

The Future is Here: Artificial Intelligence, Machine Learning and Advanced Pipeline Condition Assessment Technologies

Jeff Maier, PE



To have an effective pipeline asset management program, we need to work with good information and clearly understand the situation



**Knowledge is power:
Key component of
effective asset
management programs**



**Inspection
information provides
a snapshot of pipeline
condition**



**Proactive condition
assessment prevents
failures**



**Basis for informed, risk
management decision
making**



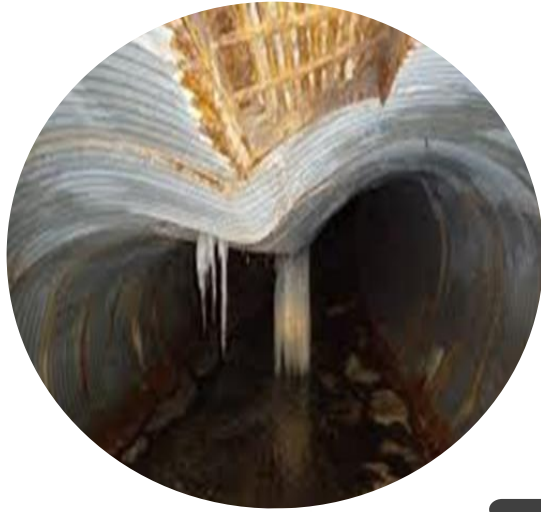
**Improves budgeting &
capital management**



**Critical for selecting
rehabilitation/
repair methods**



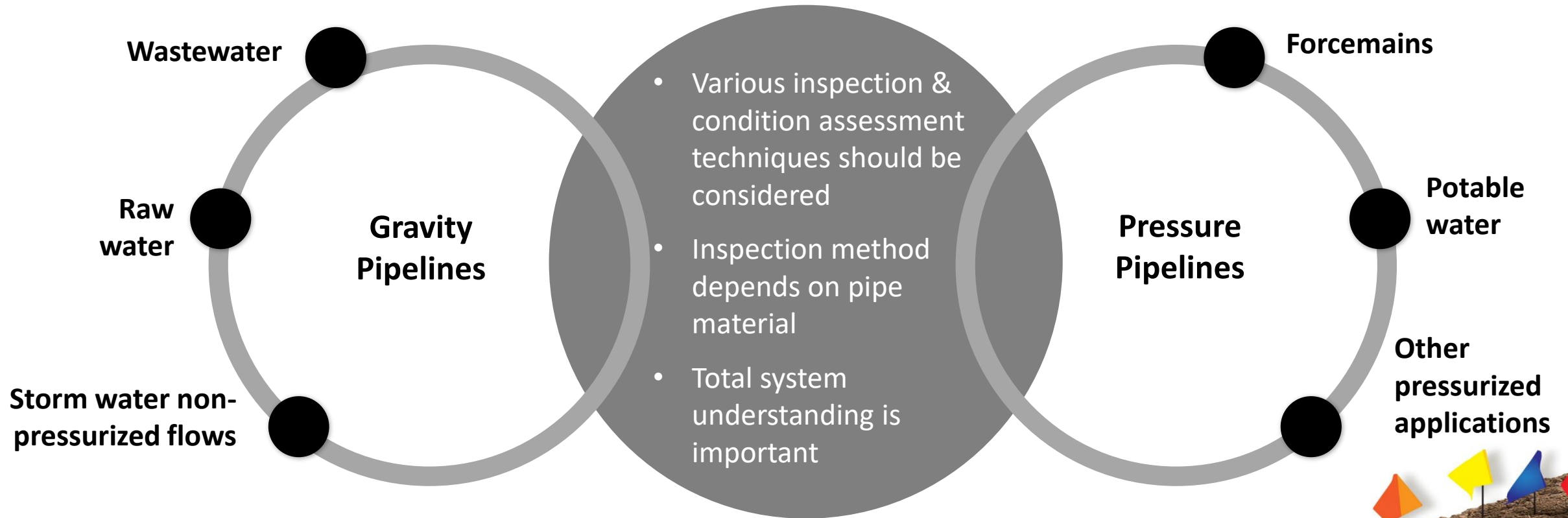
Because if you ignore your pipes, they will ignore you



Address the
problem...before it is
too late!



Different pipeline types require different condition assessment approaches



Traditional pipe inspection methods in past included...



Core Sampling

- × Destructive
- × Time-consuming
- × Limited sample set



Visual Inspection

- × Dangerous
- × Time-consuming
- × Limited sample set



Hope for the best?

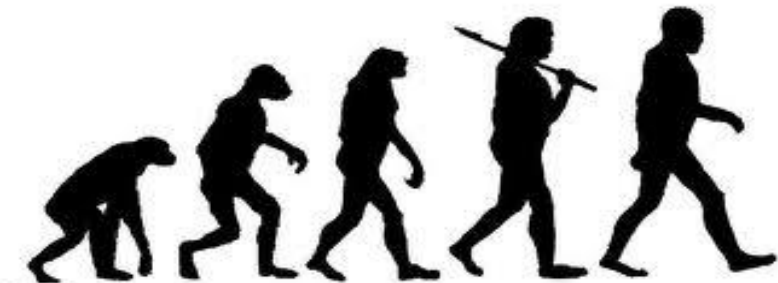
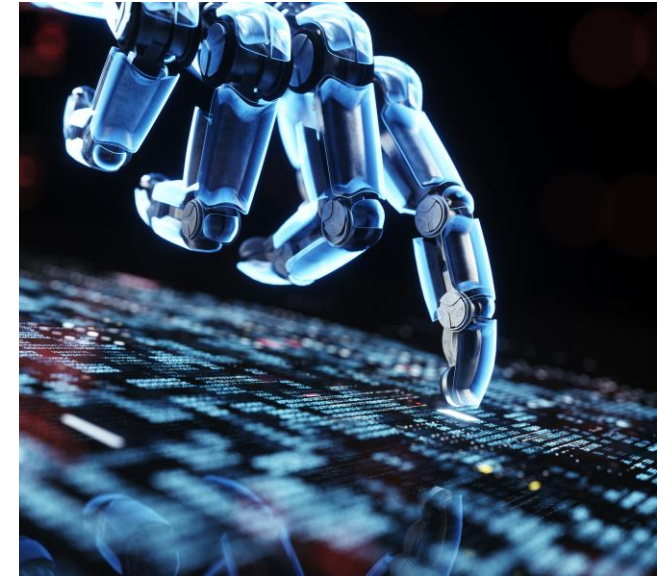
- × Maximum risk
- × Reactive
- ✓ Low-cost (initially)

52 nd Ave. SCP 22 -> SCP 21
Surface Aggregate Visible Unknown, from 08
to 04 o'clock, within 8 inch: YES, start

Then along came CCTV...

- Most pipeline inspection data today is collected using CCTV systems
- Basic visual information- flat picture above the waterline
- Basis for NASSCO PACP/ LACP rating system
- Cost effective, consistent
- Non-destructive
- No man-entry required
- Readily available
- Helps identify defects
- Non-quantifiable information

Condition assessment technologies have evolved significantly over the years



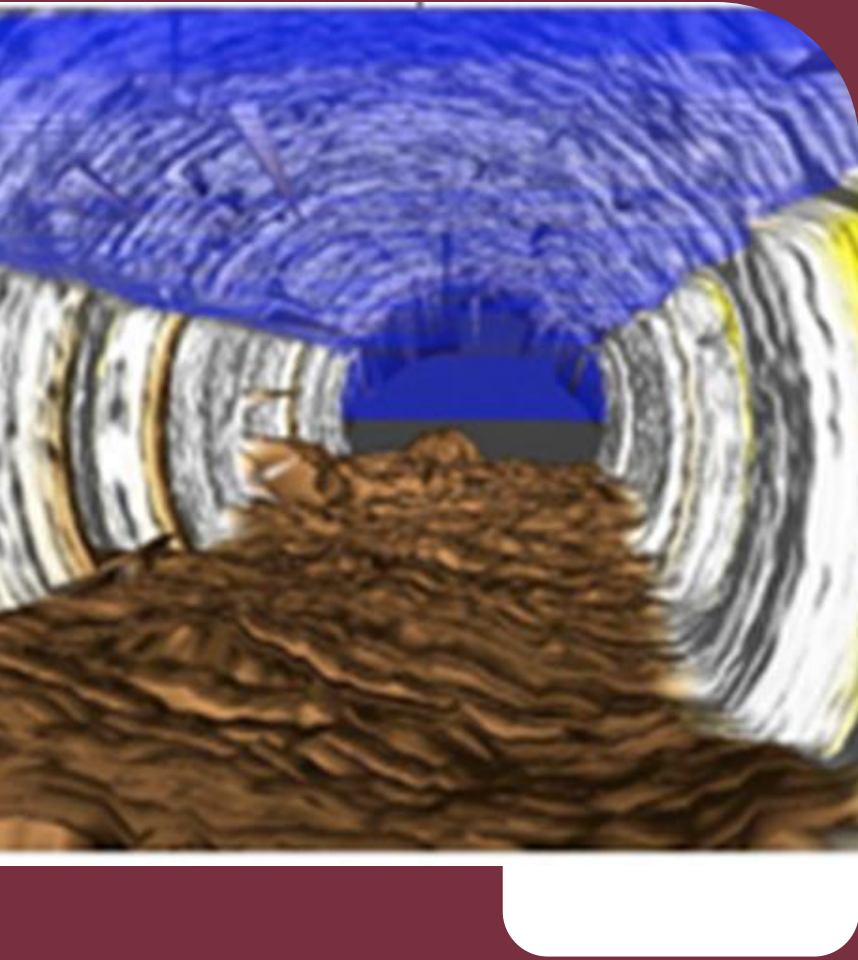
UNDERGROUND CONSTRUCTION TECHNOLOGY
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Technological advances in pipe inspection now provide a wide variety of options in the toolbox

Now we can obtain quantifiable inspection information

- Ability to see-through pipe walls
- **Assess remaining** wall thickness
- Underwater inspection capabilities
- Quantification & identification of leakage and defects
- Pressure pipe inspection capabilities
- PCCP and Metallic pipe inspection
- 3D mapping and imaging capabilities
- Emerging AI & machine learning
- Predictive evaluation and assessments
- Total technology integration



01.

02.

03.

Advanced pipeline inspection technologies

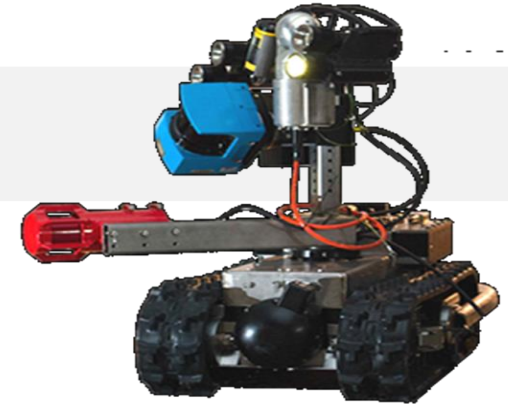
Advanced pipeline inspection and condition assessment technology: Gravity pipeline applications



WHAT IS IT?

Multi-sensor systems

- Often includes laser profiling/ LIDAR, SONAR, pipe penetrating RADAR, HD-CCTV, electromagnetic systems, gas detection, etc.



WHY WOULD YOU CHOOSE THIS TECHNOLOGY?

Selection depends on pipe material, diameter, water level, access, data needed

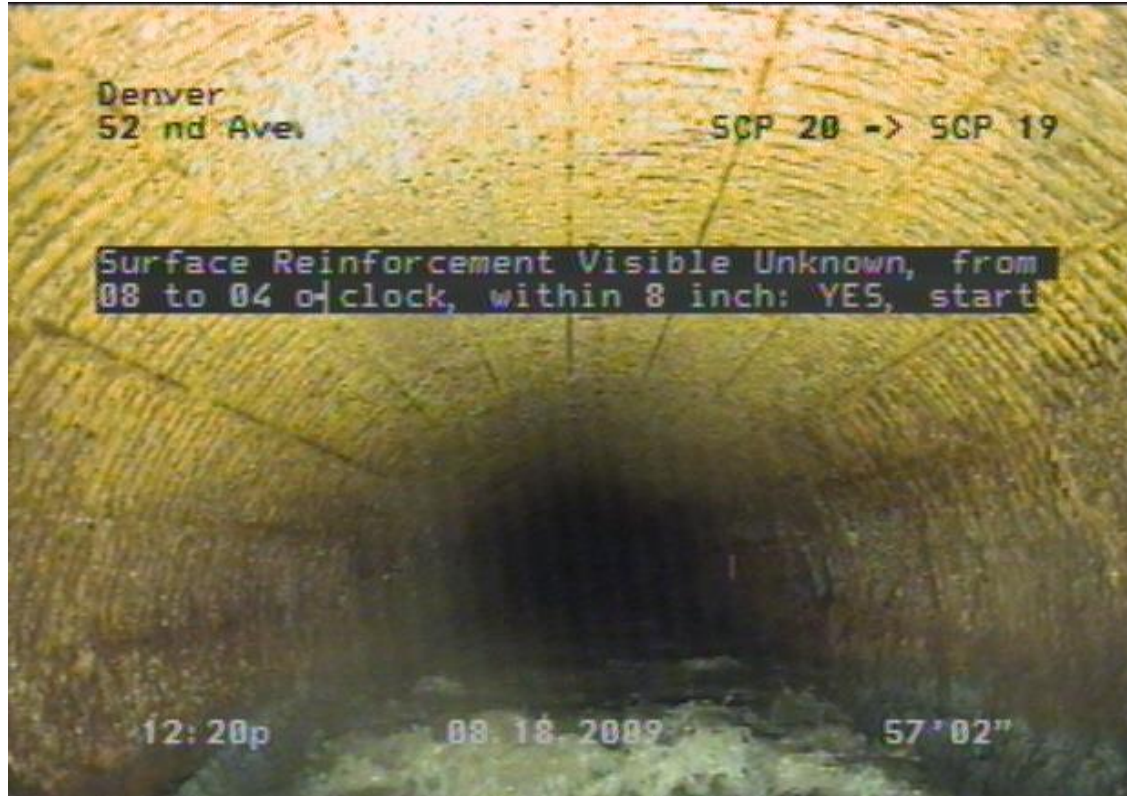
- Pipe wall thickness, defects, deformation, debris, rebar, structural issues



WHAT DOES IT PROVIDE?

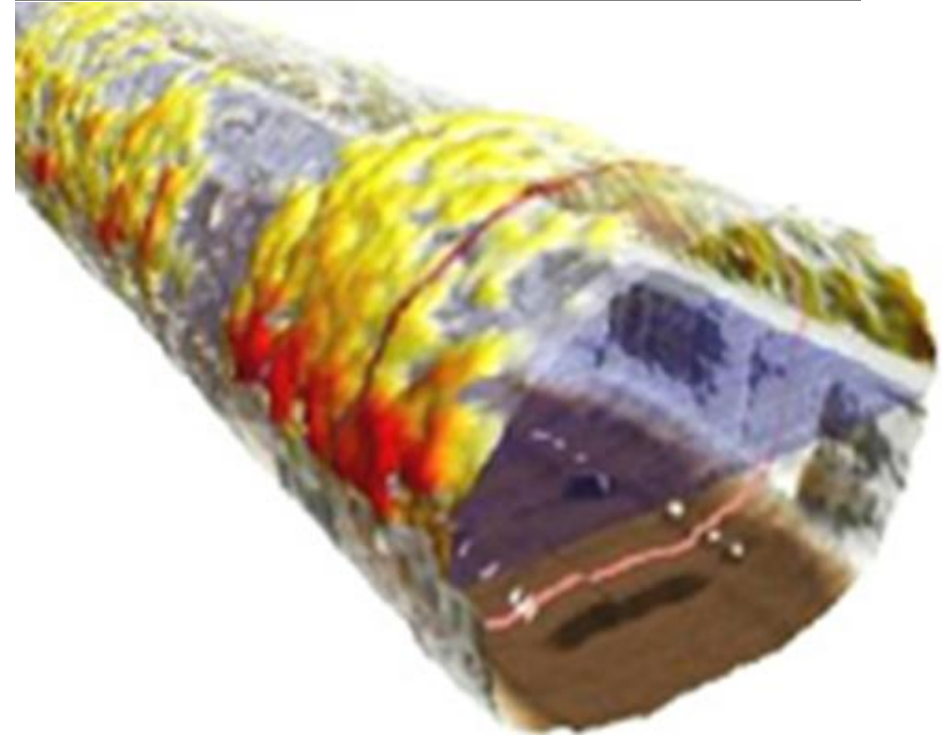
Quantifiable & accurate inspection information

Multi-sensor technology dramatically improves condition assessment visualization and understanding



CCTV

3-D data from laser profiling and SONAR inspection



Advanced pipeline inspection and condition assessment technology: **Pressure pipeline applications**



WHAT IS IT?

Internal and external inspection systems

- RFT, MFL, pulse wave systems, acoustics, ultrasonics, multi-sensor



WHY WOULD YOU CHOOSE THIS TECHNOLOGY?

Selection depends on pipe material, diameter, live flow inspection capabilities, and access

- Leak detection, wall thickness, defect identification, air pockets, structural integrity



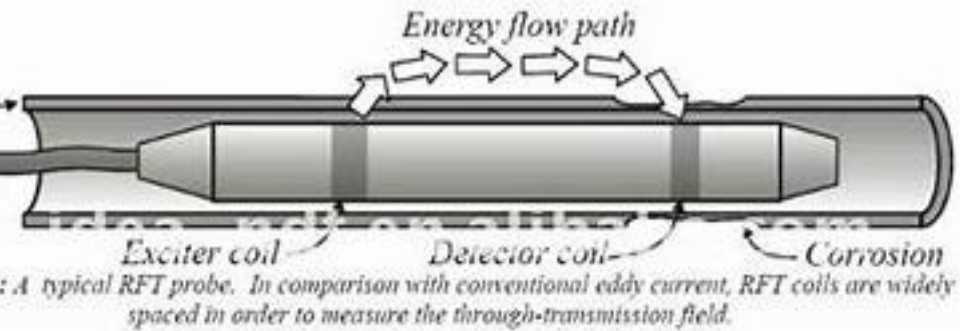
WHAT DOES IT PROVIDE?

Quantifiable & accurate inspection information

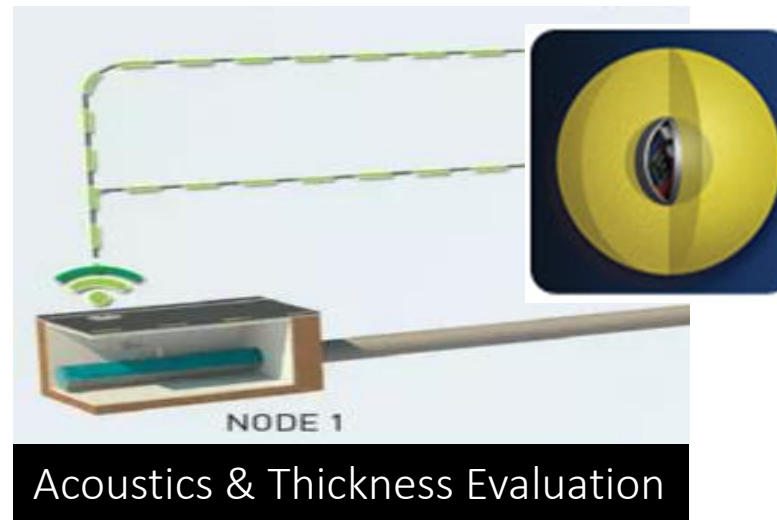


Force main pipe inspection can be divided into different categories:

- ✓ Visual inspection
- ✓ Internal inspection
- ✓ External inspection
- ✓ Leak detection



Remote Field Technology and MFL

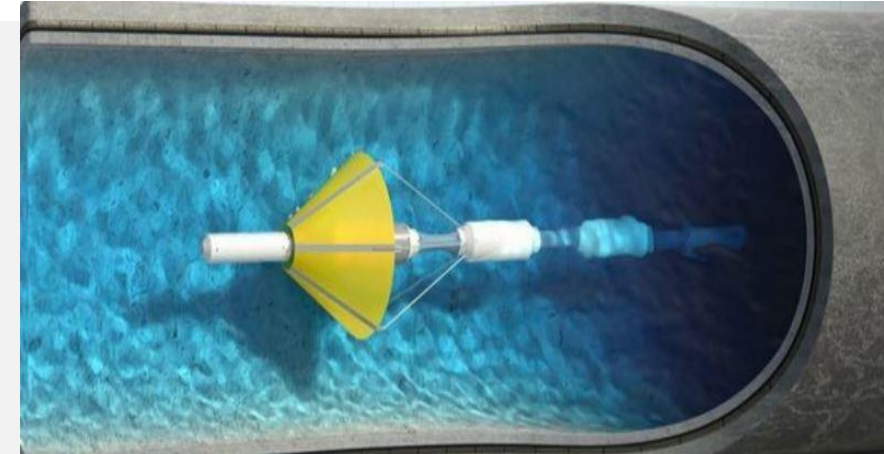
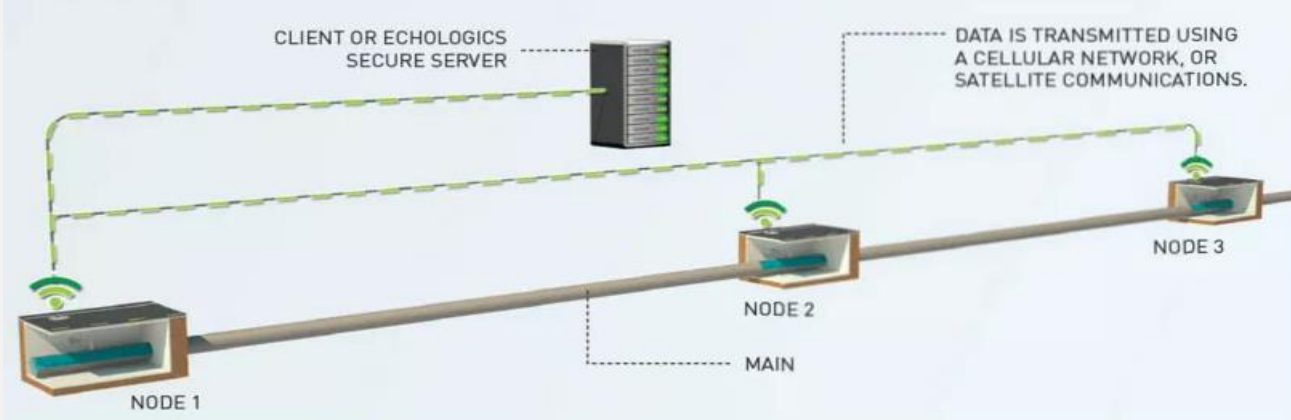




Electromagnetic Corrosion Detection - RFT and MFL technologies detect corrosion and structural defects in metallic pipe materials



Acoustic leak detection systems identify leakage issues and air pockets within the force main



External Leak Detection Technologies = no flow disruption
Acoustic and pulse wave systems available

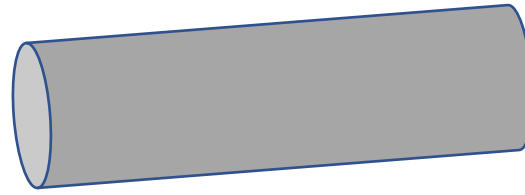
Tethered leak detection



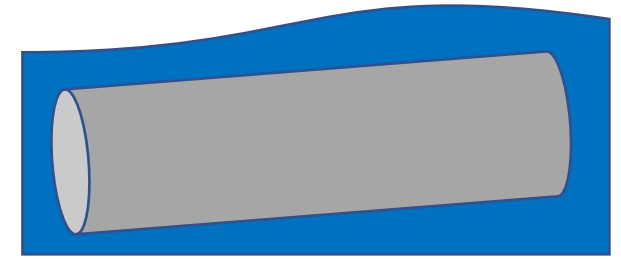
Free-swimming systems



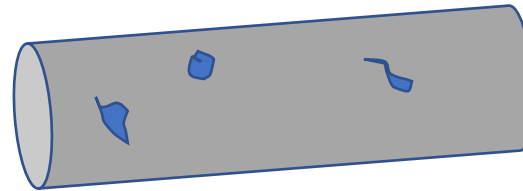
**Quantifiable
inspection data
provides basis for
informed asset
management
decisions and
reduces risk...but it
is not cheap**



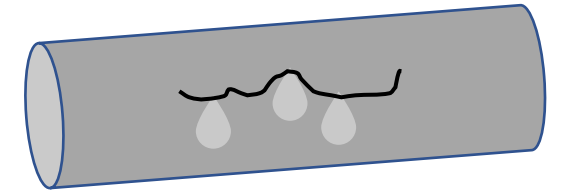
Precise diameter and
deformation measurements



Underwater and
submerged inspection



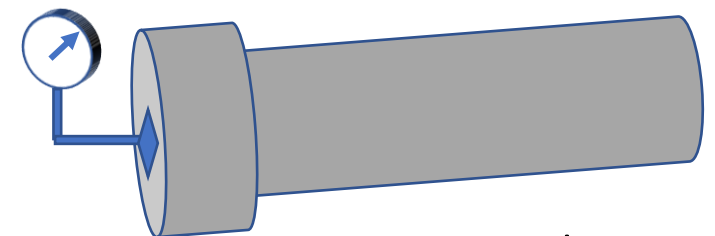
Corrosion and defects



Leakage and air
pocket information



Ability to measure
pipe wall thickness



Testing in live,
pressurized conditions



01.

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The latest pipeline mapping technologies

Part of an asset management strategy includes knowing exactly where these pipes are in the system

State-of-the-art X,Y,Z coordinate mapping systems are now available

Provides very accurate 3D vertical & horizontal location information

Internal mapping probe technology compatible with GIS systems

Detects pipe sags, misaligned joints, horizontal and vertical design issues

Long length deployments possible

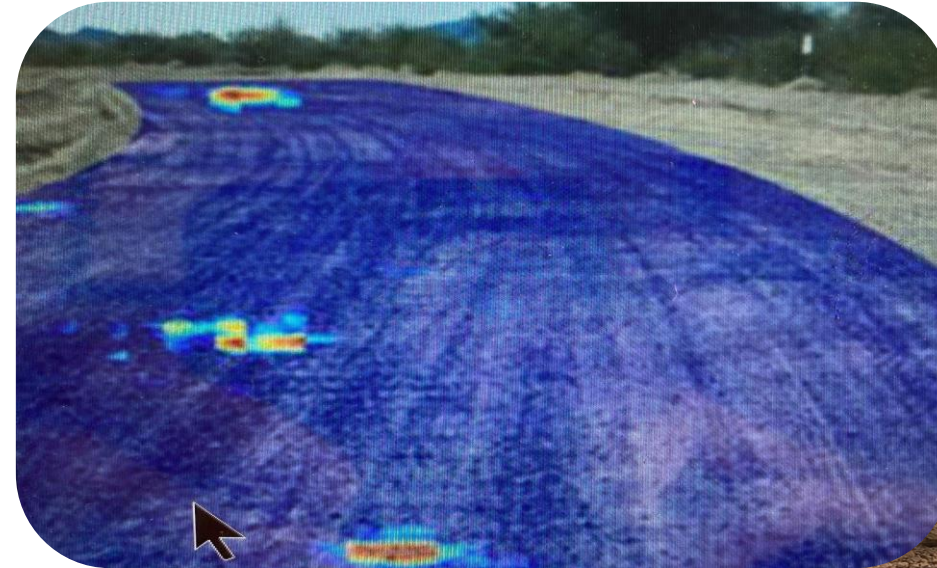
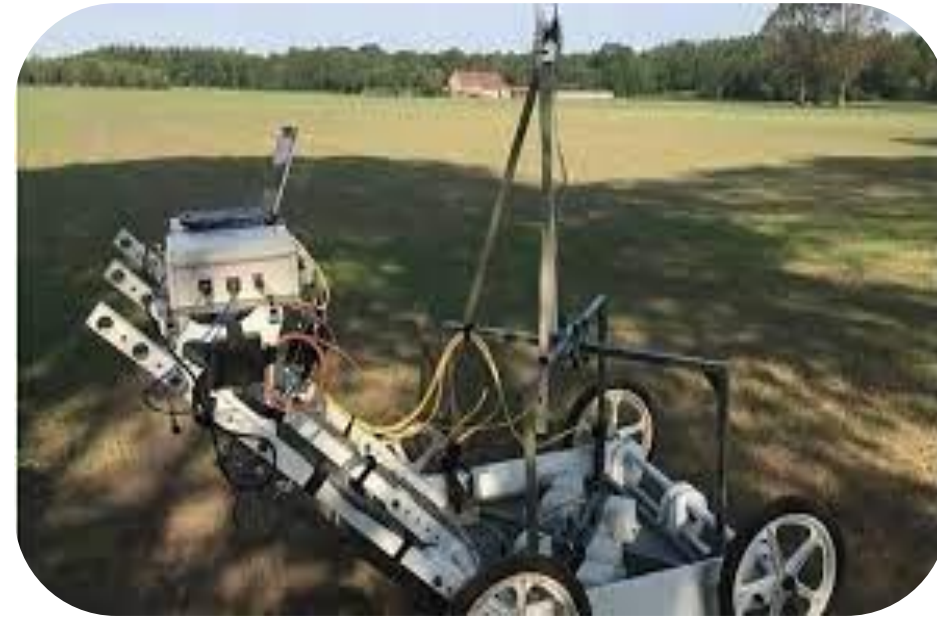
Wide range of diameters, all pipe materials

Integrate GIS & CCTV visual inspection



Emerging pipeline mapping technologies provide even more detailed information that is easier to obtain & less invasive

- ✓ Above-ground, external 3D electromagnetic/ GPR locating and mapping technology
- ✓ Originally developed to detect and identify unexploded ordnance for military applications
- ✓ Dept of Defense technology transfer over to pipeline/ infrastructure applications
- ✓ Being refined to automatically detect & characterize various pipes & their locations



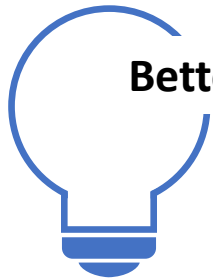
All of these new pipeline inspection & mapping technologies allow us to make better asset management decisions



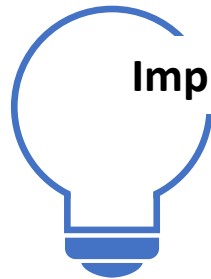
Options range from basic visual information to highly accurate, quantifiable data



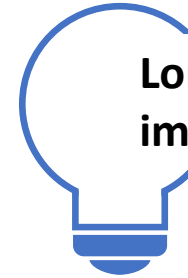
Better understanding of the pipeline system as a whole



Better risk management



Improved O&M strategies



Long term cost savings and improved budgeting

*But what about emerging artificial intelligence and machine learning technologies?
How can we take this progress even further?*





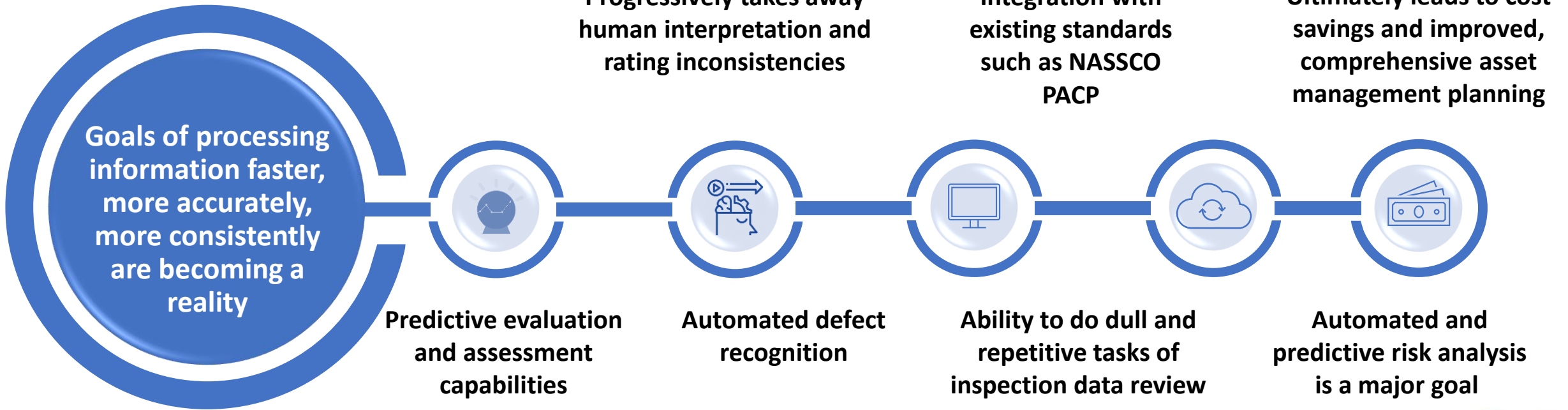
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Artificial intelligence &
machine learning

Artificial Intelligence (AI) & machine learning concepts represent the next generation of pipeline inspection and condition assessment



AI can provide the benefit of automated defect recognition: Large amounts of data is captured and processed quickly and comprehensively with the system

Proactive vs Reactive: Catch potential failures well before they happen!



- Current iterations blend with CCTV inspection, NASSCO PACP codes create uniformity



- Works with advanced pipeline inspection data, with continued integration of technologies



- Standardized decisions based on a rapidly expanding data set, integrated into other platforms with continual improvement through machine learning



- Enhanced, more automated programs through predictive modeling and assessment



- ID factors to proactively prioritize different pipelines and assets for rehabilitation



- NASSCO PACP codes create uniformity for the computer systems to operate more effectively

Integration with asset management and GIS will be very powerful

But there are limitations to AI that are still being improved upon

Limitations

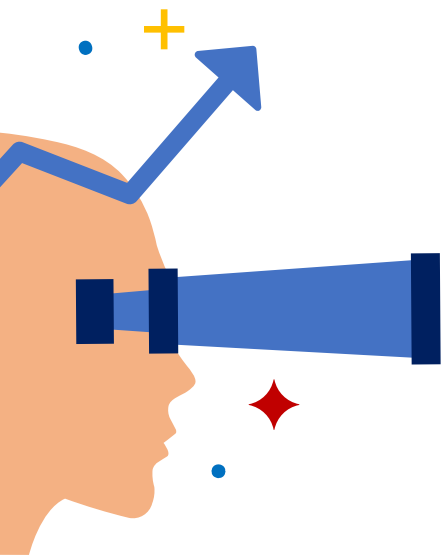
- Still developing - not self-sustaining yet
- Systems are only as "smart" as input of learning data set
- Human element still involved for now
- Beta testing taking place for different systems
- Need to review and verify accuracy before reducing human component
- The more data we gather, the better baselines we can create, which allows AI to determine conditions and predictions more accurately...but this will take time and a lot of data
- Systems need to learn many scenarios in order to exhibit self-sustaining accuracy

Machine learning and AI systems will take on repetitive tasks for operators- increasing speed, efficiency and accuracy

Advantages

- Fast and accurate condition assessment is becoming realized
- Reduce failures – Proactive instead of Reactive
- Saves money, time and improves budgeting
- Target high risk pipelines or infrastructure quickly
- Risk management program enhanced
- Better determine life expectancy of infrastructure through predictive infrastructure management
- Improve O&M efficiency and manage very large data sets easier
- Accurate, more complete information allows utilities to make better O&M decisions
- Next generation asset management strategies & continued integration with GIS systems

Looking further into the future of pipeline inspection...What can we expect?



Continued improvements to existing advanced pipeline inspection technologies



More sophisticated AI technology and autonomous inspection systems



Satellite inspection systems



Inspection drones and autonomous condition assessment systems



Further refinement & advancement to external, non-invasive inspection systems



Smart materials built into infrastructure



Fully integrated and automated, proactive asset management programs



Significantly reduced human role in inspection tasks



A lot fewer pipeline failures and emergency repairs

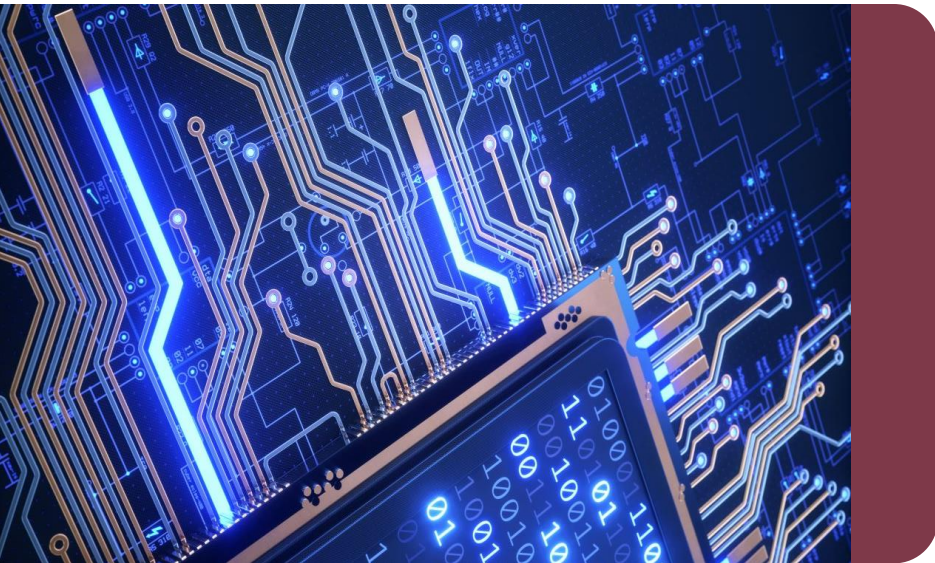


Significant cost savings and better water & wastewater operations



A large, light gray speech bubble graphic containing the text 'Q&A' in a bold, dark red, sans-serif font. The speech bubble has a tail pointing downwards and to the left, and a question mark is visible at the top right corner of the bubble's border.

Q&A



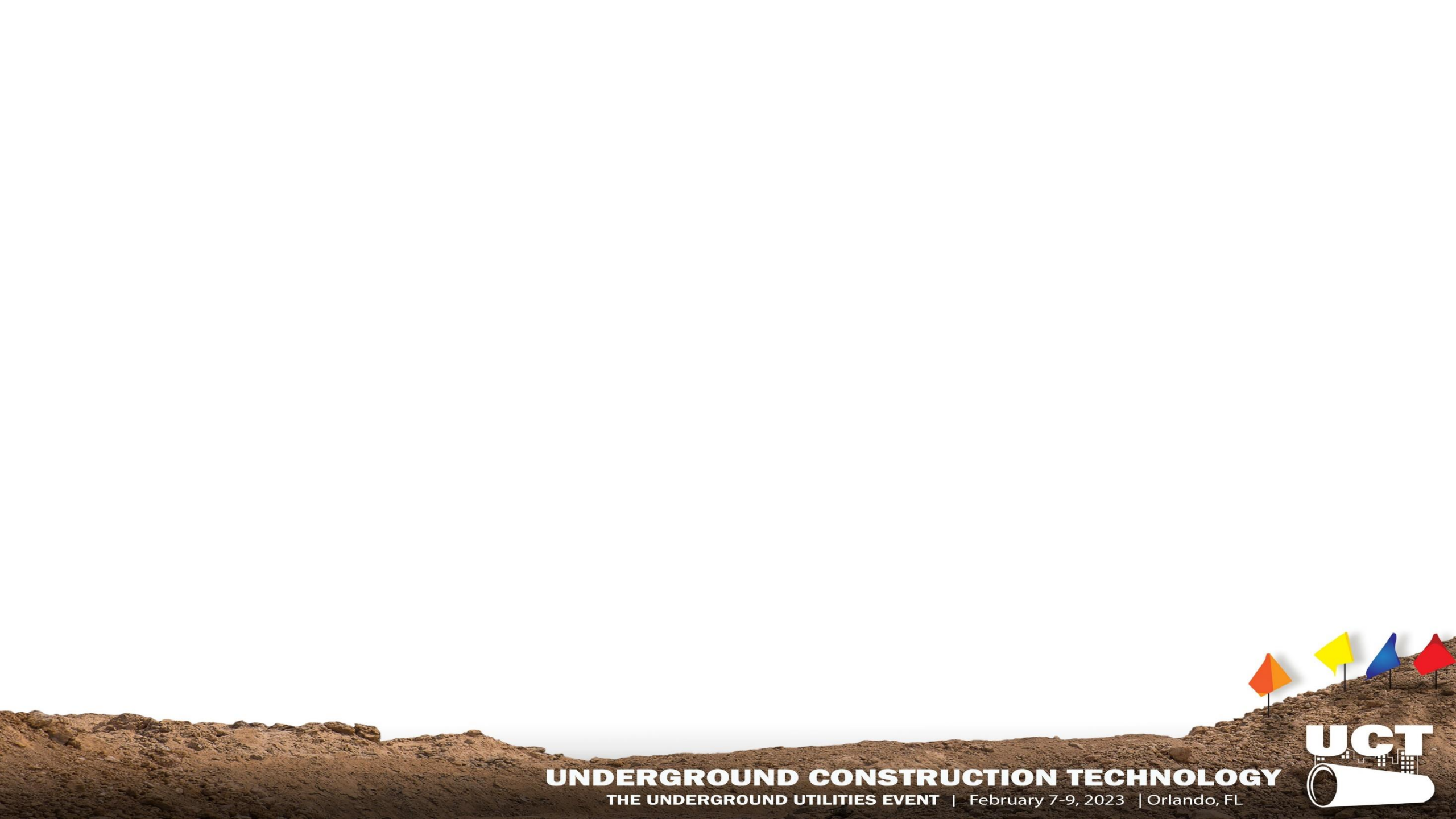
JEFF MAIER, PE



303-596-0744



JRMaier@GarverUSA.com



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