

BUSINESS RISK EXPOSURE MODEL

Water Operations Division

Water Committee
October 13, 2021

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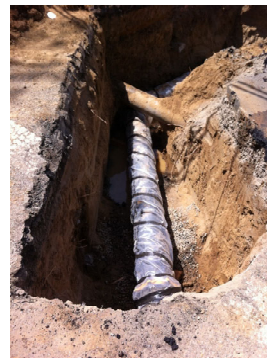
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BACKGROUND

Distribution Pipeline
Replacement in 2008:

1. More leaks were being experienced
2. Increased effort to replace pipelines
3. Increased budget due to new rates



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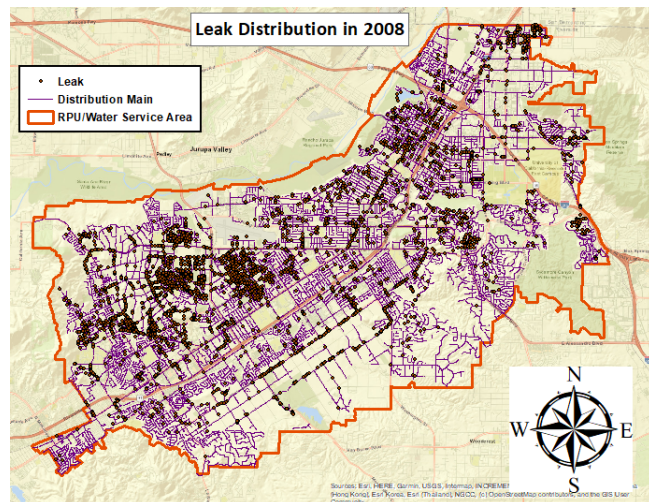
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BACKGROUND

Selection Process in 2008:

1. Visual selection
2. Manual
3. Susceptible to human biases
4. Non-reproducible
5. Not able to balance competing priorities



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DISCUSSION

Methodology - Overview:

1. Calculates risk posed by the failure of each pipeline

$$\text{Risk} = \text{Probability of Failure (PoF)} \times \text{Consequence of Failure (CoF)}$$

2. Considers risks to the Triple-Bottom Line (Economic, Environmental, and Social)
3. Risk management workshops and interviews were conducted in 2011

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DISCUSSION

Methodology - CoF:

CoF Risk Factors and Weighting

Risk Factor	Justification	Weighting
Traffic	Proxy for economic activity	Max 0.45
w/o Casing under Railroad	Leak could jeopardize integrity of railroad	0.4
Within Median	Difficult to repair, long repair times	0.15
Proximity to Structure	Chances of damage to private property is high	0.15
Undersized for Fire Flow	Poses risk due to deficient fire flow	Max 0.3
Within Sidewalk	Difficult to repair, long repair times	0.1



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DISCUSSION

Methodology - PoF

1. Attempts were made to identify correlation between failures soil chemistry, material type, and age
2. Statistically significant correlations were not found for soil chemistry and material type
 - A. Presence of corrosive soil is known in some areas of the City
 - B. Lack of accurate data lead to statistically insignificant results
3. Age and pipe's leak history are used as indicators of future failures.



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DISCUSSION

Methodology – BRE Score:

1. BRE Score is calculated for each pipe segment

$$\text{BRE Score} = \text{PoF} \times \text{CoF}$$

2. Projects are built around the highest BRE score pipes
3. Due to the use of the methodology
 - A. Unencased pipelines under railroads were identified and encased
 - B. Preventive replacements were performed in high traffic streets
 - C. Pipelines on private properties were abandoned



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DISCUSSION

Strengths of The Methodology

1. Transparent, reproducible, and consensus based
2. Considers non-economic factors that impact the community
3. Single index methodology avoids the pitfalls of a risk matrix-based selection

		Impact →				
		Negligible	Minor	Moderate	Significant	Severe
Likelihood ↑	Very Likely	Low Med	Medium	Med Hi	High	High
	Likely	Low	Low Med	Medium	Med Hi	High
	Possible	Low	Low Med	Medium	Med Hi	Med Hi
	Unlikely	Low	Low Med	Low Med	Medium	Med Hi
	Very Unlikely	Low	Low	Low Med	Medium	Medium



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DISCUSSION

Ideas for Future Improvements

1. Inclusion of soil corrosivity in PoF calculations
 - A. Mapping of geotechnical reports with kriging for spatial interpolation;
 - B. Logistic regression with new data on corrosivity values
2. Normalization of PoF values to 1 and BRE Scores on linear length of pipe

DISCUSSION

Ideas for Future Improvements (Continued)

3. Build a project selection tool that:
 - A. Optimizes the selection on Reduced Risk / Cost of Project
 - B. Takes into account economy of scale
4. Implement similar methodology to other asset types such as boosters stations

DISCUSSION

Implementation to Other Asset Types

1. Implementation of Reliability Centered Maintenance (RCM) to booster stations.
2. Steps for RCM:
 - A. Identify risk factors and assign CoF ratings to each pump.
 - B. Identify failure-modes for pumps
 - C. Select the most common failure modes using the pareto rule
 - D. Perform condition assessment and assign PoF rating to each pump
 - E. Develop a predictive maintenance plan customized for each pump
3. Expected Outcomes from RCM:
 - A. Fewer "high risk" failures with same maintenance budget
 - B. Improved capital expenditure decisions



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DISCUSSION

Recent Pipeline Projects Identified by the BRE Model

1. History of multiple failures
2. Greatest risk of experiencing future failures
3. Two examples:
 - a) Matheson Steel pipe
 - b) Ferrous pipe in active soils



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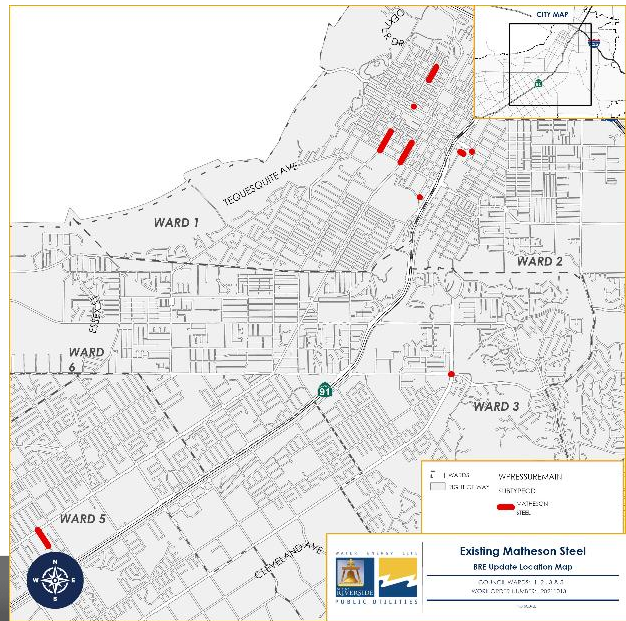
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DISCUSSION

Matheson Steel Pipe in Brockton Ave.

1. 4,630 LF total in RPU's system
 - A. Installed in early 1900s
2. 1,200 LF in Brockton Ave.
 - A. Installed in 1914
 - B. 15 leaks to date



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DISCUSSION

Ferrous Pipe in Active Soils – Wolfe and Bingham

1. 2,000 LF total
2. Installed in 1998
3. 20 Leaks to date



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STRATEGIC PLAN ALIGNMENT

1. Environmental Stewardship; High Performing Government; and Infrastructure, Mobility & Connectivity
2. Cross-Cutting Threads include:
 - a) Community Trust – Use of the BRE Model ensures transparency in the identification and selection process of pipeline replacements utilizing limited CIP resources.
 - b) Equity – The use of the BRE Model ensures that main replacement dollars are utilized where there is the greatest need and funding can address the most vulnerable segments of pipeline.



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STRATEGIC PLAN ALIGNMENT

- c) Fiscal Responsibility – Utilization of the BRE Model helps to maximize the use of limited CIP funding to address the areas of greatest system need and also those areas that would have the greatest consequence of failure.
- d) Innovation – The use of a model-based approach to main replacement selection is an innovative approach that was developed in-house by RPU staff nearly ten years ago. It has been proven to be an effective risk-based methodology which has helped RPU to maximize the impact of its main replacement funding.



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STRATEGIC PLAN ALIGNMENT

- e) Sustainability & Resiliency – Infrastructure renewal helps to maintain the reliability and a high level of service to RPU customers; replacing the right mains at the right time helps to mitigate against lost water, damages to property and infrastructure, and ensure that staff and field labor resources are conserved.

RECOMMENDATION

That the Water Committee receive the update on RPU's Business Risk Exposure Model.