Proceedings of

Pipelines Research Needs Symposium
Sunday, August 10, 2025

In conjunction with the ASCE/UESI Pipelines Conference 2025

Tampa, Florida

Co-Chairs:

Dr. Ram Krishna Mazumder, Georgia Southern University

Dr. Mo Najafi, CUIRE, The University of Texas at Arlington

Committee Members:

Ehsan Rajaie, CUIRE, The University of Texas at Arlington

Dr. Harshit Shukla, Texas A&M Transportation Institute

Dr. Khalid Kaddoura, GHD

Compiled by: Ehsan Rajaie, CUIRE, The University of Texas at Arlington

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Table of Contents

Foreword 1

Agenda 2

Biography of Speakers 4

Symposium Photos 7

Presentations 10

- Overview of Pipelines Research at WRF 11
- PIPES in Action: Smart Investment, Practical Research, and a Safer Water Future 35
- Non-linear Analysis of Buried Steel Pipelines with Out of Roundness Defect 45
- Finite element simulation of steel pipe JCOE fabrication for hydrocarbon pipeline applications 51
- Limitations of ASTM F3182 SIPP Standard in Defining Performance, Structural Classification, and Field Qualification 61
- Is Fully Structural SIPP Lining Possible? A Look at Current & Emerging Spray Applied Pipe Rehabilitation Technologies and SIPP Lining Design Methodologies 70
- Value of Geological Information and Drilling Data for Annular Pressure Analysis in Horizontal Directional Drilling 77
- AI-Driven Capital Planning and Asset Management in Wastewater Infrastructure 87

Group Discussion Reports 95

- Group 1 Report: Structural Analysis & Integrity of Pipelines 96
- Group 2 Report: Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards 97
- Group 3 Report: Subsurface Conditions & Trenchless Construction 98
- Group 4 Report: Asset Management & Condition Assessment 99

Symposium Attendees List 100

Foreword

The ASCE/UESI Pipeline Research Needs Symposium was held on Sunday, August 10, 2025, in Tampa, Florida, and brought together researchers, practitioners, industry professionals, and students to exchange ideas on current challenges and emerging developments in pipeline engineering, rehabilitation, construction, and asset management. The symposium served as a focused technical forum for identifying research needs relevant to current practice and for encouraging collaboration among academia, utilities, consultants, manufacturers, and technology providers.

The 2025 program was structured to combine broad industry perspective with targeted technical discussion. The symposium began with a welcome from the Symposium Chair, Dr. Ram Krishna Mazumder, followed by three keynote presentations by Dr. Jian Zhang of the Water Research Foundation (WRF), Brad L. Baird, and Rory Jones from the City of Tampa. These keynote presentations helped frame the symposium by connecting research activity with utility priorities, implementation needs, and broader infrastructure planning considerations.

The symposium featured presentations by six speakers on pipeline-related topics. The technical program was organized around four areas and included six research presentations, followed by four discussion groups to identify research needs, practical challenges, and future directions for the pipeline industry. Each group was structured to encourage focused discussion and capture key points and outcomes for its respective topic area.

The presentations included the following topics:

- Structural Analysis & Integrity of Pipelines
- Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards
- Subsurface Conditions & Trenchless Construction
- Asset Management & Condition Assessment.

These sessions highlighted both ongoing technical challenges and opportunities for future advancement, while also emphasizing the importance of connecting research with implementation, standards development, and industry needs.

Following the presentations, attendees participated in group discussions led by Dr. Mo Najafi and Mr. Ehsan Rajaie. These discussions provided an opportunity to identify research gaps, practical needs, and future directions for the pipeline profession. The symposium format encouraged open exchange among participants with different backgrounds and experiences and helped connect technical research with the needs of owners, engineers, contractors, and technology developers.

Our industry continues to benefit from a friendly, objective, and technically focused forum where participants from within and outside the profession can share knowledge, discuss emerging technologies, and explore future research directions. It is our hope that the 2025 ASCE/UESI Pipeline Research Needs Symposium will contribute to continued progress in pipeline engineering by encouraging thoughtful discussion, stronger collaboration, and practical research that responds

to real infrastructure challenges. The proceedings that follow are intended to document the key themes, presentations, and discussion outcomes of the symposium and to support future work in this important field.

We are very appreciative of the many individuals who graciously contributed their time and effort to make this symposium a success.

Dr. Mo Najafi
Co-Chair, ASCE/UESI Pipeline Research Needs Committee and Symposium

Dr. Ram Krishna Mazumder
Co-Chair, ASCE/UESI Pipeline Research Needs Committee and Symposium

Ehsan Rajaie,
Member ASCE/UESI Pipeline Research Needs Committee and Symposium

Dr. Khalid Kaddoura,
Member ASCE/UESI Pipeline Research Needs Committee and Symposium

Dr. Harshit Shukla,
Member ASCE/UESI Pipeline Research Needs Committee and Symposium

Agenda

ASCE/UESI Pipeline Research Needs Symposium
Sunday, August 10, 2025
12:30 – 3:30 pm EDT
Grand Ballroom: Salon F

12.30 - 12.35:

1. **Welcome Speech from Research Symposium Chair**
    - Dr. Ram Krishna Mazumder, Georgia Southern University

12.35 -13.00:

2. **Keynote - 1**: ***Overview of Pipelines Research at WRF***
    - Dr. Jian Zhang, Water Research Foundation

13.0 -13.25:

3. **Keynote - 2**: ***PIPES in Action: Smart Investment, Practical Research, and a Safer Water Future***
    - Mr. Brad L. Baird and Mr. Rory Jones, City of Tampa

13.25 -14.40:

4. **Research Presentation (10 mins + 2 mins Q&A)**

Moderator: Dr. Khalid Kaddoura, GHD & Dr. Harshit Shukla, Texas A&M Transportation Institute

I. *Structural Analysis & Integrity of Pipelines*

a. Non-linear Analysis of Buried Steel Pipelines with Out of Roundness Defect
    - Mr. Ikram Efaz, Xylem

b. Finite Element Simulation of Steel Pipe Fabrication for Hydrocarbon Pipeline Applications
    - Dr. Spyros Karamanos, University of Thessaly

II. *Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards*

c. What Are the Limitations of ASTM F3182 in Defining the Performance of Spray-In-Place-Polymeric Liners, and How Can They Be Resolved to Support Structural Classification and Field Qualification?
    - Dr. Sanaz Ghalambor, Thompson Pipe Group

d. Is Fully Structural SIPP Lining Possible? A Look at Current and Emerging Spray Applied Pipe Rehabilitation Technologies and SIPP Lining Design Methodologies
    - Mr. Jeff Maier, Dewberry

III. *Subsurface Conditions & Trenchless Construction*

e. Value of Geological Information and Drilling Data for Annular Pressure Analysis in Horizontal Directional Drilling
    - Mr. Inshik Park, University of Alberta

IV. *Asset Management & Condition Assessment*

f. AI-Driven Capital Planning and Asset Management in Wastewater Infrastructure
   - Eric Sullivan, SewerAI

14.40 -15.25:

5. **Group Discussion**:

   Lead by: Dr. Mo Najafi and Mr. Ehsan Rajaie, The University of Texas at Arlington

15.25 -15.30:

6. **Closing Remark**

Biography of Speakers



Ikram Efaz, Ph.D., P.E.
Structural Engineer
Xylem
Email: Ikram.Efaz@xylem.com

Dr. Ikram Efaz, a Structural Engineer at Xylem with over eight years of experience, specializes in designing, analyzing, and evaluating pipelines, bridges, buildings, and towers. His expertise includes Finite Element Modeling, materials mechanics, and fatigue analysis. He has authored numerous publications in respected journals and conferences, making significant contributions to structural engineering.



Sanaz Ghalambor, Ph.D.
Technical Resource Engineer
Thompson Pipe Group
Phone: 949-295-5799
Email: sanaz.ghalambor@thompsonpipegroup.com

Dr. Sanaz Ghalambor is a Strategic Products Technical Resource Engineer at Thompson Pipe Group with 15+ years of experience in pipeline protection, corrosion prevention, and rehabilitation. Holds a PhD in Civil Engineering and a background in polymer engineering. Technical Lead for ASTM F3182, Lead Contributor to ASCE MOP 120, and Voting Member/Peer Reviewer for AWWA M28, M81, and C620. Committed to science-based solutions that safeguard critical infrastructure.



Spyros A. Karamanos, Ph.D.
Professor of Structural Mechanics
Department of Mechanical Engineering
University of Thessaly
Email: skara@mie.uth.gr

Dr. Spyros A. Karamanos is Professor of Structural Mechanics at the Department of Mechanical Engineering, University of Thessaly, Volos, Greece. Spyros specializes in structural mechanics and integrity of energy infrastructure systems. His research interests focus on buckling and fatigue of pipelines and offshore structures, mainly tubular components and systems, using computational (finite element) methods, and experimental testing.



Jeff Maier
Associate Vice President
Dewberry Engineers
Phone: 303-596-0744
Email: jmaier@dewberry.com

Mr. Jeff Maier serves as the Western Water Infrastructure Discipline Leader at Dewberry Engineers. He is responsible for providing in-depth technical expertise for a variety of trenchless pipeline and manhole rehabilitation technologies, pipeline construction applications, corrosion mitigation, advanced pipeline inspection methods and asset management strategies. He is a Colorado, Utah and Texas registered professional engineer with over 25 years of experience, primarily in the water and wastewater sectors.



Inshik Park
Ph.D. Candidate
University of Alberta
Phone: 647-884-3999
Email: inshik@ualberta.ca

Mr. Inshik Park, a PhD Candidate/Graduate Research Assistant at the University of Alberta's Underground Trenchless Construction Program under Dr. Bayat, also serves as a Teaching Assistant in the Department of Civil and Environmental Engineering, actively teaching undergraduate and graduate courses. His research focuses on geotechnical aspects of horizontal directional drilling.

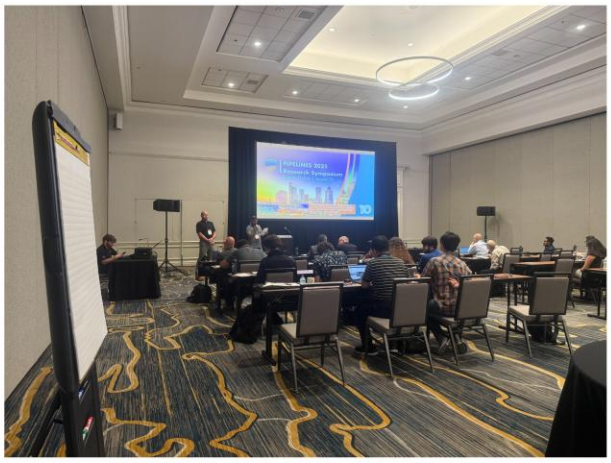


Eric Sullivan
Director of Strategic Development
SewerAI
Phone: 206-457-7610
Email: esullivan@sewerai.com

Mr. Eric Sullivan is Director of Strategic Development at SewerAI. Over 18 years, he has worked with water and sewer utilities, consulting engineers, and contractors on trenchless projects. Since 2012, he's been a NASSCO Trainer, leading programs across the US and Canada. He is based in Seattle, WA.

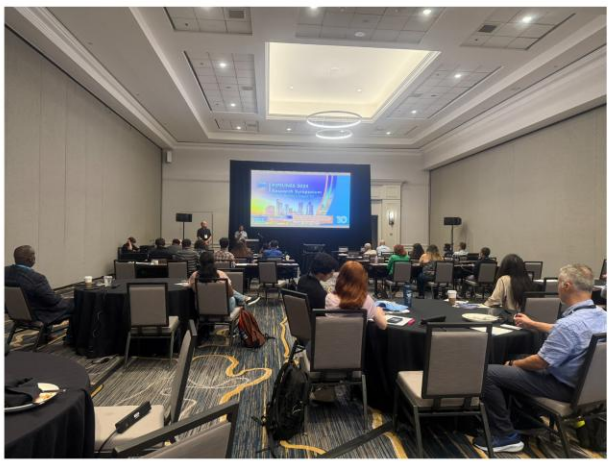
Symposium Photos

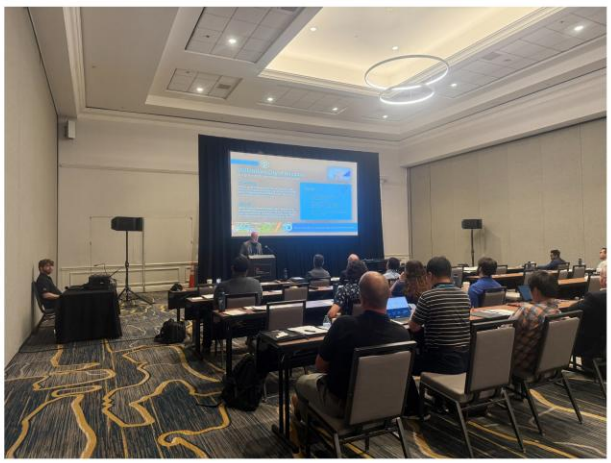

PIPELINES 2025
Research Symposium
Tampa, Florida | August 10
Welcome
ASCE
Younger Member
Engagement Committee






Problem Statement Model Results










SAVE THE DATE


Presentations

Keynote Presentation No. 1

Overview of Pipelines Research at WRF

Jian Zhang, Ph.D., P.E.

Water Research Foundation

Email: jzhang@waterrf.org

OVERVIEW OF PIPELINES RESEARCH AT WRF

Pipelines Research Symposium

August 10, 2025

advancing the science of water®

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Agenda

- About WRF
- WRF Research Programs
- Pipeline-related research
- RFPs to be released

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THE Water Research FOUNDATION®

OUR PURPOSE

To advance the science of water to improve the quality of life for all communities.

OUR VISION

The science and knowledge we generate allow the water sector to provide high-quality, safe, accessible, and affordable water services that contribute to healthy, resilient communities and a sustainable global environment.

OUR MISSION

To help our subscribers discover opportunities and solve problems by delivering actionable water research to meet the needs of the communities they serve.

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2025 Engagement Dashboard – Q1

904 UTILITIES 48 CONSULTANTS 30 MANUFACTURERS	$71M FUNDED RESEARCH	245 ACTIVE PROJECTS	1,390 WEBCAST VIEWS	401M MEDIA REACH	81,428 SOCIAL MEDIA FOLLOWERS

Most Visited Research Project Pages

1. Residential End Uses of Water, Version 3: A Single-Family and Multi-Family Study (5242)
2. Autonomous in situ Monitoring of Harmful Algal Blooms (5154)
3. The Role of Generative AI (GenAI) for the Global Water Sector (5321)
4. Utility Field Guide for Developing a Cyanobacteria and Cyanotoxin Monitoring Program (5120)
5. Data-Driven Process Control for Maximizing Resource Efficiency (5141)

Top Visitor Countries

1. United States
2. Canada
3. Australia
4. China
5. India
6. United Kingdom
7. France
8. Netherlands
9. Germany
10. Ireland

Most Popular Topics

1. Advanced Treatment
2. Climate Change
3. Per- and Polyfluoroalkyl Substances (PFAS)
4. Water Use & Efficiency
5. Reuse
6. Asset Management
7. Lead & Copper
8. Cyanobacteria & Cyanotoxins
9. Biosolids
10. Intelligent Water Systems

Most Popular Webcast



Most Visited Website Resources

1. Concept of Operations (CONOPS) Plan for Water Distribution System Testing and Recovery *Project Paper*
2. Implementing Machine Learning Process Controls at Water Resource Recovery Facilities *Webcast*
3. Utility Field Guide for Developing a Cyanobacteria and Cyanotoxin Monitoring Program *Project Paper*
4. Autonomous in situ Monitoring of Harmful Algal Blooms *Webcast*
5. Diversifying Water Portfolios through Stormwater Capture and Use: Contributing to a Water Resilient Future *Webcast*

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WRF in the News

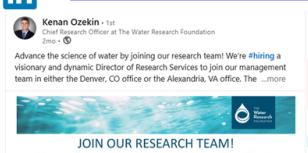


Wildfires can contaminate drinking water systems with harmful chemicals – here's what Los Angeles needs to know

193M Reach

Top Social Media Post

We're Hiring - Come Work with Kenan



7K Impressions

4

WRF-Funded Research Programs

- Research Priority Program (RPP) – 60%
- Tailored Collaboration (TC) – 20%
- Unsolicited Research (UR) – 10%
- Emerging Opportunity (EO) – 10%



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Research Priority Program

▶ Addressing Subscriber Challenges in Priority Research Areas

- Project concepts are developed by advisory committees for each research area made up of experts from utilities, consultants, academia, and government entities
- Board-appointed Research Advisory Council (RAC) approves projects for funding
- 60% of WRF Research Budget

RFPs posted around September

GET INVOLVED

- Project Advisory Committee Member
- Participating Utility
- Co-Sponsor
- In-Kind Solution Provider

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Tailored Collaboration Program

▶ Matching Funds for Research Tailored to Subscriber Needs

- WRF partners directly with utility subscriber(s)
- Subscriber or group of subscribers can receive up to $150K in matching funds for a research project
- Projects can be national or regional in nature and chosen annually
- Projects are chosen by the Tailored Collaboration Review Committee (TCRC)
- Constitutes 20% of WRF research budget

Pre-proposals accepted, full proposals due in September

GET INVOLVED

- Sponsoring Utility
- Participating Utility
- Project Advisory Committee Member

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Unsolicited Research Program

▶ Pitch Your Ideas for Novel, Transformative Research

- Funds projects that significantly advance the science of water
- Creates opportunities to protect and preserve water more sustainably and cost-effectively
- Takes existing research to the next level of completion, producing practical solutions to water quality challenges
- Research Advisory Council prioritizes and approves project for funding
- 10% of WRF research budget
- Program runs every other year

Pre-proposals accepted in January with March deadline

GET INVOLVED

- Project Advisory Committee Member
- Participating Utility
- Co-Sponsor
- In-Kind Solution Provider

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Emerging Opportunities Program

▶ Time-Critical Research

- WRF Staff-sponsored
- Emergent, high-priority subscriber issues
- Partnership projects encourage matching funds from approved partners
- Allows supplementary work to be added to ongoing WRF projects
- Projects approved for funding by BOD Executive Committee throughout the year
- Usually short in duration (3-12 months)
- Range in value $25K to $200K
- 10% of WRF budget

GET INVOLVED

- Project Advisory Committee Member
- Participating Utility

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Pipeline Research at WRF

- All water systems
- Resilience
- Condition assessment
- Risk management
- Data management (including ML & AI)



Pipeline Resilience

- Wildfire
- Earthquakes
- Flooding & Drought
- Interdependencies



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Wildfire-Related WRF Resources

- #5168: Enhancing Drinking Water Treatment Resilience to Wildfire Events, ongoing
- #4636: An Integrated Modeling and Decision Framework to Evaluate Adaptation Strategies for Sustainable Drinking Water Utility Management Under Drought and Climate Change, Published in 2019.
- #4590: Wildfire Impacts on Drinking Water Treatment Process Performance: Development of Evaluation Protocols and Management Practices Published in 2018.
- #4524: Impact of Wildfires on Source Water Quality & Implications for Water Treatment and Finished Water Quality published in 2016.
- #4529: Wildfire Impacts on Water Supplies and Potential for Mitigation: Workshop Report Published in 2014
- # 4482: Effects of Wildfire on Drinking Water Utilities and Best Practices for Wildfire Risk Reduction and Mitigation Published in 2013.



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PROJECT NO. 5106

Concept of Operations (CONOPS) Plan for Water Distribution System Testing and Recovery

LA DWP Los Angeles Department of Water & Power · SAN JOSE WATER · EBMUD · CONTRA COSTA WATER DISTRICT

Key Benefits

- Developed for utilities, by utilities
- Draws from experiences from wildfire incidents in multiple states
- Evidence-based decision support framework
  - How to detect the full extent of chemical contamination and damage
  - Unique testing and sampling procedures
  - Customer notifications about health risks from contaminated drinking water
  - Actions to restore pressure and remove contaminated water from the system
  - Communicating postfire drinking water safety issues to customers, elected leaders, and support organizations

Water Utility Resilience: A Case Study of the 2021 Marshall Fire (5192)

- Led by Brad Wham, University of Colorado at Boulder
- Idea: Water Utilities in CO
- Status: ongoing, will be published in 2025.
- **Objectives:**
  - Establish timeline of events, including emergency preparedness, response, and recovery
  - Investigate lifeline interdependencies and impact on water utility actions
  - Define technology investments that supported response/recovery and potential improvements
  - Document utility communication with the public and customers over course of recovery

Report
- Timeline
- Key Lessons Learned
- Recommendations

Interviews
- East Boulder County Water District, Louisville, Superior
- Experts, CDPHE

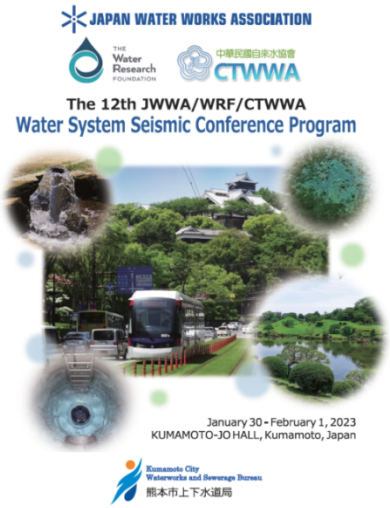
Focus
- Interdependencies
- Infrastructure/Technology
- Communication
- Resources
- Decision-making
- General Lessons

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Earthquakes

- Water System Seismic Conference
- Biennial conference since 1999
- WRF, Japan, and Taiwan
- To exchange knowledge and research on preparing for, and responding to, earthquakes with topics on risk analysis techniques, seismic measures for pipelines, etc.
- The 11th Water System Seismic Conference in 2019 in Los Angeles
- The 12th Water System Seismic Conference in 2023 in Kumamoto, Japan
- The 13th Water System Seismic Conference to be held in November 2025 in Taiwan

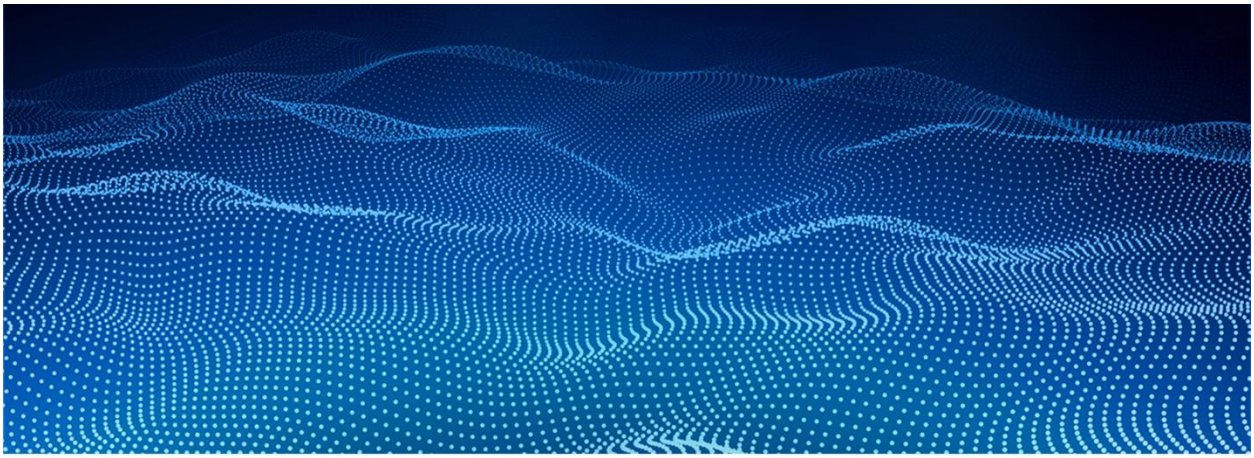
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Conference Themes

- Earthquake resistant designs and their practices
- Inter-sector dependencies before and after earthquake events
- Mitigation of multi-hazards and extreme events
- Best practices for preparedness, response, recovery
- New developments in research and how to implement the findings into actual practice

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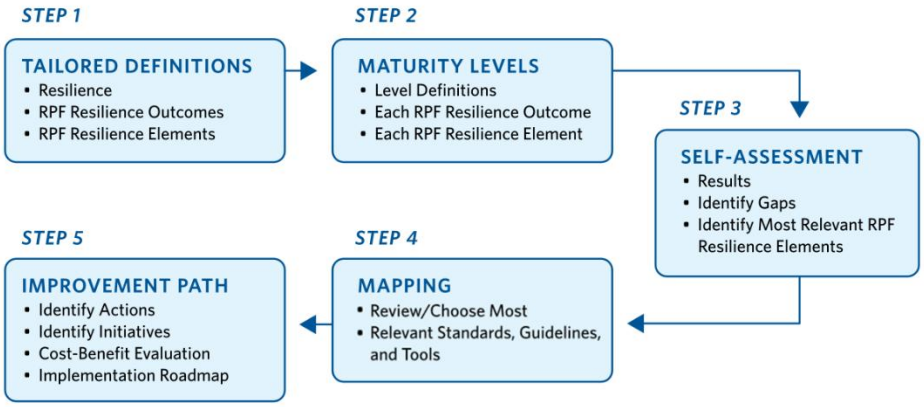
Resilience Practical Framework (RPF) for Water Infrastructure Resilience – WRF Project 5014

The Water Research Foundation

BLACK & VEATCH

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5-Step Process



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Key Benefits

• This project summarizes the results of an extensive investigation into utility management practices and how these practices have created opportunities for utilities to increase organizational resilience and sustainability.

• Provides detailed case studies on how the participating utilities improved their interdependencies with other lifeline sectors through partnerships, leading practices, innovations, asset management resilience, and lessons learned.

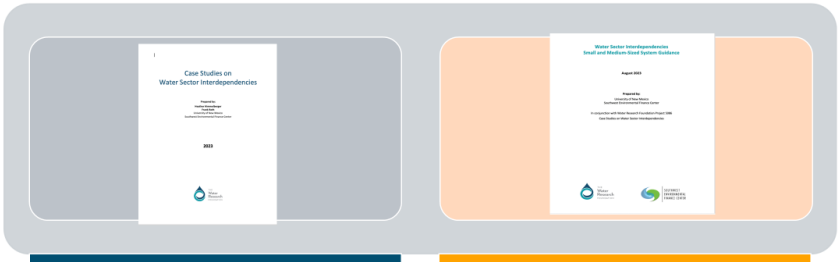
• Includes a guidance document that will help small and medium-sized utilities improve their capabilities in working with other critical infrastructure or lifeline sectors.



PROJECT NO. 5086

Case Studies on Water Sector Interdependencies

#5086—Case Studies on Water Sector Interdependencies
https://www.waterrf.org/research/projects/case-studies-water-sector-interdependencies



Case studies on existing utility practices for determining risk-based organizational interdependencies

Small to medium-sized water utilities guidebook for management of cross-sector interdependencies

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21

Pipe Research

- Various pipe materials & appurtenances
- Pipe renewal technologies
- Condition assessment
- Risk management
- Data management (including ML & AI)



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22

Pipeline Materials

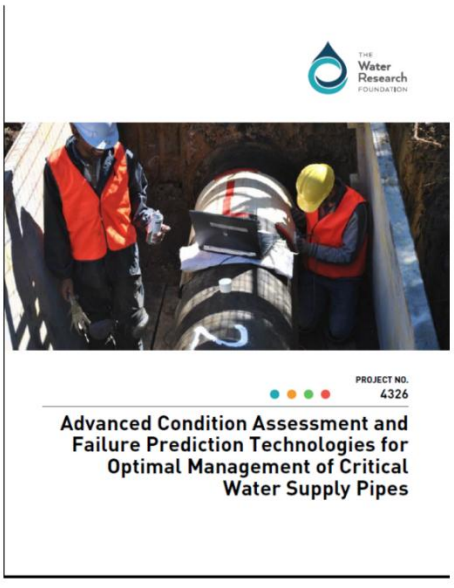
- Performance Evaluation
  - Plastic service lines
  - PVC pipe
  - PE pipe
  - Asbestos cement pipe
  - Iron pipes (CI & DI)
  - Steel and stainless steel pipes
  - PCCP
  - Lining materials
  - Non-leaded meters, components, etc.
  - Joints



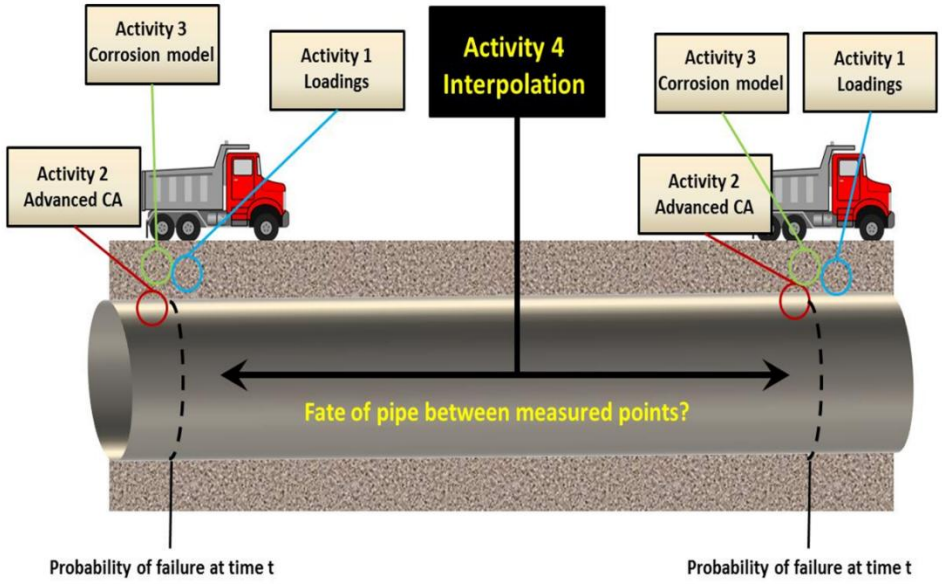
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WRF 4326 - Critical Pipe Project

- Partnership project funded by Sydney Water, UKWIR, WRF, etc.
- $4M+ of committed funding spread over 5 years, plus over $16M of committed cost-share and in-kind support.
- Monash University



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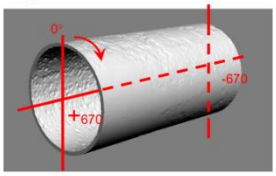
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25

Pipe burst test

Burst test program-Sample 1 corrosion analysis





Patch Locations

Patch 1: -200 to -400 and 270° to 315 °
(minimum remaining wall thickness= 11.7mm)

Patch 2: 0 to -400 and 180° to 247.5°
(minimum remaining wall thickness= 7.4mm)

Patch 3: 100 to 500 and 315° to 22.5°
(minimum remaining wall thickness= 6.5mm)

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26

Key learnings



- 1.2Km cast iron cement lined 600mm
- Traffic loadings not significant as pressure transients
- Smooth system operations essential
- Potential for leak before the break
- Longitudinal fractures at high pressure
- Critical for failure probability
  - Pressure change
  - Pipe thickness
  - Corrosion rate

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Large-Diameter Steel Pressure Pipes

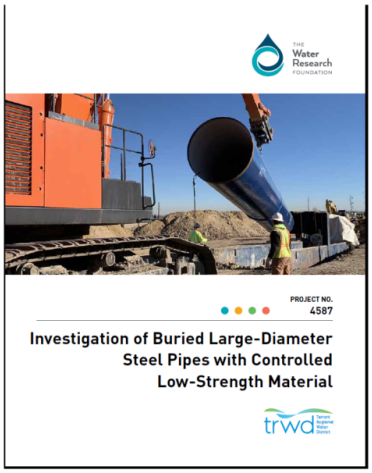
- WRF 4587, Investigation of Buried Large-Diameter Steel Pipes with Controlled Low-Strength Material, 2019
- WRF 4735, Application of Finite Element Modeling for Large-Diameter Steel Pressure Pipes Buried in Any Type of Backfill Materials, 2020
- WRF 5109, Application of Finite Element Analysis in the Design of Large-Diameter Buried Pressure Pipes-Special Cases, 2025

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WRF 4587 – Investigation of Buried Large-Diameter Steel Pipes with Controlled Low-Strength Material

Key Findings

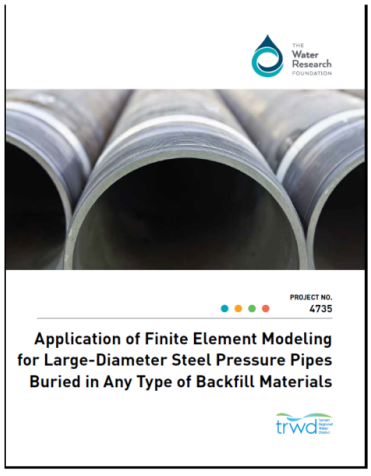
- This project provides an in-depth understanding of the behavior of buried large-diameter pipes with controlled low-strength material (CLSM).
- Experimental measurements were conducted to measure the deflection of the pipe during the construction stages.
- A Finite Element Model (FEM) was developed to mimic the experimental conditions of the pipe tested.
- The material properties of the CLSM were investigated in the lab.
- Unique design equations were developed for large-diameter steel pipes with CLSM.



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WRF 4735 - Application of Finite Element Modeling for Large-Diameter Steel Pressure Pipes Buried in Any Type of Backfill Materials

- Presents common methods of finite element modeling of large-diameter steel pipes buried in different types of backfill and trench geometries.
- Presents a method for compaction simulation based on theory of elasticity that is validated with experimental and field measurements.
- Provides a manual of practice for finite element simulations of buried flexible pipes.
- Presents two detailed examples of the application of finite elements in special cases such as a “wye” and a pipe buried in controlled low strength material (CLSM).



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Key Benefits

- Contributes significantly to a topic that is of concern to owners, engineers, and contractors across the nation
- Shows that the method used by TRWD is one successful design that can prevent issues and serve as a baseline for future applications
- Helps design engineers refine their knowledge on FEA and how to apply this knowledge in providing more optimized designs, including fittings
- Will help with avoiding unnecessary failures that are preventable by analyzing the designs using FEA
- Promotes a system design approach as opposed to component design and helps establish a comprehensive FEA knowledge among the water pipe industry and make FEA a standard practice in designing large-diameter flexible pipes

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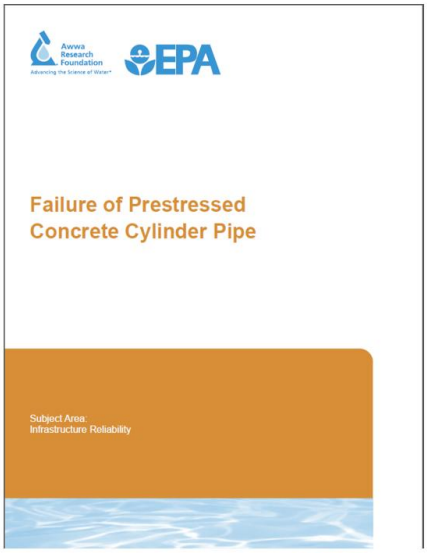
PROJECT NO. 5109

Application of Finite Element Analysis in the Design of Large-Diameter Buried Pressure Pipes-Special Cases

trwd Tarrant Regional Water District

Prestressed Concrete Cylinder Pipe

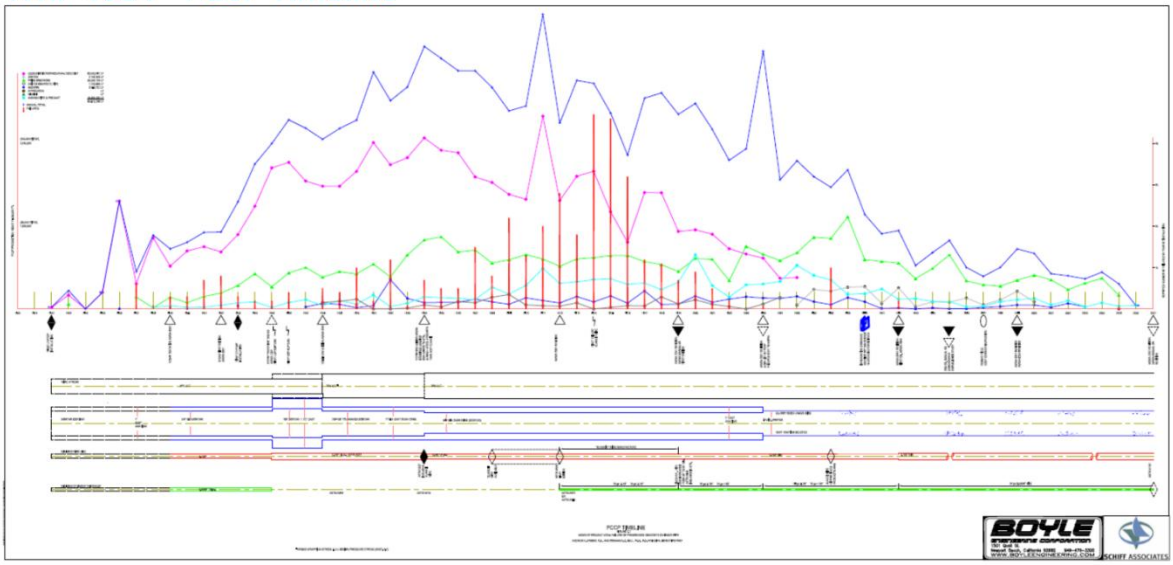
- WRF 4034, 2008
  - Andrew E. Romer, Boyle Engineering Corp.
  - Developed a PCCP evaluation method
  - Determined the causes of PCCP failures
  - Conducted a statistical analysis of PCCP failure data to provide service life prediction models.



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32

WRF 4034 - PCCP Timeline



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33

WRF 5069 - Managing PCCP to Extend Asset Life

This project

- Updated the performance history of PCCP based on reported failures through 2022 to compare and contrast with data previously collected and report in WRF 4034.
- Identified emerging and evolving PCCP assessment and monitoring technologies.
- Investigated emerging repair and renewal technologies for large diameter pipe.
- Documented the range of management approaches for PCCP and large diameter pressure pipes to extend asset life from 11 geographically diverse water purveyors.

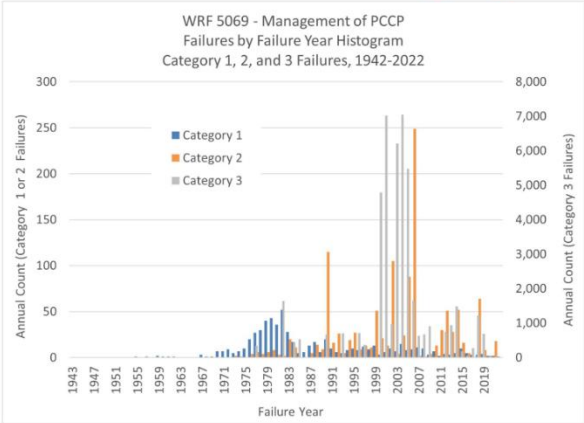
Key Findings

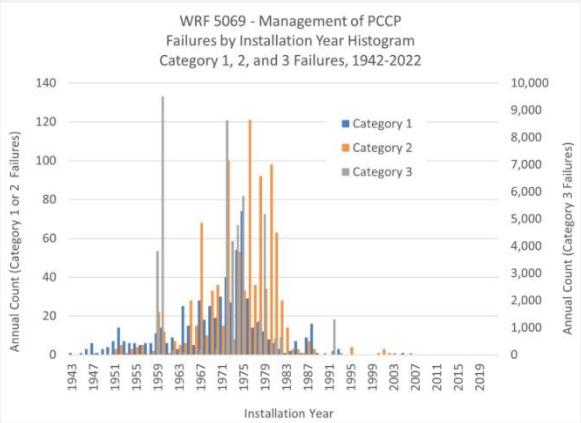
- The findings of WRF 4034 regarding causation of PCCP failures due to changes in design practices and materials/manufacturing defects were confirmed and supported by expansion of the dataset from 2006 to 2022.
- On average, catastrophic failures continue to occur at a reduced frequency compared to the crisis period in the 1970's and 1980's as Category 1 failures have continued a steady decline through 2022.
- The failure rate for PCCP has declined over the past 20 years due to the implementation of pipe management practices which use technology to locate distressed PCCP that in turn can be managed through monitoring, repairing, or replacing the distressed pipe section.
- Failures rates for PCCP will likely continue to decline

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34

WRF 5069 - Managing PCCP to Extend Asset Life





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Appurtenances, Linings, & Other Components

- Elastomeric Components
- Linings – epoxy, cement-mortar, CIPP, etc.
- Water Meters
- Valves
  - Key Criteria for Valve Operation and Maintenance (#2713)
  - Criteria for Valve Location and System Reliability (#2869)

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5241– Technology and Innovation for Assessing Operability and Full Closure of High Consequence Valves

PI: Dr. Himan Hojat Jalali, UTA

Co-PI: Dr. Mohsen Shahandashti, UTA

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37

Objectives



Literature Review on High-Consequence Valves
- Focus on gate valves 24 inches or larger
- Emphasize their role in system resiliency
- Explore strategic placement and importance in water networks

Valve Condition Assessment
- Evaluate valve functionality and performance
- Analyze structural integrity and reliability metrics
- Review assessment methodologies and tools

Maintenance and Operation Practices
- Identify effective valve maintenance strategies
- Compare industry best practices for operations
- Highlight methods to improve system efficiency

Development of Practical Guidelines
- Establish comprehensive guidelines for valve assessment
- Include maintenance and rebuilding approaches
- Ensure alignment with utility needs and industry standards

AI/ML in Predictive Maintenance
- Explore AI/ML for predicting valve failures
- Utilize historical and real-time data
- Optimize maintenance strategies with advanced analytics

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38

Survey of Utilities

Task

02

In Progress

Survey Preparation:
A preliminary framework for a survey targeting utilities and water management professionals was developed to gather insights into best practices and operational challenges, but it has not yet been distributed to any utilities.
The surveys can be found from the below link:

Utility survey:
https://docs.google.com/forms/d/e/1FAIpQLSfPtu2WJE95o6s6XlD5jNrbeI_OE-hmeE4kGJYSlOYw9vVkVQ/viewform?usp=header

This survey will ultimately be distributed as a PDF to ensure that if multiple individuals complete the same form together, the data will not be lost.

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Workshop & Gap Identification

Task

04



Goals
- Share findings from Tasks 1–3 and gather feedback
- Promote best practices for valve operation, maintenance, and renewal

Events
- Webinar: Initial presentation of findings and feedback collection
- Workshop: Planned in Detroit, open to all, and free of charge

Structure
- Presenting case studies, technical demonstrations, and gap analysis
- Facilitate interactive discussions and collaboration

Deliverables
- Workshop summary report with insights and feedback
- Final report with several representative case studies and data management discussions

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Recent projects and RFPs to be released

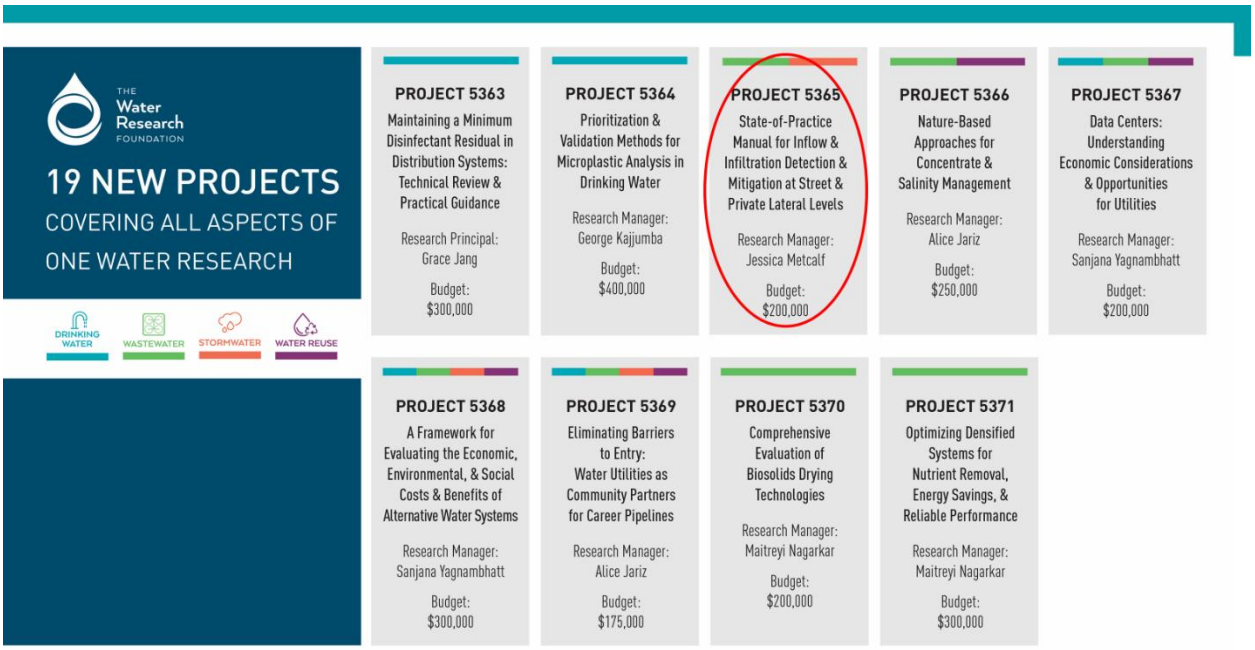
Pipeline-related projects funded in 2023 and 2024

- Enhancing Collection Systems Integrity with Application of Emerging Assessment and Renewal Methods (5240)
- Thinking Outside the Pipe: Comparison of Non-invasive, Non-destructive Condition Assessment Technologies for Distribution Pipe (5289)
- Pipeline Infrastructure Replacement Costs Guide (5292)

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RFP Schedule

	Batch 1	Batch 2
RFPs to be released on	8/25/2025	9/22/2025
Proposals due by	10/22/2025	11/20/2025
RFPs	5298, 5306, 5309, 5353 5359, 5362, 5363, 5364 5365, 5370, 5372	5366, 5367, 5369, 5355 5358, 5356, 5354, 5357 5371, 5361, 5368, 5360

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Thank you!

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Keynote Presentation No. 2

PIPES in Action: Smart Investment, Practical Research, and a Safer Water Future

Brad L. Baird, P.E., Deputy Administrator of Infrastructure

City of Tampa

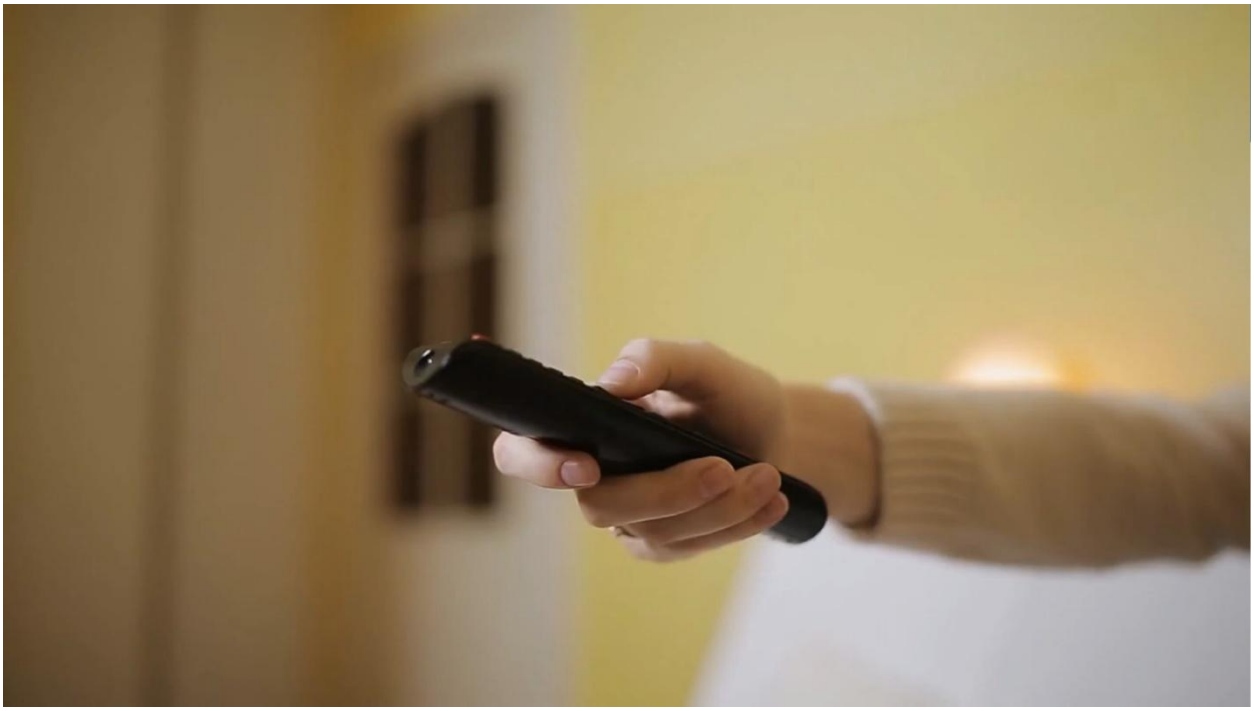
Email: brad.baird@tampagov.net

Rory Jones, Director

City of Tampa

Email: rory.jones@tampagov.net


WELCOME
PIPES in Action: Smart Investment, Practical Research, and a Safer Water Future
City of Tampa
Florida



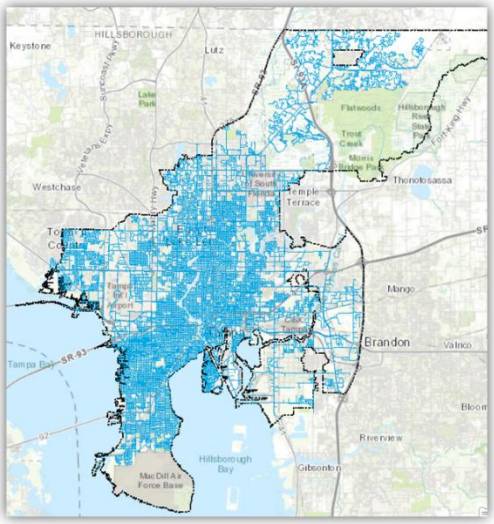
The Solution?

PIPES

PROGRESSIVE INFRASTRUCTURE PLANNING
TO ENSURE SUSTAINABILITY

About us

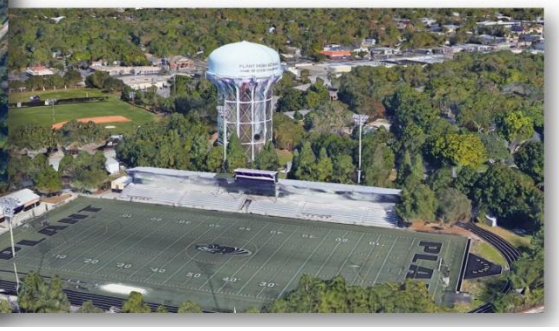
- 220 square miles service area
- Service Population: 725,000
- 142,000+ accounts
- Distribution System
  - ~ 2,200 miles of water main pipe
  - Range in size from 54” to 2”
  - ~ 50,000 valves
  - 15,217 hydrants

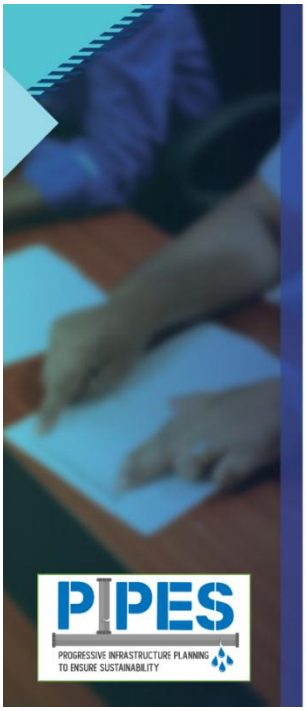


About us



- (1) – Treatment Plant (David L. Tippin Water Treatment Facility)
- (2) – Elevated Storage Tanks (West Tampa Tank & Palma Ceia Tank)





Capital Master Planning

- CIP prioritization based on condition and consequence of failure
- Risk-informed approach across pipeline and plant assets
- Pipeline
  - Many miles of pipeline at end-of-life
- DLTWTF
  - Aging Infrastructure (100+ year old pumps)
  - Desire for TOC removal
  - Regulatory requirements

PIPES in Action

- (8) new pumps
- 140 mgd capacity
- Chlorine contact chamber
- Rehabilitation of existing clearwells

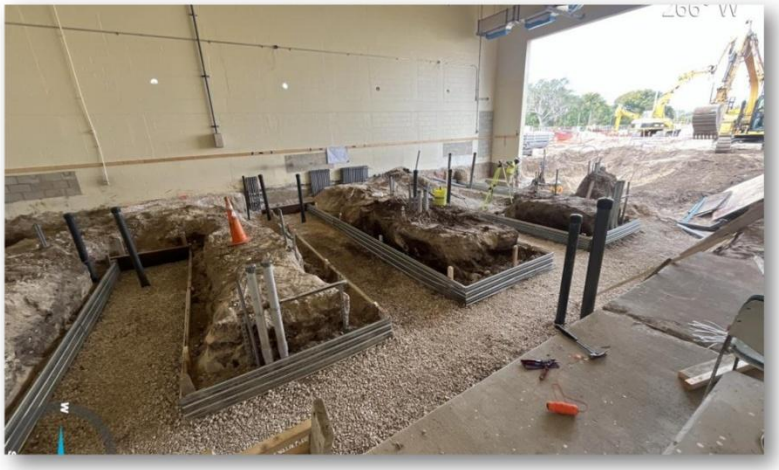
Jacobs





Chemical System Improvements

- On-site hypochlorite generators
- Aqueous Ammonia
- Redundancy
- Safer



Filter Improvements

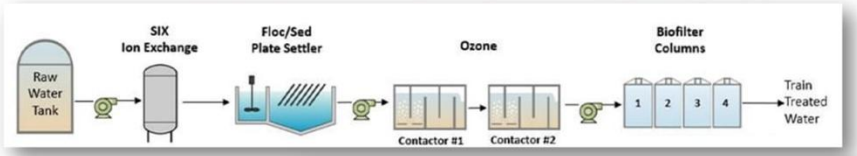
- Added capacity (20 mgd)
- More efficient (deeper filter media)
- Added redundancy
- Start 2024
- Completion 2027



PIPES Funded Research



PIPES Funded Research



- TOC goals
- Chemical Savings
- Reduced Solids Production
- Potential Reduction in PFOS/PFOA

carollo



SIX – Additional Piloting On-going

- Can SIX be the "one stop shop" for PFAS?
  - Bench testing indicates direct removal of PFAS to below the regulatory limit
  - 6-month pilot on-going
- Additional pilot benefits
  - Design improvements
  - Operational training



Full Scale SIX Design

- Regenerant Selection
- Chemical Dose
- Hydraulic Performance
- Integration with other processes



Filter Research

- Problem
  - Chloramine residuals were decaying faster than expected after filtration
- Research
  - 5-phase pilot study
  - Compared chlorinated vs non-chlorinated backwash water
  - GAC vs anthracite
- Results
  - Switch to non-chlorinated backwash
  - Save up to $170,000/year
  - Longer filter run-times
  - More stable finished water



What's Next for PIPES?

- ActiFlo Train Modernization
- Dewatering Process Replacement
- Continued Research
  - Contaminants of Emerging Concern
    - Microplastics
    - Chloronitramide Anion
- Integrated Water Management Approach (One Water)



What's Next for PIPES?

- ActiFlo Train Modernization
- Dewatering Process Replacement
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  - Contaminants of Emerging Concern
    - Microplastics
    - Chloronitramide Anion
- Integrated Water Management Approach (One Water)



Group I

Structural Analysis & Integrity of Pipelines

Presentation No. 1

Non-linear Analysis of Buried Steel Pipelines with Out of Roundness Defect

Ikram Efaz, Ph.D., P.E.

Xylem

Email: Ikram.Efaz@xylem.com



Out of Roundness Defect of Steel Pipeline

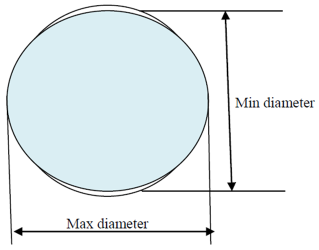
What is Ovality?
- Deviation from a perfect circular shape in pipes

Most Susceptible:
- Pipes with high D/t ratio (large diameter, thin wall)

Types of Ovality:
1. Symmetric
2. Asymmetric / Irregular

Causes:
- Manufacturing / Installation: welding, handling, joint defects
- External Loads: soil pressure, overburden, transportation

Standards & Observations:
- AWWA M11: ≤ 5% deflection allowed for flexible linings/coatings
- Steel pipes often exceed this limit



$$\text{Ovality \%} = \frac{\text{Max OD} - \text{Min OD}}{\text{Nominal OD}} \times 100$$



Objective and Finite Element Analysis

Objective:

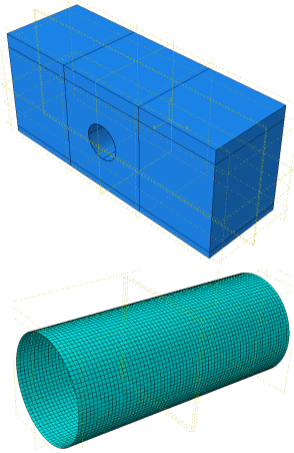
- Assess structural capacity of steel pipes with combined Ovality (OOR) and corrosion — *a first in existing research.*

Model Setup:

- Pipe: 42" diameter, 0.385" wall thickness
- Material: Steel (Yield: 30,000 psi | Ultimate: 45,000 psi)
- Soil Cover: 8 ft
- Software: ABAQUS CAE

Methodology:

- Created 41 models with varying degrees of:
  - OOR (Out-of-Roundness)
  - Corrosion defects



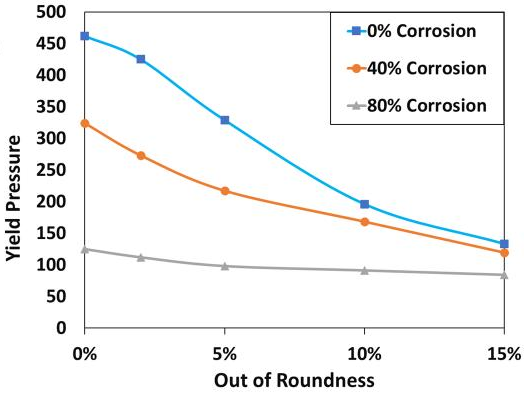
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Research Symposium

Results—X axis OOR, Corrosion in Springline



Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	425	329	196	133
	40%	324	273	217	168	119
	80%	125	112	98	91	84

- Stress concentrated near springline both for OOR and corrosion.
- Combined effect of corrosion and OOR was achieved.



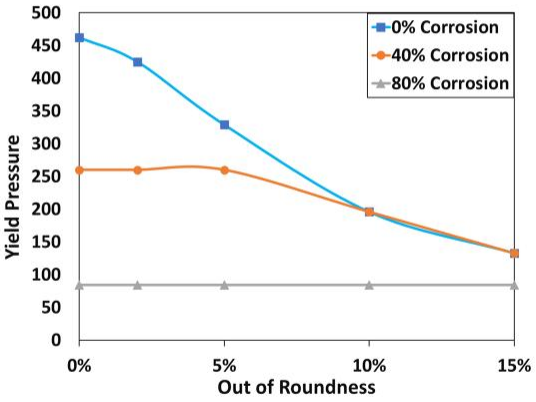
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Results–X axis OOR, Corrosion in Invert



Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	425	329	196	133
	40%	260	260	260	196	133
	80%	84	84	84	84	84

- Stress concentrated near springline for OOR and in invert for corrosion.
- Individual effects of OOR and corrosion were achieved.



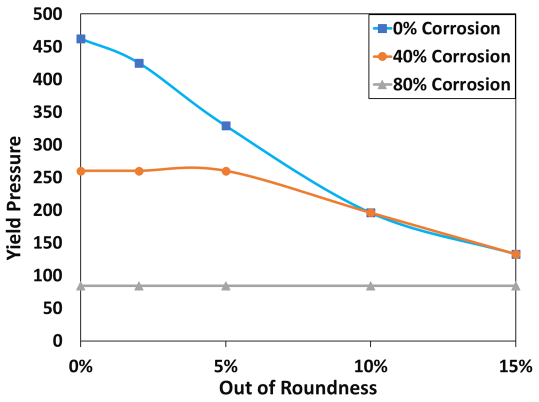


Results–X axis OOR, Corrosion in Invert (Cont.)

Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	425	329	196	133
	40%	260	260	260	196	133
	80%	84	84	84	84	84

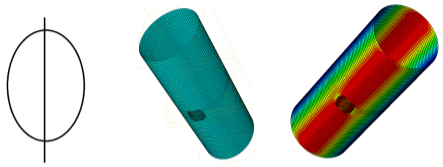
Ovality
Corrosion

- 0% corrosion line is pure corrosion line- no OOR.
- 80% corrosion line- only corrosion controls through the entire straight line.
- 40% corrosion line- corrosion controls up to 5% ovality. Ovality controls from 10% ovality.



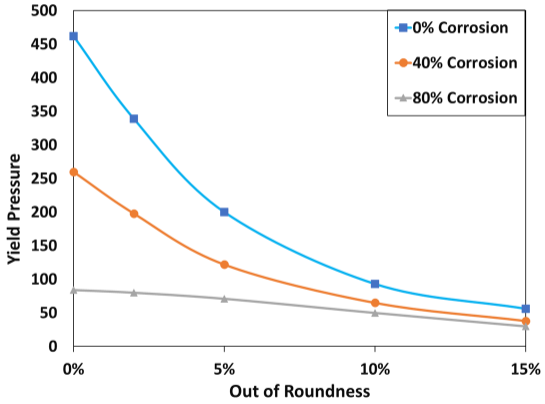


Results–Y axis OOR, Corrosion in Invert



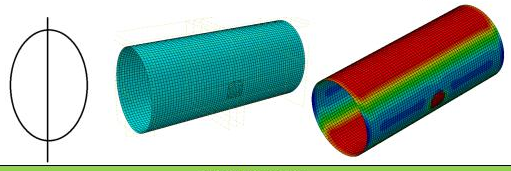
Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	339	200	93	56
	40%	260	198	122	65	38
	80%	84	80	71	50	30

- Stress concentrated in invert both for OOR and corrosion.
- Combined effect of corrosion and OOR was achieved.



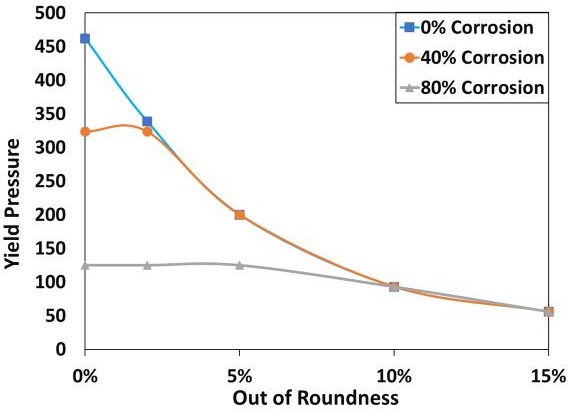


Results–Y axis OOR, Corrosion in Springline



Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	339	200	93	56
	40%	324	324	200	93	56
	80%	125	125	125	93	56

- Stress concentrated in invert for OOR and near springline for corrosion.
- Individual effects of OOR and corrosion were achieved.





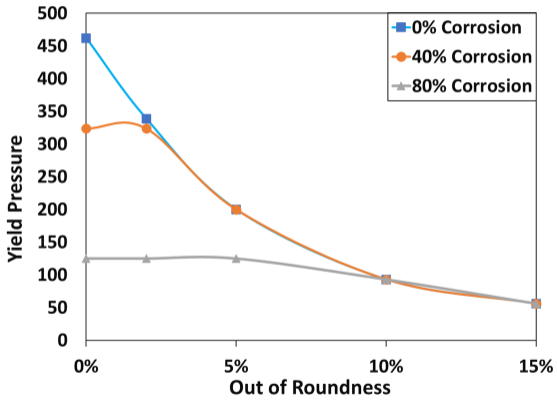
Results—Y axis OOR, Corrosion in Springline (Cont.)

Yield Pressure						
	Ovality	0%	2%	5%	10%	15%
Corrosion	0%	462	339	200	93	56
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	80%	125	125	125	93	56

Ovality

Corrosion

- 0% corrosion line is pure corrosion line- no OOR.
- 80% corrosion line- only corrosion controls up to 5% ovality. Ovality controls from 10% ovality.
- 40% corrosion line- corrosion controls up to 2% ovality. Ovality controls from 5% ovality.



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Conclusion

- Ovality significantly affects failure risk, especially when combined with corrosion.
- Corrosion amplifies OOR-related failures — the impact varies based on whether it acts independently or alongside OOR.
- Y-axis Ovality causes greater structural impact than X-axis, though it's less common.
- These results provide pipeline owners with valuable insights into the condition and remaining capacity of steel pipes with ovality defects.

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Group I

Structural Analysis & Integrity of Pipelines

Presentation No. 2

Finite element simulation of steel pipe JCOE fabrication for hydrocarbon pipeline applications

Spyros A. Karamanos, Ph.D.

University of Thessaly

Email: skara@mie.uth.gr



FINITE ELEMENT SIMULATION OF STEEL PIPE JCOE FABRICATION FOR HYDROCARBON PIPELINE APPLICATIONS

Spyros A. Karamanos

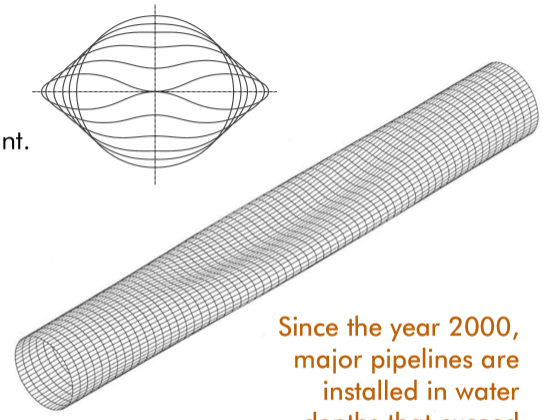
UNIVERSITY OF THESSALY

email: skara@mie.uth.gr



Pipe collapse in deep water

- In deep water pipelines, external pressure is a dominant loading factor for pipeline design.
- Pipelines are (most often) installed empty of content.
- Collapse may happen during installation of the pipeline in deep water.
- When the pipeline collapses:
  - the cross-section becomes flat
  - the flattening pattern may propagate, destroying a significant part of the pipeline ("propagating buckle")

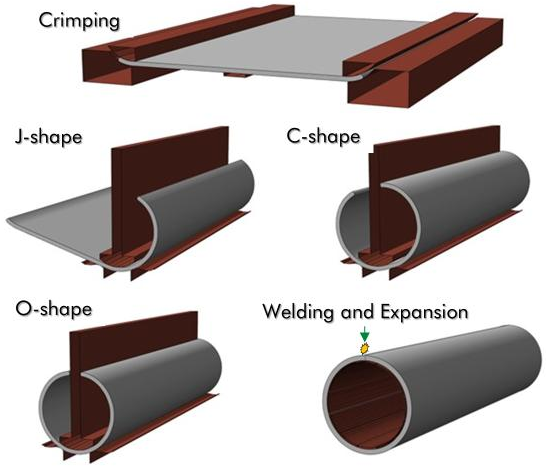


Since the year 2000, major pipelines are installed in water depths that exceed 2,000m (6,500ft)

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JCOE fabrication process

- Crimping of the plate edges
- J-ing: plate is formed into J-shape
- C-ing: plate is formed into C-shape
- O-ing: plate is formed into O-shape and welding
- Welding with SAW method (SAWL pipe)
- Expansion through an internal mandrel



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JCOE fabrication process

- JCO-E is an efficient method for manufacturing of thick-walled line pipes with minimum diameter 16 inches.
- The cold forming process affects the final product (line pipe):
  - *it induces geometric imperfections in terms of cross sectional ovalization and wall thickness reduction.*
  - *(most importantly) it influences material degradation of compressive strength in the circumferential direction due to Bauschinger effect.*
- Geometric and material imperfections significantly influence the structural performance of pipelines under external pressure loading conditions.



JCO forming punch
Corinth Pipeworks S.A. plant,
Thisvi, Greece

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Aim of the present research

- Investigate the influence of JCOE pipe fabrication process on the collapse pressure.
- Outline:
  - The JCO-E manufacturing process and pipe collapse under external pressure is simulated using a two-dimensional (2D) finite element model.
  - Material tests, on small-scale specimens extracted from the plate material to calibrate the numerical model.
  - Quantification of geometric imperfections and material property changes due to JCOE forming process on the final product.
  - Compute the collapse strength of the fabricated pipe.
- Application on a X60 steel 30-inch-diameter pipe

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NUMERICAL SIMULATION OF JCOE FABRICATION PROCESS

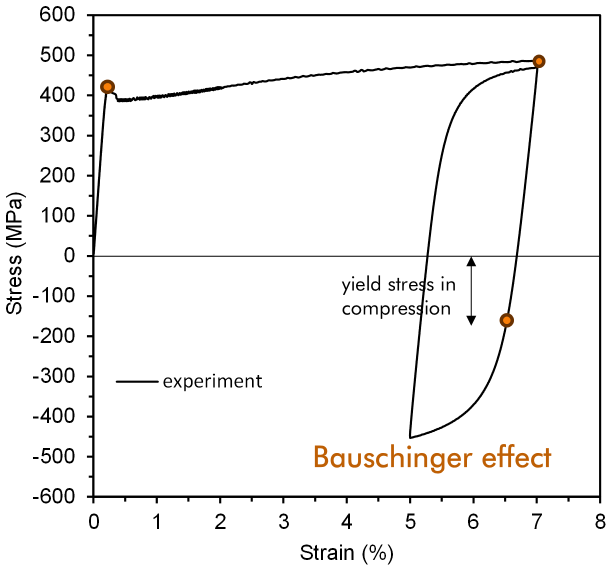
Material stress-strain curve
Finite element simulation of pipe forming process
Prediction of geometric and material properties of the final product

UNIVERSITY OF THESSALY



Plate material

- Uniaxial cyclic tests
- The plate material is considered isotropic and homogeneous.
- To model material behavior: a combined (non-linear/isotropic) hardening constitutive model is employed.
- Yield strength is equal to 440 MPa (at 0.5% of engineering strain).
- Upon reverse loading, the Bauschinger effect is activated, reducing the yield stress in compression.





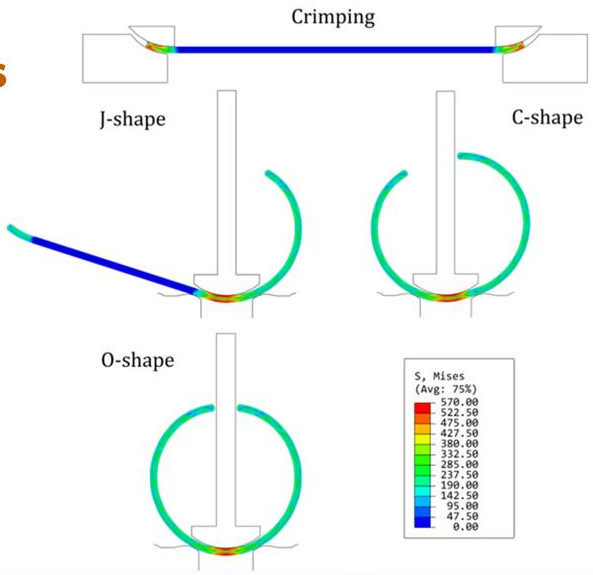
Finite element model

- FE analysis model with ABAQUS/Standard under generalized plane strain conditions for simulating the JCO-E forming process.
- The model employs:
  - *Generalized plane-strain elements for the steel plate (GPEG4R)*
  - *Analytical rigid surfaces as forming dies*
- Upon simulation of JCOE manufacturing process, the analysis continues with application of uniform external pressure for calculating the collapse pressure of the JCOE pipe ("**all in one model**").
- Application: X60 line pipe, using the manufacturing parameters set by the pipe mill:
  - *Nominal OD=30" (762 mm)*
  - *Nominal WT=1.52" (38.5 mm)*

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Crimping and JCO steps

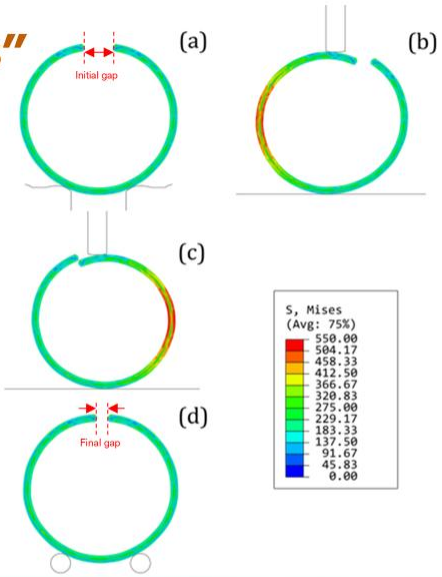
- Plate deformation during JCO forming process prior to welding.
- Number of punching steps: 15



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Gap closing: "finishing press"

- With two extra punches in the "finishing press", the "final gap" is obtained.
- Gap size is in good agreement with measurements provided by CPW for the pipe under consideration.



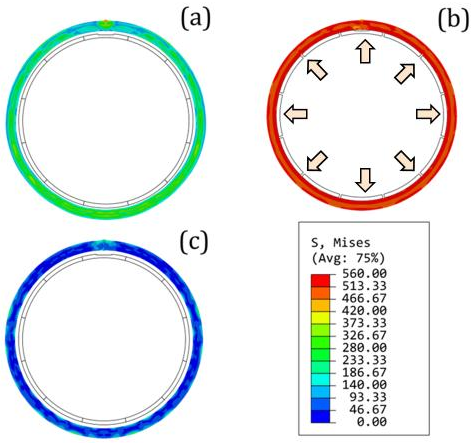
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Expansion

- Nearly circular pipe: JCO pipe (a).
- JCO pipe expansion with 12-segment expander (b).
- Final configuration is the "JCOE pipe" (c).
- Expansion is quantified by the following parameter (expansion strain):

$$\varepsilon_E = \frac{C_{\mathrm{E}} - C_{\mathrm{W}}}{C_{\mathrm{W}}}$$

where C_E and C_W are the mid-surface length of pipe circumference after expansion and after welding, respectively.



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Animation of JCOE pipe fabrication process (video)

Crimping



Line pipe geometry

- The expansion strain applied in the pipe mill has been equal to 1.30% (approximately the value of actual expansion used).
- The numerical predictions and measurements are made at 0°, 45°, 90° from the weld seam.
- The numerical predictions are in good agreement with the pipe mill measurements.

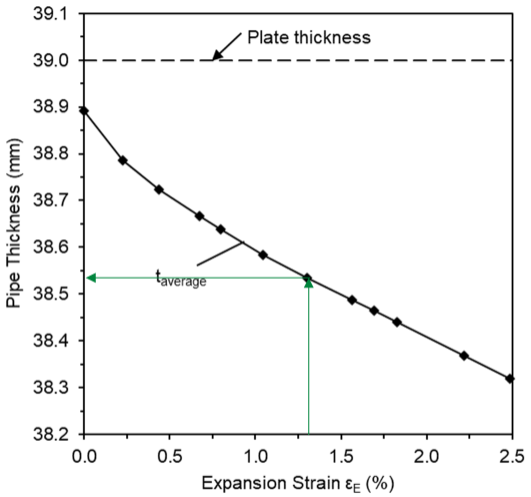
Inner diameter size (mm)

location	JCO pipe (before expansion)			JCOE pipe		
	0°	45°	90°	0°	45°	90°
FE simulation	675	675	679	687	686	686
actual (pipe mill)	675-677	678-681	683-689	684-686	686-687	686-688



Effect of expansion on pipe wall thickness

- The thickness of the JCO pipe (before expansion) is reduced by 0.1mm when compared to the initial plate thickness (39mm).
- The average wall thickness of the line pipe decreases with increasing expansion strain in a quasi-linear manner.
- At 1.3% expansion strain, the average thickness is 38.54 mm.
- Controlling thickness is essential, not only for QA but also for collapse strength.



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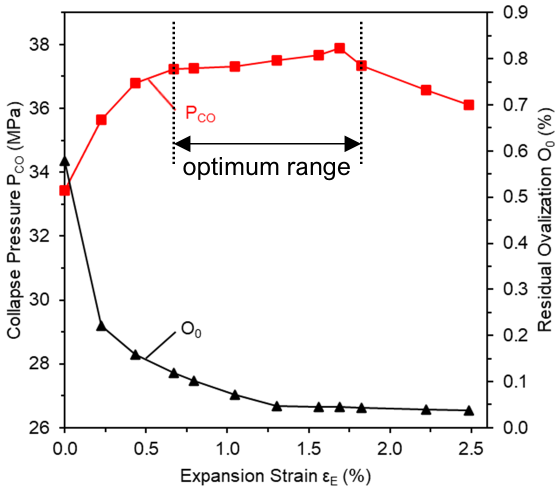
Effect of expansion on ovality and collapse pressure

- Residual cross-sectional ovality:

$$O_o = \frac{D_{\max} - D_{\min}}{D}$$

where $D_{\max}$ and $D_{\min}$ are the maximum and minimum values of the outer diameter.

- The maximum collapse pressure is equal to 37.9 MPa at 1.69% expansion strain.
- At 1.30% expansion strain, the collapse pressure is 37.5 MPa, nearly equal to the maximum collapse capacity.
- Cross-sectional ovality improves up to 1.3% expansion strain.
- After 1.8% of expansion strain, collapse pressure reduces, because of the Bauschinger effect.



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Conclusions

- A finite element model has been developed, capable of predicting accurately the influence of JCOE process on
  - geometric/material properties of the pipe
  - collapse strength of the pipe.
- It is a powerful and useful tool for optimizing the manufacturing process of offshore pipes.
- Increase of expansion level decreases the cross-sectional ovality and increases the corresponding collapse pressure.
- Beyond a certain amount of expansion (~1.3%) the change of ovality is negligible.
- There exists an optimum expansion range in terms of collapse pressure, between 0.7% and 1.8%; beyond that range, Bauschinger effect has an important influence.
- The geometric characteristics of the final pipe are in good agreement with measurements obtained by the pipe mill.



Group II

Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards

Presentation No. 3

Limitations of ASTM F3182 SIPP Standard in Defining Performance, Structural Classification, and Field Qualification

Sanaz Ghalambor, Ph.D.

Thompson Pipe Group

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What Are the Limitations of ASTM F3182 in Defining the Performance of Spray–In–Place–Polymeric Liners, and How Can They Be Resolved to Support Structural Classification and Field Qualification?



Brief Overview of SIPP Technology

• SIPP: Spray-In-Place-Polymeric liners , Polymeric Spray-In-Place-Pipes. Or Polymeric SAPL.

• A class of trenchless rehabilitation methods (TRM) where polymeric liners (e.g., epoxies, polyurethanes, polyureas) are sprayed into the pipe to form a seamless, jointless lining inside existing pipes.

• Applied robotically, manually, or through spin-cast unit.

• SIPP creates a new pipe-within-a-pipe that can prevent further degradation, restore hydraulic function, and provide structural integrity.



Why SIPP Liners Matter

•Adaptability Structural Versatility (various stages of pipeline deterioration—from internal corrosion protection to fully self-supporting structural renewal)
•Environmental Benefits (No VOC, Styrene Emission, Reduces Carbon Footprint)
•Minimal Excavation
•Versatility (pipe materials and diameters)
•Rapid Installation & Back to Service

Importance of Having a Comprehensive Standard

•Less reliance on other technologies' standards. Better industry-wide adoption. Risk and uncertainty reduction. Consistency across products and projects.



Current ASTM F3182 Standard Shortcomings

Lack of a Design Appendix

No Guidance on Design Performance and Physical Properties

Inadequate Material Testing and Performance Criteria



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Current ASTM F3182 Standard Shortcomings

Minimal Guidance on Installation Procedures

Absence of Repair Procedures

Inspection and Quality Assurance Limitations

Lack of Flexibility for Emerging Technologies

Limited Scope of Application

Requirements for Material Properties and Design



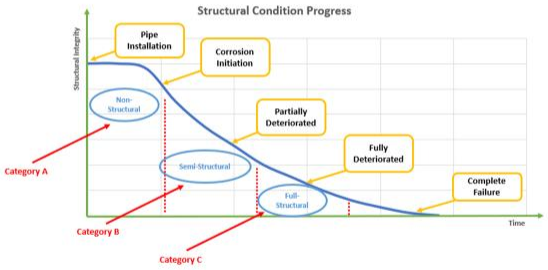




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Research Ideas
SIPP Design

- Designing SIPP Systems (Non-Structural, Semi-Structural, Full Structural)
- Designing SIPP Systems (Bonded and Non-Bonded)
- Composite action between liner and host pipe
- Load transfer
- Differential movement (thermal, pressure) and potential for debonding
- Termination design. Branch lines and manways design



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Research Ideas
Host Pipe Remaining Strength

- Should the host pipe's contribution to structural performance be ignored?
- Full structural designs (Class IV) assume no host pipe contribution to maintain a conservative approach.
- Host pipe strength might exist in practice
- Optimizing designs to account for residual host pipe capacity

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Research Ideas
Time Corrected Properties

Much of the industry relies on a value known as the **Creep Retention Factor** (CRF) to determine the allowable stress when designing liners.

CRF = Ratio of the Creep Modulus to the Elastic Modulus.

The CRF is often applied as a factor to adjust the **tensile/flexural strength/modulus**, resulting in a time-corrected property used for long-term performance evaluations.

This does not indicate that the long-term strength of the material CRF x original strength. It only indicates that the creep strain at time (x) is 1/CRF x elastic strain for a given applied stress value.

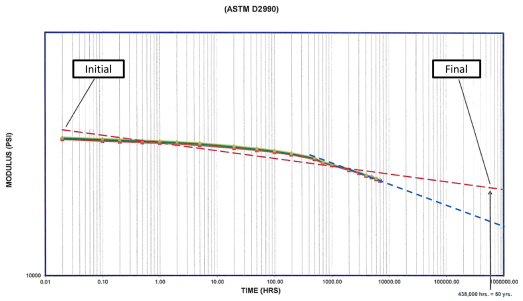


Research Ideas
Time–Corrected Properties

ASTM D2990
Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastic

Creep Modulus Test
OR
Creep Rupture Test

Liner design criteria documents such as ASTM F1216 do not provide any guidance on calculating this value





Research Ideas
Time–Corrected Properties

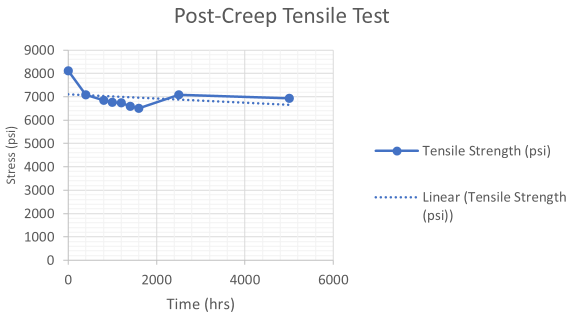
Literatures: CIPP/PLASTIC PIPES STUDIES

- If not exposed to a chemical degradation environment, properties of many plastic materials remain pristine over time (Watkins and Anderson, 2000) .
- Creep modulus is an inappropriate property to predict long-term deflection of buried plastic pipe (Moser et al., 1990).
- The creep retention factor is not an accurate estimate of rupture strength or fatigue strength reduction (Shannon et al., 2022).



Research Ideas
Post–Creep Properties

The experimental results indicate that relying solely on creep modulus curves and CRF for predicting the long-term performance of SIPP liners may be overly conservative.





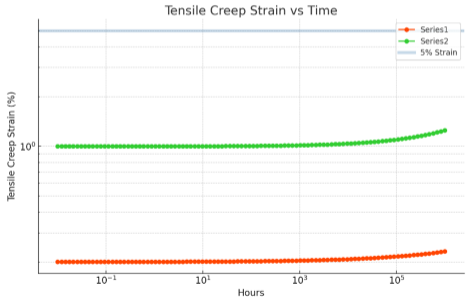
Research Ideas
Rights Method for Predicting Long–Term Properties

ASTM D2837 – Hydrostatic Design Basis for thermoplastic pipe materials.

ASTM F2018 - Time-to-Failure of Plastics Using Plane Strain Tensile Specimens

Max Allowable Strain

Wet Properties?!



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Proposed Changes in F3182 Revision

- Consider including non-potable pipelines.
- Address small and large-diameter pipes. Ensure inclusivity for various pipeline materials.
- Define structural classes of SIPP based on host pipe conditions. Standardize terminology to reflect industry needs.
- Define key material properties (short-term and long-term), long-term durability assessment.
- Advances in Testing and Material Certification
- Advances in Installation, Inspection, and Repair Procedures
- Inclusion of lining system design

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Thank You
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Group II

Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards

Presentation No. 4

Is Fully Structural SIPP Lining Possible? A Look at Current & Emerging Spray Applied Pipe Rehabilitation Technologies and SIPP Lining Design Methodologies

Jeff Maier

Dewberry Engineers

Email: jmaier@dewberry.com



What is SIPP lining?

SIPP = Spray-In-Place-Pipe lining

- ✓ Method of trenchless pipeline rehabilitation
- ✓ Fast application, minimally invasive pipe lining
- ✓ Can line a variety of pipe sizes and configurations
- ✓ Two main types of SIPP lining
  - Cementitious
  - Polymeric

Polymeric systems will be the focus of this presentation



What polymeric SIPP systems are available today?

- Spin cast, orbital or manual plural component pipelining application
- High build lining materials available
  - ✓ 100% solids epoxy systems
  - ✓ Polyurethane systems
  - ✓ Polyurea hybrid lining systems
- Mostly gravity pipe applications, some progress toward pressure
- Liner thicknesses can often range from 5 mils to 500 mils+



What are some potential advantages of SIPP?

- Minimally invasive, fast installation process
- Smaller, more versatile footprint
- No styrenated resins and less overland shipping restrictions
- Ability to conform to a variety of pipe sizes and configurations without the need for liner pre-manufacturing and wet out



SIPP systems, until recently, have had a number of limitations

*Being able to produce a **verifiable** fully structural, stand-alone liner has been a big challenge for many systems*

- Surface preparation can be challenging, expensive & time consuming
- Deployment length
- Shadowing issues
- Consistent design criteria has been lacking
- Misinformation on structural capabilities



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Polymeric systems often require a thorough surface preparation process to allow for intimate bonding of the liner

- Adequately prepared substrate is critical to bonding
  - ✓ Establishes anchor profile, removes corrosion, contaminants, debris
- Common surface preparation methods
  - ✓ Abrasive blasting
  - ✓ High pressure water jetting
  - ✓ Chemical preparation
- Different substrates can require different preparation
- Time consuming and expensive process

But how good does the surface preparation have to be?



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Design methodologies need to be consistent & appropriate

By design, an interactive lining system that is reliant to some degree on existing host pipe integrity, provides a semi-structural liner

- Minimum liner thickness calculated for a particular application
- Claims of fully structural lining, but this can be challenging to verify
- Interactive structural solution can be acceptable if the composite system is taken into account during design (host pipe & liner together)
- Progress toward verifiable structural design through different approaches
  - ✓ ASME PCC-2 vs. thin shelled ring theory vs. ASTM F1216 vs. FEA, etc.
- Industry standards for SIPP lining are evolving
  - ✓ ASTM F3182, AWWA C620, etc.



Times are changing: Recent advances & improved understanding are helping overcome some of the limitations

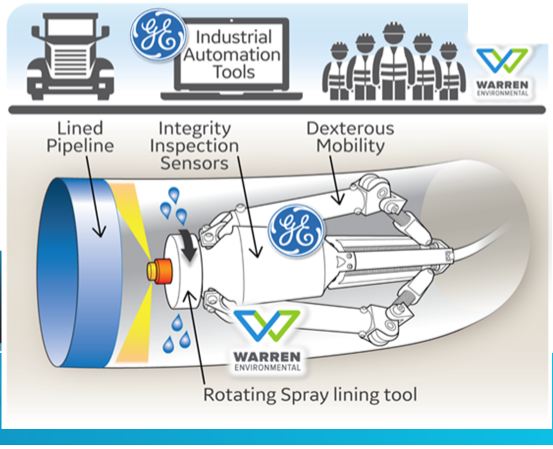
- Evolving design criteria and industry standards
- Improvements in SIPP lining materials & installation methods
- Innovative surface preparation and cleaning processes
- Better understanding of liner structural capabilities
  - ✓ Fully structural vs Semi-structural
- What degree of surface preparation is *really* needed?



The US Department of Energy's groundbreaking ARPA-E REPAIR research & development program focused on rapid trenchless rehabilitation of existing gas pipelines

- PLUTO has been a collaborative effort between GE Research, Warren Environmental/ Garney Construction and Dewberry
- Minimally invasive, long-range, structural pipeline rehabilitation
- Next generation SIPP lining concept

arpa·e
CHANGING WHAT'S POSSIBLE



Emerging SIPP systems, R&D and new lining concepts

- Advanced robotic lining systems with pre & post inspection capabilities
- Manufactured In-Place Composite Pipe (MICP) fully structural lining
- Advanced materials, composite reinforcement and self-healing additives
- Long reach resin supply hose configurations
- Small diameter SIPP lining for fire lines within buildings
- More efficient substrate preparation concepts

Fully structural polymeric SIPP lining is an ultimate goal for many systems

Next steps: Getting involved with the evolution of design methodologies for SIPP lining

Structural SIPP lining is becoming more of a reality, but there is still work to be done

- Revisions to ASTM F3182 focusing on standard updates and development of a new design methodology for SIPP lining for water mains
- New ASTM work items to develop a structural lining design standard for spray applied lining for general applications are being proposed
- Revisions to AWWA C620 for spray-in-place polymeric potable water pipelines
- NASSCO pressure pipeline committee
- AWWA committees, ASTM F17.67 subcommittee on trenchless technologies
- Other opportunities

The future is becoming brighter for SIPP lining technologies!



Questions?

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Dewberry



Group III

Subsurface Conditions & Trenchless Construction

Presentation No. 5

Value of Geological Information and Drilling Data for Annular Pressure Analysis in Horizontal Directional Drilling

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Background Information: Horizontal Directional Drilling & Annular Pressure

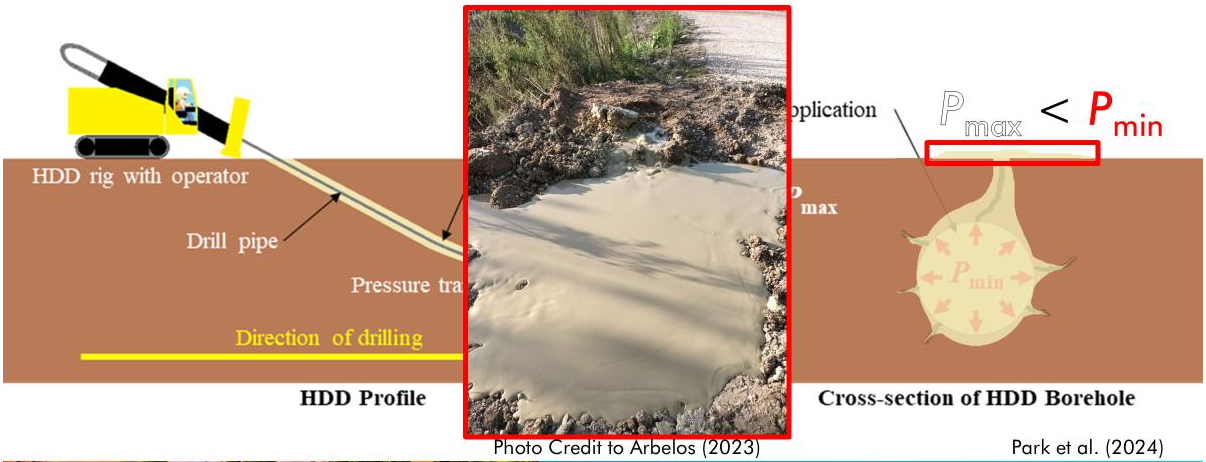


Photo Credit to Arbelos (2023)

Park et al. (2024)

Background Information:
Hydraulic Fracture & Its Consequences…



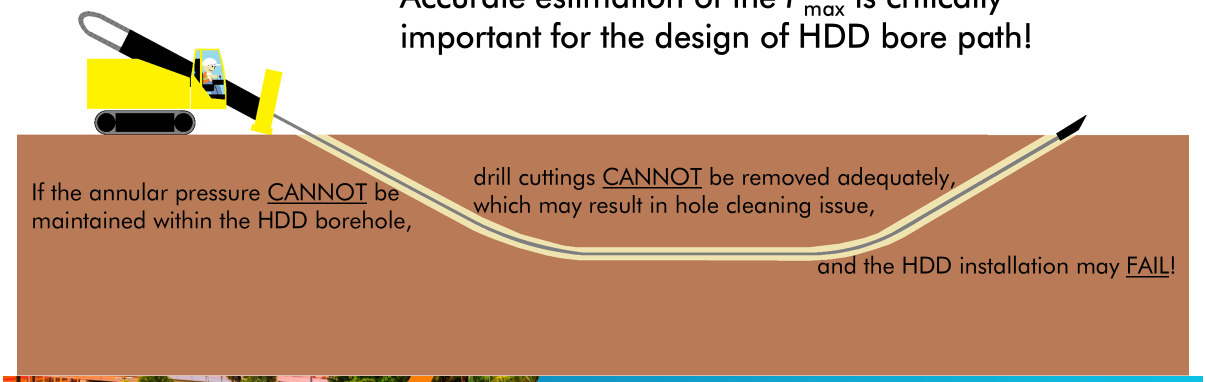
Nichols (2018)



Tabesh et al., (2019)

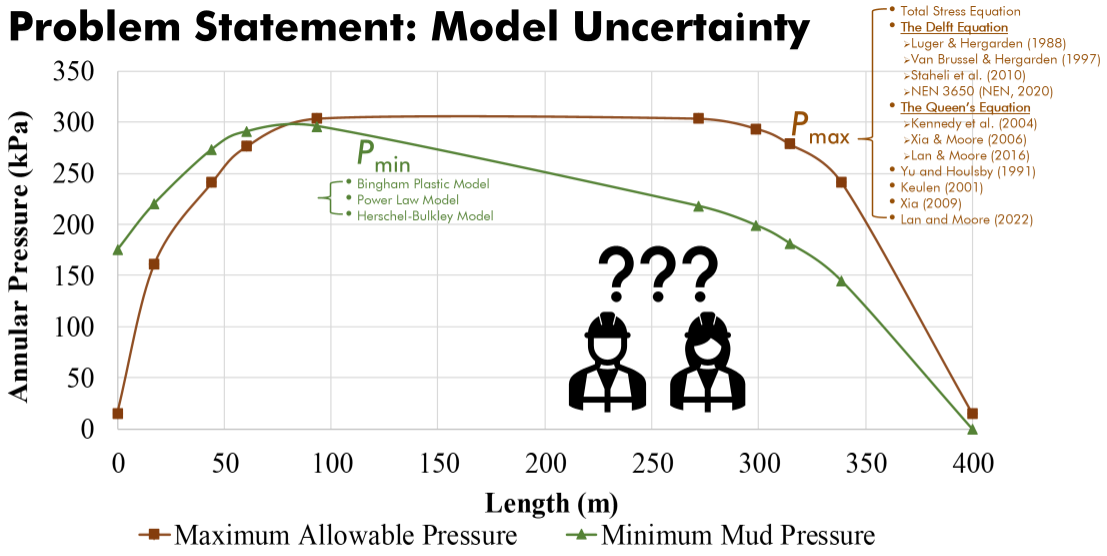
Background Information:
Hydraulic Fracture & Its Consequences…

Accurate estimation of the P_{max} is critically important for the design of HDD bore path!



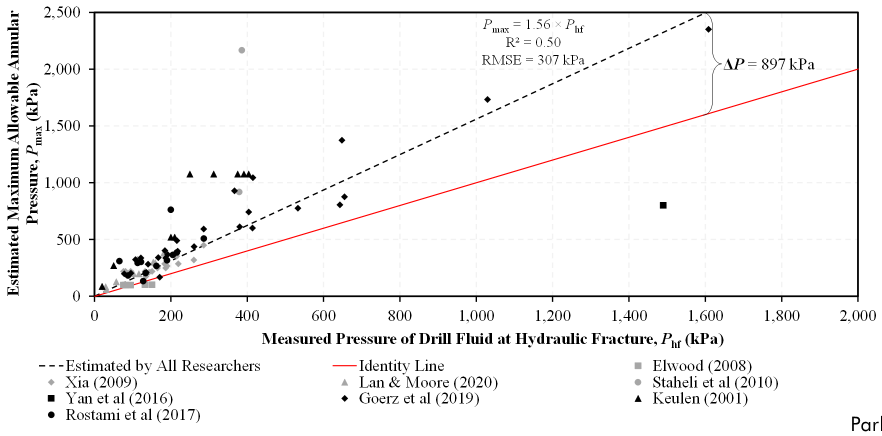
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Problem Statement: Model Uncertainty





Problem Statement: Tendency of the Delft Equation to Overestimate P_{max}



Park et al. (2024)



Problem Statement: Relevant Case Studies (Laboratory)

Case study	Method used in the study	
Keulen (2001)	BTL21 BTL48	• Assumed unit weight, cohesion, internal friction angle, modulus of elasticity, Poisson's ratio, and dilation angle (method not specified)
Elwood (2008)	• Assumed based on the typical values provided in the Canadian Foundation Engineering Manual, 4th Edition (Canadian Geotechnical Society, 2006) and Foundation Analysis and Design (Bowles, 1996)	
Xia (2009)	• Obtained internal friction angle from a series of direct shear tests • Assumed modulus of elasticity (method not specified)	
Lan (2018)	• Obtained internal friction angle and tangent elastic modulus from a series of isotopically consolidated drained triaxial compression (CIDC) tests • Estimated modulus of elasticity based on an empirical correlation, which was found by curve-fitting the sets of measurements from the CIDC tests (tangent elastic modulus and confining stress) with the model proposed by Janbu (1963)	
Soares et al. (2023)	• Estimated internal friction angle based on the ranges of peak friction angle and constant volume friction angle reported by Oliveira Filho (1987) • Estimated modulus of elasticity based on an empirical correlation proposed by Baldi et al. (1989) • Assumed Poisson's ratio based on the suggestion provided by Kulhawy and Mayne (1990)	

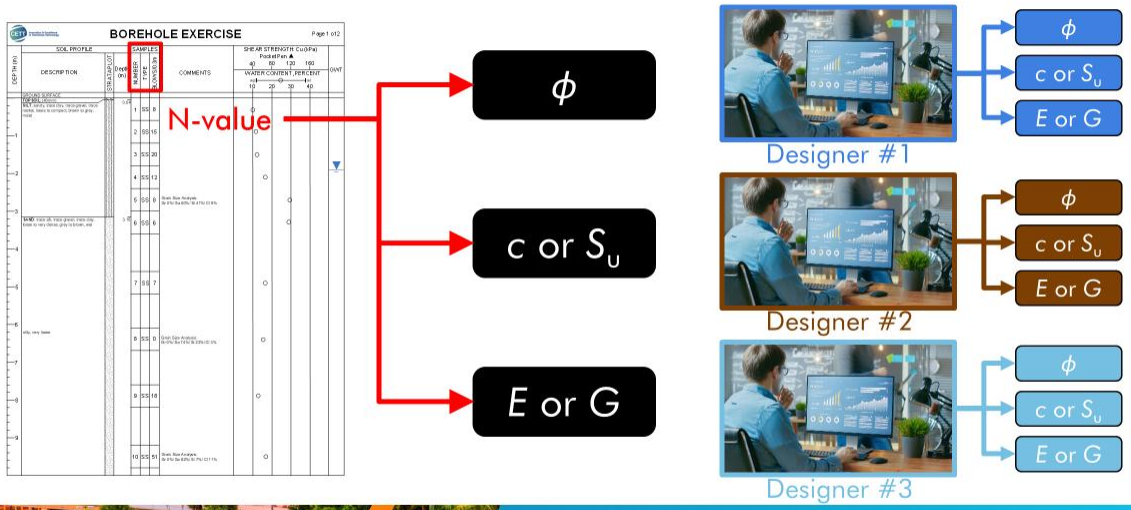


Problem Statement: Relevant Case Studies (Field)

Case study	Method used in the study	
Keulen (2001)	BTL47	• Derived from the report: BTL54 (method not specified)
Staheli et al. (2010)	Case 1	• Obtained the measured values of unit weight and internal friction angle from a geotechnical report • Assumed cohesion, modulus of elasticity, and Poisson's ratio (method not specified)
	Case 2	• Obtained unit weight from a geotechnical report • Assumed cohesion, internal friction angle, modulus of elasticity, and Poisson's ratio (method not specified)
Yan et al. (2015)	• Assumed all the geotechnical parameters based on the typical values suggested by multiple web-based sources (currently inaccessible)	
Yan et al. (2016)	• Characterized soil formations based on the detailed preliminary geological investigation information • Estimated lateral earth pressure coefficient at rest based on an empirical correlation proposed by Jaky (1944) • Assumed density, cohesion, internal friction angle, modulus of elasticity, and Poisson's ratio (method not specified)	
Goerz et al. (2019) Goerz and Boelhouwer (2022)	• Used site-specific geotechnical parameters (method not specified)	
Hoyles and Campos (2024)	• Obtained unit weight from laboratory tests using relatively undisturbed Shelby tube samples • Obtained undrained shear strength from unconsolidated undrained triaxial tests and/or unconfined compressive strength tests • Estimated modulus of elasticity based on an empirical correlation provided by Ladd (1964) • Assumed lateral earth pressure coefficient at rest and Poisson's ratio based on their judgment	

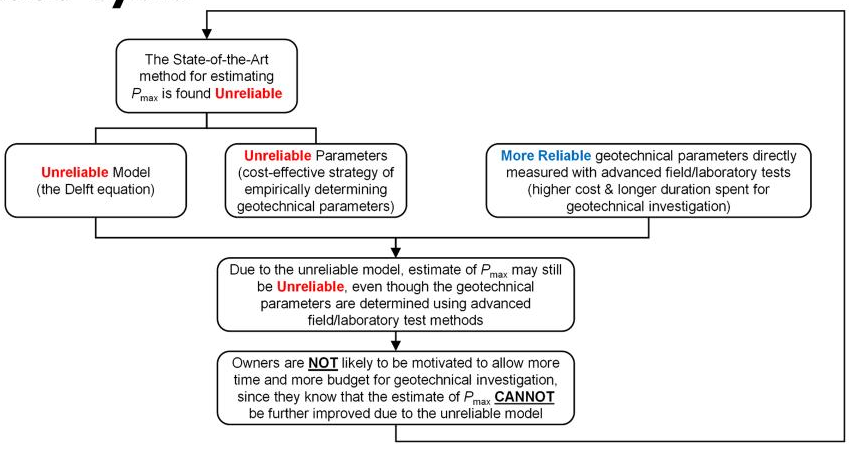


Problem Statement: Parameter Uncertainty



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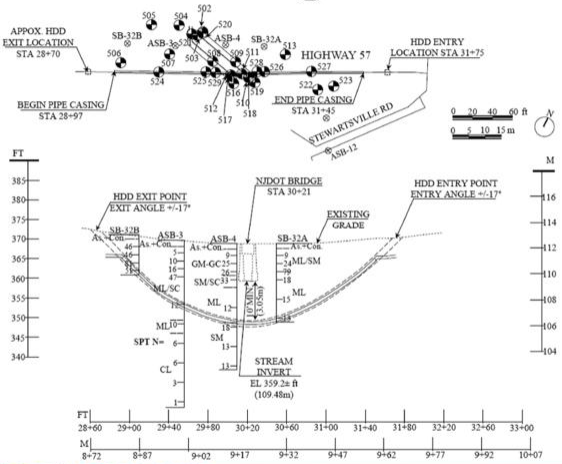
Problem Statement: Vicious Cycle



Park & Bayat (2025)

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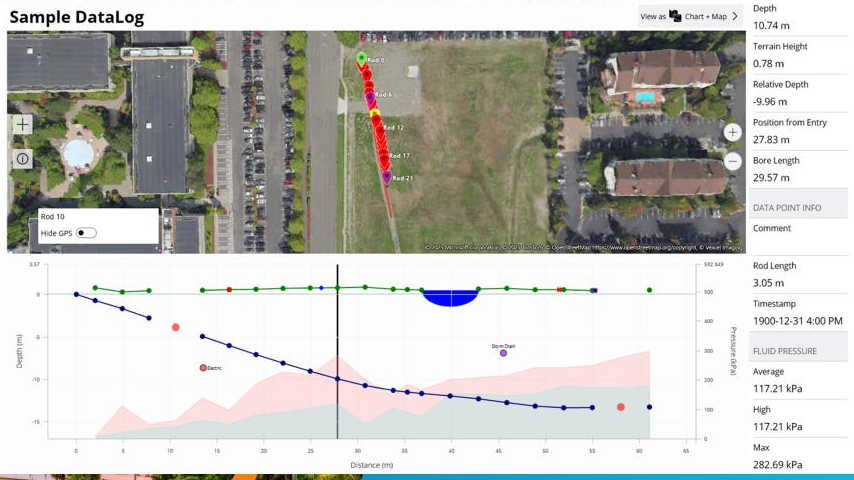
Field Data & Information Required for the Project: Ground Information Along the HDD Bore Paths



Oweis & Setya (2022)



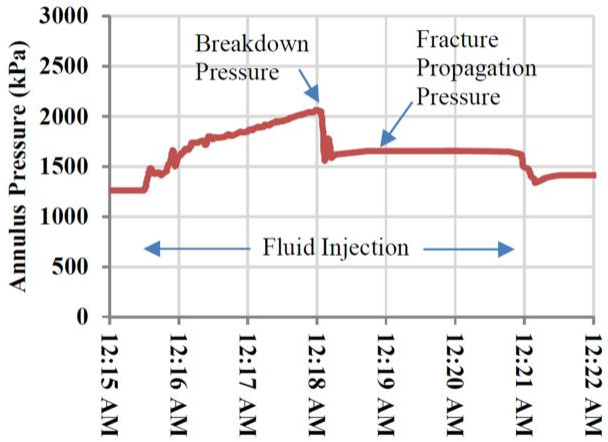
Field Data & Information Required for the Project: Measurements of Annular Pressure



Digital Control, Inc. (2024)



Field Data & Information Required for the Project: Real–time Recordings of Annular Pressure



Goerz & Boelhouwer (2022)

Field Data & Information Required for the Project: Construction Records Related to HDD and IR Events



This illustration was created by ChatGPT

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Anticipated Research Outcome

- Thorough Evaluation of existing Analytical Models
  - (e.g., the Delft equation, the Queen's equation, and many others)
- Evaluation of the P_{max} estimates made by analytical models and the measurements of annular pressure at hydraulic fracture from a Geomechanics Perspective
  - (e.g., elastic/plastic deformation of the HDD borehole at hydraulic fracture)
- Evaluation of the Constitutive Relations applied for each analytical model
  - (e.g., M-C, Tresca, Cam-Clay, and others)
- A careful review of the input geotechnical parameters determined for estimating the P_{max} from a Geological/Geotechnical Perspective
  - (e.g., *in situ* stresses, mechanical properties of soil/rock, and others)



References

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Group IV

Asset Management & Condition Assessment

Presentation No. 6

AI-Driven Capital Planning and Asset Management in Wastewater Infrastructure

Eric Sullivan

SewerAI

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Research Problem & Guiding Question

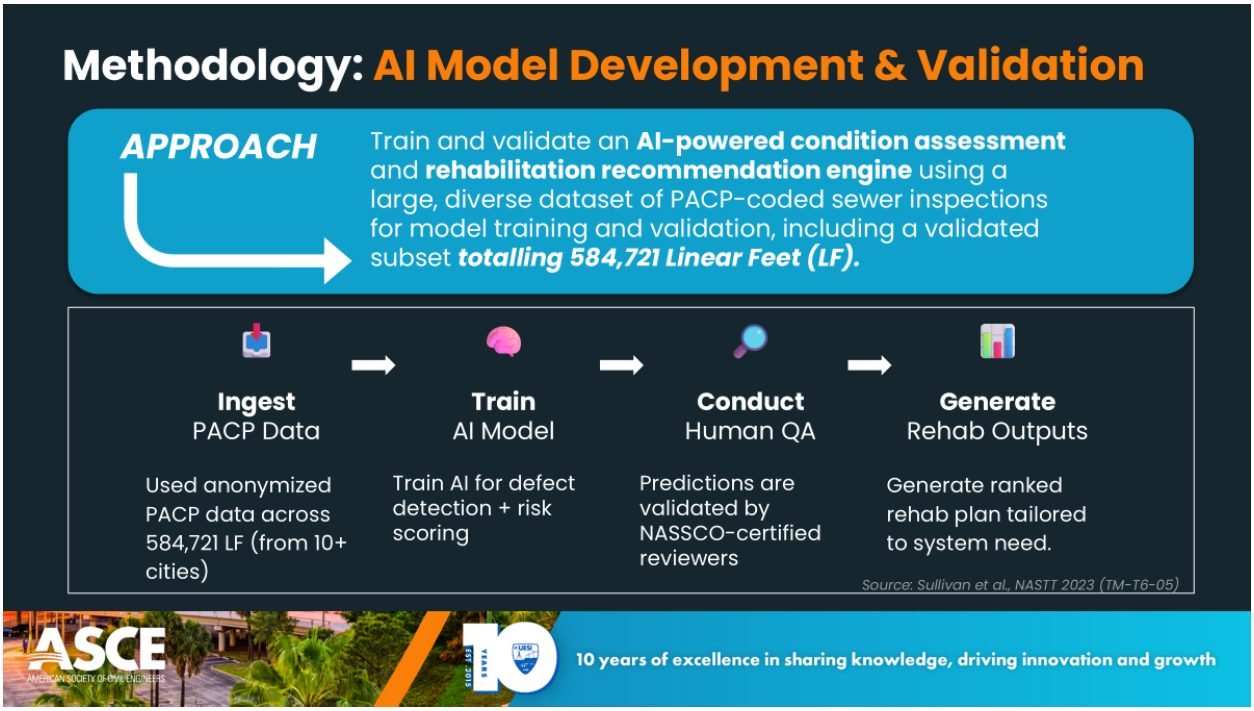
CHALLENGE:
Traditional CCTV inspection workflows are slow, subjective, and inconsistent—**limiting their value for proactive capital planning.**

- Traditional CCTV → inconsistent PACP data
- Limited staffing = inspection backlog
- Rehab planning often **reactive**, not risk-based

RESEARCH QUESTION:

How can AI-assisted inspection tools be used to improve accuracy and efficiency in sewer rehab planning at scale?

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Research Gaps and Progress

- Study and comparison of throughput with respect to the entire "life cycle" of CCTV inspection (Capture -> Assessment -> Decision -> Construction)
- Ability for AI to enhance PACP deliverables (quantification of I/I, pipe ovality etc)
- Comparison of AI Risk & Rehab Recommendations to manual asset planning decisions



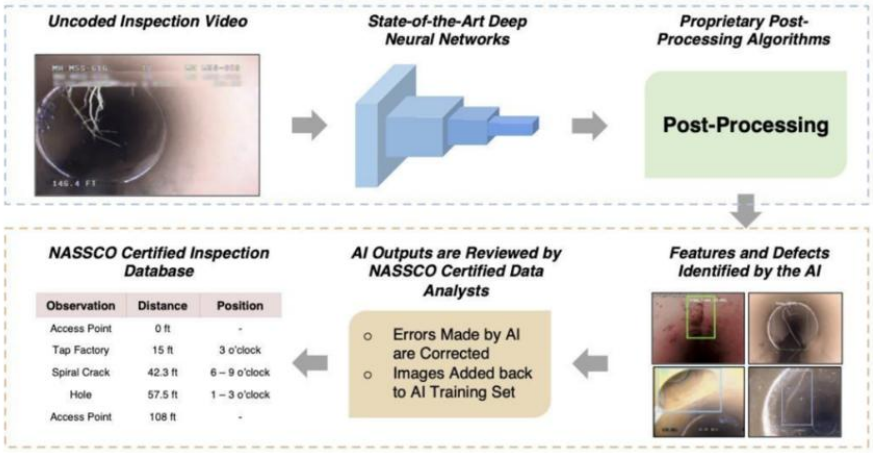


Figure 1. Overview of AutoCode™ & Data Analysis Workflow



Validated Research Foundation

Sullivan 2023, TM-T6-05

1. **112.9% increase** in inspection productivity with AI-assisted workflows *(Based on 3M+ LF across 16 operators)*
2. **97.5% detection accuracy** in cross-bore analysis vs. ground-truth
3. **8x higher defect accuracy** than manual coding in Houston consent decree review *(Bello 2022 memo to City of Houston)*

Anonymized Name	Total LF in Dataset	Total Inspections in Dataset	LF Per Workday	Inspections Per Workday	Minutes Between Inspections	Minutes Per Inspection	LF Per Minute	Inspections Per Hour	Number of Workdays in Dataset
AutoCode Operator 1	519210	3300	2660	16.9	13.2	4.94	31.9	3.31	195
AutoCode Operator 2	610550	3100	3280	16.65	14.01	9.86	20.0	2.51	186
AutoCode Operator 3	727180	3580	3370	10.21	14.41	11.38	29.0	2.33	351
AutoCode Operator 4	341000	1580	2040	9.47	29.2	14.42	14.9	1.38	167
AutoCode Operator 5	101680	486	4070	19.44	12.28	13.49	15.5	2.33	25
AutoCode Operator 6	32050	205	2670	17.08	4.92	11.6	13.5	3.63	12
AutoCode Operator 7	33640	155	3060	14.09	16.83	6.05	35.9	2.62	11
Manual Operator 1	15700	62	923.71	3.65	53.13	18.79	13.5	0.83	17
Manual Operator 2	36740	765	496.43	10.34	16.85	3.3	14.5	2.98	74
Manual Operator 3	171680	675	2420	9.51	24.15	14.75	17.3	1.54	71
Manual Operator 4	37420	162	1870	8.1	35.68	19.12	12.1	1.09	20
Manual Operator 5	139290	634	1410	6.4	31.49	16.46	13.4	1.25	99
Manual Operator 6	18181	80	1818.1	8	31.93	16.99	13.4	1.37	10
Manual Operator 7	19610	89	2450	11.12	36.43	17.6	12.5	1.63	8
Manual Operator 8	64580	469	500.61	3.64	37.23	6.81	20.2	1.36	129
Manual Operator 9	45560	134	1660	4.76	33.3	23.1	15.1	1.06	28

Table 2 - Summary of Results

LF CCTV / Workday (Avg Per Operator)		Inspections / Workday (Avg Per Operator)	
Manual Workflow Avg	1172.9	6.73	Manual Workflow Avg
AutoCode Avg	2497.9	13.10	AutoCode Avg

Table 3 - Overall Summary of Average Linear Feet of Inspections & Total Number of Inspections Per Day



Results

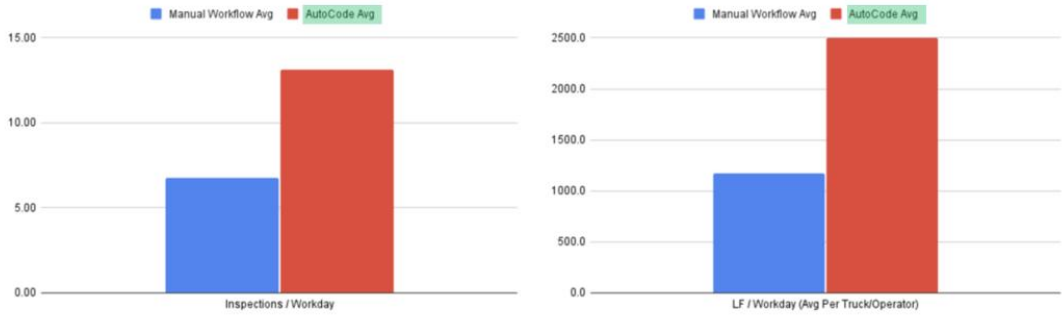


Figure 7 - Overall Summary of Average Linear Feet of Inspections & Total Number of Inspections Per Day





CASE STUDY

LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste into Resources

Validation: Los Angeles County Sanitation Districts

Study Area II: Manhole Application

Challenge

Inspect 25,000 MHs within 5 years to:

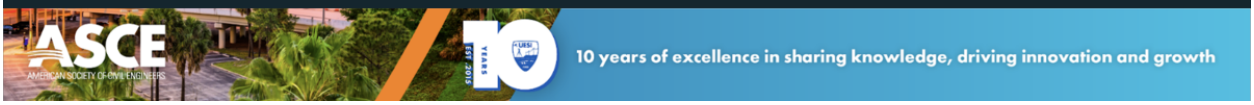
- Identify rehab priorities
- Avoid future overflows
- Overhaul QC for large diameter pipe assessments

Solution

Adopt PIONEER as the single platform-of-record for all MACP and PACP contractor submittals.

Result

- Inspection of **>5,000 MHs per year** and **>450,000 LF** of large diameter pipe
- Leveraged the PIONEER API to build custom workflows
- Inclusion of 2 sewer services contractors (National Plant Services and RedZone Robotics) in data collection tasks.



CASE STUDY

City of Phoenix

Validation: City of Phoenix

Study Area III: Reducing Inspection Cycle Timelines

Challenge

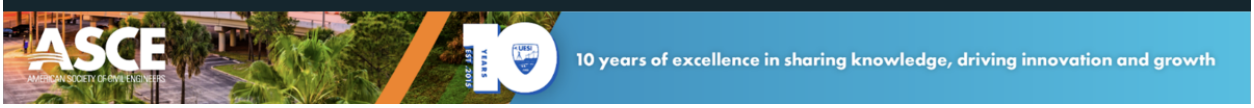
The City of Phoenix needed to significantly cut delays in its inspection program. The goal was to reduce the inspection cycle from 16 years to 9 years across 5,100 miles of its wastewater collection system in order to properly support needed capital improvements for rehab and replacement. Maintaining compliance with strict cyber security guidelines and enabling storage and consumption in on-prem environment using only basic Microsoft Office tools.

Solution

5.3M LF per year of PACP AutoCode, custom integration with data workflows.

Result

- Onboarding 5 services contractors tasked with field data collection
- Partnered with City's consultant (Dibble Corp) to achieve >double engineering throughput during asset management process.
- Seamless data collection and integration across City in-house CCTV operations.



Findings Summary & Rehab Impact

Accuracy & Efficiency → Smarter Rehab Decisions

Validated across
584,721 LF and 4 field studies:

- AI-assisted workflows **improved field productivity by 113%**
- Accuracy exceeded manual coding in every case **(8x more accurate)**
- PSCI analysis reveals critical misses (e.g., missed laterals, infiltration defects)

Why it Matters

- Enables risk-based rehab targeting across full networks
- Reduces costly re-inspections and emergency repairs
- Supports confident capital planning with data to back it up

The future of rehab isn't reactive —
it's risk-ranked, AI-backed, and engineer-approved.



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Thank You!
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NASSCO-Certified PACP LACP MACP Trainer
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Group Discussion Reports

Group 1 Report:
Structural Analysis & Integrity of Pipelines

Group Leader: Dr. Jian Zhang.

Attendees:

Ashley Roa-Martinez

Spyros Karamanos

Pharoah Ramirez

Jian Zhang

Ehsan Rajaie

Mo. Najafi

Research Needs and Discussions:

1. The group discussed the importance of structural integrity in pipeline systems, particularly within water and other critical infrastructure applications.
2. Emphasis was placed on the need for pipelines to remain structurally sound through proper design, installation, and evaluation.
3. Pipe selection was discussed in relation to service conditions, loading demands, and overall system requirements.
4. Deep-water pipeline applications were referenced as an example of severe loading conditions, where high external pressure must be considered in the structural design.
5. Environmental concerns related to pipeline systems were also noted during the discussion.
6. A large transmission pipeline project involving steel and PCC pipe was referenced to illustrate the scale and complexity of current infrastructure systems.
7. Ongoing parametric study work on pipe lining was discussed, including the effects of soil load, internal pressure, external pressure, and buckling.
8. Finite element modeling was identified as an important tool for structural analysis and evaluation.
9. The need for a standard equation or design relationship for SAPL and similar lining applications was discussed, including possible modification of existing equations and identification of governing parameters.

Group 2 Report:
Trenchless Technology, Spray-In-Place Lining Rehabilitation Methods Standards

Group Leader: Dr. Sanaz Ghalambor.

Attendees:

Sanaz Ghalambor

Jeff Maier

Brad L. Baird

Research Needs and Discussions:

1. Municipal rehabilitation needs were discussed, including the City of Tampa CIPP program.
2. The discussion also referenced the history of pipe rehabilitation and the increasing attention being given to lateral repair applications.
3. SIPP and CIPP were compared, with pricing identified as one of the main discussion points.
4. The group discussed the advantages of SIPP lining as a trenchless rehabilitation method.
5. Structural performance of SIPP lining was discussed, including performance evaluation and testing criteria.
6. Potential application of SIPP in stormwater systems was identified as an area of interest.
7. The group also discussed design considerations and future potential for irregular-shaped pipe applications.
8. Continued research and development needs were identified for SIPP lining and trenchless pipe rehabilitation methods.

Group 3 Report:
Subsurface Conditions & Trenchless Construction

Group Leader: Dr. Firat Sever

Attendees:

Zak Hanif

Reid Mete

Marc Cheneval

Firat Sever

Patrick Walker

Ram Krishna Mazumder

Aiden Moran

Inshik Park

Research Needs and Discussions:

1. The group discussed common challenges related to ground conditions and other existing site conditions affecting trenchless construction.
2. Existing conditions such as sinkholes were specifically noted as important factors in planning and execution.
3. Regulations and policies were discussed, including situations in which certain trenchless methods may be limited, such as railway crossings.
4. The legal environment and associated project risks were identified as important considerations.
5. Environmental aspects were discussed, including frac-out during HDD operations.
6. Styrene associated with CIPP was also raised as an environmental concern.
7. Economic considerations included comparison of trenchless construction with open-cut installation.
8. The group discussed "what-if" scenarios involving unforeseen conditions, such as abandoned foundations and other unknown existing structures.
9. Managing uncertainty in subsurface and construction conditions was identified as a key issue.
10. The need for additional tools in the toolbox was discussed, including the use of SUE and ASCE 38.
11. Colorado was specifically mentioned in relation to mandatory requirements associated with these practices.

Group 4 Report:
Asset Management & Condition Assessment

Group Leader: Dr. Kalyan Piratla.

Attendees:

Kalyan Piratla

Christine Bruno

Rory Jones

Muhammad Waqas

Seung Park

Adib Altalal

Xinyue Luo

Swarna Roy

Research Needs and Discussions:

1. The group discussed the use of AI in sewer condition assessment.
2. A major topic was the need to establish credibility for AI-based methods, particularly in response to skepticism about the reliability of results.
3. The importance of validation was emphasized, with the view that users need to see supporting evidence before adopting AI tools.
4. Dataset sharing was discussed, along with possible ways to enable broader access to data.
5. CNN-based approaches were mentioned in relation to AI technology and data use.
6. NDA-related restrictions were noted as a challenge for data sharing and collaboration.
7. The group discussed the potential for AI to speed up inspections and support faster review.
8. AI was recognized as an important and growing topic, but broader implementation in industry is still needed.
9. It was also noted that academia often lacks access to real-world data.
10. Transferable learning of AI models was identified as an area of interest.
11. Real-time feedback from AI systems was also discussed.
12. Concern was raised regarding possible intrusion issues.

Symposium Attendees List

Adib Altalal **Water and Sewer Engineer** **City of Tukwila Public Works** **Email: Adib.Altallal@TukwilaWA.gov**	**Fredy Ariza-Abero** **Senior Engineer** **YPF S.A – Argentina** **Phone: +54 11501 90860** **Email: fredy.ariza@YPF.com**
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