

Advanced Condition Assessment & Pipe Failure Prediction

Optimal management of water infrastructure

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Project overview: - New activities and project update

Overview

The Advanced Condition Assessment & Pipe Failure Prediction Project is a vibrant collaboration of researchers and water utilities from around the globe dedicated to solving a major problem - failures in ageing critical pipelines which deliver fresh water to the towns and cities of the world. Failures in "critical pipes", those with diameter greater than 300 mm, present a major challenge to cost effective management of water pipe assets.

To address this issue, members of the world's water industry concluded a Collaborative Research Agreement in July 2011. This Agreement provides for cash and in-kind funding of \$13.4 million (including \$5.9 million cash) over five years.

The partners in this research project include Sydney Water Corporation, UK Water Industry Research Ltd., Water Research Foundation of the USA, Water Corporation (WA), City West Water, Melbourne Water, South Australia Water Corporation, South East Water Ltd, and Hunter Water Corporation. Monash University leads the research supported by University of Technology Sydney and the University of Newcastle. Other collaborators include Dr Balvant Rajani of Canada.

The Project comprises five Activities. Work began on the first three in the second half of 2011 while work on Activities 4 and 5 began in early 2014.

What the project will achieve

This project will deliver a failure prediction model along a cast iron cement lined critical water pipe, taking into consideration failure data, the data driven interpretation of condition assessment and the

validated corrosion rate.

Value to the water industry

Benefits for the water industry from this failure prediction model include:

- Improved targeting of high risk critical pipe renewals with savings in investment – up to 20% saving on current investment levels is feasible
- Improved preventative maintenance strategies providing better targeting of pipes ahead of failure, with resulting less disruption to customers
- Better communication with customers and enhanced reputation for water utilities

Project Activities

The Activities making up this project are:

Activity 1 – How, when and where will critical pipes fail within our network? Monash University is conducting the research for this Activity and is the lead university for the Project.

Activity 2 – How do we assess the condition of the pipe cost-effectively? University of Technology Sydney is conducting the research for this Activity.

Activity 3 – How do we calculate pipe deterioration rates accurately with respect to the environment? University of Newcastle is conducting the research for this Activity.

Activity 4 - Improving confidence in critical pipe failure prediction. The three universities have recently begun research across five sub-activities.

Industry Partners



Activity 5 – Knowledge management and decision support. Sydney Water is coordinating this Activity with its industry partners.

More detailed information about Activities 4 and 5 follows:

Activity 4

The aim of Activity 4 is to improve current capacities to predict the likelihood of pipe failure for a given length of pipe. Figure 1. illustrates how Activity 4 will relate to Activities 1 – 3.

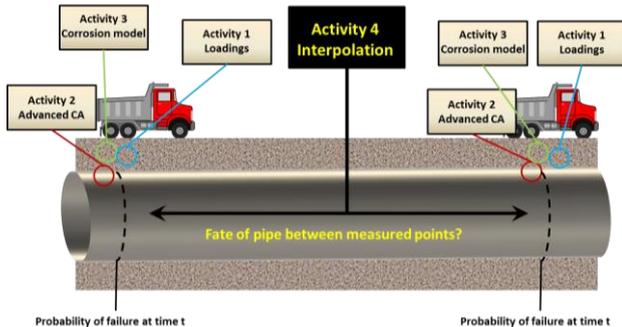


Figure 1. Illustration of how Activity 4 will improve prediction of pipe failure by interpolation between measurements at fixed points.

The five sub-activities of Activity 4 to be researched by the relevant Universities are:

- 4(a) – Enhancing the reliability of condition assessment of buried large diameter water mains (UTS)
- 4(b) – Reducing the uncertainty of non-destructive, indirect measurement with linear polarisation resistance (LPR) (University of Newcastle and UTS)
- 4(c) – Predicting the likelihood of pipe corrosion and its severity along the pipe to forecast failure (University of Newcastle)
- 4(d) – Enhancing the reliability of emerging technologies that have not yet been incorporated into the current research project (UTS)
- 4(e) – The probability of failure (Monash University)

Activity 5

This Activity is concerned with knowledge management and decision support for the water industry partners. This will include a user-friendly menu driven knowledge management system providing technical know-how and guidance for use of the water industry partners. Also, an updated decision making framework for the management of

critical pipes will be provided. The decision support system will be a utility partner based development.

Update on Activities 1, 2 and 3

Activity 1

The outcome of Activity 1 will be twofold: (1) Improved methods for estimation of pipe remaining life considering available information including condition assessment data; (2) Development of practical concepts for monitoring of new pipelines using optical fibres and other sensors.

Current work includes monitoring of stresses in the Sydney Water test bed, monitoring of pressure transients in water networks, development and validation of pipe failure models using field case studies, field measurements and full scale pipe burst tests, investigation of pipe material properties and failure potential, and development of optical fibre technologies for pipeline monitoring.

Activity 2

Activity 2 will deliver outcomes including; - Improvements to magnetic flux leakage (MFL) and broadband electromagnetics (BEM) sensing technologies, a database providing for the direct evaluation of the effectiveness of various technologies, and guidelines for selecting inspection technologies for a range of common application scenarios based on the relative merits of the technologies evaluated.

Current work includes investigation of simulation models for two additional condition assessment technologies. They are: (i) modeling with finite element analysis (FEA) of an acoustic wave propagation technology applied to a fluid filled pipe and (ii) modeling with FEA of a remote field eddy current technology in conjunction with the ground truth to improve sensor localisation. At this stage, detection and verification of pipe construction features such as joints has been developed using machine learning.

Activity 3

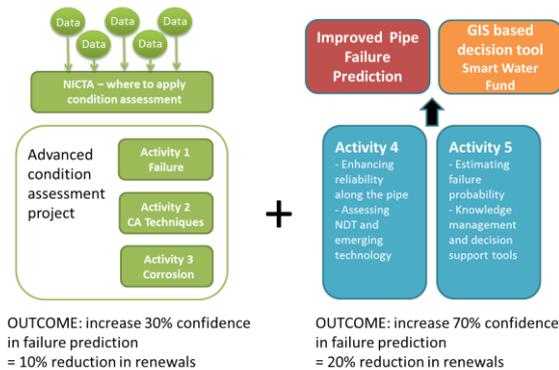
The outcome of Activity 3 will be the development and calibration of a realistic predictive model for pipe corrosion in soil. Associated with this outcome is the collection of data sets for measured pit depths and associated soil conditions, covering a wide range of climatic conditions.

Current work includes application of 3D imaging techniques, such as photogrammetry, to characterize the surface state around the circumference of selected pipe sections provided by Sydney Water and other utilities, and determination of the effect of soil conditions (including moisture content, soil type and soil water chemistry) on corrosion rate.

Other related projects

- NICTA – Sydney Water research collaboration; Sydney Water has engaged NICTA over the last two years to use data driven research to predict where high risk critical pipes are in order to plan its condition assessment program.
- In March 2014 Monash University entered into an agreement with the Melbourne Water administered Smart Water Fund to develop integrated algorithms and modules for effective water pipe asset management for both large and small diameter pipes, considering external and internal factors leading to pipe failure.

Benefits



This figure illustrates how these two related projects interact with the project Activities.

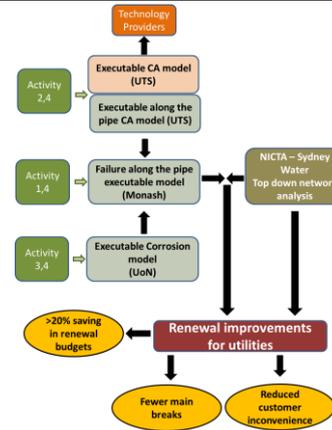


Figure showing how project can deliver improvements for water utilities.

Summary

The objective of the Advanced Condition Assessment and Pipe Failure Prediction Project is to solve the problem of failures in ageing critical pipelines which deliver fresh water to the towns and cities of the world. The partners in this research project include water utilities from Australia, the United Kingdom and North America, and three Australian universities. The project has total funds available of \$13.4 million (including \$5.9 million cash) for research across five Activities taking from 2011 to 2016.

The project will deliver a failure prediction model along a cast iron cement lined critical water pipe, taking into consideration failure data, the data driven interpretation of condition assessment and the validated corrosion rate. Benefits for the water industry from this failure prediction model will include:

- Improved targeting of high risk critical pipe renewals
- Improved preventative maintenance strategies
- Better communication with customers

Other projects related to the Advanced Condition Assessment and Pipe Failure Prediction Project include the NICTA – Sydney Water research collaboration and the research agreement between Monash University and the Melbourne Water administered Smart Water Fund.

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