

## Attachment 1 – Asset Risk Assessment

### Overview

The District measures risk as Business Risk Exposure (BRE). BRE is calculated as follows:

$$\text{BRE} = (\text{Probability of Failure}) \times (\text{Consequence of Failure}) \times (\text{Redundancy})$$

Each of these components is discussed in more detail below.

### Probability of Failure (PoF)

PoF is equal to an asset's condition score. The condition score indicates how close the asset is to failure. Scores range from 1 to 5, as shown below:

1 – Excellent (Normal Maintenance Required)

2 – Minor Defects Only

3 – Maintenance Required

4 – Major Renewal Required

5 – Unserviceable or Failed

The Asset Management Unit assesses asset condition every two years, and assigns an overall condition score, which becomes the asset's PoF. An example of asset condition assessment criteria for a mixer is shown in Table 1. The assessor evaluates the asset for each inspection criteria, and assigns the appropriate rating. The assessor then assigns an overall condition score, typically equal to the worst scoring criteria. For example, if 'Corrosion' is 'excessive', but all other criteria are 'excellent', the asset would receive an overall score of 5, because it requires immediate maintenance. The overall condition/PoF score is loaded into the asset databases in Maximo and AMPT and is monitored for changes over time.

**Table 1. Mixer Assessment Criteria**

Inspection Criteria	Rating				
	1	2	3	4	5
Corrosion	Negligible	Minor	Moderate	Major	Excessive
Support	Excellent		Moderate		Inadequate, Failure Imminent
Functional	Excellent Mixing at all flows	Mixing adequate under all flow conditions	Mixing adequate under most flow conditions	Mixing inadequate 50% of time	Inadequate Mixing
Shaft Alignment	Excellent	Minor Wear but no Misalignment	Moderate Wear or Misalignment	Major Wear	Failure Imminent
Belt/Chain	Excellent	Minor Wear	Moderate Wear	Major Wear	Failure Imminent

### Consequence of Failure (CoF)

Consequence of failure measures impacts of asset failure. The District evaluates the social, environmental, and financial effects of asset failure to determine CoF. To calculate CoF, staff subject matter experts assign a one to five score for six categories using a standardized matrix, shown in Table 4. The total CoF score is the sum of the scores for each of the six categories. The minimum CoF score is zero, which would occur if an asset scored zero in each of the six categories. The maximum CoF score is 30, which would occur if an asset scored five in each of the six categories. CoF scores do not vary much over time, unless external conditions change, such as an area becoming more populated.

### Redundancy

Redundancy accounts for back-up assets or extra capacity within a system. The Asset Management Program doesn't currently include a separate factor for redundancy in the BRE calculation, but rather accounts for redundancy in the CoF score. For example, staff would assign a lower CoF score for a chemical metering pump with two back-up pumps than for a single pump with no back-up. The consequence of one of three pumps failing is low, while the consequence of a single pump failing is higher.

The asset management program is working to develop standards for measuring redundancy and incorporate a redundancy factor into the BRE score.

### Total BRE Score

To recap, the District measures risk associated with an asset with a Business Risk Exposure (BRE) score.

$$\text{BRE} = (\text{Probability of Failure}) \times (\text{Consequence of Failure}) \times (\text{Redundancy})$$

Probability of Failure equals the asset's condition score, which ranges from one to five. Consequence of Failure is determined using the matrix in Table 4, and ranges from zero to thirty. Total BRE scores, therefore, can range from 0 to 150.

The total BRE score is used to determine when an asset requires action or a changed maintenance strategy. The Water Utility has set the BRE score thresholds below. These thresholds identify when an adjustment in an asset's management strategy is needed. The thresholds may be adjusted over time as risk scores are refined.

BRE Score	Risk Category	Action
61 – 150	Critical	Develop and implement a risk mitigation strategy such as accelerated asset replacement or rehabilitation
51 – 60	Moderate	Implement more frequent condition monitoring
0 – 50	Low	Continue routine maintenance program as planned

In addition, the total BRE score is useful in determining relative risk among assets. Rehabilitation work on an asset with a higher BRE score should be prioritized over work on an asset with a lower BRE score.

### History and Maintenance of Water Utility BRE Scores

The Water Utility Asset Management Program developed risk scores for all assets when the program began in 2003. The scores at that time were not "BRE" scores, but have been

converted to BRE scores. The probability of failure component of the risk score has been updated periodically for almost all assets through routine condition assessments.

Consequence of failure scores don't typically change much over time, but have been updated recently for San Felipe Division Reach 1, pond and canal systems, and pre-stressed concrete cylinder pipe (PCCP); but not for most water treatment plant, pump station, or welded steel pipeline assets.

The Asset Management Unit will update CoF scores for remaining assets; however, rather than updating CoF for all assets at once, staff will evaluate scores as part of developing asset management plans. The Asset Management Unit will develop an asset management plan for one or two major facilities or asset classes per year. In the process of developing an asset management plan, staff subject matter experts will review and update CoF scores. In fiscal years 2017 and 2018, the program will analyze all pipe infrastructure.

#### Additional BRE Modifications

Some improvements related to BRE that the Asset Management Unit will be working on in the coming years include:

- Developing standards for measuring redundancy and incorporating a redundancy factor into the BRE score
- Evaluating and refining thresholds for critical, moderate, and low risk scores
- Refining and updating the CoF matrix
- Incorporating BRE into capital project prioritization
- Updating CoF scores for assets that have not had scores updated since 2003

#### Water Utility Risk Summary

The most recent comprehensive assessment of Water Utility asset condition and risk was compiled for the 2014 District-wide Asset Management Plan, and is shown in Tables 2 and 3 below.

**Table 2. Water Utility Asset Condition Summary from 2014 District-wide AMP**

Condition Score	No. of Assets	% by Number	Value of Assets	% by Value
<b>1 – Excellent</b>	902	11%	\$58,329,000	<1%
<b>2 – Minor Defects</b>	3,477	43%	\$3,301,437,000	47%
<b>3 – Maintenance Required</b>	2,277	28%	\$2,037,709,000	29%
<b>4 – Major Renewal Required</b>	585	7%	\$139,946,000	2%
<b>5 – Unserviceable/Failed</b>	227	3%	\$5,535,000	<1%
<b>Land (Not Scored)</b>	300	4%	\$915,705,000	13%
<b>Other Not Scored</b>	285	4%	\$596,201,000	8%
<b>Total</b>	8,053	100%	\$7,054,861,000	100%

**Table 3. Water Utility Asset Risk Summary from 2014 District-wide AMP**

<b>Risk Level</b>	<b>No. of Assets</b>	<b>% by Number</b>	<b>Value of Assets</b>	<b>% by Value</b>
<b>Low</b>	6,186	83%	\$1,298,885,000	22%
<b>Moderate</b>	712	9%	\$2,320,677,000	39%
<b>Critical</b>	570	7%	\$2,323,802,000	39%

Staff will provide a more detailed update on asset risk at a Board meeting in May 2017, including an updated condition and risk profile.

Table 4. Consequence of Failure Matrix

	Impact	None	Very Low	Low	Medium	High	Critical
	Score->	0	1	2	3	4	5
Social (Score 0 to 10)	Service Delivery	No impact	Failure of asset results in <b>short term (&lt; 30 days), local reduction</b> in service delivery	Failure of asset likely to result in <b>long term (&gt; 30 days), local reduction</b> in service delivery	Failure of asset likely to result in <b>short term (&lt;30 days), wide spread reduction</b> in service delivery	Failure of asset likely to result in a <b>long term (&gt; 30 days), localized total loss</b> in service delivery	Failure of asset likely to result in a <b>long term (&gt; 30 days), wide spread total loss</b> in service delivery
	Impact to Community Property	No impact/damage	Failure of the asset results in <b>minor, localized damage</b> to community property	Failure of the asset results in <b>minor, wide spread damage</b> to community property	Failure of asset results in <b>major, localized damage</b> to community property	Failure of asset results in <b>major, wide spread damage</b> to community property	Failure of asset results in <b>catastrophic, wide spread damage</b> to community property
Environmental (Score 0 to 10)	Environmental Impacts	No impact	Failure of the asset does <b>minor</b> environmental damage	Failure of asset likely to cause non-lasting <b>(short term) repairable damage</b> and expect recovery within one year	Failure of asset likely to cause medium-term repairable damage and expect <b>recovery within 3 years</b>	Failure of asset likely to cause long-term repairable damage and recovery requires <b>more than 5 years</b> and may significantly compromise habitat	Failure of the asset likely to cause environmental damage with lasting consequences (permanent change to habitat) and <b>permanent damage to habitat</b>
	Life Safety	No Impact	Failure of the asset results in <b>minor</b> reportable injuries	Failure of asset results in <b>significant</b> reportable injuries	Failure of asset results in <b>short-term</b> disabilities	Failure of asset results in <b>long-term</b> disabilities	Failure of asset likely to result in <b>death</b>
Economic (Score 0 to 10)	Financial Impact	No impact	Failure of asset results in <b>&lt;\$10,000</b> rehab/replacement/penalty cost	Failure of asset results in <b>\$10,000 - \$50,000</b> rehab/replacement/penalty cost	Failure of asset results in <b>\$50,000 - \$100,000</b> rehab/replacement/penalty cost	Failure of asset results in <b>\$100,000 - \$500,000</b> rehab/replacement/penalty cost	Failure of asset results in <b>&gt;\$500,000</b> rehab/replacement/penalty cost
	Impact to Reputation	No impact	Failure of asset likely to cause minor impact to reputation	Failure of asset likely to cause minor public complaints to District	Failure of asset likely to get attention of Board Members	Failure of asset likely to create negative media coverage	Failure of asset likely to bring criminal charges to District