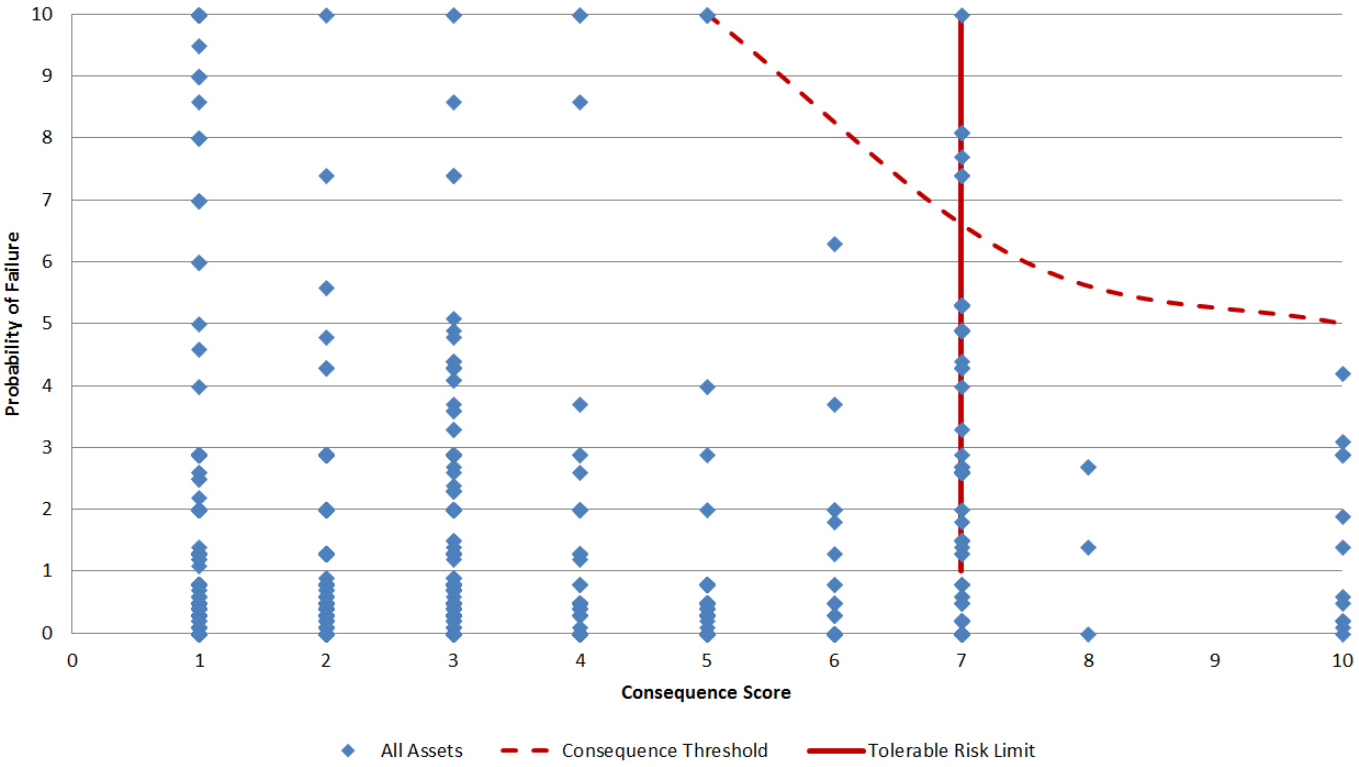

Figure 4-2: Risk Plot for all EGWD's Assets

Probability of Failure											
	10	13	1	2	2	4	0	1	0	0	0
	9	6	0	1	1	0	0	0	0	0	0
	8	3	0	0	0	0	0	4	0	0	0
	7	4	1	3	0	0	0	3	0	0	0
	6	3	1	0	0	0	1	0	0	0	0
	5	2	1	3	0	0	0	21	0	0	0
	4	1	3	14	1	1	1	5	0	0	1
	3	27	73	19	3	1	0	21	2	0	5
	2	25	117	31	5	1	3	7	0	0	1
	1	142	502	80	25	76	7	12	1	0	3
	0	465	2385	225	43	98	26	46	1	0	4
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
		Consequence of Failure									

Figure 4-3: Total Number of Assets

	PoF	CoF
High	• Review scoring logic • Assess condition • Repair if feasible • Add to CIP for Rehab/Replacement	• Review scoring logic • Assess condition at short intervals • Repair if feasible • Develop risk mitigation strategy
Med	• Review scoring logic • Assess condition • Repair if required • Add to future CIP for Rehab/Replace	• Review scoring logic • Assess condition at regular intervals • Repair if required • Develop risk mitigation strategy
Low	• Monitor and assess	• Monitor and assess

Figure 4-4: Suggested Actions by Risk Rating

Table 4-5: EGWD Critical Assets

Asset ID	CoF	PoF	BRE	Intervention Cost
WE3-ST-PIPE	7	10	70	$200,000
HV-BW-PU01	7	8.1	56.7	$10,000
HV-BW-PU02	7	8.1	56.7	$10,000
HV-BW-PU03	7	8.1	56.7	$10,000
WE3-WP-MT	7	7.7	53.9	$35,000
HV-FV01-ME	7	7.4	51.8	$35,000
HV-FV02-ME	7	7.4	51.8	$35,000
HV-FV03-ME	7	7.4	51.8	$35,000
RR-CHEM-SHP01	5	10	50	$10,000
RR-CHEM-SHP02	5	10	50	$10,000
RR-CHEM-SHP03	5	10	50	$10,000
RR-CHEM-SHP04	5	10	50	$10,000
WE11D-WP-PU	10	4.2	42	$14,000
RR-SC-SERV01	4	10	40	$10,000
RR-SC-SERV02	4	10	40	$10,000

Figure 4-5 represents the risk scores of EGWD's water distribution pipes on a map of the District. Ranges of risk are geographically depicted on the map.

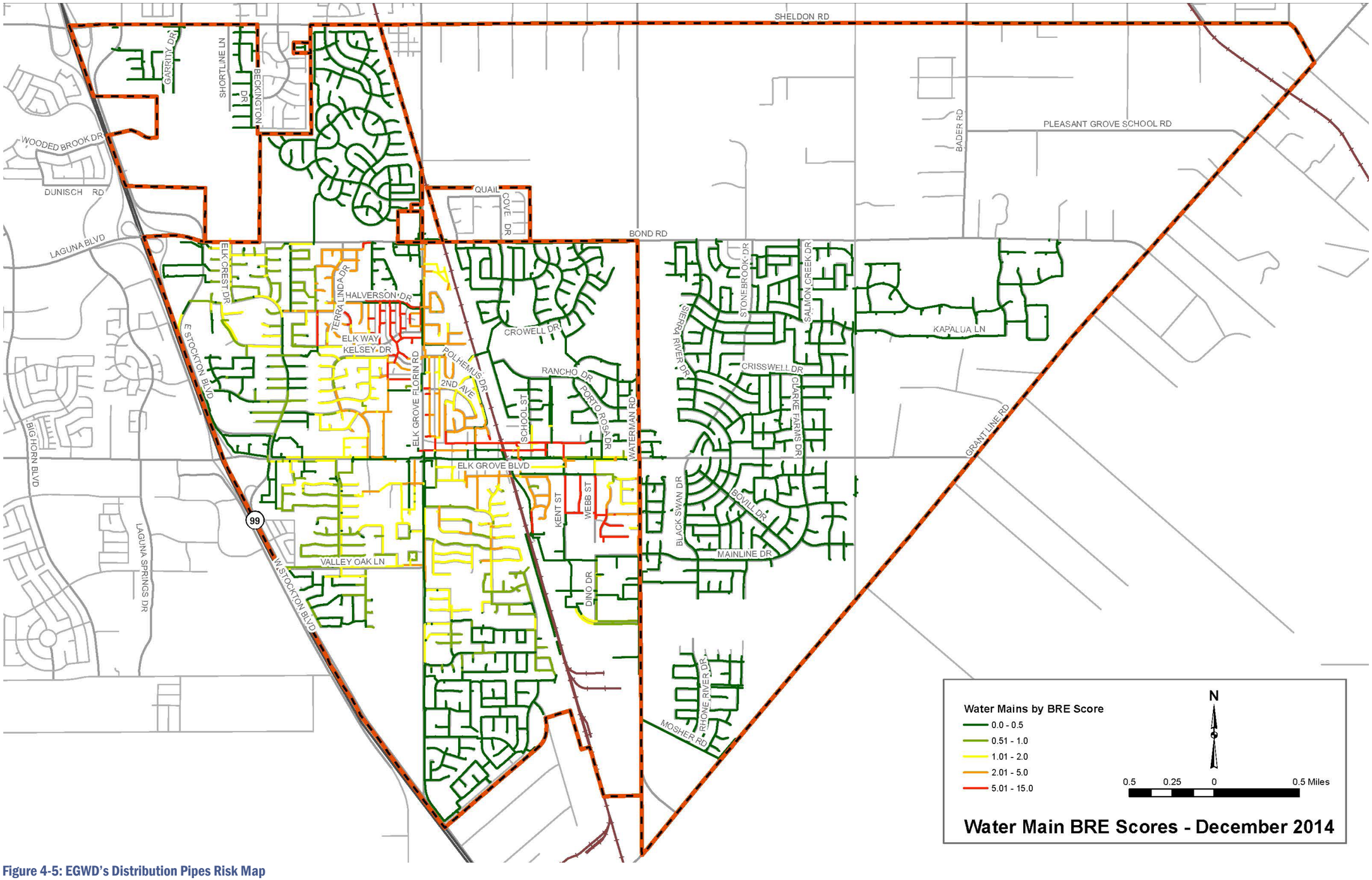

Figure 4-5: EGWD's Distribution Pipes Risk Map

Section 5: Lifecycle Management Strategies

5.1 Overview

This section describes the management strategies that were used in the financial modeling work during the development of KJ-IAM to help develop EGWD's asset management plan. Management strategies are the choices made throughout an asset's life that determine how the asset life will be extended through rehabilitations and/or replacement. Management strategies may vary from intervention at the end of the asset's effective economic life to multiple interventions to extend the life of the asset to not intervening at all and simply letting the asset run to end of its useful life.

Management strategies are the combination of the appropriate intervention activities, such as rehabilitation or replacement. Intervention is the individual event or set of events that comprise the strategy over the life of the asset. The major question that every asset manager needs to ask is which strategy or combination of strategies gives the longest life extension to the asset at the least life-cycle cost (lowest total cost of ownership).

An asset management-based organization should understand how its assets are performing in relation to the rate of consumption and current condition of the assets. Condition assessment provides insight into the remaining physical effective life of the asset and the probability of a breakdown. The inability to fully understand an asset's current condition, remaining life, and probability of a breakdown may lead to the asset's premature failure (i.e., having to spend money in an emergency situation) or to the misdirection or mistiming of reinvestment in the asset (i.e., spending money before getting the most "bang for the buck").

Unanticipated failure of an asset often leaves the asset manager with only one option – to replace the asset in an emergency situation, and this option is often the most expensive one. The unanticipated failure can unduly expose the organization to undesired consequences, depending on the nature and context of the failed asset. The undesired consequences, and the cost of those consequences, could have been managed through well-timed intervention prior to physical failure.

5.2 Management Strategies by Asset Type

The management strategy answers the questions: "What will I do to my assets? When? At what cost?" Management strategies define and summarize the activities and associated costs of an asset through its entire life cycle. Common activities in the life cycle defining the management strategies include:

- **Acquisition** – Commonly part of a CIP project.
- **Operations and Maintenance** – Cost of repairs, labor, spares, and overheads.
- **Rehabilitation** – Timing and cost of options for improving the performance or condition of the asset.
- **Replacement** – Disposal and installation of new assets.

Each activity provides information on decisions defining the management strategy for assets. This information guides future field operations, maintenance, rehabilitation and replacement activities, and defines the options for modeling an asset's behavior over time.

5.3 Key Management Strategies

For the purpose of this initial AMP, the management strategies that were modeled are shown below in **Table 5-1**. These management strategies are a "first cut" of strategies that were developed in a collaboration of the Kennedy/ Jenks team past experiences, then bolstered by feedback gathered from EGWD staff via workshops and follow-up conversations.

The management strategies define interventions, such as rehabilitation and/ or replacement of EGWD's assets and the resulting costs. . At this time, two primary "triggers" have been established in KJ-IAM. First, there is a condition trigger for each asset. Hence, when the condition score of an asset reaches the prescribed level shown in **Table 5-1**, it will generate the rehabilitation or replacement cost of the asset. There is also a BRE score threshold, hence if the risk score of the asset exceeds a certain threshold (as noted in **Table 5-1**), it will generate a prescribed rehab or replacement activity at a pre-defined cost in KJ-IAM. Where rehabilitations were determined feasible, KJ-IAM has been programmed to model the number of rehabilitations that can occur and the condition of the asset after rehabilitation. This is defined as the "Next Renewal Trigger" in KJ-IAM. Finally, after the number of prescribed renewals are met, KJ-IAM will model the cost to replace the asset and will give it a new condition score (which in this case is 10).

Future management strategies should be developed by EGWD that would include tracking asset O&M activities/cost and to create a baseline trigger to rehabilitate an asset to extend its useful life, where technically and cost effectively feasible. Doing so will likely reduce the need for as much capital costs as are projected in this initial AMP for future renewal of the assets.

Table 5-1: Management Strategy Groups for Future Funding Needs Analysis

Asset Class	Useful Life	Decay Curve Exponent	Trigger-Condition	Trigger-BRE	# of Rehab Cycles	Rehab Cost (% of Replacement)	Condition after Rehab	Next Renewal Trigger
AC Roller	20	5	3		1	50	8	1
Backhoe	20	5	3		1	50	8	1
Backwash Pump	20	4	1					
Backwash Tank	20	3	3		2	25	8	3
Booster Pump	25	4	5		2	40	9	4
Bore Machine	5	5	3		2	25	8	3
Building	20	4	3					
Chlorine Generator	15	1	4		2	10	9	4
Clear Well	25	3	3		2	25	8	3
Coagulant Dosing	15	6	1					
Compressor Trailer	5	5	3		1	50	8	1
Diesel Storage Tank	25	3	1					
Electrical System	25	6	1					
Excavator	20	5	3		1	50	8	1
Fence	50	6	1					
Filter Media	20	6	1					
Filter Vessel	20	6	5		3	10	9	5
Flow Meter	20	6	1					
Furnishings	100	6	1					
Genset	20	3	4		2	20	9	4
GPR	10	5	1					
HVAC	20	3	5		1	10	9	1
Lighting	25	6	1					
MCC	30	6	1					
Pavement	10	1	5		4	15	9	4
Piping	50	4	1					
PLC	15	6	1					
Polymer Dosing	15	6	1					
Pressure Transducer	10	6	1					
Pump Motor (over 100 HP)	25	6	5		3	50	9	5
Pump Motor (under 100 HP)	25	6	1					
Reaction Vessel	25	4	5		1	25	9	1
Roll-up Door	20	6	1					
Roof	20	1	3					
Salt Brine Tank	20	3	1					
Security System	15	6	3					
Server	10	6	3					
Skid Steer	20	5	3		1	50	8	1
Sodium Hypochlorite Pump	10	4	1					
Sodium Hypochlorite Tank	15	3	1					
Sodium Hypochlorite System	15	6	1					
Soft Starter	15	6	1					
Surge Tank	40	3	3		2	25	8	3
Transfer Switch	25	6	1					
Vac Trailer	20	5	3		1	50	8	1
Vehicle	10	1	4					
VFD	15	6	1					
Water Main	75	4	1	55				
Well Casing	30	1	7		5	10	10	7
Well Pump	15	4	5		2	40	9	4

Section 6: Data for Suggested 10-Year CIP

Table 6-1 lists the assets that are in need of refurbishment or replacement over the next 10-year period. The list is sorted by intervention year, then by the BRE score. Kennedy/Jenks recommends that a business case review be conducted prior to inclusion into the CIP.

Table 6-1: Recommended Projects for Review

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
WE3-ST-PIPE	Underground Piping	1956	2015	Replacement	50	0	7	10	70	$200,000	$200,000
RR-CHEM-SHP01	Sodium Hypochlorite Pump 1	2005	2015	Replacement	10	0	5	10	50	$10,000	$10,000
RR-CHEM-SHP02	Sodium Hypochlorite Pump 2	2005	2015	Replacement	10	0	5	10	50	$10,000	$10,000
RR-CHEM-SHP03	Sodium Hypochlorite Pump 3	2005	2015	Replacement	10	0	5	10	50	$10,000	$10,000
RR-CHEM-SHP04	Sodium Hypochlorite Pump 4	2005	2015	Replacement	10	0	5	10	50	$10,000	$10,000
RR-SC-SERV01	SCADA Application Server	2005	2015	Replacement	10	0	4	10	40	$10,000	$10,000
RR-SC-SERV02	SCADA Historian Server	2005	2015	Replacement	10	0	4	10	40	$10,000	$10,000
WE1D-WP-MT	Well Pump Motor	2008	2015	Rehabilitation - 1	25	2	7	5.3	37.1	$50,000	$25,000
HV-ST-GEN	Genset	1996	2015	Rehabilitation - 1	20	1	4	8.6	34.4	$250,000	$50,000
WE4D-WP-WC	Well Casing	2003	2015	Rehabilitation - 2	40	27	10	3.1	31	$1,000,000	$100,000
WE3-CB-STRUCT	Building	1990	2015	Replacement	20	0	3	10	30	$20,000	$20,000
WE13-WP-PLC	PLC	1996	2015	Replacement	15	0	3	10	30	$50,000	$50,000
WE1D-WP-WC	Well Casing	2008	2015	Rehabilitation - 2	40	28	10	2.9	29	$1,000,000	$100,000
HV-BW-TANK	Backwash Tank	1996	2015	Rehabilitation - 1	20	1	3	8.6	25.8	$10,000	$2,500
HV-FV01	Filter Vessel 1	1996	2015	Rehabilitation - 1	20	1	3	7.4	22.2	$100,000	$10,000
HV-FV02	Filter Vessel 2	1996	2015	Rehabilitation - 1	20	1	3	7.4	22.2	$100,000	$10,000
HV-FV03	Filter Vessel 3	1996	2015	Rehabilitation - 1	20	1	3	7.4	22.2	$100,000	$10,000
HV-ST-SEC	Security	1996	2015	Replacement	15	0	2	10	20	$100,000	$100,000
AD-OF-ROOF	Roof	1975	2015	Replacement	20	0	1	10	10	$25,000	$25,000

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
AD-WH-ROOF	Roof	1975	2015	Replacement	20	0	1	10	10	$25,000	$25,000
AD-VEH-102	Chevy 3500	2004	2015	Replacement	10	0	1	10	10	$50,000	$50,000
AD-VEH-107	Chevy 3500	2004	2015	Replacement	10	0	1	10	10	$50,000	$50,000
AD-VEH-108	Chevy 3500	2004	2015	Replacement	10	0	1	10	10	$50,000	$50,000
AD-VEH-203	Chevy Colorado	2005	2015	Replacement	10	0	1	10	10	$36,500	$36,500
AD-VEH-204	Chevy 4500	2004	2015	Replacement	10	0	1	10	10	$58,500	$58,500
AD-ME-501	Air Compressor Trailer	1999	2015	Rehabilitation - 1	5	0	1	10	10	$15,000	$7,500
AD-ME-502	Bore Machine Vermeer	1997	2015	Rehabilitation - 1	5	0	1	10	10	$100,000	$25,000
HV-ST-PAVE	Pavement	1996	2015	Rehabilitation - 1	10	0	1	10	10	$75,000	$11,250
WE13-WP-PT	Pressure Transducer	1996	2015	Replacement	10	0	1	10	10	$1,500	$1,500
WE14D-WP-PT	Pressure Transducer	2005	2015	Replacement	10	0	1	10	10	$1,500	$1,500
HV-CB-ROOF	Roof	1996	2015	Replacement	20	1	1	9.5	9.5	$25,000	$25,000
AD-ST-PAVE	Pavement	2006	2015	Rehabilitation - 1	10	1	1	9	9	$15,000	$2,250
AD-VEH-301	Chevy 3500	2006	2015	Replacement	10	1	1	9	9	$54,250	$54,250
AD-VEH-302	Chevy 3500	2006	2015	Replacement	10	1	1	9	9	$52,000	$52,000
AD-VEH-303	Ford F650	2006	2015	Replacement	10	1	1	9	9	$79,850	$79,850
AD-VEH-304	Chevy 2500	2006	2015	Replacement	10	1	1	9	9	$49,000	$49,000
HV-CB-HVAC	HVAC	1996	2015	Rehabilitation - 1	20	1	1	8.6	8.6	$50,000	$5,000
AD-VEH-401	Chevy C2500	2007	2015	Replacement	10	2	1	8	8	$50,000	$50,000
AD-VEH-403	Chevy Tahoe	2007	2015	Replacement	10	2	1	8	8	$49,000	$49,000
AD-VEH-405	Ford F550	2007	2015	Replacement	10	2	1	8	8	$62,000	$62,000
AD-VEH-402	Ford F250	2008	2015	Replacement	10	3	1	7	7	$45,000	$45,000
AD-VEH-404	Ford Escape	2008	2015	Replacement	10	3	1	7	7	$52,000	$52,000
AD-VEH-406	Ford Escape	2008	2015	Replacement	10	3	1	7	7	$55,000	$55,000
AD-VEH-407	Ford F550	2008	2015	Replacement	10	3	1	7	7	$98,500	$98,500
HV-BW-PU01	Backwash Pump 1	1996	2016	Replacement	20	1	7	8.1	56.7	$10,000	$10,000
HV-BW-PU02	Backwash Pump 2	1996	2016	Replacement	20	1	7	8.1	56.7	$10,000	$10,000
HV-BW-PU03	Backwash Pump 3	1996	2016	Replacement	20	1	7	8.1	56.7	$10,000	$10,000
WE3-WP-MT	Well Pump Motor	2011	2016	Replacement	25	1	7	7.7	53.9	$35,000	$35,000
HV-FV01-ME	Filter Media 1	1996	2016	Replacement	20	1	7	7.4	51.8	$35,000	$35,000
HV-FV02-ME	Filter Media 2	1996	2016	Replacement	20	1	7	7.4	51.8	$35,000	$35,000

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
HV-FV03-ME	Filter Media 3	1996	2016	Replacement	20	1	7	7.4	51.8	$35,000	$35,000
WE11D-WP-PU	Well Pump	2005	2016	Rehabilitation - 1	15	2	10	4.2	42	$35,000	$14,000
WE9-WP-SHC	Sodium Hypochloride System	2013	2016	Replacement	15	1	6	6.3	37.8	$5,000	$5,000
RR-BP01	Booster Pump 1	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP02	Booster Pump 2	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP03	Booster Pump 3	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP04	Booster Pump 4	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP05	Booster Pump 5	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP06	Booster Pump 6	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP07	Booster Pump 7	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP08	Booster Pump 8	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP09	Booster Pump 9	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
RR-BP10	Booster Pump 10	2005	2016	Rehabilitation - 1	25	4	7	4.9	34.3	$15,000	$6,000
WE13-WP-FM	Flow Meter	1996	2016	Replacement	20	1	2	7.4	14.8	$5,000	$5,000
RR-FV01	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
RR-FV02	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
RR-FV03	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
RR-FV04	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
RR-FV05	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
RR-FV06	Filter Vessel	2005	2016	Rehabilitation - 1	20	2	3	4.3	12.9	$120,000	$12,000
WE11D-ST-SEC	Security	2005	2016	Replacement	15	1	2	4.8	9.6	$50,000	$50,000
AD-VEH-409	Ford F650	2009	2016	Replacement	10	4	1	6	6	$89,850	$89,850
AD-VEH-410	Ford F550	2009	2016	Replacement	10	4	1	6	6	$98,000	$98,000
AD-VEH-411	Ford F250	2009	2016	Replacement	10	4	1	6	6	$48,000	$48,000
RR-ST-PAVE	Pavement	2005	2016	Rehabilitation - 1	10	5	1	5	5	$750,000	$112,500
WE4D-WP-PU	Well Pump	2012	2017	Rehabilitation - 1	15	3	10	2.9	29	$35,000	$14,000
WE8-WP-PU	Well Pump	1996	2017	Rehabilitation - 1	15	3	10	2.9	29	$25,000	$10,000
WE14D-WP-PU	Well Pump	2010	2017	Rehabilitation - 1	15	3	10	2.9	29	$35,000	$14,000
WE9-CB-STRUCT	Building	2005	2017	Replacement	20	3	3	5.1	15.3	$25,000	$25,000
WE11D-WP-PLC	PLC	2005	2017	Replacement	15	1	3	4.8	14.4	$25,000	$25,000
RR-BP-FM	Booster Pumping Magmeter	2005	2017	Replacement	20	1	2	5.6	11.2	$15,000	$15,000

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
RR-BP-MT01	Booster Pump Motor 1	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT02	Booster Pump Motor 2	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT03	Booster Pump Motor 3	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT04	Booster Pump Motor 4	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT05	Booster Pump Motor 5	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT06	Booster Pump Motor 6	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT07	Booster Pump Motor 7	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT08	Booster Pump Motor 8	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT09	Booster Pump Motor 9	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-BP-MT10	Booster Pump Motor 10	2005	2018	Replacement	25	2	7	5.3	37.1	$15,000	$15,000
RR-FV04-ME	Filter Media	2005	2018	Replacement	20	2	7	4.3	30.1	$50,000	$50,000
RR-FV05-ME	Filter Media	2005	2018	Replacement	20	2	7	4.3	30.1	$50,000	$50,000
RR-FV06-ME	Filter Media	2005	2018	Replacement	20	2	7	4.3	30.1	$50,000	$50,000
WE3-WP-WC	Well Casing	1956	2018	Rehabilitation - 2	40	32	10	1.9	19	$1,000,000	$100,000
WE4D-WP-MT	Well Pump Motor	2012	2018	Rehabilitation - 1	25	4	7	2.7	18.9	$45,000	$22,500
WE14D-WP-MT	Well Pump Motor	2005	2018	Rehabilitation - 1	25	4	7	2.7	18.9	$50,000	$25,000
WE11D-ST-GEN	Generator	2005	2018	Rehabilitation - 1	20	5	4	3.7	14.8	$250,000	$50,000
RR-BW-TANK	Backwash Tank	2005	2018	Rehabilitation - 1	20	4	3	4.9	14.7	$10,000	$2,500
HV-CRV01	Contact Reaction Vessel 1	1996	2018	Rehabilitation - 1	25	6	3	3.3	9.9	$100,000	$25,000
HV-CRV02	Contact Reaction Vessel 2	1996	2018	Rehabilitation - 1	25	6	3	3.3	9.9	$100,000	$25,000
RR-BW-FM01	Magmeter	2005	2018	Replacement	20	2	2	4.3	8.6	$5,000	$5,000
RR-BW-FM02	Magmeter	2005	2018	Replacement	20	2	2	4.3	8.6	$5,000	$5,000
WE14D-WP-FM	Flow Meter	2005	2018	Replacement	20	2	2	4.3	8.6	$5,000	$5,000
WE4D-WP-PLC	PLC	2003	2018	Replacement	15	3	3	2.6	7.8	$25,000	$25,000
AD-VEH-412	Ford F150	2011	2018	Replacement	10	6	1	4	4	$47,250	$47,250
WE1D-WP-PT	Pressure Transducer	2008	2018	Replacement	10	3	1	1.2	1.2	$1,500	$1,500
WE8-WP-MT	Well Pump Motor	1996	2019	Replacement	25	3	7	4	28	$35,000	$35,000
RR-CHEM-CHLOR	ChlorTec Chlorine Generator	2005	2019	Rehabilitation - 1	15	9	6	3.7	22.2	$50,000	$5,000
WE9-WP-MT	Well Pump w/Submersible Motor	2012	2019	Replacement	20	3	7	2.9	20.3	$25,000	$25,000
RR-CHEM-SHTANK	Sodium Hypochlorite Tank	2005	2019	Replacement	15	3	5	4	20	$25,000	$25,000

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
WE11D-WP-VFD	Variable Frequency Drive	2012	2019	Replacement	15	3	7	1.8	12.6	$75,000	$75,000
WE3-WP-SHC	Sodium Hypochloride System	2013	2019	Replacement	15	3	6	1.8	10.8	$5,000	$5,000
WE1D-WP-FM	Flow Meter	2008	2019	Replacement	20	3	2	2.9	5.8	$20,000	$20,000
RR-FV07	Filter Vessel	2012	2019	Rehabilitation - 1	20	5	3	1.5	4.5	$120,000	$12,000
RR-FV08	Filter Vessel	2012	2019	Rehabilitation - 1	20	5	3	1.5	4.5	$120,000	$12,000
RR-CC-DOOR	Rollup Door	2005	2019	Replacement	20	3	1	2.9	2.9	$50,000	$50,000
RR-CC-HVAC	HVAC	2005	2019	Rehabilitation - 1	20	7	1	2.6	2.6	$50,000	$5,000
RR-OM-HVAC	HVAC	2005	2019	Rehabilitation - 1	20	7	1	2.6	2.6	$50,000	$5,000
WE1D-ST-ELEC	Electrical	2008	2020	Replacement	25	4	8	2.7	21.6	$10,000	$10,000
WE9-ST-ELEC	Electrical	2013	2020	Replacement	25	4	8	2.7	21.6	$10,000	$10,000
WE11D-WP-WC	Well Casing	2003	2020	Rehabilitation - 2	40	34	10	1.4	14	$1,000,000	$100,000
RR-CHEM-SBTANK	Salt Brine Tank	2005	2020	Replacement	20	5	3	3.7	11.1	$25,000	$25,000
RR-WS-TANK01	Clearwell Tank 1	2005	2020	Rehabilitation - 1	25	7	3	3.6	10.8	$1,000,000	$250,000
RR-WS-TANK02	Clearwell Tank 2	2005	2020	Rehabilitation - 1	25	7	3	3.6	10.8	$1,000,000	$250,000
RR-ST-GEN	Genset	2005	2020	Rehabilitation - 1	20	7	4	2.6	10.4	$350,000	$70,000
WE11D-WP-MT	Well Pump Motor	2012	2020	Rehabilitation - 1	25	6	7	1.4	9.8	$45,000	$22,500
RR-CC-GTS	Generator Transfer Switch	2005	2020	Replacement	25	4	3	2.7	8.1	$25,000	$25,000
RR-SC-PLC01	PLC Electric Control Room	2005	2020	Replacement	15	5	3	0.9	2.7	$50,000	$50,000
RR-SC-PLC02	PLC Filter Panel	2005	2020	Replacement	15	5	3	0.9	2.7	$50,000	$50,000
WE14D-WP-PLC	PLC	2005	2020	Replacement	15	5	3	0.9	2.7	$50,000	$50,000
RR-ST-SEC	Security	2005	2020	Replacement	15	5	2	0.9	1.8	$200,000	$200,000
WE4D-ST-SEC	Security	2005	2020	Replacement	15	5	2	0.9	1.8	$50,000	$50,000
AD-ME-503	Ground Penetrating Radar (GPR)	2010	2020	Replacement	10	5	1	0.3	0.3	$25,000	$25,000
RR-CC-MCC	Motor Control Center	2005	2021	Replacement	30	6	7	2.6	18.2	$350,000	$350,000
RR-CC-MCBP01	MCC Booster Pump 1	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP02	MCC Booster Pump 2	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP03	MCC Booster Pump 3	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP04	MCC Booster Pump 4	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP05	MCC Booster Pump 5	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
RR-CC-MCBP06	MCC Booster Pump 6	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP07	MCC Booster Pump 7	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP08	MCC Booster Pump 8	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP09	MCC Booster Pump 9	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCBP10	MCC Booster Pump 10	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
RR-CC-MCCHLOR	MCC ChlorTec	2005	2021	Replacement	30	6	7	2.6	18.2	$20,000	$20,000
WE1D-WP-MC	MCC	2008	2021	Replacement	30	6	7	2.6	18.2	$150,000	$150,000
WE3-WP-MC	MCC	2012	2021	Replacement	30	6	7	2.6	18.2	$150,000	$150,000
WE4D-WP-MC	MCC	2012	2021	Replacement	30	6	7	2.6	18.2	$250,000	$250,000
HV-ST-DTANK	Diesel Storage Tank	1996	2021	Replacement	25	6	3	4.4	13.2	$20,000	$20,000
WE3-WP-STANK	Hydropneumatic Surge Control Tank	1956	2021	Rehabilitation - 1	40	9	3	4.4	13.2	$100,000	$25,000
WE8-WP-STANK	Hydropneumatic Surge Control Tank	1979	2021	Rehabilitation - 1	40	9	3	4.4	13.2	$100,000	$25,000
AD-OF-STRUCT	Structure	1975	2021	Replacement	50	10	3	4.1	12.3	$1,000,000	$1,000,000
AD-WH-STRUCT	Structure	1975	2021	Replacement	50	10	3	4.1	12.3	$450,000	$450,000
RR-FV01-ME	Filter Media	2012	2021	Replacement	20	5	7	1.5	10.5	$50,000	$50,000
RR-FV02-ME	Filter Media	2012	2021	Replacement	20	5	7	1.5	10.5	$50,000	$50,000
RR-FV03-ME	Filter Media	2005	2021	Replacement	20	5	7	1.5	10.5	$50,000	$50,000
RR-FV07-ME	Filter Media	2012	2021	Replacement	20	5	7	1.5	10.5	$50,000	$50,000
RR-FV08-ME	Filter Media	2012	2021	Replacement	20	5	7	1.5	10.5	$50,000	$50,000
WE1D-WP-PU	Well Pump	2008	2021	Rehabilitation - 1	15	8	10	0.5	5	$30,000	$12,000
RR-ST-FENCE	Fencing	2005	2021	Replacement	50	6	1	4.6	4.6	$100,000	$100,000
AD-OF-HVAC	HVAC	2005	2021	Rehabilitation - 1	20	10	1	1.2	1.2	$50,000	$5,000
WE8-ST-ELEC	Electrical	2013	2022	Replacement	25	6	8	1.4	11.2	$10,000	$10,000
WE4D-ST-GEN	Generator	2005	2022	Rehabilitation - 1	20	10	4	1.2	4.8	$250,000	$50,000
WE8-CB-STRUCT	Building	2013	2022	Replacement	20	7	3	1.4	4.2	$20,000	$20,000
WE11D-CB-STRUCT	Building	2003	2022	Replacement	20	8	3	1.3	3.9	$25,000	$25,000
WE3-WP-PT	Pressure Transducer	2012	2022	Replacement	10	7	1	0	0	$1,500	$1,500
WE4D-WP-PT	Pressure Transducer	2012	2022	Replacement	10	7	1	0	0	$1,500	$1,500

Asset ID	Asset Name	Installation Date	Next Intervention Date	Intervention Type	Asset Life	Remaining Asset Life	CoF	PoF	BRE	Replace Cost	Intervention Cost
WE11D-WP-PT	Pressure Transducer	2012	2022	Replacement	10	7	1	0	0	$1,500	$1,500
WE9-WP-WC	Well Casing	1979	2023	Rehabilitation - 2	40	37	10	0.6	6	$1,000,000	$100,000
WE4D-WP-FM	Flow Meter	2003	2023	Replacement	20	8	2	0.5	1	$15,000	$15,000
AD-ME-508	Vac Trailer FX30 Ditch Witch 1	2004	2023	Rehabilitation - 1	20	9	1	0.5	0.5	$65,000	$32,500
WE1D-ST-SEC	Security	2008	2023	Replacement	15	8	2	0.1	0.2	$50,000	$50,000
WE9-WP-PT	Pressure Transducer	2013	2023	Replacement	10	8	1	0	0	$1,500	$1,500
RR-ST-PIPE	Underground Piping	2005	2024	Replacement	50	9	7	4.4	30.8	$2,500,000	$2,500,000
WE8-WP-MC	MCC	2013	2024	Replacement	30	8	7	1.3	9.1	$150,000	$150,000
WE9-WP-MC	MCC	2013	2024	Replacement	30	8	7	1.3	9.1	$150,000	$150,000
RR-ST-DTANK	Diesel Storage Tank	2005	2024	Replacement	25	9	3	2.4	7.2	$20,000	$20,000
WE4D-CB-STRUCT	Building	2005	2024	Replacement	20	10	3	0.6	1.8	$20,000	$20,000
WE3-WP-PU	Well Pump	2011	2024	Rehabilitation - 1	15	11	10	0.1	1	$25,000	$10,000

Section 7: Future Investment Needs

7.1 Overview

The result of the future funding needs modeling in KJ-IAM produced a set of graphs that describe the needed funding for the asset portfolio over 100-year and 10-year periods to present the importance of the longer term projection, see **Figure 7-1**. The graphs give the total renewal cash flow by summing the estimated refurbishment and replacement cost of modeled assets (replacement costs for assets at the end of their assumed useful lives). The key data sets used in these graphs are the estimated refurbishment and replacement costs, physical effective life, maximum potential life, count of assets, and available condition data over the 100-year period. A short-term 10-year investment graph also provides valuable information in developing a prioritized list of projects needed in the first 10 years after the analysis, see **Figure 7-2**.

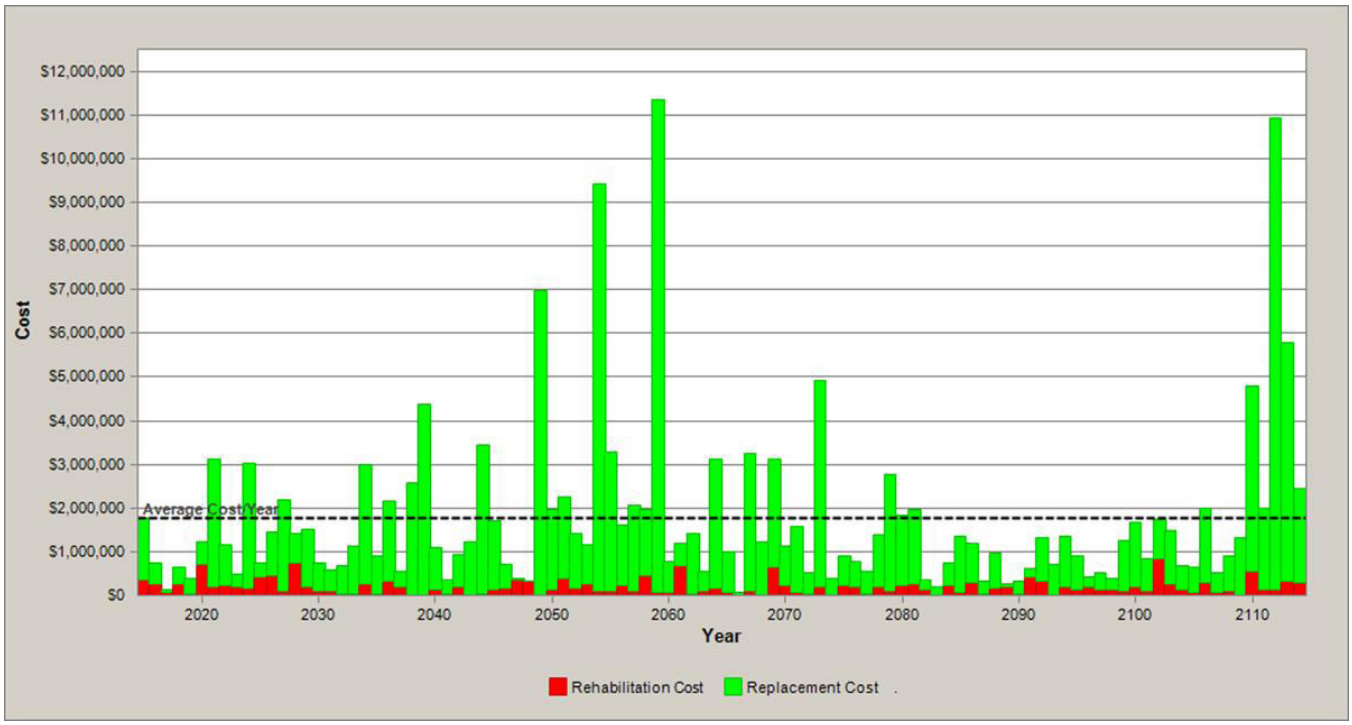

Figure 7-1: EGWD 100-Year Future Funding Needs Assessment

Figure 7-1 shows the future funding needs assessment results for the entire asset portfolio. This graph shows the year-by-year investments predicted from the potential asset refurbishment and replacement needs as well as an average line showing the average annual expenditure needed to cover the entire 100-year period, encompassing the longest lived assets in the system. This average cost for the 100-year period represents the sustainable cost of providing the asset-related services. Note the average annual cost in 2014 dollars is approximately $1.9M, EGWD will need to reconcile any difference in costs during the next justification for rates.

Figure 7-2 shows the year-by-year investments predicted from the potential asset refurbishment and replacement needs as well as an average line showing the average annual expenditure needed to cover the near-term 10-year period. The average annual expenditure for period is slightly more than $1.2M. As presented here, if EGWD were only looking at the 10-year forecast, there is potential for a significant shortfall in future renewal funding.

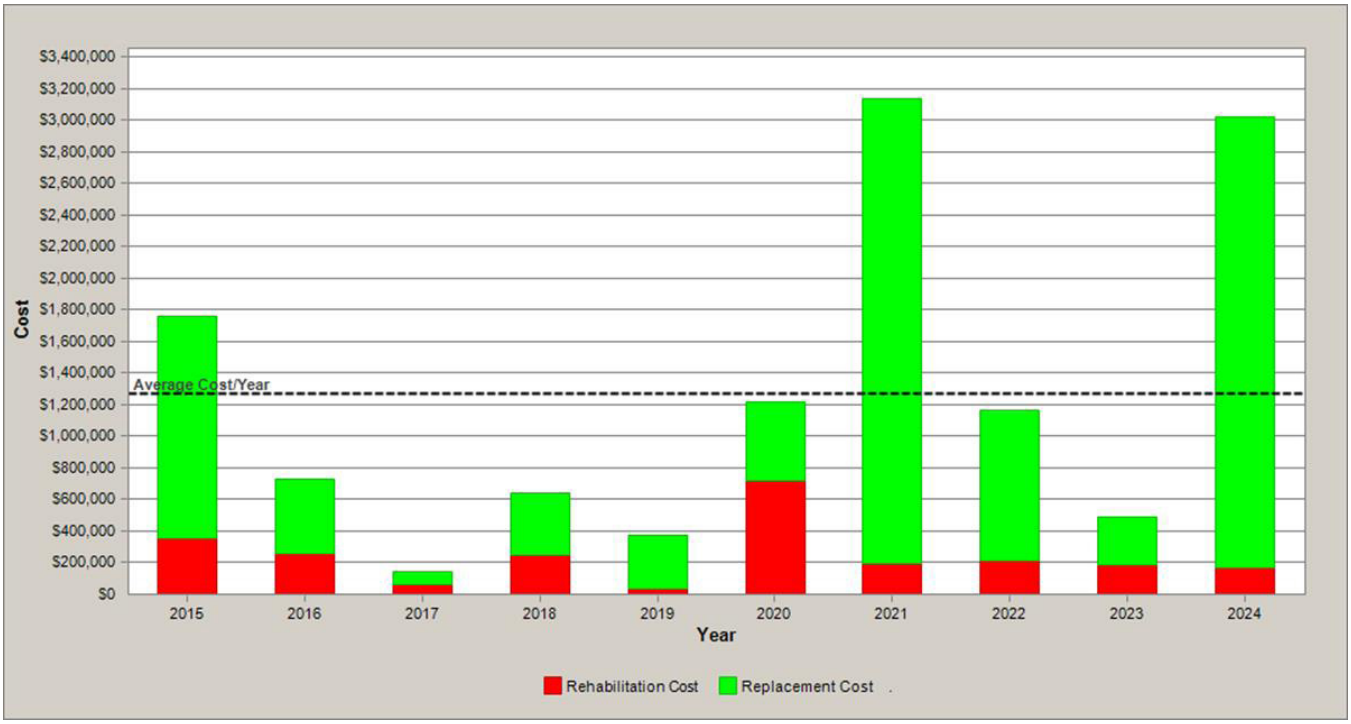

Figure 7-2: EGWD 10-Year Future Funding Needs Assessment

Short-Term and Long-Term Financing Recommendations

Table 7-1 provides the estimated short-term refurbishment and replacement costs over the next 10-year period along with a longer-term look at the remaining 90 years.

Table 7-1: EGWD Short-Term and Long-Term Financing Recommendations

Year	R&R Expenditures	10-Year Average	$1,085,120
2015	$1,768,100	10-Year Total	$10,851,200
2016	$724,350		
2017	$103,000		
2018	$638,750		
2019	$274,000		
2020	$1,187,500		
2021	$3,007,000		
2022	$109,500		
2023	$199,000		
2024	$2,840,000		
2025-2114		Remaining 90-Year Average	$1,808,917
		Remaining 90-Year Average	$162,802,521
		Annual R&R Funding Forecast	$1,736,537
		100-Year R&R Funding Forecast Total	$173,653,721

Section 8: Future AMP Improvement Recommendations

Review assets with the highest risk.

Business risk exposure enables EGWD to assess and manage risks that assets present to the organization. In cooperation with EGWD, Kennedy/Jenks developed business risk exposure for all EGWD assets. Assets were evaluated in terms of probability and consequence of failure, enabling the assets to be ranked based on risk.

Appropriate risk-based management strategies should be further developed to minimize the business risk exposure and optimize the use of funds, and to prioritize and optimize the management decisions for all EGWD-owned assets.

Create condition assessment protocols to assist in determining the remaining useful life of assets.

The purpose of developing a condition assessment protocol is to assist staff with a process for ongoing determination of the physical condition of infrastructure assets. The performance of an asset needs to be understood to assist in management decisions related to maintenance, operations and renewal. A well-structured condition assessment program will increase the confidence of these management decisions.

Develop failure codes by asset type to assist in determining when to intervene with appropriate levels of maintenance or rehabilitations.

A failure code is a code that illustrates why an asset failed or the reason that the asset failed. Failure codes are applied to identify all minor faults, undesirable conditions or degraded states, which may eventually progress into actual failures. For example, the code “F-0015 Bearing Failure” would be applied to any asset that may have had a bearing failure.

The failure code is applied to a work order and indicates an instance of a particular failure behavior. The use of codes in a CMMS ensures a consistent way of documenting the key aspects of the failure event according to pre-defined categories. Some examples include:

- Breakage
- Corrosion
- Imbalance
- Misalignment
- Overheating
- Vibration.

Failure codes provide an expedient method of getting statistics about equipment failures or breakdowns. Based on the fault, a determination can be made as to what the effects of these failures or faults may be, and to identify maintenance tasks that are needed to avoid or correct the problems (e.g., the bearing failure may have been caused from poor lubrication practices).

Knowing the failure rate of assets can help in doing the following:

- Optimize PM intervals
- Assess the benefit of additional PM tasks
- Eliminate unnecessary PM tasks
- Improve failure response
- Improve work practices.

The use of the failure codes provides a useful method of getting statistics about equipment failures or breakdowns. They aid in the ability to effectively identify trends and problems.

The identification of faults can lead to their elimination or mitigation. Having appropriate failure codes will assist in creating/modifying asset management strategies that are based on the failure modes analysis and in developing risk mitigation strategies. Where best appropriate practices suggest that current practices are not preventing or predicting failures, the asset manager can make recommendations as to what asset maintenance tasks should be adopted.

Identify assets where additional maintenance or rehabilitation would cost-effectively extend lives.

In developing the asset management plan, management strategy groups were established at the asset class level. **Figure 8-1**, **8-2**, and **8-3** present an example of how a management strategy was developed from KJ-IAM for Well 11D.

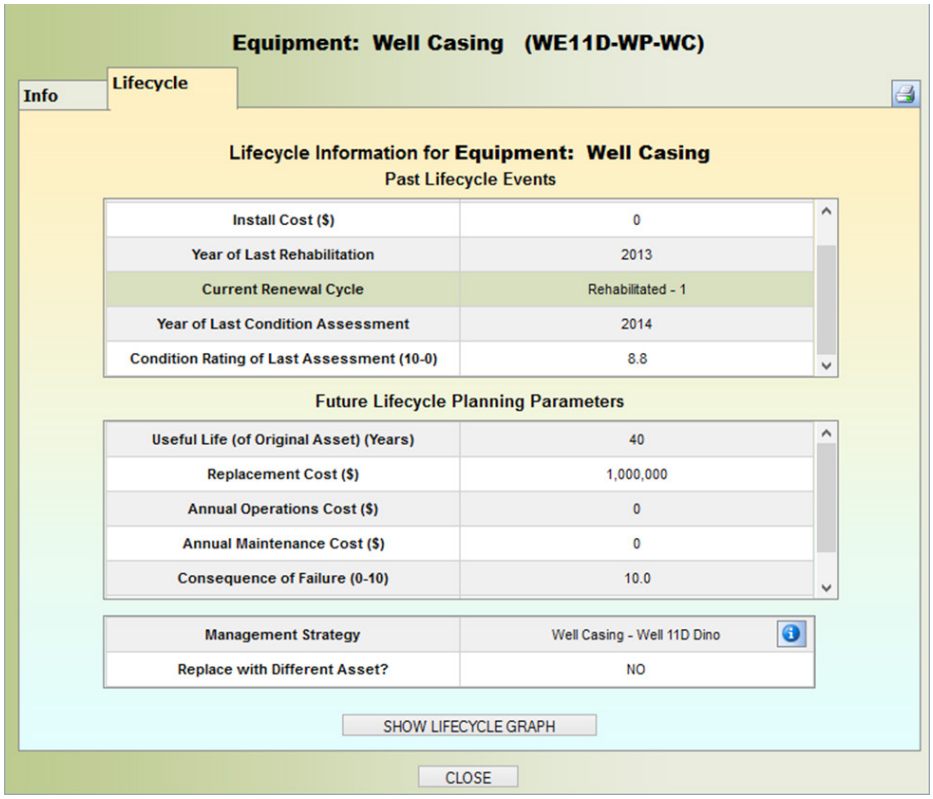

Figure 8-1: Well 11D Equipment Details

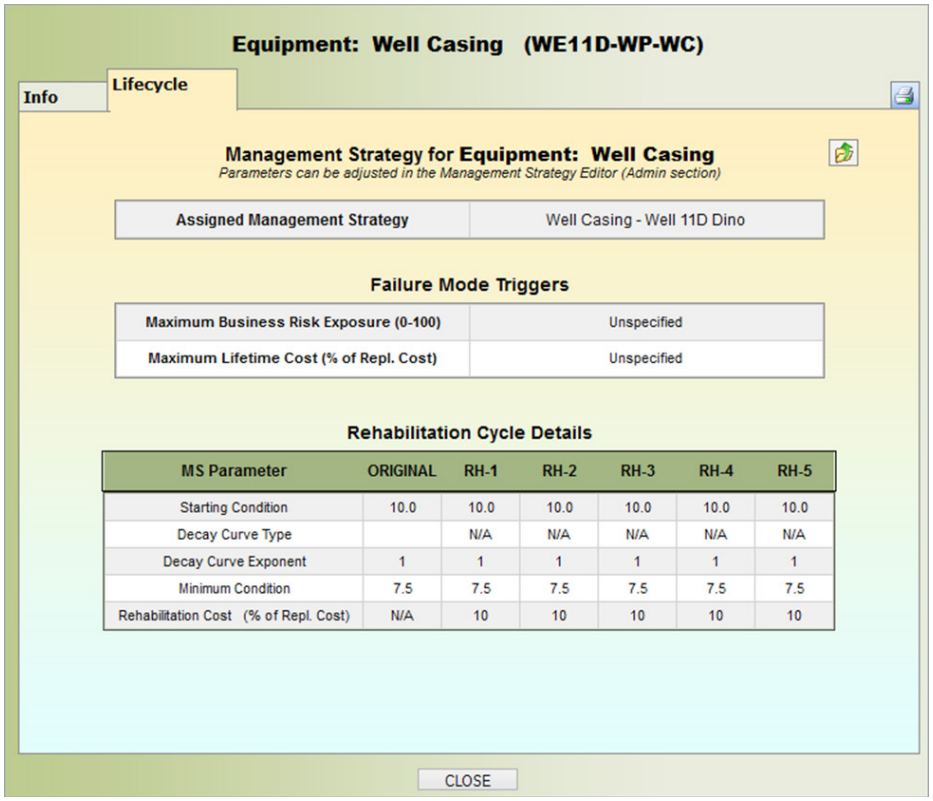

Figure 8-2: Well 11D Asset Lifecycle

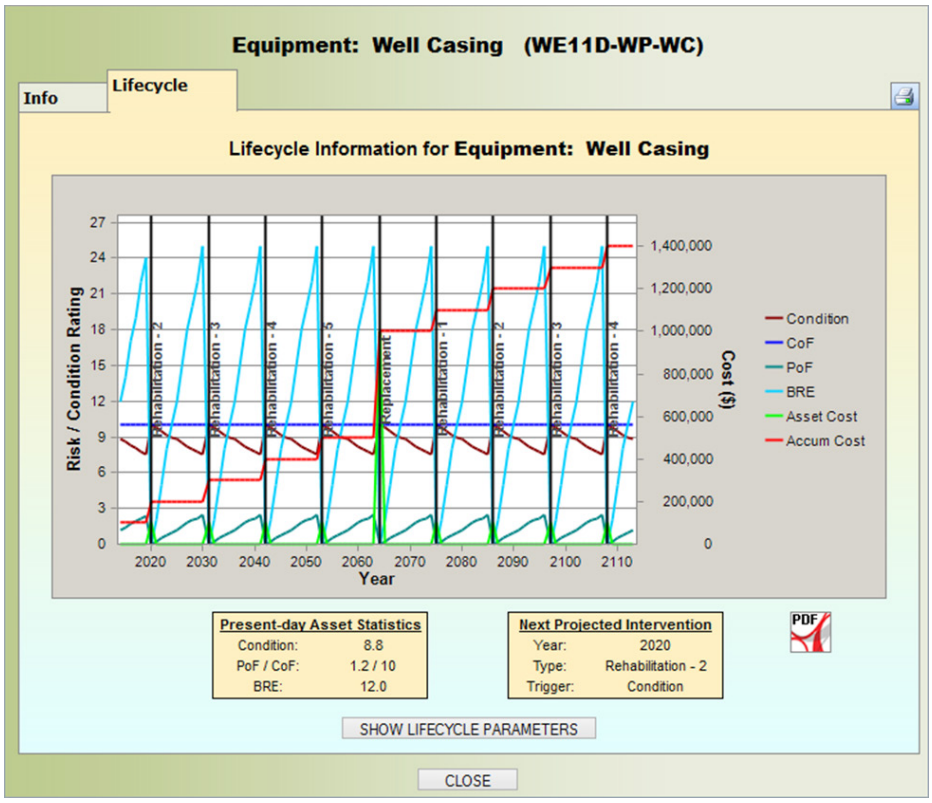

Figure 8-3: Well 11D Asset Lifecycle 100-Year Graph

The well casing for Well 11D (Dino) was installed in 2003 and rehabilitated in January 2013. After the rehabilitation, a specific capacity of 31.63 was measured, and then in July 2014, the latest specific capacity measurement was taken with a number of 27.71. If we take the 31.63 as the 100% mark (or a KJ-IAM condition score of 10), then the 27.71 would equal 88% of that (or a KJ-IAM condition score of 8.8). The condition at the time of the last measurement was set to 8.8 in KJ-IAM (on a scale of 0–10). For well casings, the management strategy defines that decay is linear (represented by a decay curve exponent of 1). Decay of a well casing is measured by a decline in specific capacity and then normalized on a 0-10 scale for compatibility with the model's condition trigger. The well's initial specific capacity is used as the baseline 100% (or condition of 10), and a renewal will be triggered once the specific capacity has declined to 75% or below (or condition of 7.5 or below).

As part of the initial modeling effort, it was estimated that a well casing can be rehabilitated 5 times before it has to be replaced with a new one. After each rehabilitation event, the condition of the well casing increases to a perfect 10. The useful life of a well casing is established at 40 years, meaning that the specific capacity is estimated to reach 0 in 40 years' time. Using linear decay, this results in a lifespan between rehabilitation events of 10 years (a decline from 10 to 7.5 takes a quarter of its total useful life). The model reaches the trigger in year 10, and in year 11 the rehabilitation takes place. Complete replacement of the asset is estimated to cost $1,000,000, while the cost of

a rehabilitation event is estimated to be 10% of the replacement cost, which is $100,000. With an original installation year of 2003, this particular casing is actually due for its first rehabilitation event in 2014. Additional information regarding condition and specific capacity could potentially move the event in or out, if the condition rating reaches 7.5 before 2014 or if it is deemed to still be higher than a 7.5 in 2014.

Terms used in developing management strategies in KJ-IAM include the following:

- "# of Rehabs" is the number of potential rehabilitation options before replacement.
- "Next renewal trigger" is the condition score to be used after the first upcoming rehabilitation has taken place. For instance, for the original asset, a condition trigger score of 7.5 ("trigger condition") may be used to kick off the first rehabilitation event. Afterwards, the condition trigger score is set to 10 ("next renewal trigger"), which would then result in a replacement.
- "Trigger condition" represents the condition level at which each renewal is kicked off.
- "Condition after rehabilitation" is the condition that the asset is restored to after a rehabilitation event (i.e., 10).

These management strategy groups should be re-evaluated by staff on an annual basis and refined to provide a more accurate representation of the future expenditure outlook in the AMP. Adjustments in the management strategy heavily influence the timing of EGWD's future expenditure requirement.

Processes for creating and updating asset management strategies should be developed to improve day-to-day operations and maintenance, medium-term rehabilitation maintenance, and long-term operations strategies. A coordinated training effort on the asset management program should be conducted with EGWD staff.

These activities provide potential for the greatest long-term benefit to the EGWD. Refining the current management focus may require reallocating funding and resources (e.g., adjusting frequency of maintenance versus a capital replacement).

Improve the asset management plan.

In order to continue momentum, EGWD should develop a process for updating the AMP to reflect the results of implementing the recommendations presented within this initial AMP. The future versions will have an increased confidence-level rating with more accurate data and refined management strategies, resulting in improved confidence for both short- and long-term expenditure forecasting.

Appendix A

Table A-1: Equipment Type Asset Class Replacement Estimates (2014)

Asset Type	Area	Useful Life	Repl. Cost
Electrical System	Well 01D - School St	25	$10,000
Electrical System	Well 03 - Marvel	25	$10,000
Electrical System	Well 08 - Williamson	25	$10,000
Electrical System	Well 09 - Polhemus	25	$10,000
Fence	Admin Buildings	50	$10,000
Fence	HVWTP	50	$75,000
Fence	RRWTP	50	$100,000
Fence	Well 01D - School St	50	$100,000
Fence	Well 03 - Marvel	50	$35,000
Fence	Well 04D - Webb	50	$75,000
Fence	Well 08 - Williamson	50	$35,000
Fence	Well 09 - Polhemus	50	$35,000
Fence	Well 11D - Dino	50	$50,000
Furnishings	Admin Buildings	100	$100,000
Furnishings	RRWTP	100	$50,000
Genset	HVWTP	20	$250,000
Genset	RRWTP	20	$350,000
Genset	Well 04D - Webb	20	$250,000
Genset	Well 11D - Dino	20	$250,000
HVAC	Admin Buildings	20	$50,000
HVAC	HVWTP	20	$50,000
HVAC	RRWTP	20	$50,000
HVAC	RRWTP	20	$50,000
Lighting	HVWTP	25	$10,000
Lighting	RRWTP	25	$10,000
MCC	HVWTP	30	$300,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000

Asset Type	Area	Useful Life	Repl. Cost
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$20,000
MCC	RRWTP	30	$350,000
MCC	Well 01D - School St	30	$150,000
MCC	Well 03 - Marvel	30	$150,000
MCC	Well 04D - Webb	30	$250,000
MCC	Well 08 - Williamson	30	$150,000
MCC	Well 09 - Polhemus	30	$150,000
MCC	Well 11D - Dino	30	$250,000
MCC	Well 13 - Hampton	30	$300,000
MCC	Well 14D - Railroad	30	$25,000
Pavement	Admin Buildings	10	$15,000
Pavement	HVWTP	10	$75,000
Pavement	RRWTP	10	$750,000
Piping	HVWTP	50	$25,000
Piping	HVWTP	50	$25,000
Piping	HVWTP	50	$25,000
Piping	HVWTP	50	$40,000
Piping	HVWTP	50	$40,000
Piping	HVWTP	50	$40,000
Piping	HVWTP	50	$750,000
Piping	RRWTP	50	$25,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$50,000
Piping	RRWTP	50	$350,000
Piping	RRWTP	50	$2,500,000
Piping	Well 01D - School St	50	$350,000
Piping	Well 03 - Marvel	50	$200,000
Piping	Well 04D - Webb	50	$250,000
Piping	Well 08 - Williamson	50	$200,000
Piping	Well 09 - Polhemus	50	$200,000
Piping	Well 11D - Dino	50	$200,000
Piping	Well 13 - Hampton	50	$50,000
Piping	Well 14D - Railroad	50	$25,000
PLC	RRWTP	15	$50,000

Asset Type	Area	Useful Life	Repl. Cost
PLC	RRWTP	15	$50,000
PLC	Well 03 - Marvel	15	$50,000
PLC	Well 04D - Webb	15	$25,000
PLC	Well 08 - Williamson	15	$50,000
PLC	Well 09 - Polhemus	15	$50,000
PLC	Well 11D - Dino	15	$25,000
PLC	Well 13 - Hampton	15	$50,000
PLC	Well 14D - Railroad	15	$50,000
Roof	Admin Buildings	20	$25,000
Roof	Admin Buildings	20	$25,000
Roof	HVWTP	20	$25,000
Roof	RRWTP	20	$25,000
Roof	RRWTP	20	$25,000
Roof	Well 01D - School St	20	$25,000
Security System	HVWTP	15	$100,000
Security System	RRWTP	15	$200,000
Security System	Well 01D - School St	15	$50,000
Security System	Well 04D - Webb	15	$50,000
Security System	Well 11D - Dino	15	$50,000
Soft Starter	Well 03 - Marvel	15	$15,000
Soft Starter	Well 08 - Williamson	15	$15,000
Soft Starter	Well 09 - Polhemus	15	$15,000
Vehicle	Parking Lot	10	$36,500
Vehicle	Parking Lot	10	$45,000
Vehicle	Parking Lot	10	$47,250
Vehicle	Parking Lot	10	$48,000
Vehicle	Parking Lot	10	$49,000
Vehicle	Parking Lot	10	$49,000
Vehicle	Parking Lot	10	$50,000
Vehicle	Parking Lot	10	$50,000
Vehicle	Parking Lot	10	$50,000
Vehicle	Parking Lot	10	$50,000
Vehicle	Parking Lot	10	$52,000
Vehicle	Parking Lot	10	$52,000
Vehicle	Parking Lot	10	$54,250
Vehicle	Parking Lot	10	$55,000
Vehicle	Parking Lot	10	$58,500
Vehicle	Parking Lot	10	$62,000
Vehicle	Parking Lot	10	$79,850
Vehicle	Parking Lot	10	$89,850
Vehicle	Parking Lot	10	$98,000

Asset Type	Area	Useful Life	Repl. Cost
Vehicle	Parking Lot	10	$98,500
VFD	Well 04D - Webb	15	$75,000
VFD	Well 11D - Dino	15	$75,000
AC Roller Mobile Equipment	Parking Lot	20	$50,000
Backhoe Mobile Equipment	Parking Lot	20	$100,000
Backwash Pump	HVWTP	20	$10,000
Backwash Pump	HVWTP	20	$10,000
Backwash Pump	HVWTP	20	$10,000
Backwash Pump	RRWTP	20	$10,000
Backwash Pump	RRWTP	20	$10,000
Backwash Tank	HVWTP	20	$10,000
Backwash Tank	RRWTP	20	$10,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Booster Pump	RRWTP	25	$15,000
Bore Machine Mobile Equipment	Parking Lot	5	$100,000
Building Structure	Admin Buildings	50	$450,000
Building Structure	Admin Buildings	50	$1,000,000
Building Structure	HVWTP	50	$100,000
Building Structure	HVWTP	50	$500,000
Building Structure	RRWTP	50	$100,000
Building Structure	RRWTP	50	$750,000
Building Structure	RRWTP	50	$1,000,000
Building Structure	Well 01D - School St	50	$200,000
Building Structure	Well 03 - Marvel	20	$20,000
Building Structure	Well 04D - Webb	20	$20,000
Building Structure	Well 08 - Williamson	20	$20,000
Building Structure	Well 09 - Polhemus	20	$25,000
Building Structure	Well 11D - Dino	20	$25,000
ChlorTec Chemical System	RRWTP	15	$50,000
Clear Well Tank	RRWTP	25	$1,000,000
Clear Well Tank	RRWTP	25	$1,000,000
Coagulant Dosing Chemical System	HVWTP	15	$10,000
Coagulant Dosing Chemical System	RRWTP	15	$10,000

Asset Type	Area	Useful Life	Repl. Cost
Compressor Trailer Mobile Equipment	Parking Lot	5	$15,000
Diesel Storage Tank	HVWTP	25	$20,000
Diesel Storage Tank	RRWTP	25	$20,000
Excavator Mobile Equipment	Parking Lot	20	$50,000
Excavator Mobile Equipment	Parking Lot	20	$120,000
Filter Media	HVWTP	20	$35,000
Filter Media	HVWTP	20	$35,000
Filter Media	HVWTP	20	$35,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Media	RRWTP	20	$50,000
Filter Vessel	HVWTP	20	$100,000
Filter Vessel	HVWTP	20	$100,000
Filter Vessel	HVWTP	20	$100,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Filter Vessel	RRWTP	20	$120,000
Flow Meter	RRWTP	20	$5,000
Flow Meter	RRWTP	20	$5,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$15,000
Flow Meter	RRWTP	20	$50,000
Flow Meter	Well 01D - School St	20	$20,000
Flow Meter	Well 03 - Marvel	20	$5,000

Asset Type	Area	Useful Life	Repl. Cost
Flow Meter	Well 04D - Webb	20	$15,000
Flow Meter	Well 08 - Williamson	20	$5,000
Flow Meter	Well 09 - Polhemus	20	$5,000
Flow Meter	Well 11D - Dino	20	$15,000
Flow Meter	Well 13 - Hampton	20	$5,000
Flow Meter	Well 14D - Railroad	20	$5,000
GPR Mobile Equipment	Parking Lot	10	$25,000
Polymer Dosing Chemical System	HVWTP	15	$10,000
Polymer Dosing Chemical System	RRWTP	15	$10,000
Pressure Transducer	Well 01D - School St	10	$1,500
Pressure Transducer	Well 03 - Marvel	10	$1,500
Pressure Transducer	Well 04D - Webb	10	$1,500
Pressure Transducer	Well 09 - Polhemus	10	$1,500
Pressure Transducer	Well 11D - Dino	10	$1,500
Pressure Transducer	Well 13 - Hampton	10	$1,500
Pressure Transducer	Well 14D - Railroad	10	$1,500
Pump Motor	RRWTP	25	$10,000
Pump Motor	RRWTP	25	$10,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	RRWTP	25	$15,000
Pump Motor	Well 01D - School St	25	$50,000
Pump Motor	Well 03 - Marvel	25	$35,000
Pump Motor	Well 04D - Webb	25	$45,000
Pump Motor	Well 08 - Williamson	25	$35,000
Pump Motor	Well 09 - Polhemus	20	$25,000
Pump Motor	Well 11D - Dino	25	$45,000
Pump Motor	Well 13 - Hampton	25	$40,000
Pump Motor	Well 14D - Railroad	25	$50,000
Reaction Vessel	HVWTP	25	$100,000
Reaction Vessel	HVWTP	25	$100,000
Roll-up Door	RRWTP	20	$50,000
Salt Brine Tank	RRWTP	20	$25,000
SCADA Server	RRWTP	10	$10,000

Asset Type	Area	Useful Life	Repl. Cost
SCADA Server	RRWTP	10	$10,000
Skid Steer Mobile Equipment	Parking Lot	20	$55,000
Skid Steer Mobile Equipment	Parking Lot	20	$55,000
Sodium Hypochlorite Chemical System	Well 03 - Marvel	15	$5,000
Sodium Hypochlorite Chemical System	Well 08 - Williamson	15	$5,000
Sodium Hypochlorite Chemical System	Well 09 - Polhemus	15	$5,000
Sodium Hypochlorite Pump	HVWTP	15	$5,000
Sodium Hypochlorite Pump	HVWTP	15	$5,000
Sodium Hypochlorite Pump	RRWTP	10	$10,000
Sodium Hypochlorite Pump	RRWTP	10	$10,000
Sodium Hypochlorite Pump	RRWTP	10	$10,000
Sodium Hypochlorite Pump	RRWTP	10	$10,000
Sodium Hypochlorite Tank	HVWTP	15	$5,000
Sodium Hypochlorite Tank	RRWTP	15	$25,000
Surge Tank	Well 03 - Marvel	40	$100,000
Surge Tank	Well 08 - Williamson	40	$100,000
Surge Tank	Well 09 - Polhemus	40	$100,000
Transfer Switch	RRWTP	25	$25,000
Transfer Switch	Well 11D - Dino	25	$25,000
Vac Trailer Mobile Equipment	Parking Lot	20	$65,000
Vac Trailer Mobile Equipment	Parking Lot	20	$65,000
Vac Trailer Mobile Equipment	Parking Lot	20	$80,000
Well Casing	Well 01D - School St	30	$1,000,000
Well Casing	Well 03 - Marvel	30	$1,000,000
Well Casing	Well 04D - Webb	30	$1,000,000
Well Casing	Well 08 - Williamson	30	$1,000,000
Well Casing	Well 09 - Polhemus	30	$1,000,000
Well Casing	Well 11D - Dino	30	$1,000,000
Well Casing	Well 13 - Hampton	30	$1,000,000
Well Casing	Well 14D - Railroad	30	$1,000,000
Well Pump	Well 01D - School St	15	$30,000
Well Pump	Well 03 - Marvel	15	$25,000
Well Pump	Well 04D - Webb	15	$35,000
Well Pump	Well 08 - Williamson	15	$25,000
Well Pump	Well 11D - Dino	15	$35,000
Well Pump	Well 13 - Hampton	15	$25,000
Well Pump	Well 14D - Railroad	15	$35,000

Kennedy/Jenks Consultants