

Pipelines 2023

**Condition Assessment, Utility Engineering,
Surveying, and Multidiscipline**

Proceedings of Sessions of the Pipelines 2023 Conference

**San Antonio, Texas, USA
12 – 16 August 2023**

Editors:

**Christine S. Ellenberger
Jonathan D. Shirk**

ISBN: 978-1-7138-7745-5

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2023) by American Society of Civil Engineers
All rights reserved.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact American Society of Civil Engineers
at the address below.

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191
USA

Phone: (800) 548-2723
Fax: (703) 295-6333

www.asce.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

Contents

Asset Management

Increasing Confidence in Remaining Useful Life Estimation for Inspected Pipelines.....1
 Greta Vladeanu, Sepideh Yazdekhesti, and Craig M. Daly

Wired for Success: The Evolution of a Utility’s Large Diameter Force Main Asset Program11
 Jodi Litus, Anna F. Santino, and Alexandra F. Wells

Wastewater Pipe Probability and Consequence of Failure Rating Model for Decision Making.....21
 Sai Nethra Betgeri, Shashank Reddy Vadyala, and John C. Matthews

Managing 700 mi of Transmission Mains.....31
 Tyler Mott, Jayson Melcher, Kristen A. Peterson, and Peter D. Nardini

Concrete Bar Wrapped Pipe Management

Developing a Performance Curve for Bar-Wrapped Concrete Cylinder Pipe Based on Residual Factor of Safety Methodology39
 Rabia Mady

High-Resolution Inspection of AWWA C303 Bar-Wrapped Pipe with Detailed Field Verification45
 Murat Engindeniz, Piyush Garg, Troy Bontrager, Kristopher Embry, and Shane O’Brien

Digital Twin

Marching towards a Digital Twin: How GLWA Built a 3D Model of Its WRRF Complex Underground Utilities.....56
 Ahmad Habibian, Jim Broz, Mohsen Sadatiyan, Nicolas Nicolas, and Bryon Wood

A Digital Twin for Large Diameter Water Distribution Pipes67
 Andreu Fargas-Marquès and Joan Cornellà-Gil

Evaluation of Pipeline Failure

Factors Influencing Watermain Break Rates.....78
 Daniel Atambo, Shah Rahman, Madhuri Arjun, Vinayak Kaushal, Amin Tehrani, and Mohammad Najafi

State-of-the-Art Overview of Plastic Pipe Deterioration Mechanisms87
Seyed M. Yadollahi and Kalyan R. Piratla

Structural Analysis of Large Diameter Cast Iron Pipes under Cyclic Loading and Fatigue Failure97
Masood Hajali, Ashan McNealy, and Ikram Efaz

Leak Detection

A Novel Acoustic Sensor for Condition Assessment and Early Leak Detection in Water Pipes107
Joanna B. Watts, Kirill Horoshenkov, Neil Carter, and Neil Edwards

Ruidoso Leak Detection Program, Year One115
Britt Klein

Model-Based Leakage Detection for Large-Scale Water Pipeline Networks120
Ahmad Momeni and Kalyan R. Piratla

Machine Learning

Prediction of Sewer Pipelines Using Machine Learning Techniques: A Case Study on the City of Hamilton Sewer Network128
Mohammad Amini and Khalid Kaddoura

Implementation of Machine Learning Techniques for Prediction of the Corrosion Depth for Water Pipelines139
Taehyeon Kim, Kibum Kim, Jinwon Kim, Jinkeun Kim, and Jayong Koo

Why AI-Driven Analytics Are Essential for Next-Generation Pipeline Condition Assessments149
Marshall Kennedy, Boyu Liu, and Eric Toffin

Investigation of KNN and Decision Tree Methods' Efficiency in Developing Prediction Models for Sewer Pipes158
Salar Shir Khanloo, Madhuri Arjun, Mohammad Najafi, Vinayak Kaushal, Kawalpreet Kaur, and Ahmad Jibreen

Condition Prediction of Sanitary Sewer Pipe Data Set with Imbalanced Classification170
Karthikeyan Loganathan, Mohammad Najafi, Praveen Kumar Maduri, and Kawalpreet Kaur

Computer Vision for Pipeline Monitoring Using UAVs and Deep Learning181
Roy Lan, Ibukun Awolusi, and Jiannan Cai

Leakage Detection in Water Distribution Network Using Machine Learning192
 Harshit Shukla and Kalyan R. Piratla

Oil and Gas

**Bowing of a Pipeline from Longitudinal Compressive Stress Induced by
 Ground Movement.....201**
 Siavash Zamiran, Gennaro Marino, and Abdolreza Osouli

Fueling the Future: Advancements in Trenchless Gas Pipeline Rehabilitation212
 Jeff Maier, Todd Danko, and Brian Brandstetter

Technology to Monitor River Scour Exposure of Oil and Gas Pipelines221
 Samuel T. Ariaratnam and Tyler Lich

**Current Knowledge Gaps in Understanding Corrosion/Erosion Threats,
 Assessment Methodologies, and Mitigation Strategies for Pipelines228**
 Hong Pan, Xingyu Wang, Imtiaj Nahin Ahmed, Nguyen Tam, Yan Zhang,
 Trung Le, and Zhibin Lin

Optimal Proactive Seismic Rehabilitation of Gas Pipeline Networks.....240
 Sumaya Sharveen and Mohsen Shahandashti

Plow Pulling Installation of Steel Pipelines251
 Justus Vogler

PCCP Condition Assessment

**A New Method of Inspecting PCCP for a Utility with 15 Years of PCCP
 Inspection Experience.....261**
 Jared Svagera and Dustin Park

**Looking beyond Broken Wires: Baltimore’s Approach to PCCP
 Condition Assessment.....268**
 Golnaz Khorsha, Rasko Ojdrovic, Anna Pridmore, David Caughlin, Brian Ball,
 and Vennila Durai

How to Improve Renewal and Re-Inspection Decision Timing for PCCP278
 Bethany A. McDonald, Olivia Brancati, and Osai Robinson

**Investigation of Factors Affecting Remaining Useful Life of Prestressed
 Concrete Cylinder Pipes.....286**
 Ahmad Jibreen, Mohammad Najafi, Vinayak Kaushal, Kawalpreet Kaur,
 Madhuri Arjun, and Salar Shirkhanloo

Comparing Near Field Testing Technologies for PCCP Mains.....296
 Michael S. Higgins and Jody Caldwell

PCCP Management

Managing the Health of a 76-Year-Old PCCP: Successful Forever Pipe Management at Saginaw Midland Municipal Water Supply Corporation.....303
 Dan Stickel and Dustin Park

Using Life-Cycle Cost Analyses (LCCA) to Evaluate Large Diameter Water Pipeline Maintenance Strategies.....312
 Jim Geisbush, Guy Carpenter, Jason Foster, and Debra McGrew

Five More Years of Data: Predicting the Performance of Prestressed Concrete Cylinder Pipes; An Updated Case Study322
 Billy Haklander, Mike Garaci, Heather Edwards, Craig Daly, Sepideh Yazdekhasti, and Clinton Loe

Correlation of Transient Pressures and Exacerbation of Wire Breaks on PCCP Water Transmission Mains—Case Study.....330
 Karem M. Carpio and Kimberly Six

No More Failures: Charlotte Water Strengthens Its Commitment to a Comprehensive Management Strategy Targeting Large Diameter PCCPs341
 Alan L. Bair, Evan Biedenbach, Chuck Bliss, and Mike Paluso

Balancing the High Wire: A Review of Prestressing Wire in Great Lakes Water Authority’s Transmission System.....351
 Scott Jauch, Robert J. Peterman, and John W. Norton Jr.

Route 1A—A Comprehensive Management Route of Large Diameter PCCP Mains361
 Parvesh Dsingh and Lazaro Cabrera

Data-Based Management Strategies: A Case Study to Improve Performance of PCCP367
 Sepideh Yazdekhasti, Greta Vladeanu, Golnaz Khorsha, Ethan Vidal, and Craig Daly

Sewer Condition Assessment

Advanced Multi-Sensor Inspection Critical Condition Assessment on Wastewater Infrastructure377
 Csaba Ékes

Advanced Condition Assessment Using Pipe Penetrating Radar in Los Angeles County, California.....382
Csaba Ékes

Inspection Prioritization Framework and Implementation for Combined, Sanitary, and Storm Sewers.....391
Khalid Kaddoura, Chris Macey, Harry Krinas, Peter Commisso, and John Vraets

Looking in Hard to Reach Places—San Jose-Santa Clara Regional Wastewater Facility Yard Piping Condition Assessments401
Clinton McAdams and Noy Phannavong

Alternative Condition Score for Large-Diameter Pipe Rehabilitation and Inspection Prioritization.....412
Pubudu Ranasinghe, Getachew Melsew, Michael McReynolds, Christopher Garret, and Essey Woldemariam

Subsurface Utility Engineering

Lessons Learned from the BAMI-I/UESI Utility Investigation School (UIS)420
Seyed Saleh Behbahani and Tom Iseley

Subsurface Utility Engineering (SUE) Standard: To Whom SUE Is Created.....425
Ahmed Jalil Al-Bayati, Louis Panzer, and Roy Everett Sturgill Jr.

3D Utility Models—What to Consider432
Michael Woods

Lessons Learned to Minimize Signal Coupling between Utilities When Utilizing Electromagnetic Locator439
Xi Xie and Joseph Murphy

Utility Conflict Resolution for Transportation Project Delivery: Current Challenges and Potential Solutions in South Carolina447
Seyed M. Yadollahi and Kalyan R. Piratla

Protecting Our Water and Sewer Infrastructure: Developing Horizontal and Vertical Clearance Mitigation Tables454
Mark L. Reid, Susaye S. Douglas, Louis D. Arguello, and Shenica A. Knowles

What Else Is Down There?.....464
Joseph Murphy

Practical Application of Subsurface Utility Engineering: Best Practices.....474
 Josh P. Cowan

**The Use of a Drone-Based Time-Domain Metal Detector to Locate
 Unknown Pipelines483**
 Kristopher Harbin, Gary Young, and Ronald S. Bell

Water Condition Assessment

**Findings and Lessons Learned from Condition Assessment
 Inspections of Metallic Mains Using Inline Ultrasonic Technology494**
 Jesi Lay and Parvesh Dsingh

**Condition Assessment, Rehabilitation, and Validation of
 Advanced Pipe Inspection Tool for Aging 30-in. Steel Pipeline503**
 Craig VanHorn, Rick Fell, and Doug Smith

Indirect Assessment Leads to Better Planning for Condition Assessment.....513
 Benjamin C. McCray