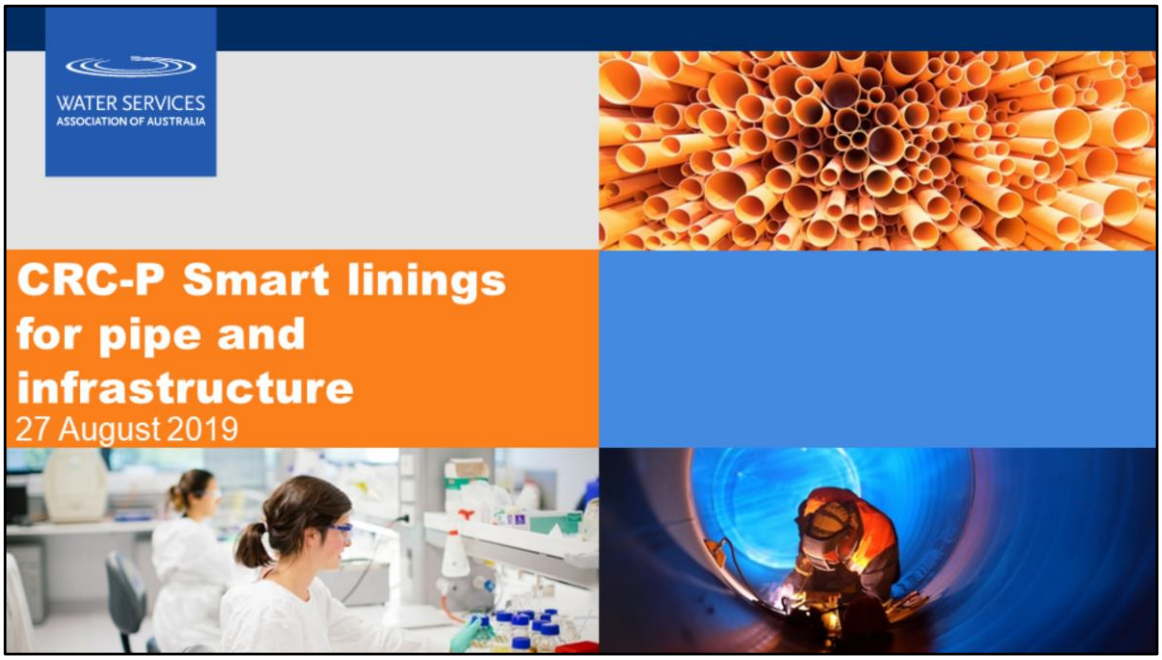


Agenda:
-Outline of who's involved
-Overview of the project
-Details of recent progress
-Project outcomes

What is WSAA?

WSAA is the water industry peak body – its key roles are:

Collaboration – we bring members together to share information, solve problems, or undertake projects that are too big or expensive to do alone.

Advocacy – we influence policy - representing water industry interests in Canberra and overseas.

Innovation – we introduce new ideas from Australia and overseas.

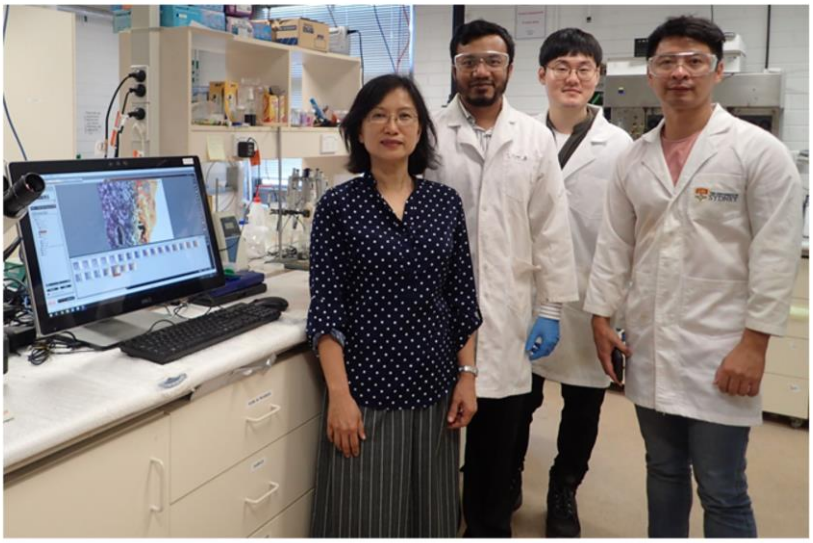
This project was made possible through the Cooperative Research Centres Program (CRC-P).

The CRC-P is an Australian Government program designed to foster high quality research to solve industry-identified problems.

The Smart Linings Project has been granted $3 million in funding through this program.

This project will improve the competitiveness, productivity, and sustainability of the Australian water industry.

Smart Linings Project Overview



Project Overview:

This is a research and development project.

Smart Linings Project Overview

We're looking at lining systems for water and wastewater pipes and infrastructure.
-Water: CIPP and Spraylining
-Wastewater – CAC and Geopolymer

Smart Linings Project Overview

We do this by running field trials of the various products.

Smart Linings Project Overview

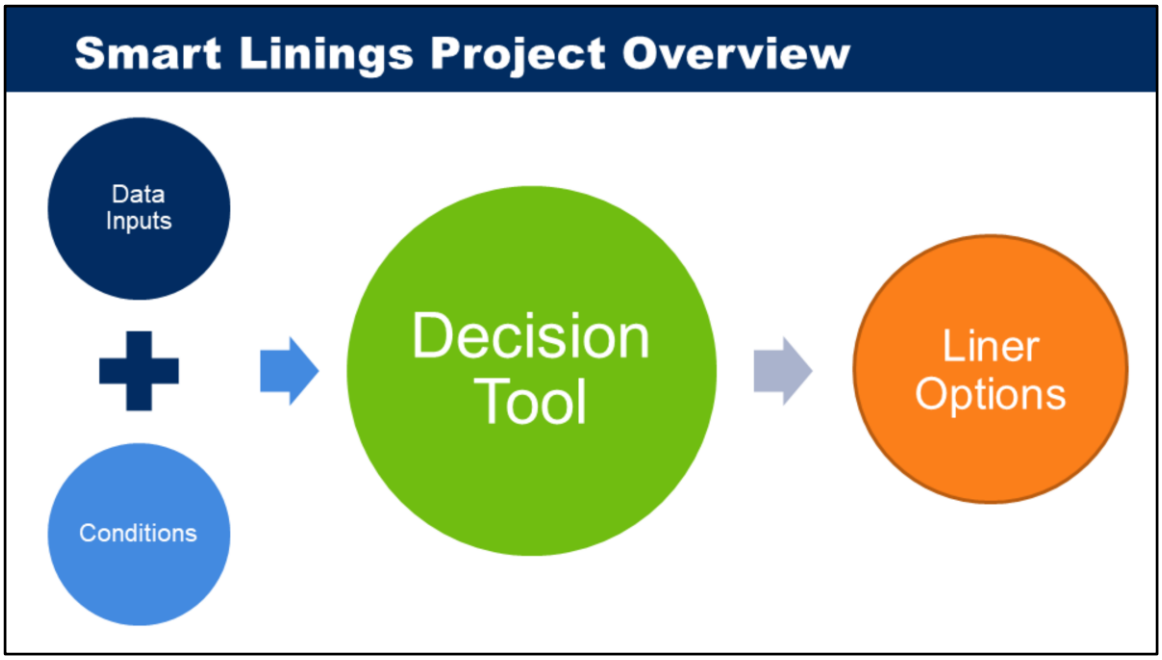
We take samples and test them at universities.

Feeding the test results into new Codes of Practice and Product Specifications.

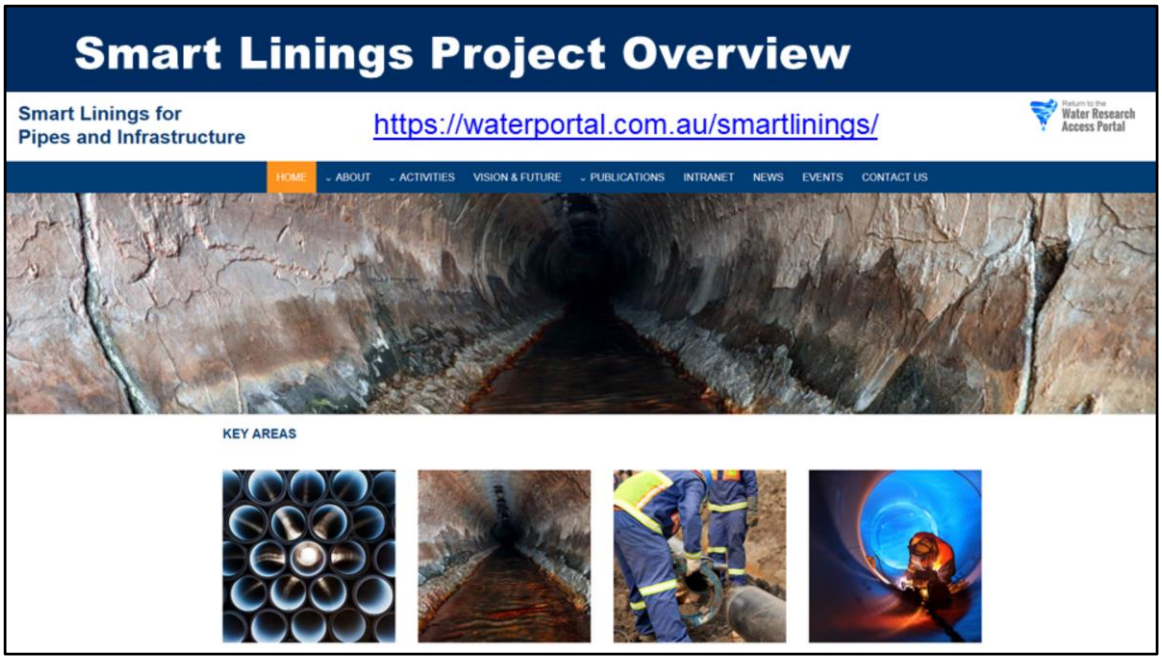
- 2 Codes of Practice
- 4 Product Specifications

Smart Linings Project Overview

We’re developing robotics and smart sensors to provide non-destructive quality assurance techniques.



We’re developing decision tools to help with pipe-liner selection and renewal prioritisation.



Educating the industry on the findings:

- Dedicated website
- Conferences
- Roadshows (technology workshops)

The project currently has 34 participating members, who all contribute through funds, expertise, materials and product application.

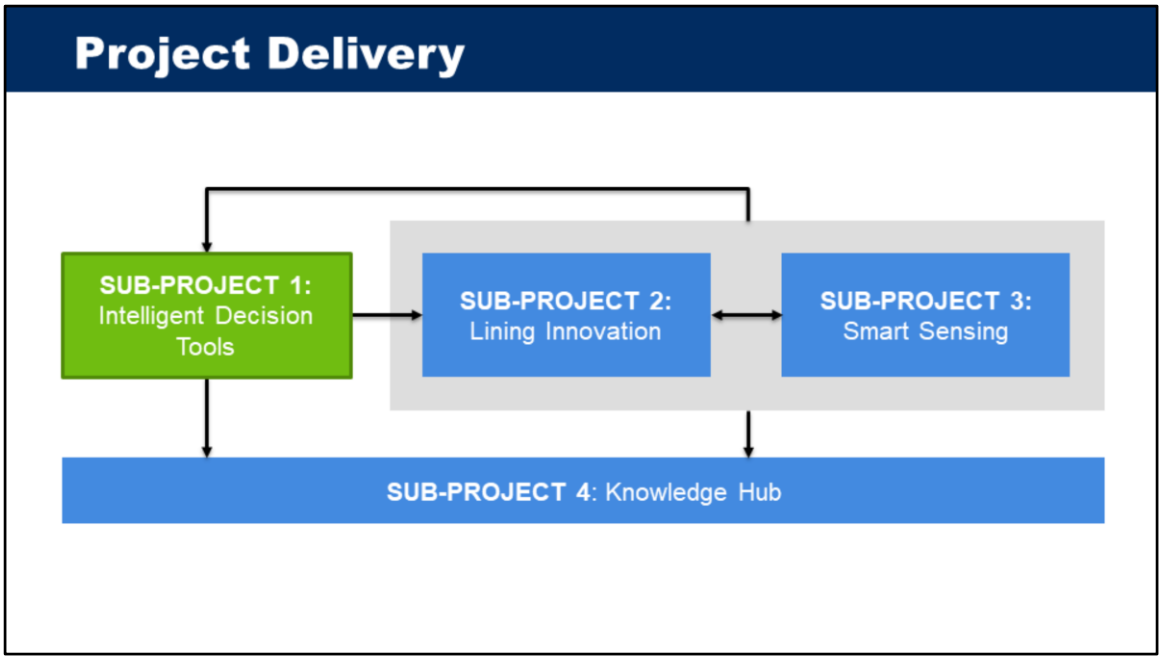
As you can see here we have Universities, Water Utilities, Water Industry Organisations (like WSAA), Applicators and Manufacturers.

We all work together, for example, a utility provides a site to trial a product, a manufacturer provides the product, an applicator applies the product and a university tests the installed product. From there, the test information is fed into product codes and standards, and representatives from these groups come together to review the documents.

Why?

WSAA and its partners are undertaking the project because of:

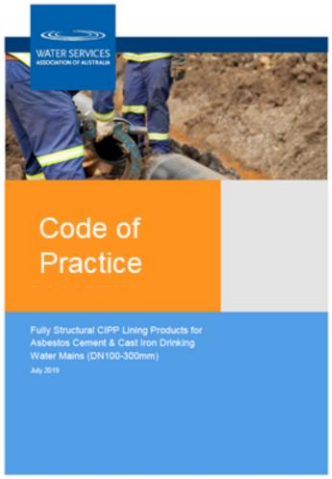
- **Aging infrastructure** – more than 50% of Australia's water assets are 60-100 years old. They will need renewal or replacement soon.
- **Increasing labour and material costs** emphasise the need for water utilities to do more with less and innovate cost effective solutions.
- **Asbestos cement pipe** presents a safety challenge for workers and for disposal. A lining system helps reduce interaction and keeps the AC pipes managed under water utility control.
- **Reduce impacts** to other authorities assets (roads and other services) and to the community (less time to install and less open trenching) at a time when customers are experiencing high work volumes.
- **Reduce the cost impact of corrosion** - aggregated cost of corrosion (to the water industry in Australia): $982 million in 2010.
- **The industry needs clarity** on the introduction, application and use of products through specifications, standards and tools to help the uptake of new products.



This is a large project and it's broken up into 4 main areas.

1. Includes Codes of Practice, Product Standards and Decision Tools.
2. Includes field trials and university research.
3. Includes development of non-destructive QA tools and embedded sensors.
4. Includes the distribution of knowledge and education of the industry on project findings.

Project 1 Update: Codes and Standards



Codes of Practice

- Wastewater linings
- Water linings

Product Specifications

- Calcium Aluminate Cement (CAC)
- Geopolymer
- Cured-In-Place-Pipe (CIPP)
- Spraylining

There are currently no standards by which to assess the quality of liners, this project will produce:

Codes of Practice

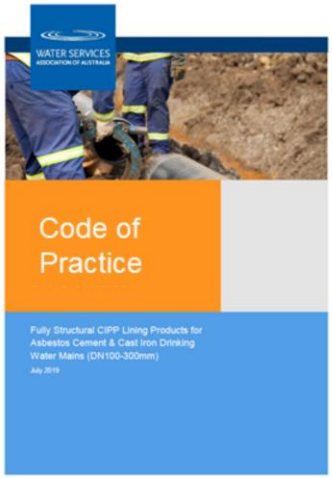
- How application should occur and where application should occur.
- Material selection.
- Post application field testing.

Product Standards

- Specify requirements for product properties, e.g. strength, life, corrosion resistance.
- Specify test methods to demonstrate requirements.

The first drafts have been completed for these documents.

Project 1 Update: Codes and Standards



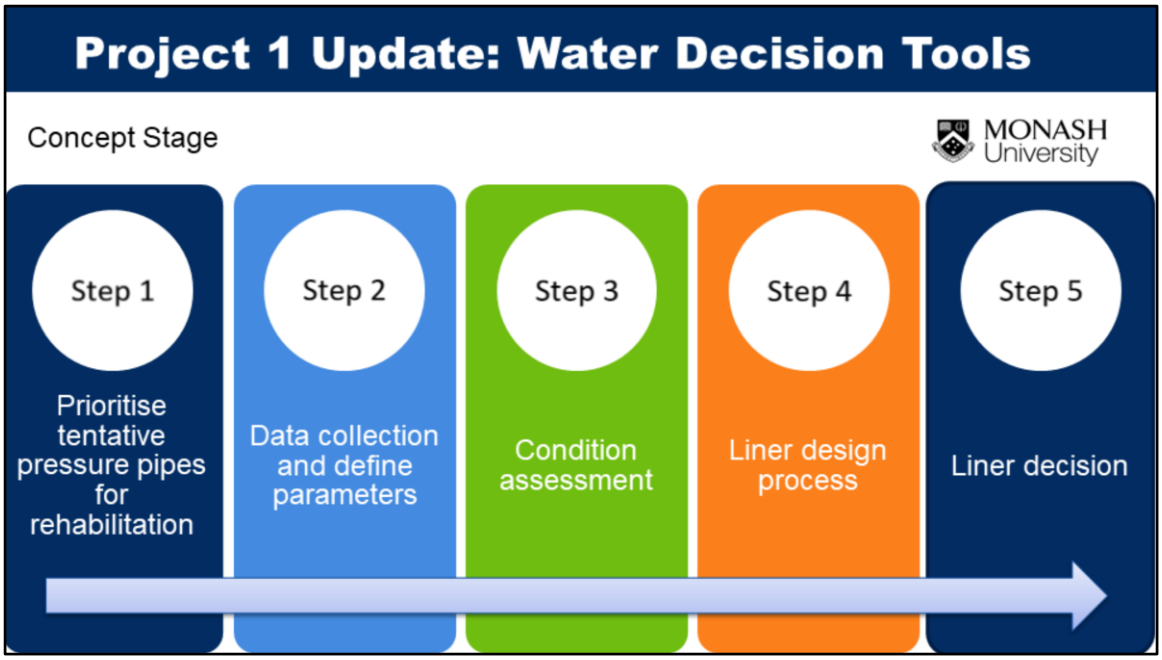
Draft framework for Codes of Practice

- Selection of Linings
- Surface Preparation
- Lining Application
- System specifications (wastewater only)
- Quality Control
- Return to Service (water only)
- Liner Maintenance

The Water Linings Code of Practice will be in the form of a standalone Manual for selection and application of cured-in-place pipe (CIPP) and spray liners for use in water pipe.

The Wastewater Linings Code of Practice will be in the form of an amendment to the existing WSA 201 Manual for Selection and Application of Protective Coatings.

The items listed on this slide are an abridged list of the documents' contents.



Part of sub-project 1 is to develop decision tools to assist the industry in knowing what products can be applied in what circumstances.

Please note that this is at concept stage, so we are expecting changes.

Step 1

- Utilities have data that they use for this already – construction date, pipe material, failure rates, risk models.

Step 2

- Pipe data – material, size (OD & ID), existing liners, no. of appurtenances, elevation changes, bends.

Step 3

- May not be economical for smaller pipes – so use data only model to predict future failure locations. Data used includes failure and leak records (including mode of failure).
- For larger diameters or critical pipes – do a more detailed condition assessment via robotics, CCTV, pulse eddy current, laser profile, and/or remaining wall thickness.

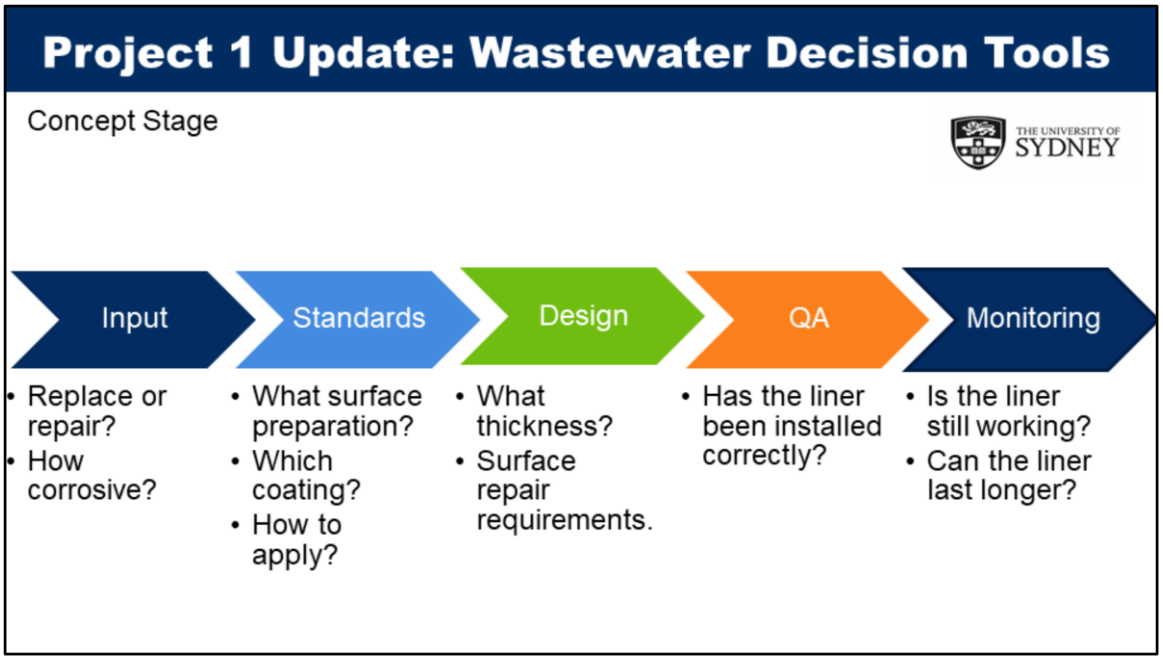
Step 4

- This is the decision tool step in the process. It pulls the data we have from the previous steps and puts it together, with other data about when a liner is best used, and provides options.

Step 5

- Recommended options for lining.

That's a simplified version of the process. The decision tool will consider: the information provided so far, host pipe deterioration models, long term liner properties (verified by lab testing), negative pressure requirements, level of corrosion, excavation requirements, social disruption, required thickness, number of connections, end seal requirements, economic viability, among other things.



Similarly for wastewater applications, we're developing a decision tool to assist with selecting the correct product for the required application.

Please note that this is at concept stage, so we are expecting changes.

On this slide we are looking at the questions that each stage of the decision tool will answer, *below is the type of data that will be used in answering these questions.*

Input
- Asset properties, pipe prioritisation, sewer corrosion categories.

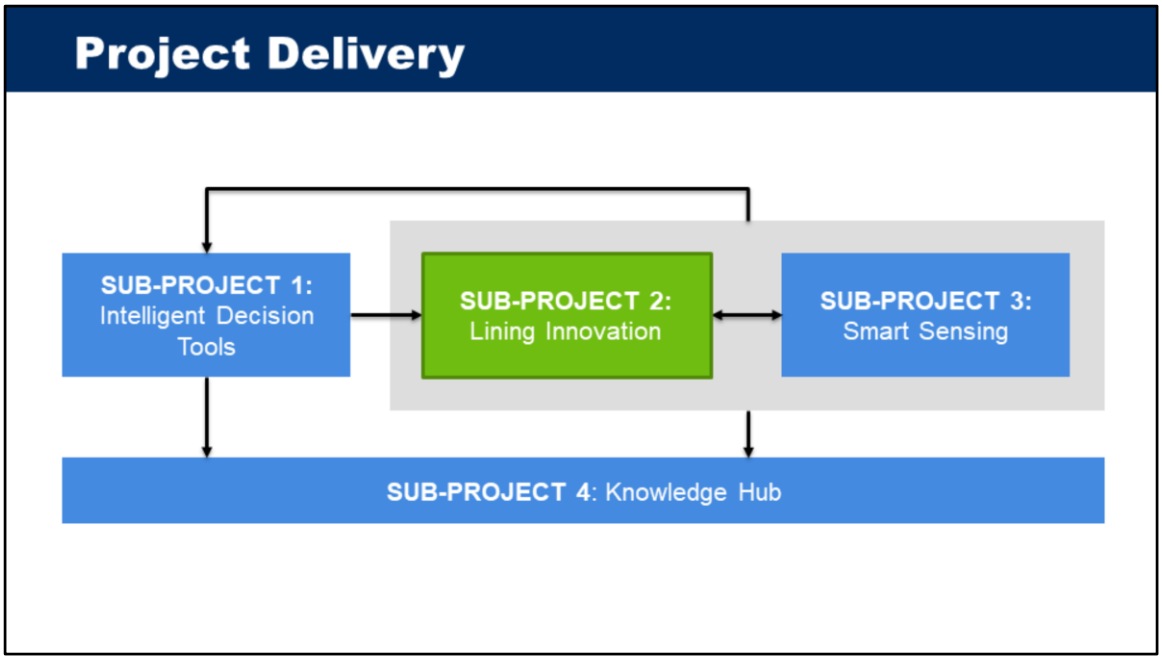
Standards/Specs/Codes of Practice
- Coating selection guidelines, host pipe requirements, surface prep., and coating application guidelines.

Design
- Service life model – what service life are we trying to achieve?

Quality Control and Quality Assurance
- Will consider aspects such as structural, bond strength, thickness, W/C ratio, curing, and porosity.

Monitoring and Maintenance

- Will consider aspects such as structural, bond strength, thickness, W/C ratio, curing, acid permeation.



Moving into and update on sub-project 2 - field trials and university research.

Water Trials

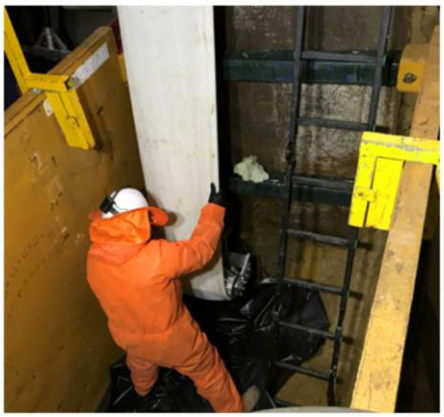
- Completed 6 – 1 Perth, 1 Melbourne, 2 Brisbane, 2 Sydney.
- Planned 5 more – 1 Adelaide, 1 Melbourne, 2 Sydney, 1 Brisbane.

Sewer Trials

- Completed 4 – 1 each in Melbourne, Perth, Adelaide and Brisbane
- Planned 1 more in Sydney

Also working with companies overseas, to share data from their field trials.

Project 2 Update: Field Trial Photos



Photos of CIPP installation in DN300 MSCL water main in WA

- Left – Worker helps feed CIPP liner into MSCL pipeline.
- Right – CIPP liner passes through a removed section of pipe (valve removed).

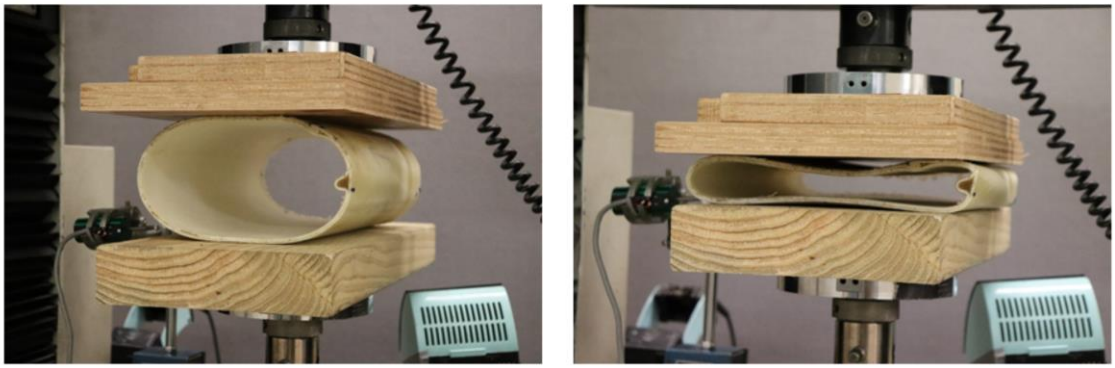
Project 2 Update: Field Trial Photos

Photos of sewer coatings via spray

- Left – application in maintenance hole.
- Right – in-pipe application under live flow.

Project 2 Update: University Testing

MONASH University



Ring test for CIPP liner - parallel plate test specimen compression with liner defects.

Monash University in undertaking testing on 5 water lining products in order to:

- Identify the main factors contributing to quality of installation
- Discover failure modes and mechanisms
- Feed this information into the codes of practice, product standards and decision tools.

The suite of tests is currently underway and includes:

- Creep tests
- Ring test (pictured)
- Vacuum test
- Burst test
- Bending test
- Gap coverage tests

Tests capture:

- Material properties
- Long-term properties
- Safety factors for defects
- Establish the class of liner

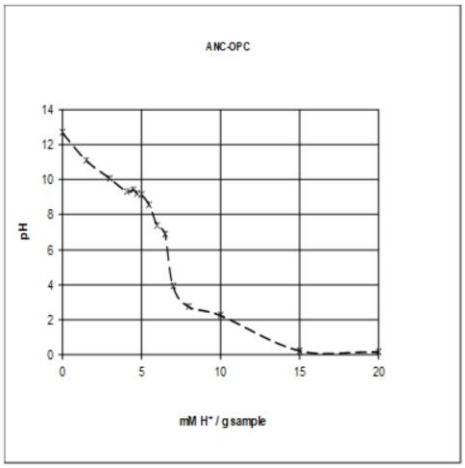
Project 2 Update: University Testing

Phenolphthalein spray application indicates when enough corroded material has been removed. It changes to pink at pH 8.2

Sydney University is undertaking testing on 8 wastewater lining/coating products in order to:

- Identify **criteria for prioritising** pipes for rehabilitation.
- Identify **environmental conditions** and establish **corrosion categories** based on impact (currently sewer environments all classed as aggressive).
- Identify coating and **host structure placement requirements** for short and long term performance for adhesion.
- Identify requirements to promote **coating durability** under different **corrosion conditions**.

Project 2 Update: University Testing



THE UNIVERSITY OF SYDNEY

Surface Preparation is Key

- In order for new coatings to work effectively the existing surface must be prepared properly prior to application of the new coating.
- Corroded material must be removed.
- The surface pH level must be checked prior to product application to be a pH 8 or higher.

An interesting finding from University of Sydney:

The Graph Explained:

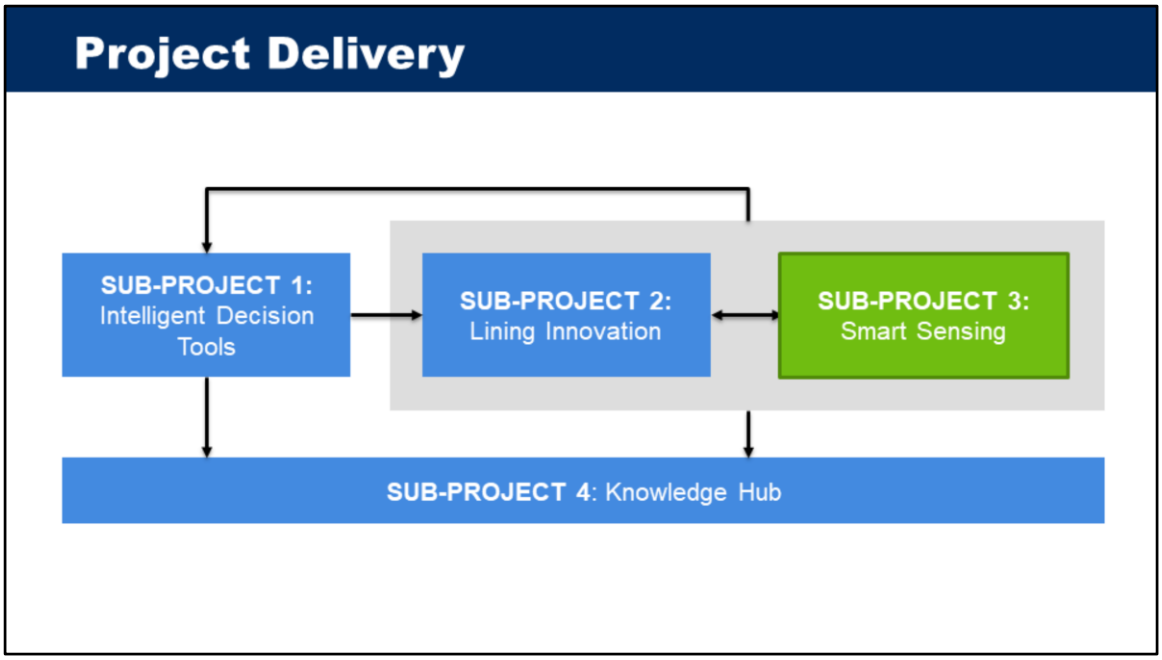
- Concrete's pH is approximately 12 when new.
- This graph indicates a relatively slow drop in in pH as acid is added to the sample between pH 12 and pH 8.
- This indicates that the concrete is resisting the acid.
- At pH 8 there is a sharp drop in pH when more acid is added.
- This indicates that the concrete is no longer resisting the acid.

Why this is important:

- When applying new coatings the main modes of failure are cohesive (within the material itself) or between the new material and the host structure.
- It's unlikely for the new material to have a cohesive failure, but it is likely for the existing structure to have a cohesive failure if it is corroded.
- By using a spray indicator the people doing the work to remove the corroded material know when they have finished.

A popular misconception

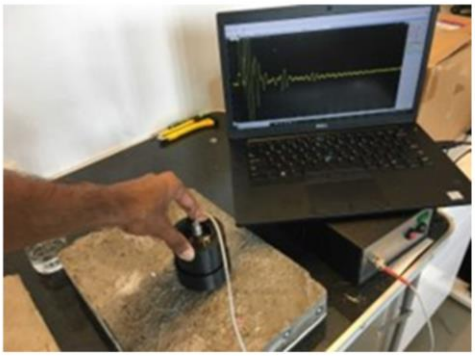
- That alkaline material can be applied to the corroded host material and this will fix the corrosion issues. This is not the case as the alkaline material does not replace the binding material that has been corroded away.



Moving into sub-project 3 with an update on the development of non-destructive QA tools and embedded sensors.

Project 3 Update: Handheld sensors

UTS



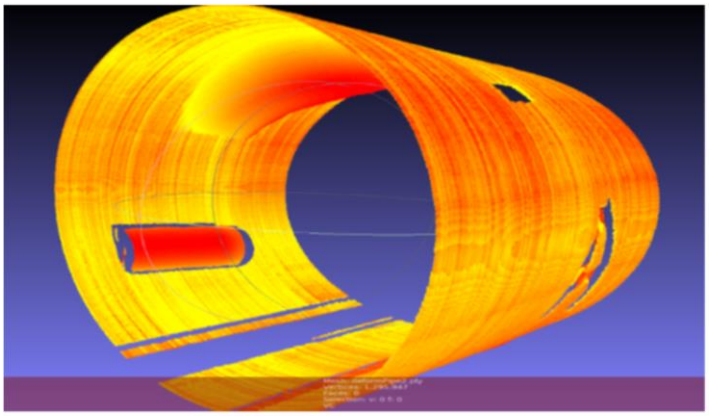
A handheld unit to measure liner thickness.

The University of Technology Sydney (UTS) is developing new technologies to measure liner thickness.

- UTS has developed a handheld unit that can accurately measure CAC and Geopolymer liner thickness using ultrasound.
- Customised hardware and software modules were developed in-house.
- Research work is in progress to develop handheld sensor units for in-situ measurement of acid permeation in liners.
- Field trials and lab validations are in progress.

Project 3 Update: Robotics

UTS



The University of Technology Sydney (UTS) is developing new technologies to identify defects.

- A robotic crawler moves inside pipes to generate accurate 3D models of the pipe.
- Generated 3D pipe models can be used to identify liner imperfections relating to folds, wrinkles, dimples, bulges, sagging, liner peeling (de-bonding), tears, damages and blisters.
- A combination of laser and ultrasound is used to measure thickness.
- The robot, sensors and preliminary algorithms are a contribution from Sydney Water and will be further developed during this project.
- Field trials and lab validations are in progress.

Project 3 Update: Embedded Sensors

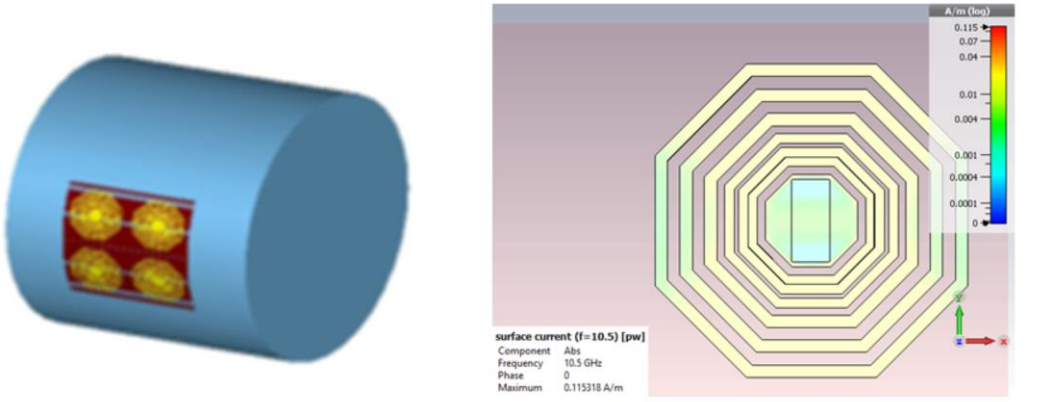
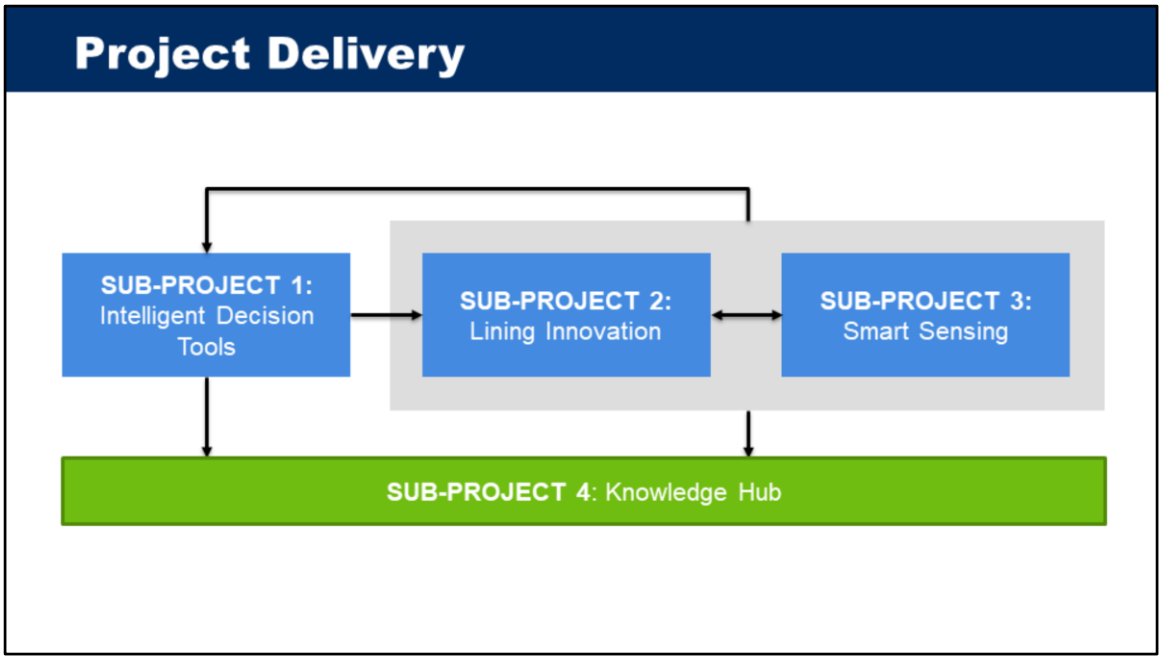


Diagram of embedded sensors in-liner (left) and close up (right).

UTS is conducting a comprehensive feasibility study of using liner embedded sensors for in-situ long term monitoring of liners.

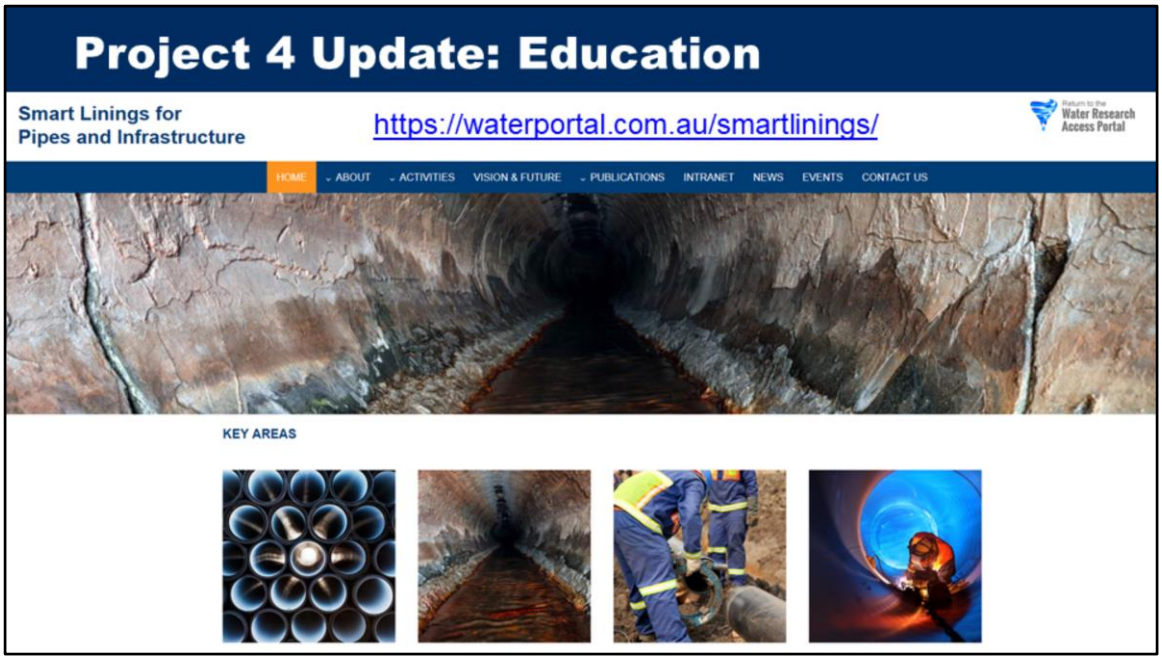
- Review of sensor technologies for measuring pH of the cementitious material has been completed.
- A smart material based sensor has been shortlisted as a potential option.

For example, a sensor may respond to a change in pH which can be picked up by a change in the sensor's radio signals. We may be able to use this to determine when the acid will permeate the liner.



Finally, sub-project 4 an update on the distribution of knowledge and education of the industry on project findings.

Project 4 Update: Education



A big part later in the project will be to educate the industry on the findings of the project. One place to get information is the Smart Linings Project Website.

The website contains:

- Updates on project activities.
- Fact sheets.
- And will eventually include training materials and be a resource on linings.

Project 4 Update: Education

Sign up for the newsletter:
http://tiny.cc/smartliningsnews

If you're interested in the latest news and updates from the project you can sign up for the newsletter which comes out every 6 weeks, or so.

Project 4 Update: Education

Technology Workshops

City	Venue	Date
Melbourne	Yarra Valley Water	15 Oct 2019
Brisbane	Mirra Events (close to QUU office)	16 Oct 2019
Sydney	Sydney Water (Potts Hill)	17 Oct 2019
Adelaide	SA Water (Adelaide)	29 Oct 2019
Perth	Water Corporation (Leederville)	4 Nov 2019

Register at: https://waterportal.com.au/smartlinings/

The technology workshops are free to attend, registration is required for catering purposes.

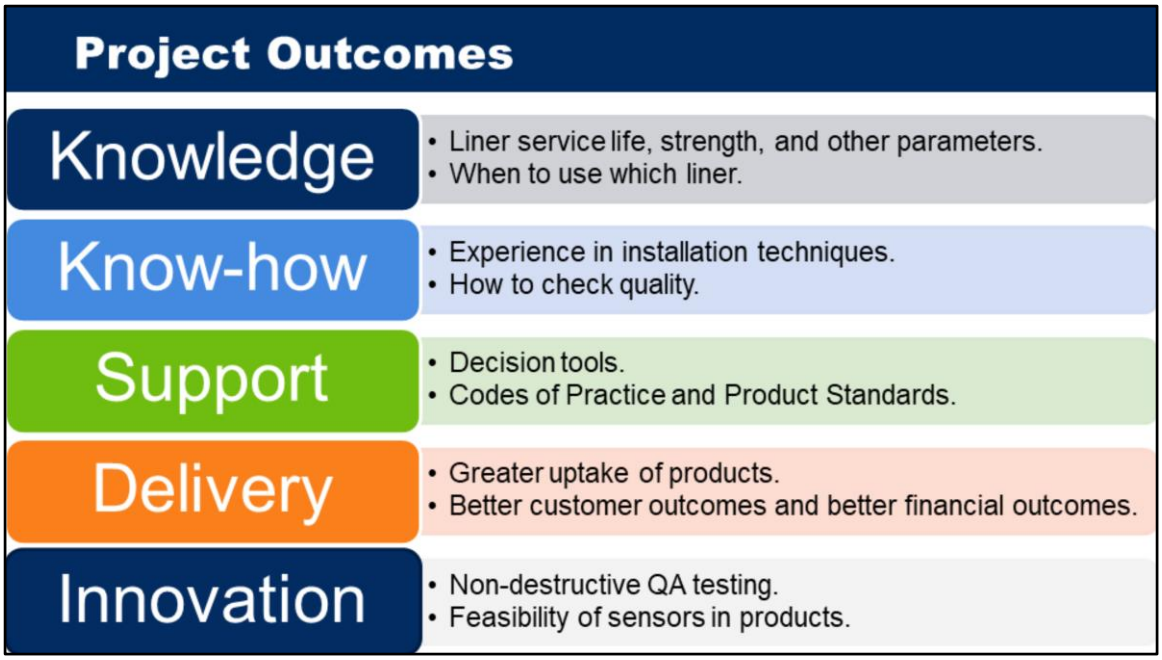
We are running the first round of technology workshops in October this year.

It will be a great opportunity to get a detailed update on project progress to date.

The workshops will include more detailed information on:

- Latest research
  - Water liners – CIPP and Spraylining
  - Wastewater liners – CAC and Geopolymers
  - QA, sensors and robotics.
- Details on the Codes of Practice and Product Standards.
- A more in-depth look at the decision tools.
- Learnings from field trials.

Register at the project website.



Additional information:

- Cost Savings - Pipe liners can provide significant cost savings over current approaches by deferring replacement.
- Confidence - We intend to help the uptake of new products by improving industry confidence in the technology by independent validation of liner products.
- Sustainability - Improvement to the total life cycle cost of pipe rehabilitation and quality with material selection.
- Increased access for Australian SMEs to international industry networks.

QUESTIONS?

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