

# ***Pipeline Research Council International, Inc.***

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PHMSA R&D Forum  
Working Group #2

**Preventing & Mitigating Geo-Forces on Pipelines & Facilities**

Carrie Greaney  
Program Manager



# Presentation Overview

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- **PRCI Overview**
- **Recent Completed Work**
- **Ongoing Work**
- **Areas of Interest**

# Our Mission

- To collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.

# Our Members

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- **33 Energy Pipeline Operating Companies**

- 15 Natural Gas Transmission; 10 Liquid
- 8 Liquid/Natural Gas

- **4 Pipeline Industry Organization (PIO) Members**

- American Petroleum Institute (API)
- Association of Oil Pipe Lines (AOPL)
- Canadian Energy Pipeline Association (CEPA)
- Operations Technology Development (OTD)

- **34 Associate Members & Technical Program Associate Members**

- Australia, Canada, China, Europe, Japan, U.S.

- **Worldwide Research Organization**

- 45 North American Companies (U.S. & Canada)
- 25 Non-NA (Australia, Brazil, China, Europe, India & Japan)



AUSTRALIA  
AUSTRIA  
BRAZIL  
CANADA  
CHINA  
FRANCE  
GERMANY  
INDIA  
IRELAND  
JAPAN  
NETHERLANDS  
NORWAY  
UNITED KINGDOM  
URUGUAY  
USA

# Current Pipeline Operator Members

## ▪ Natural Gas

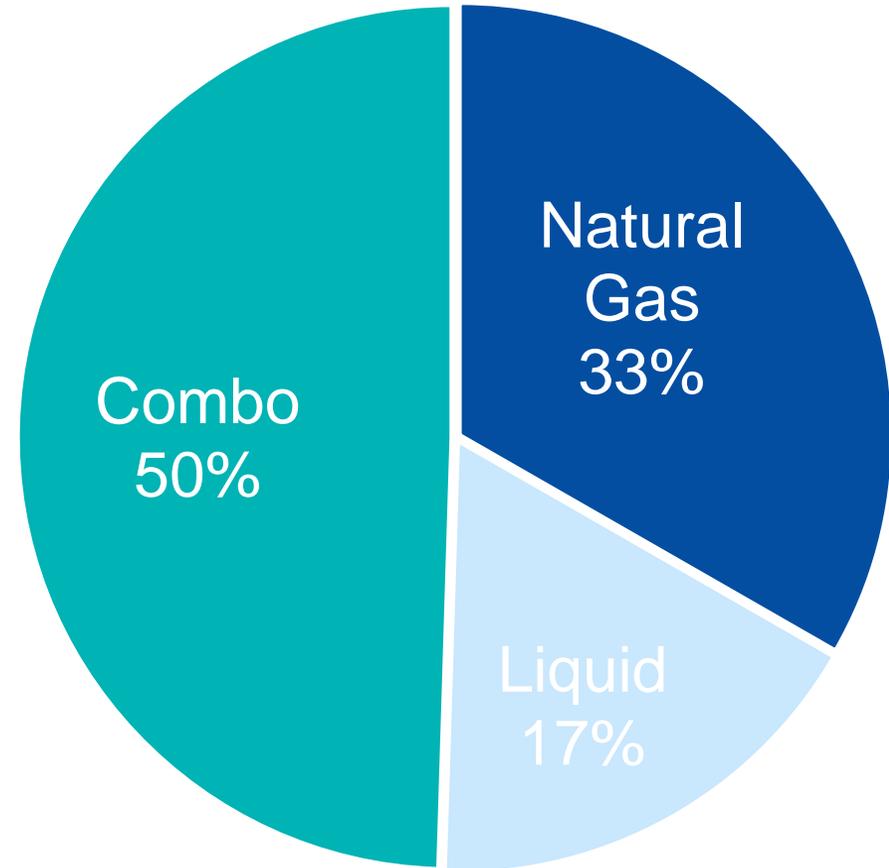
- ATCO
- Boardwalk
- Cadent
- Dominion
- Energy Transfer
- Gassco
- Gasunie
- GRTgaz
- National Fuel
- National Grid
- PG&E
- SoCalGas
- Total
- TransGas
- Williams

## ▪ Liquid

- Buckeye
- Chevron
- Colonial
- ExxonMobil
- FHR
- Marathon
- Phillips 66
- Plains
- Saudi Aramco
- Trans Mountain

## ▪ Combo

- ConocoPhillips
- Enbridge
- Enterprise
- Kinder Morgan
- Petrobras
- PetroChina
- Shell
- TC Energy





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# TECHNOLOGY DEVELOPMENT CENTER

# PRCI Technology Development Center (TDC)

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- **ILI pull test rig**
- **Thousands of pipe samples**
  - Corrosion
  - Mechanical damage
  - Cracks
  - Long seam
  - Other
- **NDE evaluation and training**
- **Conference rooms**





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# RESEARCH OVERVIEW

# PRCI Technical Committees

## PIPELINES



Corrosion



**Design,  
Materials  
& Construction**



Integrity  
& Inspection



Subsea



**Surveillance,  
Operations  
& Monitoring**

## FACILITIES



Compressor  
& Pump Station



Measurement



Underground  
Storage

# SOM Committee Overview

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## Surveillance, Operations & Monitoring *Technical Committee*

- **Right-of-Way Threat Detection/Monitoring**
  - Remote- intermittent Leak Detection, 3rd Party Threats
- **Geohazard Monitoring**
- **Continuous Leak Detection**
- **Human Organizational Factors** – Safety Engineering & Damage prevention

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### CHAIR

**Nikos Salmatanis**  
Chevron

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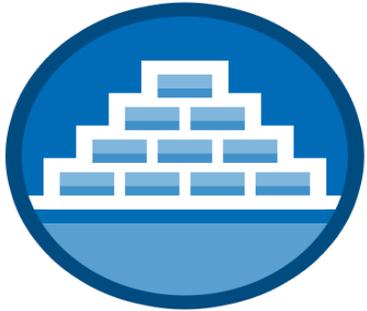
### VICE CHAIRS

**Mike McCutcheon**  
TransCanada

**Chris O'Neill**  
Enbridge

# Design, Materials & Construction Committee Overview

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## Design, Materials & Construction (DMC)

*Technical Committee*

Focus Area / Vice Chair

- **Design**
- **Materials**
- **Fracture**
- **Welding**
- **Geohazard Management**
- **Assessment and Repair**
- **Construction**

**CHAIR**  
**Steve Rapp**  
 Enbridge

### VICECHAIRS

Fred Fisher Exxon	Junfand Lu Enbridge	Eduardo Hippert Petrobras	Jorge Penso Shell	Mike Cook Exxon	Russell Scoles Enbridge	Nick Khotenko ATCO
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# Recently Completed Work

# Completed Research – DMC Geohazard Management

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- Field Validation of **Surface Loading Stress** Calculations for Buried Pipelines
- Full-Scale Buried Pipe Tests to Determine and Reduce **Soil Loads** on Buried Pipelines
- Guidance for Establishing **Geohazard Integrity** Performance Goals
- Guidance on Predicting **Pipeline Strains Induced by Slope Movement**
- Update of PRCI **Seismic Design** Guidelines
- Guidance for Conducting **Strain-Based Assessment** of Buried Pipelines Subjected to **Ground Movement**
- Review of **Compressive Strain Capacity** Assessment Methods
- Strain-Based Design - **Strain Concentration** at Girth Welds

# Completed Research – Surveillance, Operations, & Monitoring Geohazard Monitoring

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- **Ground Based Radar Monitoring of Pipeline Facilities**
- **Evaluation of Current ROW Threat Monitoring, Applications and Analysis Technology – Satellite Gap Study**
- **InSAR Detection and Quantification of Pipeline Corridor Movement Induced by Longwall Mining**
- **Quantification and Extension of Pipeline Corridor Movement Monitoring Using InSAR for Buried Pipeline in the Pacific Northwest**
- **Comparison of RADAR Satellite Methods for Observation of Elevated Pipelines in the Arctic**
- **Use of Aerial LiDAR Data Collection for Geohazard Assessment**



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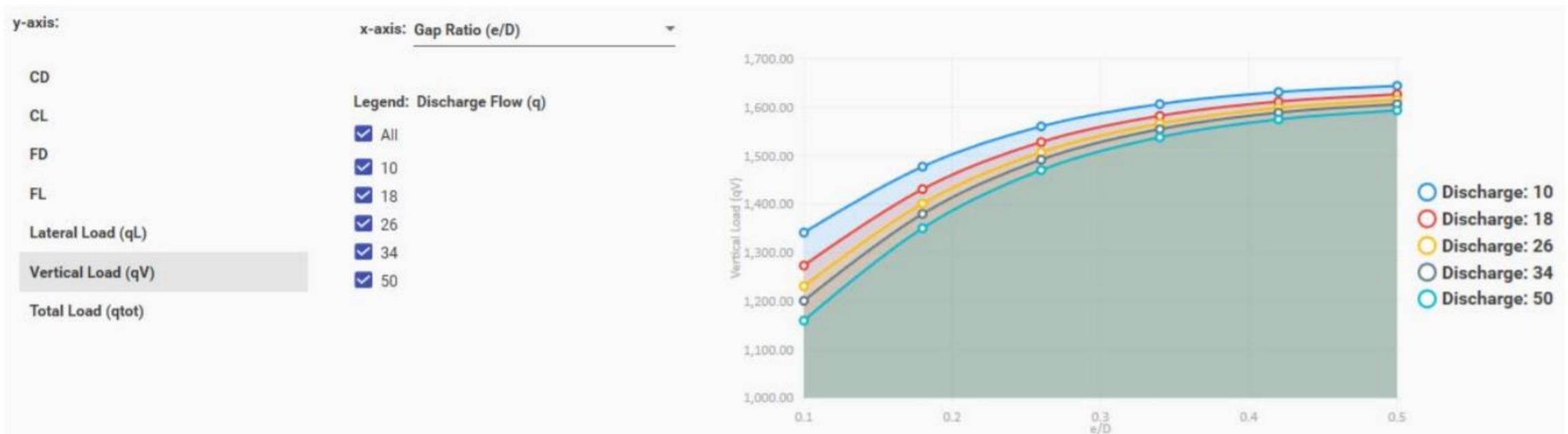
Ongoing  
Research

# Active Research – DMC

## Modernization of the River-X Software

**Objective** – Update to software methodology including hydrodynamic loading, screening/allowable free spans and Vortex Induced Vibration (VIV) fatigue loading. Comparison with the state-of-the-art formulations and methodology.

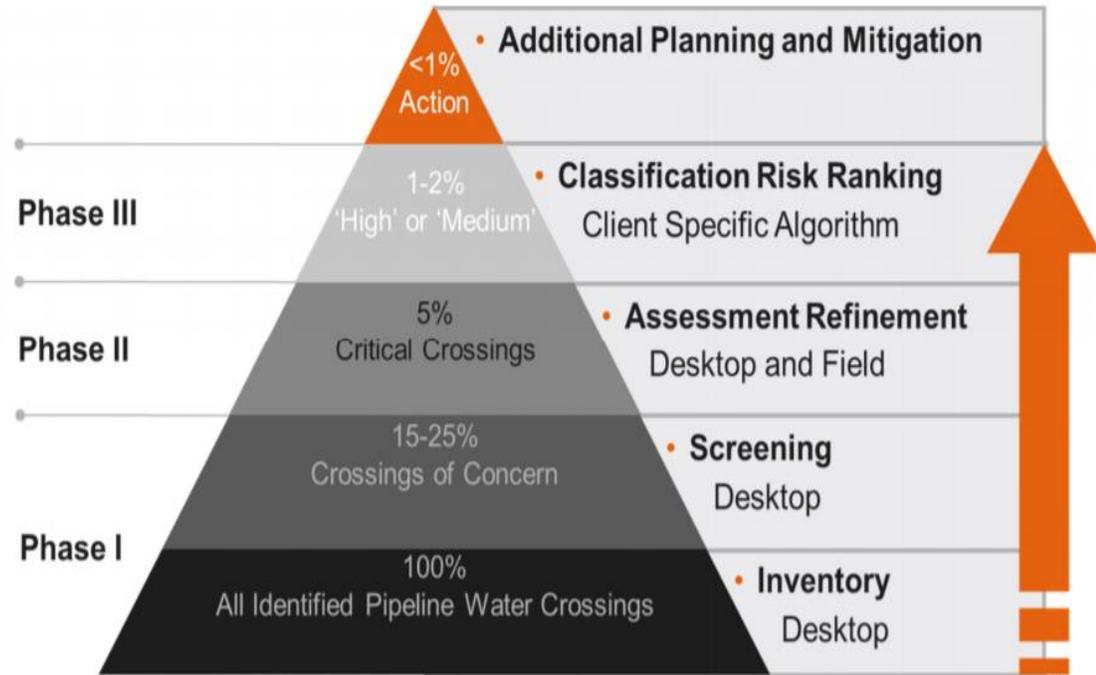
**Project Status** – Software delivered to PRCI, final modification to be delivered by mid March 2020.



# Active Research – DMC

## Modernize the Assessment of Pipeline Water Crossings (PHMSA Co-Funded)

**Objective** - To supplement and strengthen industry consensus standards, through development of screening level and detailed assessment level analytical and risk. Field verification to test the applicability of advances in vortex-induced fatigue criteria and vortex-induced vibration (VIV) response models within inland water crossings of various channel widths crossings. The third objective is to promote new knowledge, will be achieved through inclusion of fluvial geomorphological and related engineering principles to identify potential pipeline exposures at river crossings.



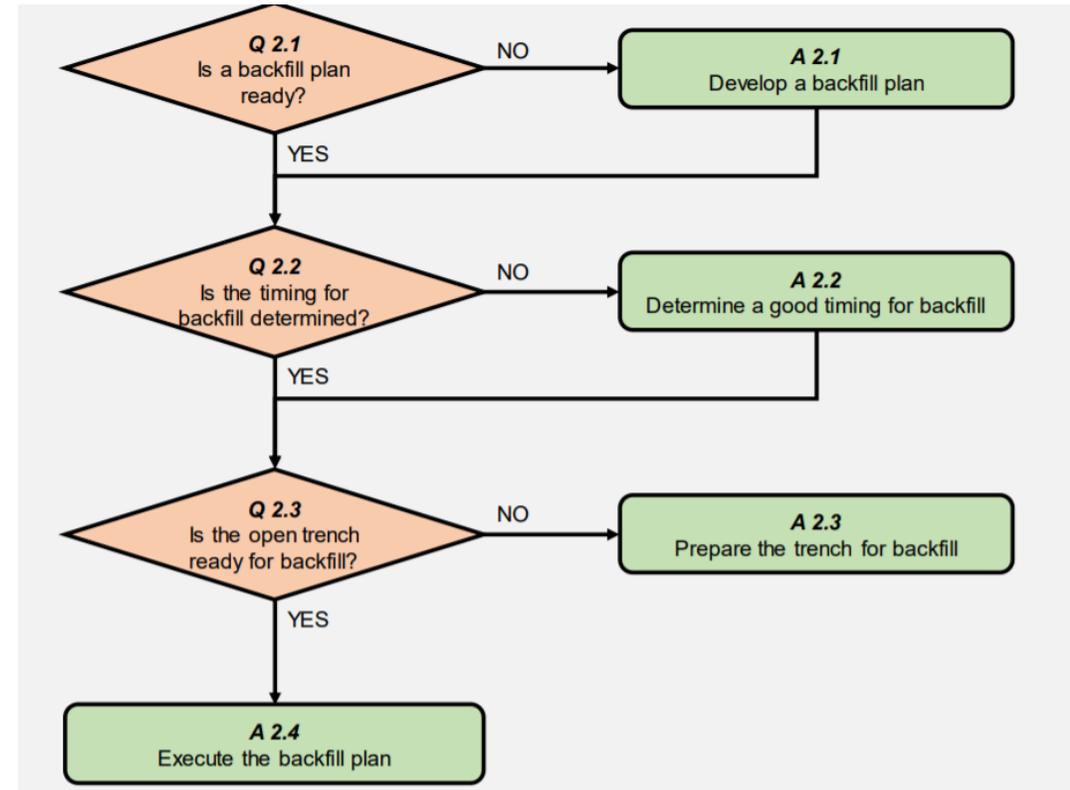
**Project Status** – Start of year two of a three year, expected completion 2021

# Active Research – DMC

## Guidance on the Excavation and Backfill Procedures in Areas of Geohazards and High Axial Stress and Strains

**Objective** – The work covers the following areas: (1) assessment of risks associated with working in areas of geohazards, (2) assessment of risks associated with disturbing pipe segments potentially under high axial stresses and strains, (3) determine the need and effectiveness of pressure reduction, (4) excavation procedure and associated risks, and (5) backfill procedure and associated risks

**Project Status** – Year two of two-year project, expected completion: summer 2020



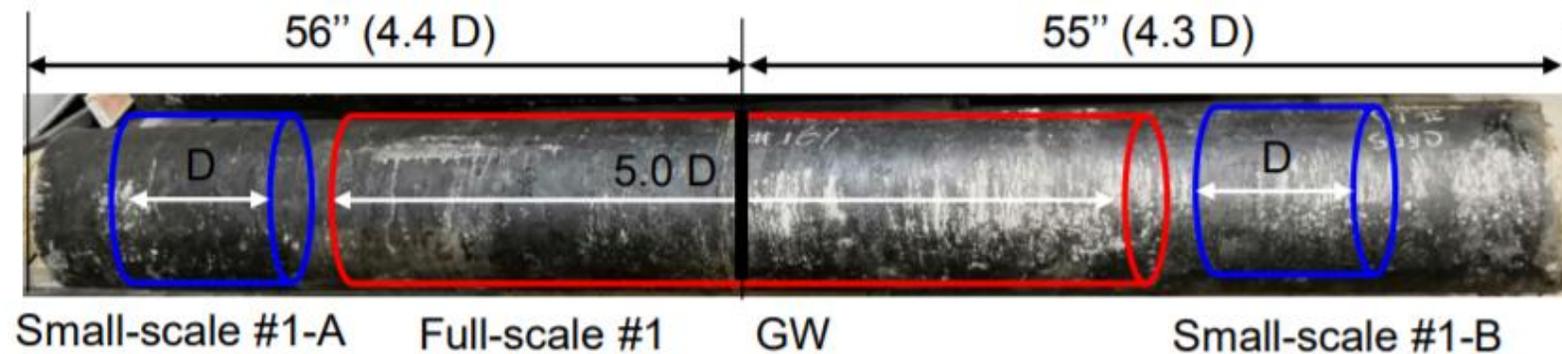
## Active Research – DMC

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### Enhancing Strain Capacity of Pipelines Subjected to Geohazards

**Objective** – The Phase 1 of this project is focusing on Type-B sleeves and girth weld cap reinforcement. The composite repair will be examined in Phase 2. Numerical analysis will be conducted to identify key drivers to the integrity and understand mechanisms of strain capacity enhancement. The analysis will also identify areas and processes suitable for experimental verification. The deliverable is a guidance for enhancement of capacity in areas subjected Geohazards.

**Project Status** – Year two of two-year project, expected completion, summer 2020



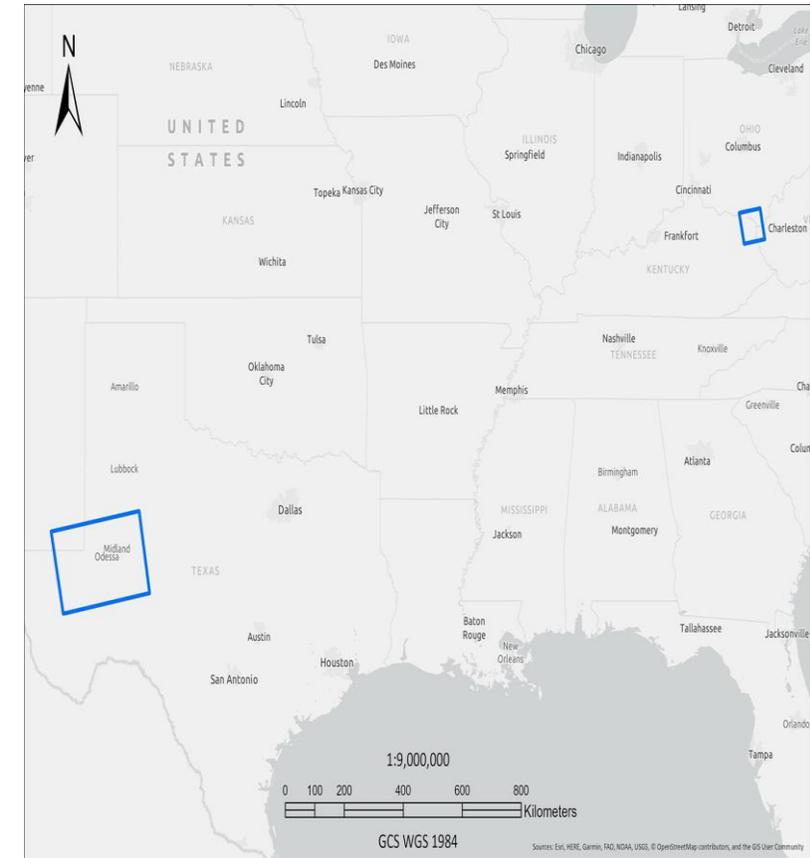
# Active Research – Surveillance, Operations, & Monitoring Geohazards

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## L-Band InSAR Monitoring of Pipeline Geohazards in Appalachia and the Permian Basin

**Objective:** Evaluate the accuracy and reliability of L-Band InSAR satellite data for heavy vegetated (Appalachian) and non-vegetated (Permian Basin) areas using.

**Project Status** – Phase 1 Final report under review. Phase 2 to be completed in 2020.



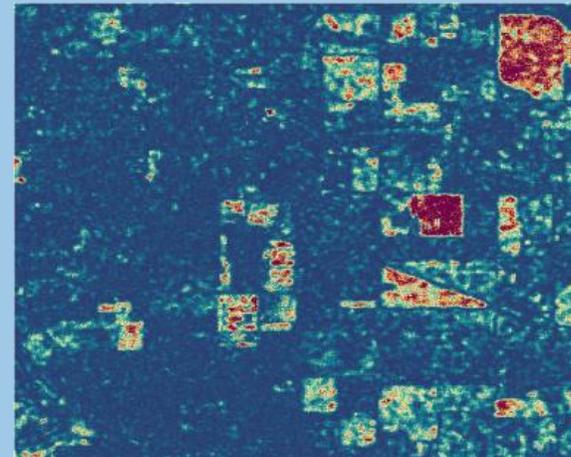
# Active Research – Surveillance, Operations, & Monitoring Geohazards

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## Optimal Approach to Multi-source, Satellite Surveillance of River Crossings, Slope Movements and Land Use Threats to Buried Pipelines

**Objective** - Investigate the application of satellite monitoring of river bank deformation, channel dynamics, changes to soil (erosional) conditions and land cover/land use over buried pipelines.

**Project Status** – Year two of two-year project, expected completion: end of 2020



# Active Research – Surveillance, Operations, & Monitoring Geohazards

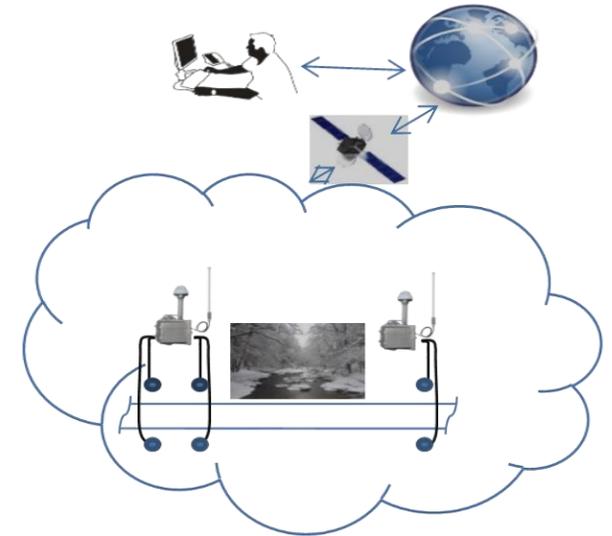
22

## System for Monitoring Integrity, Geohazards, and Leaks at River Crossings

**Objective** - The development of a dedicated system for monitoring underground pipeline facilities at river crossings, especially those without ready access to

power and communications. System to include: strain gauges, MEMS inclinometer strings, VHF buoys, polymer absorption sensors, etc.

**Project Status** – Year two of two-year project, expected completion: end of 2020



# Active Research – Inspection & Integrity

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## Numerical Modeling and Full-scale Testing to Evaluate the Performance of Large Standoff Magnetometry

- **Objective:** evaluate the performance of Large Standoff Magnetometry (LSM) technology in various combinations of loading into a pipe sample including internal pressure, axial tension / compression, and bending. The intent is to introduce loading representative of what might be encountered in a geohazard condition. The challenge with the current state-of-the-art is lack of validation data and fundamental research to support the use of LSM technology.
- **Status:** just beginning year one of a two-year project, expected completion 2021

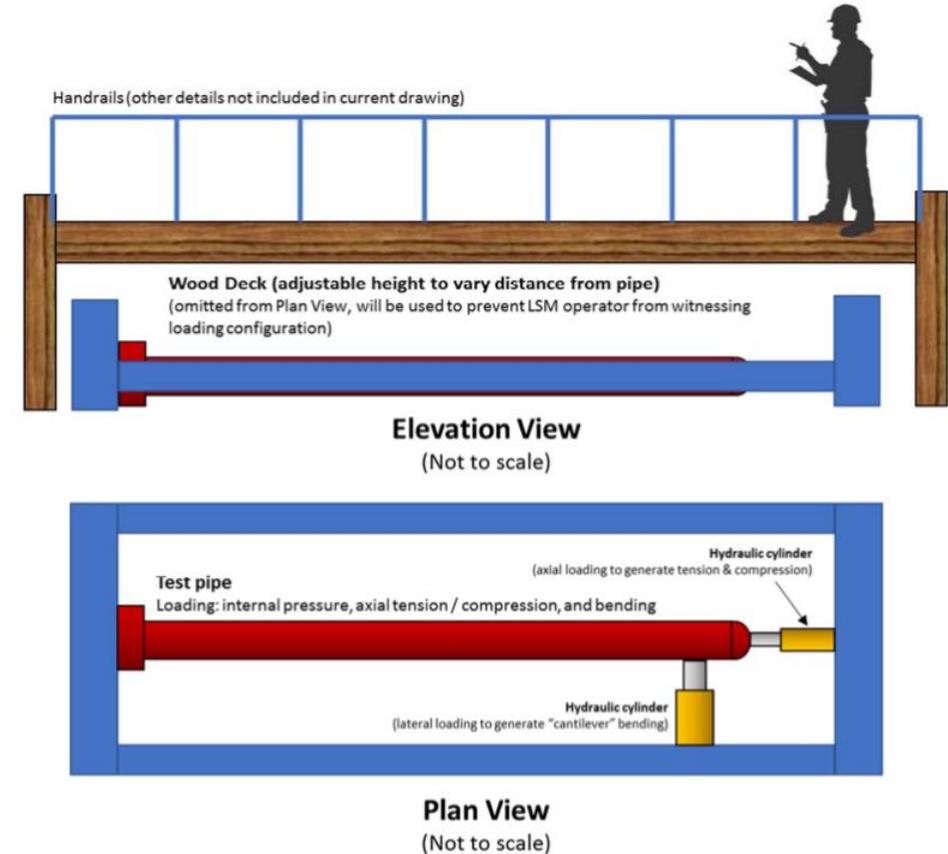


Figure 1: Conceptual schematic drawing for LSM test rig (numerous details omitted)



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# Remaining Research Gaps

# Research Gaps

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- 1. Guidance & Best Practices for displacement geohazards (e.g. landslides, subsidence, seismic events) Focusing on:**
  - Terminology
  - Prevention
  - Identification & Monitoring
  - Assessment
  
- 2. Technology/Tool evaluation for high reliability, high accuracy monitoring and assessment tools for geohazard evaluation prior to and after incidents.**



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*Surveillance, Operations & Monitoring*

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