

# Cost-Effective Pipeline Condition Assessment for Asset Management Programs

By: Tom Iseley, Wei Liao  
Purdue University



**PURDUE**  
UNIVERSITY®

Construction Engineering  
and Management

**UNDERGROUND CONSTRUCTION TECHNOLOGY**  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

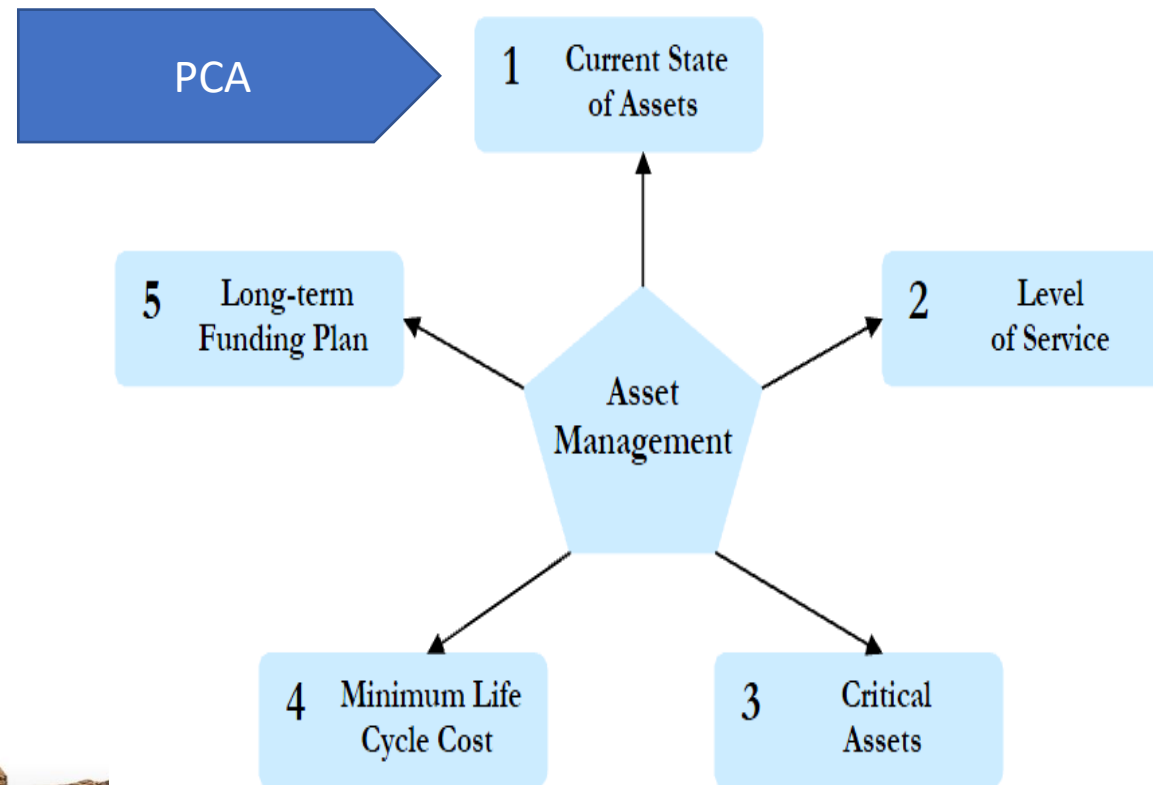


# Agenda:

1. PCA and Asset Management
2. Introduction of PCA
3. Levels of PCA and Inspection techniques
4. Case of Switz City, IN



# Pipeline Condition Assessment (PCA) & Asset Management



# CORE COMPONENT No. 1

## Current State of Assets

- What does the utility have – **Inventory**
- Where are the assets located – **Mapping**
- What are the assets condition – **PCA (Pipeline Condition Assessment)**
- What technical solutions are available to optimize the useful life of these assets – **Trenchless Technology**



# PCA Categories

1. External assessment



2. Internal assessment



3. Structural assessment



# Pipeline Condition Assessment Methods

Two Types of NDT Inspection Techniques:

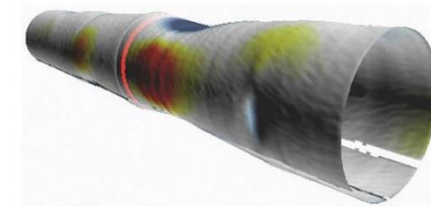
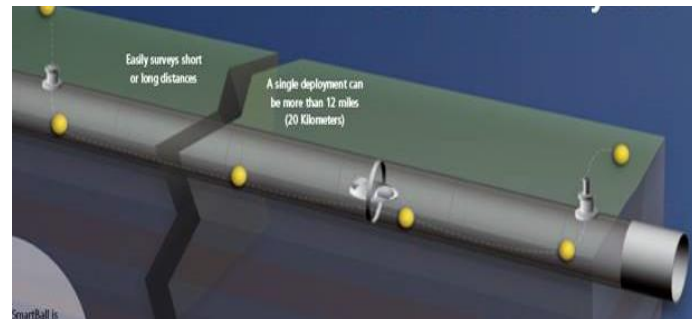
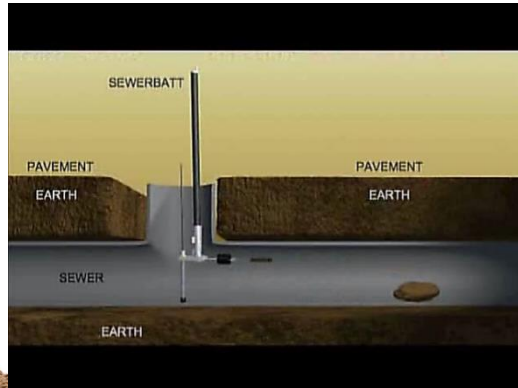
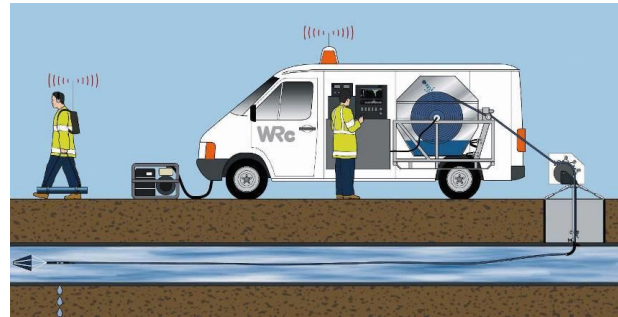
## 1- Visual NDT Methods





# Pipe Condition Assessment Methods

## 2- Non-visual NDT Methods

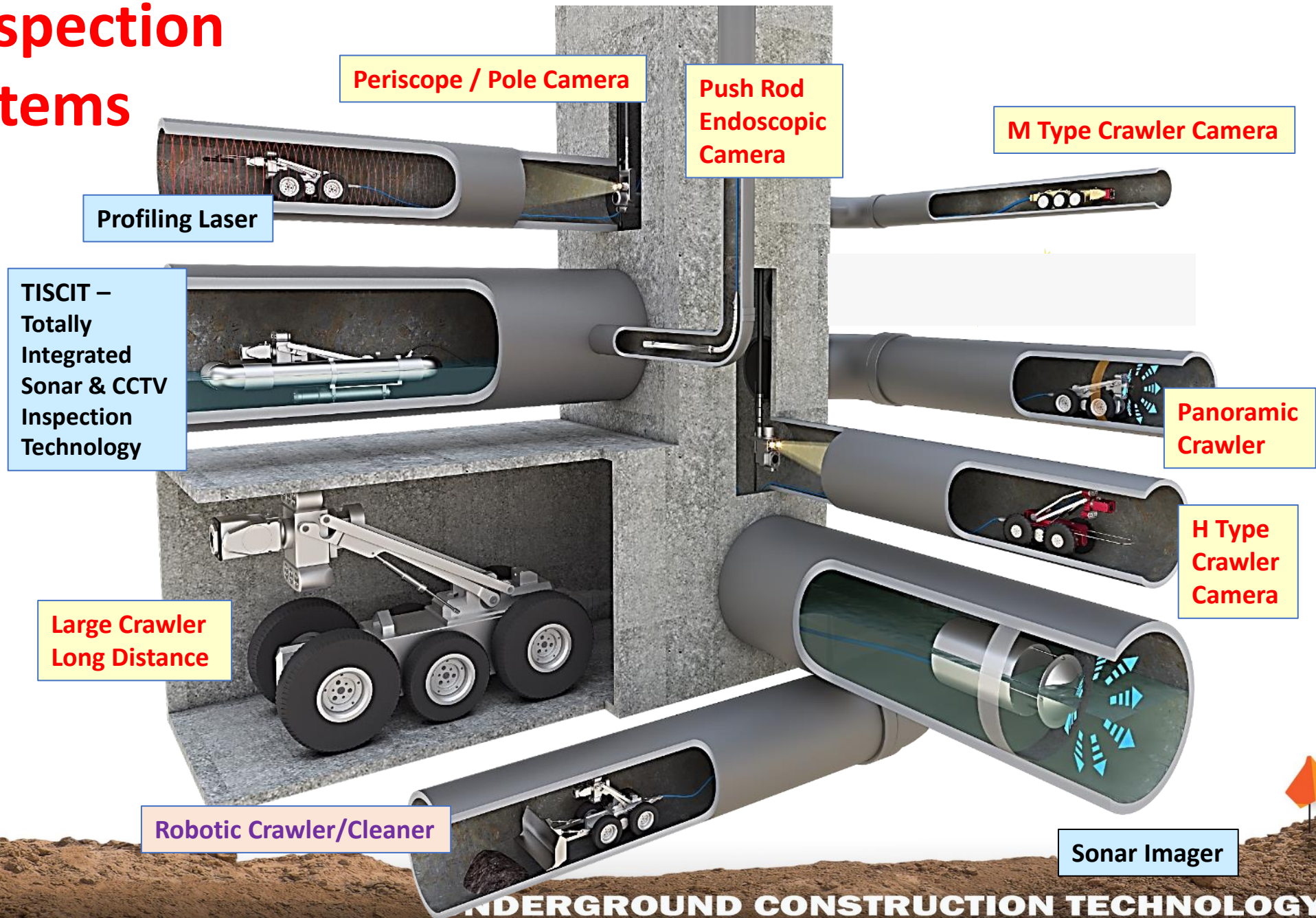


# Inspection Systems

- Internal Optical Inspection Systems
- Optical Scanning Systems
- Pipe Wall Thickness Measurements
- Void Location Outside the Pipe
- Infiltration Detection Technology
- Pipe Dimensional Measurement Technology
- Pipe Position Determination
- Acoustic Sensing Technologies
- Zoom Cameras
- Pipe Penetrating Radar



# EST Inspection Systems



UNDERGROUND CONSTRUCTION TECHNOLOGY

THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL



# 4 Levels of PCA and Inspection techniques

- 1<sup>st</sup> Level
  - Zoom Camera
  - Acoustic
- 2<sup>nd</sup> Level
  - CCTV
  - Electro scan
  - Sonar
- 3<sup>rd</sup> Level – adds more detail:
  - **Optical Scanning System**
  - GPR
- 4<sup>th</sup>
  - Specialized methods



# Condition Assessment

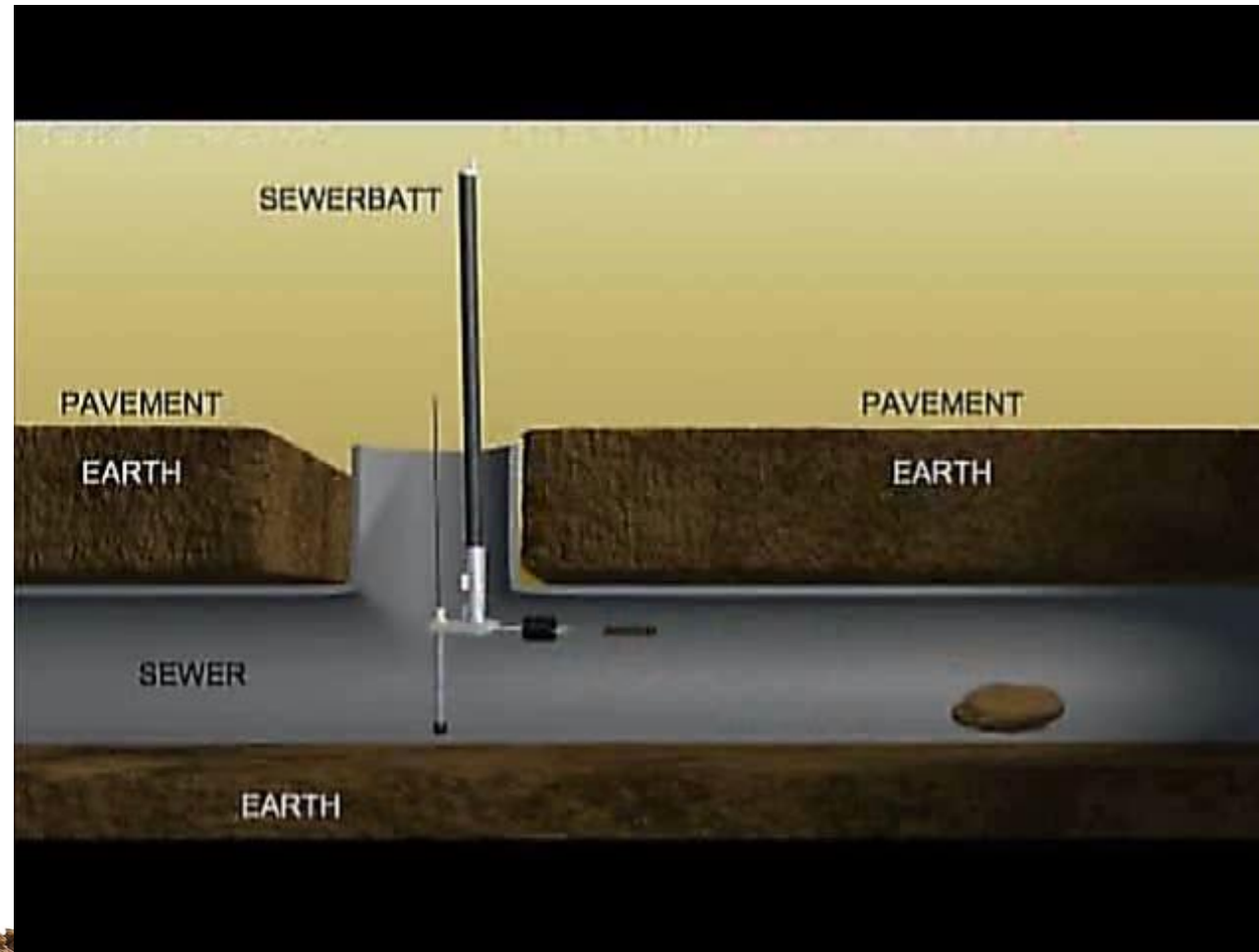
## 1<sup>st</sup> Level Inspection Techniques





# Acoustic Sensing Technologies

- SewerBatt



# Acoustic Sensing Technologies

- AST Hardware
  - Acoustic sensor

Simplicity, low-cost, speed and efficiency



CCTV



# Active Acoustic Pipe Inspection Background

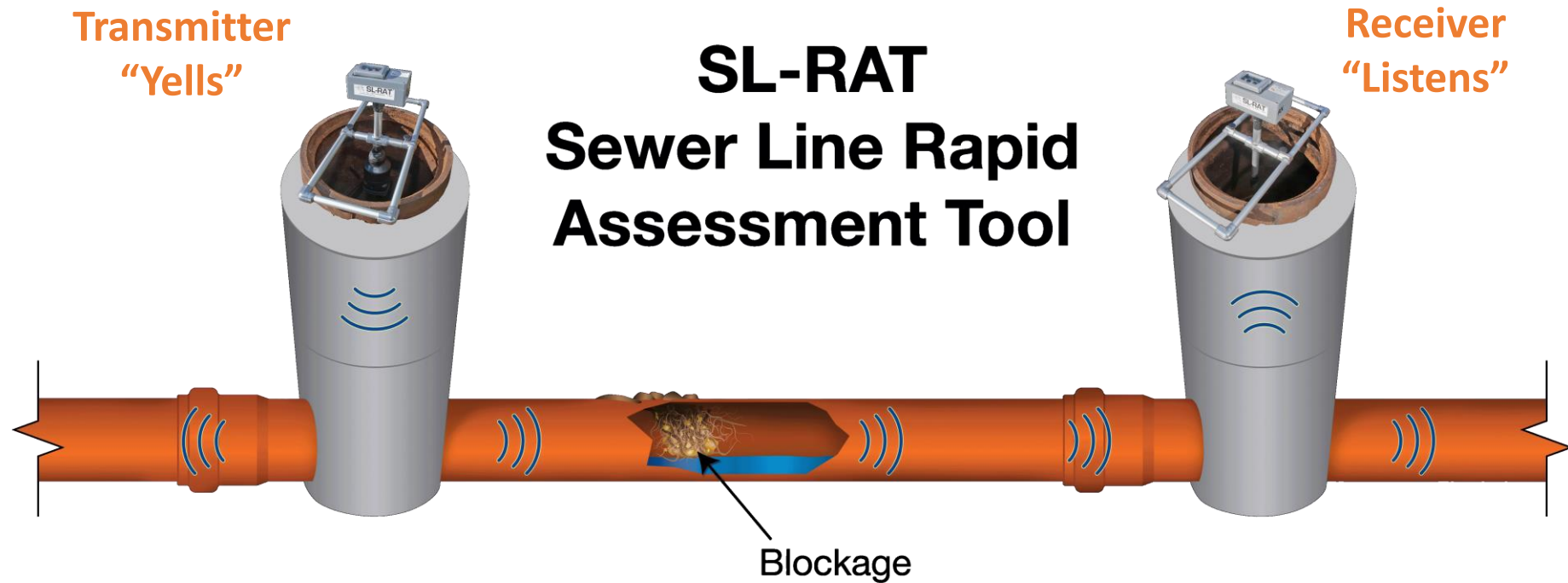
- Patented technology
- Gravity-fed sewer focus
- Developed in Charlotte with CMUD as key partner



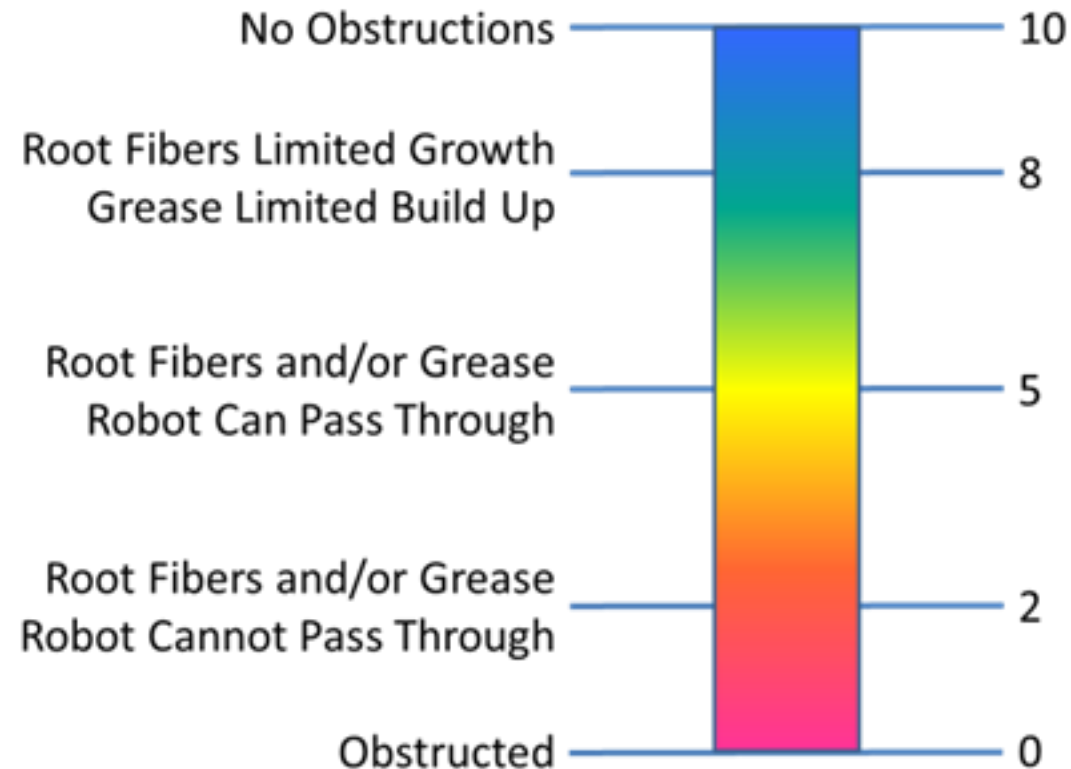
- Over 50M feet inspected with over 100 municipalities
- Rapid assessment helps better focus cleaning and CCTV resources



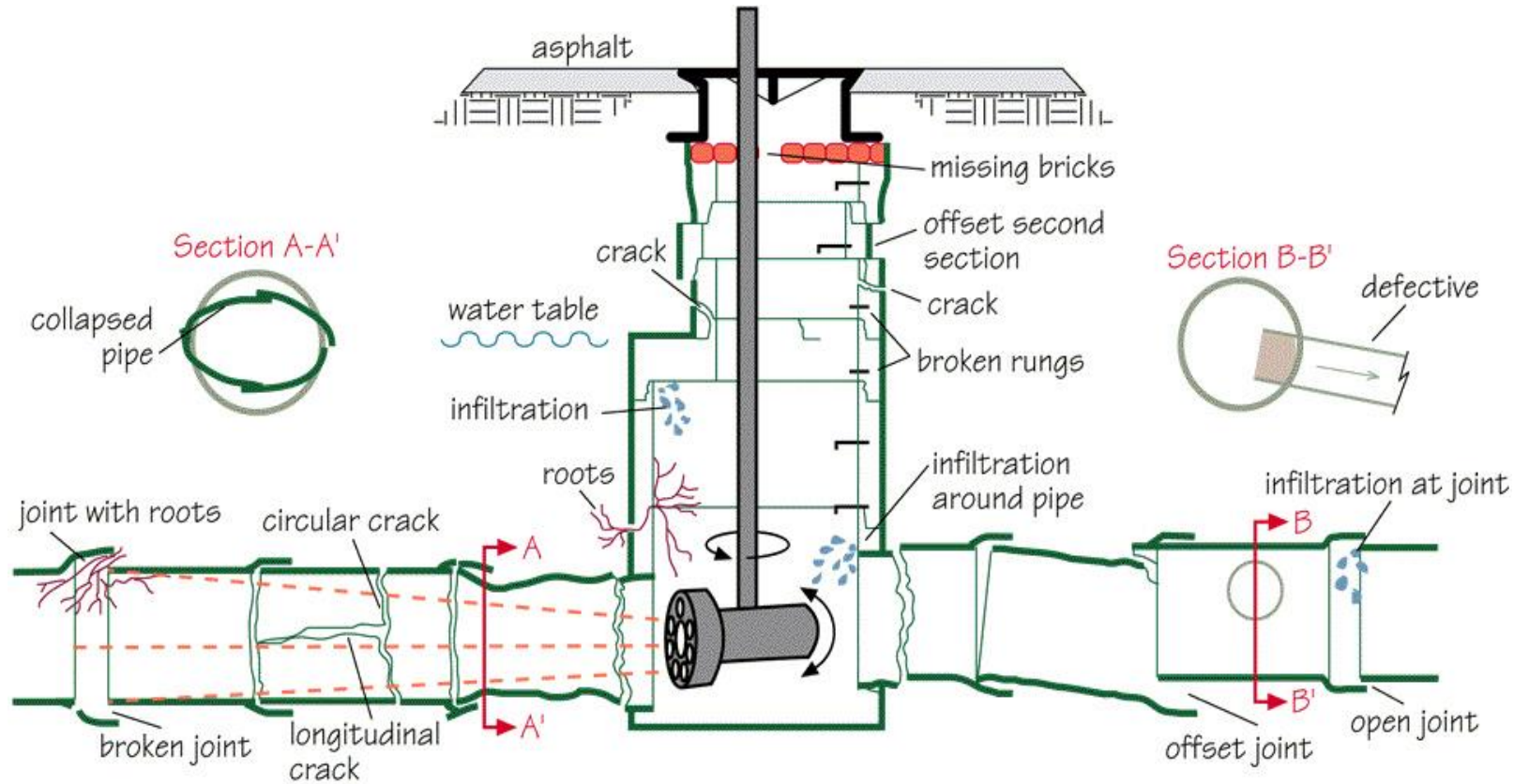
# SL-RAT -How Does It Work?



# SL-RAT Assessment Scale

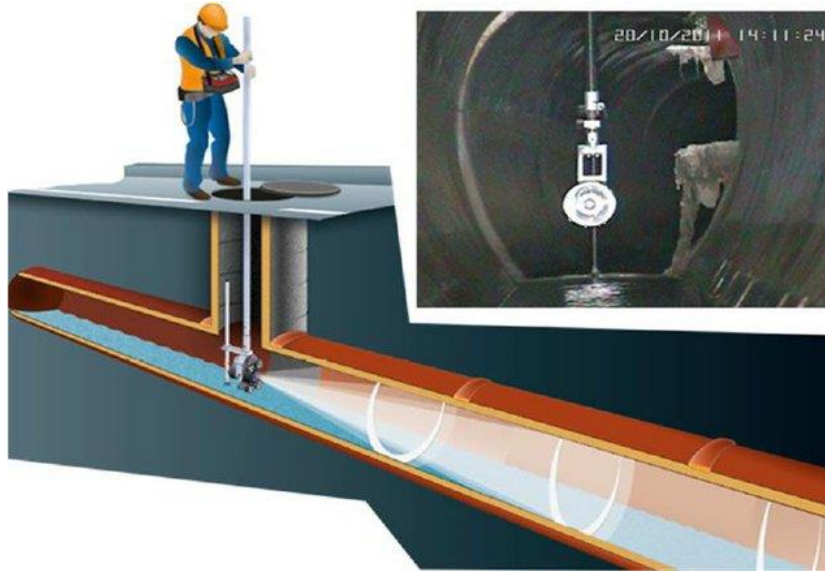


# Zoom Cameras





# Zoom Cameras



# Condition Assessment

## 2<sup>nd</sup> Level Inspection Techniques





# Closed-Circuit Television (CCTV) Inspection

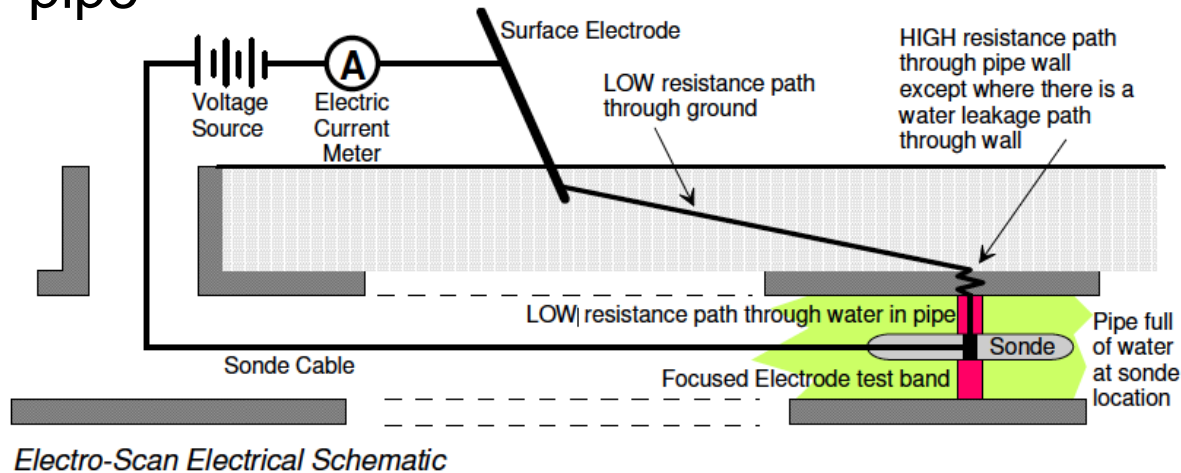
- Visual inspection without man-entry.
- CCTV systems have been widely used for sewer systems. Usage in water mains is limited mainly due to :
  - Currently not available for in-service water main inspection.
  - Requires a special launching and retrieval chamber in water mains.





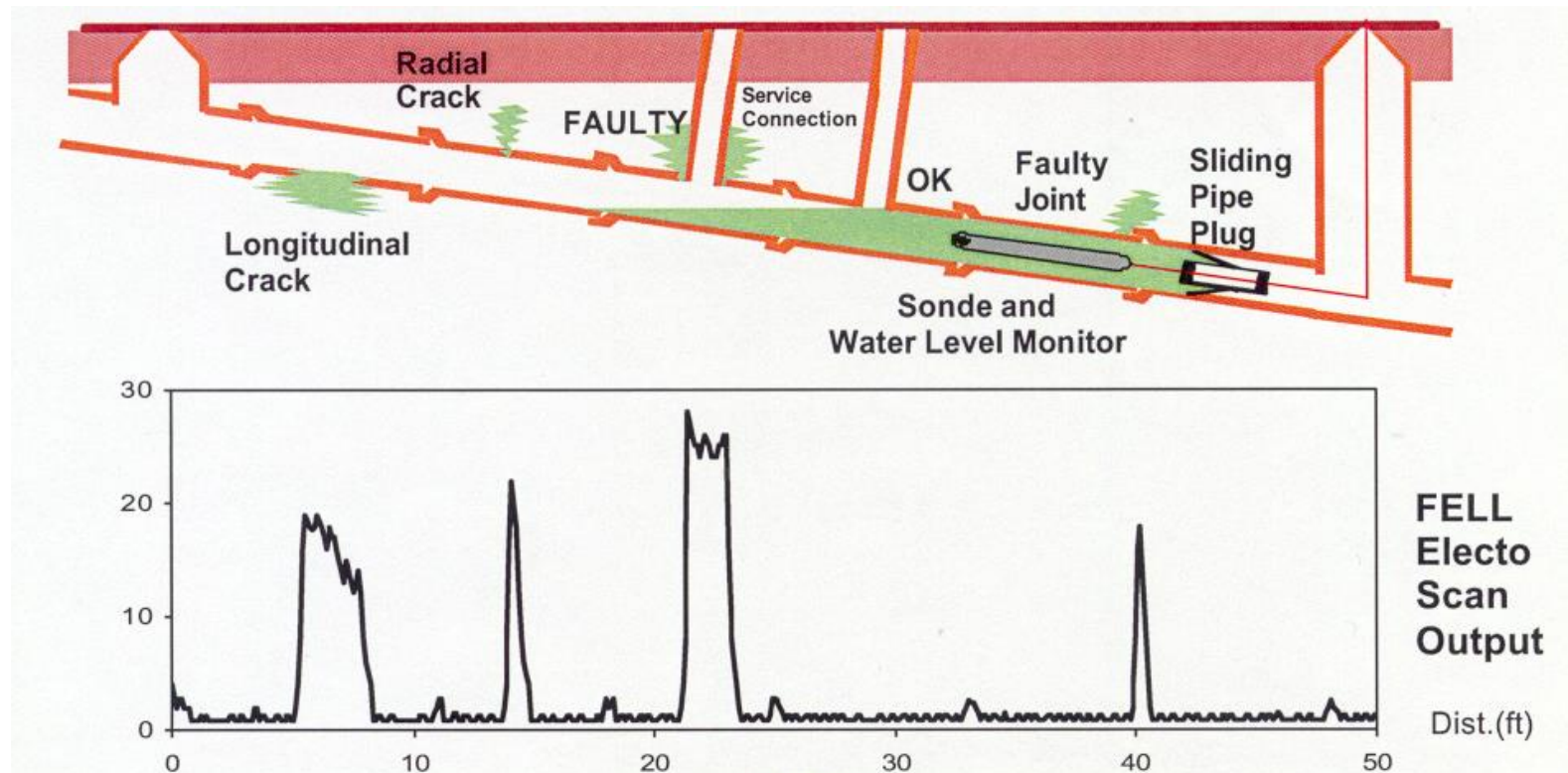
# Infiltration Detection Technology

- Focused Electrode Leak Location (FELL)
  - Ideal to detect infiltration leaks
  - Simplified electrical circuit
  - High resistance of pipe wall prevents electrical current
  - Electrical current flows through holes in the pipe



# Infiltration Detection Technology

- Focused Electrode Leak Location (FELL)



<http://www.pipelineservices.com.sg/brochure/Leak%20Detection%20-%2041%20Brochure.pdf>

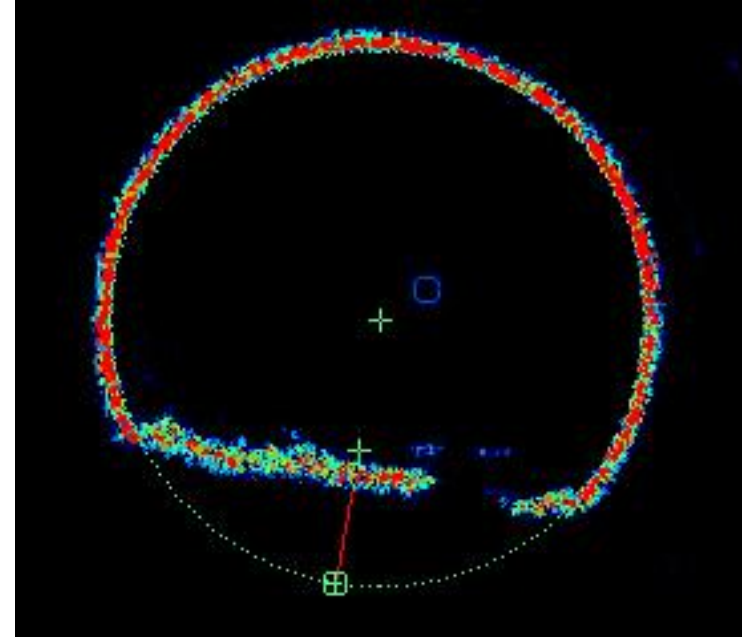


# Sonar Technologies

## Only works underwater

- Profiles the pipe every second
- Results in high resolution profiles
- Images can be measured both on and off site
- Density of silt can be assessed (color of signal. Red = dense to Blue = soft)
- Any actionable defects can easily be seen

Surcharged pipes

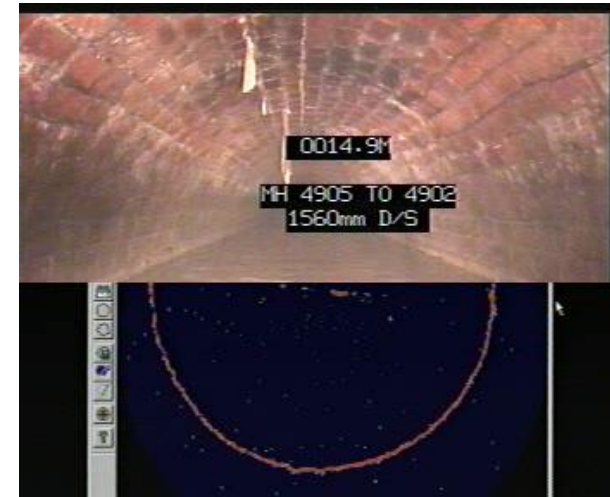




# Sonar Technologies

- Condition Assessment using CCTV and Sonar combined
- TISCIT
  - Combines the best of the two 1<sup>st</sup> level Inspection Techniques.
  - For Interceptors and any pipe with a high flow that cannot be removed/controlled
  - The invert condition can now be clearly seen, using Sonar under the CCTV camera.
  - **Floating Method**

Semi Surcharged pipes



# Condition Assessment

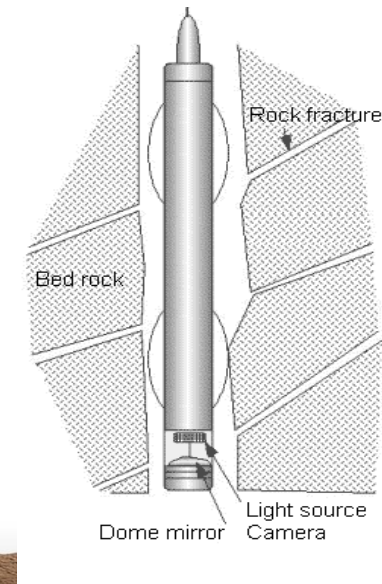
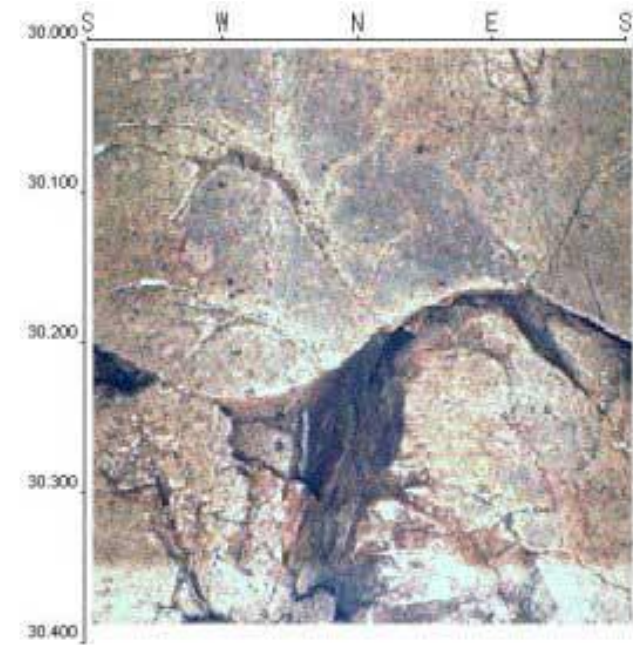
## 3<sup>rd</sup> Level Inspection Techniques





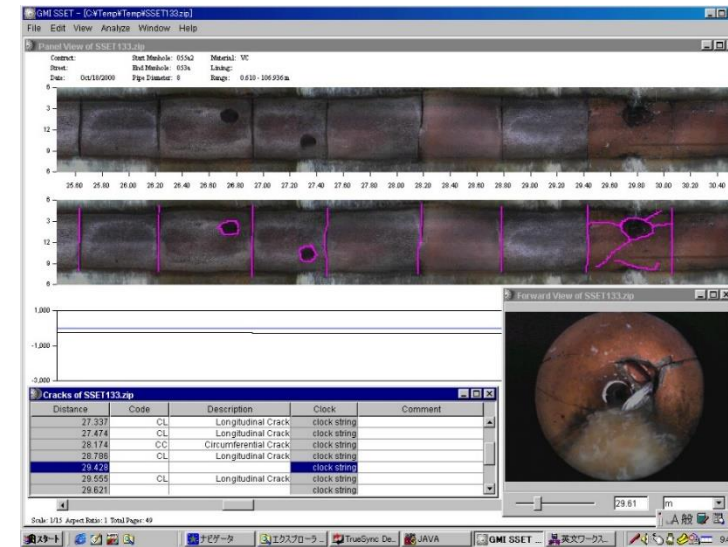
# Optical Scanning Systems

- Sewer Scanning & Evaluation Technology (SSET)
  - The SSET is based on optical borehole scanning technology developed for the oil and gas reservoir analysis
    - Provided engineers with detailed information of fractures and other geologic features
  - The same scanning technology was later adapted for use in mapping fractures for groundwater studies
    - Systems became less expensive and more portable



# Optical Scanning Systems

- SSET
- Like the borehole televiewer, SSET obtains a 360-degree scan of the inside pipe wall
  - The image is split at the invert “un-wrapped”, and laid flat for viewing
  - A forward view is also provided for 3-D effects



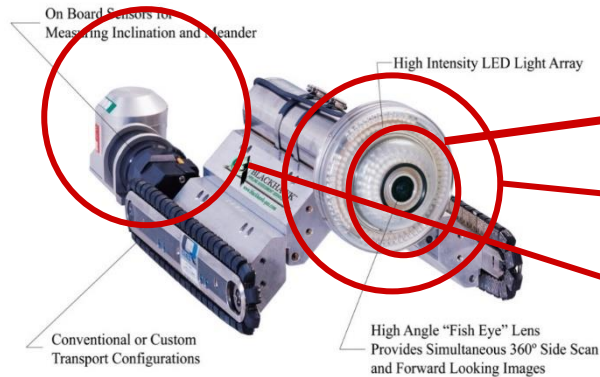


# Pipe Position Determination

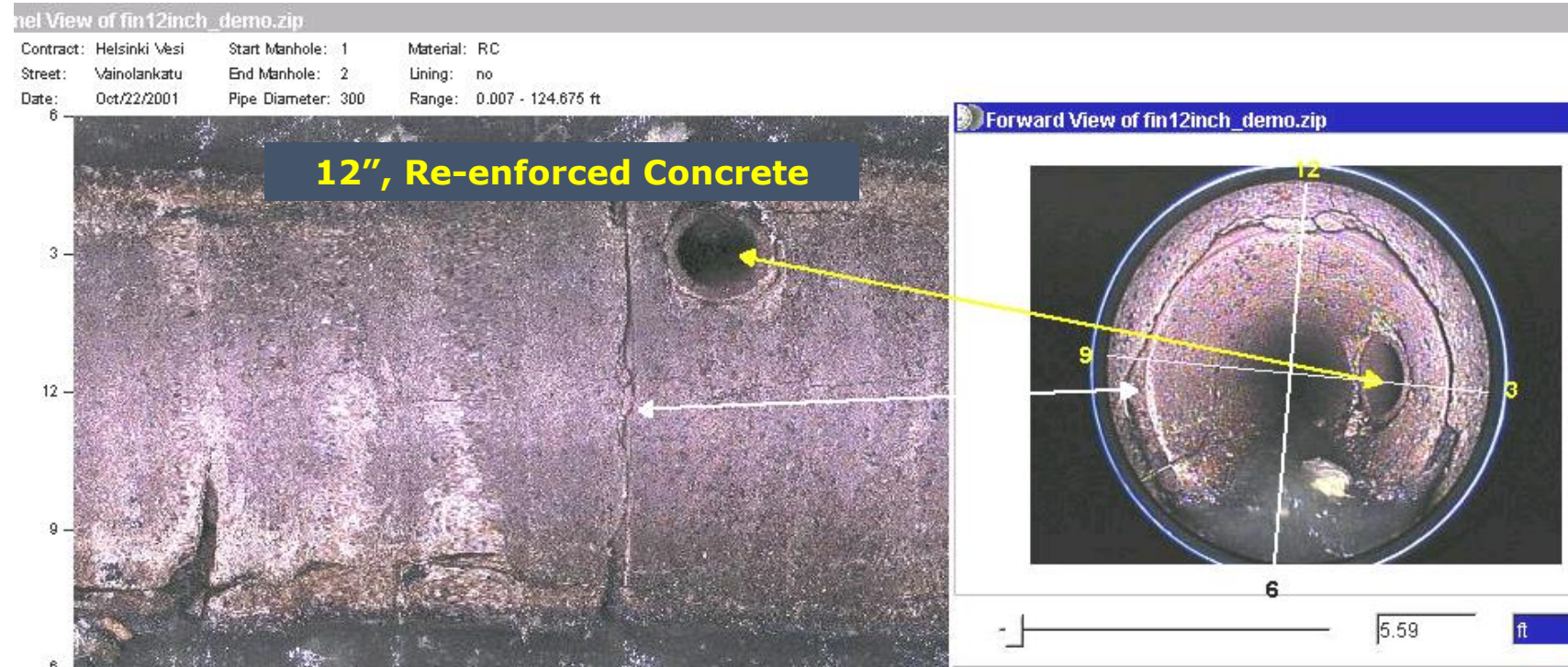
- Gyrosteering Tools

- The SSET FDA (Field Data Acquisition) Digital Scanner

- High-angle “fish eye” lens
      - 360-degree side scan
      - Forward-looking views
    - High-intensity LED light array
    - On-board gyroscope to measure meander
      - Inclination measurement
    - Data digitally recorded



# Optical Scanning Systems



"Un-wrapped"  
Side Scan Image



Forward Looking  
Image

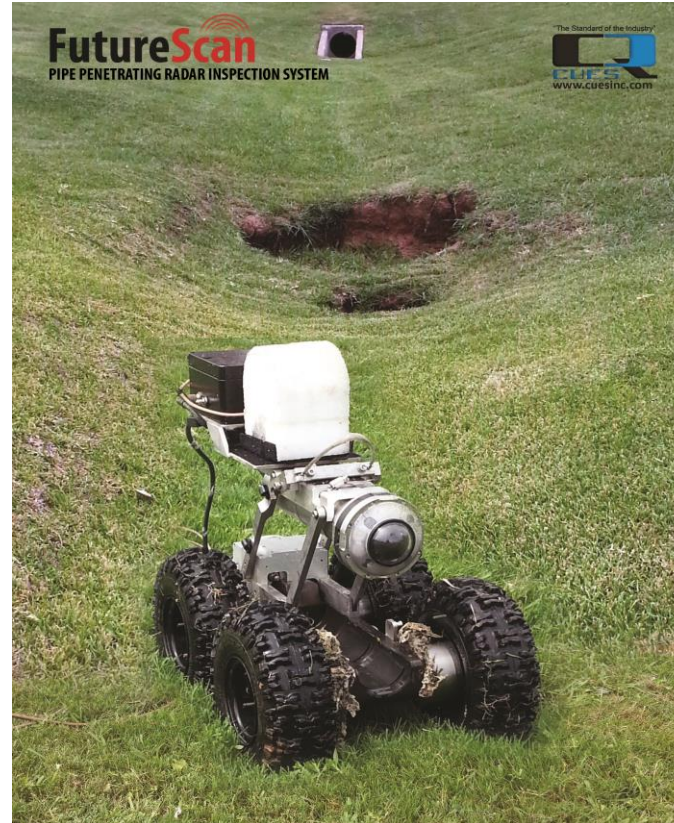


Blackhawk-PAS



# GPR (Ground Penetrating Radar)

Future Scan is a GPR (Ground Penetrating Radar) system, mounted on a pipeline inspection robot, that is able to “see” **into** and **beyond** the inner pipe wall.



## Future Scan

*Pipe Penetrating Radar*

*for...*

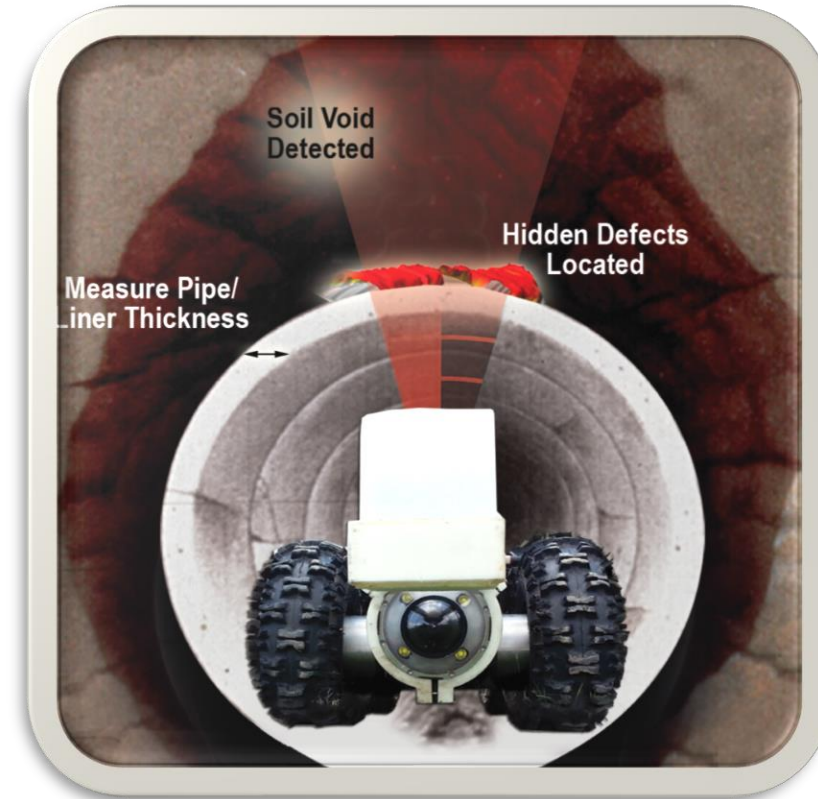
*-- Void Detection*

*&*

*-- Pipe Inspection*

# What Isn't Future Scan

- It is not SONAR, it doesn't work under water.
- It can't see thru metallic pipe, it only works in non-ferrous pipes like concrete, clay, plastic, etc.



FutureScan

**UNDERGROUND CONSTRUCTION TECHNOLOGY**

THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL





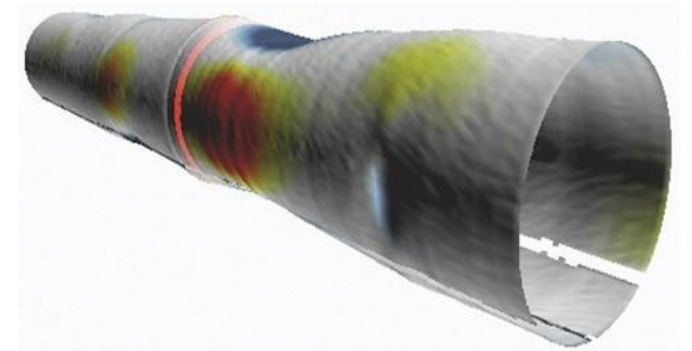
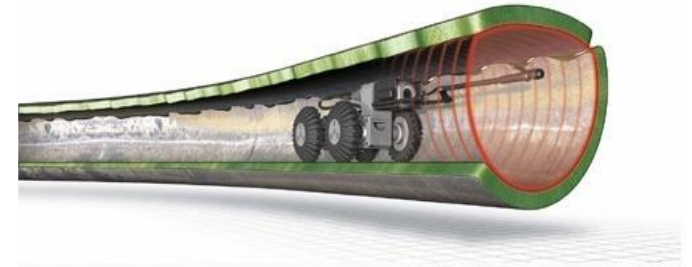
# Pipe Penetrating Radar (PPR)

- ❖ Underground in-pipe application of GPR
- ❖ Non destructive testing method
- ❖ Detects defects and cavities within and outside mainline diameter
- ❖ Unique ability to map pipe wall thickness and deterioration



# Pipe Dimensional Measurement Technology

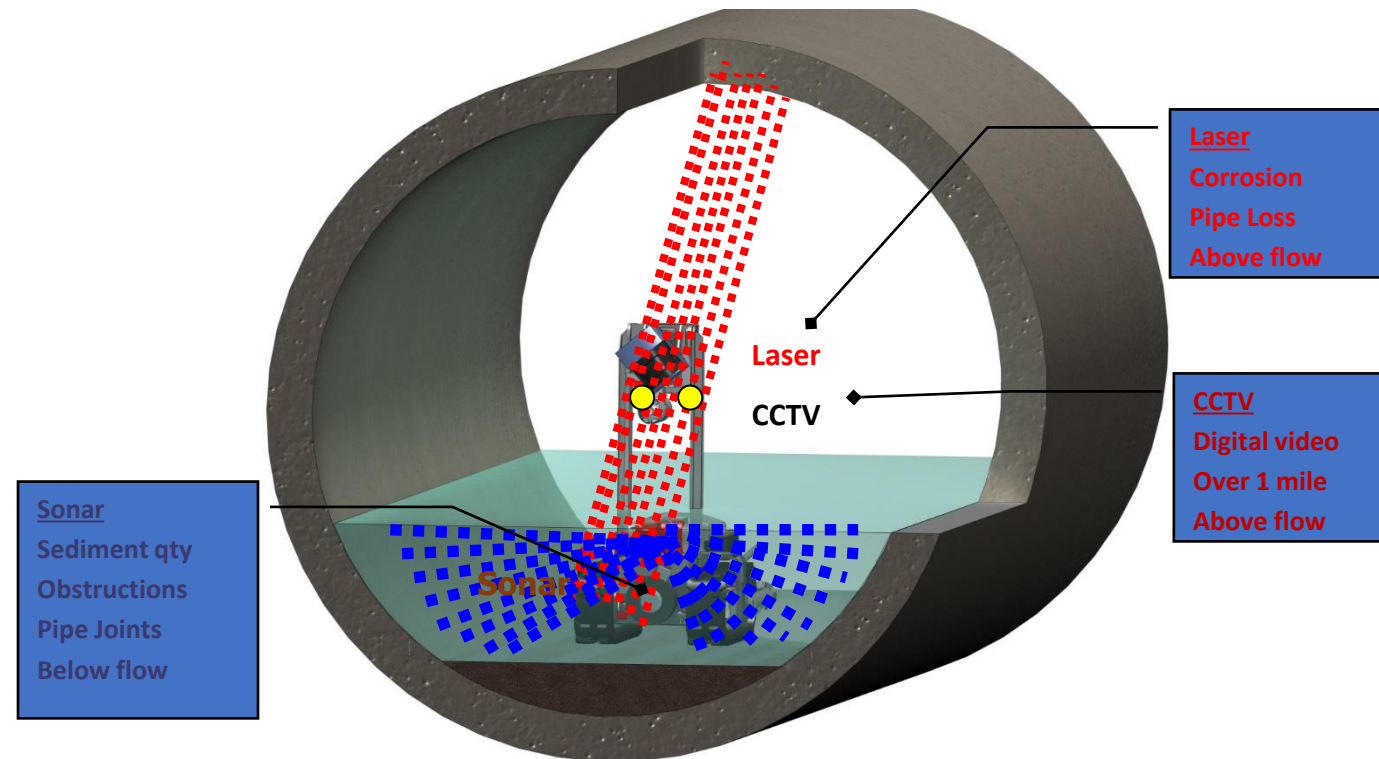
- Laser profiling
  - Typically used on large diameter projects
  - Cost is not justified for small/medium size diameters
  - Laser profiling was implemented to run pre- and post-laser profiling on CIPP to determine wall thickness
    - The accuracy on small diameter variances was not enough to successfully implement the technology as a quality control method for wall thickness



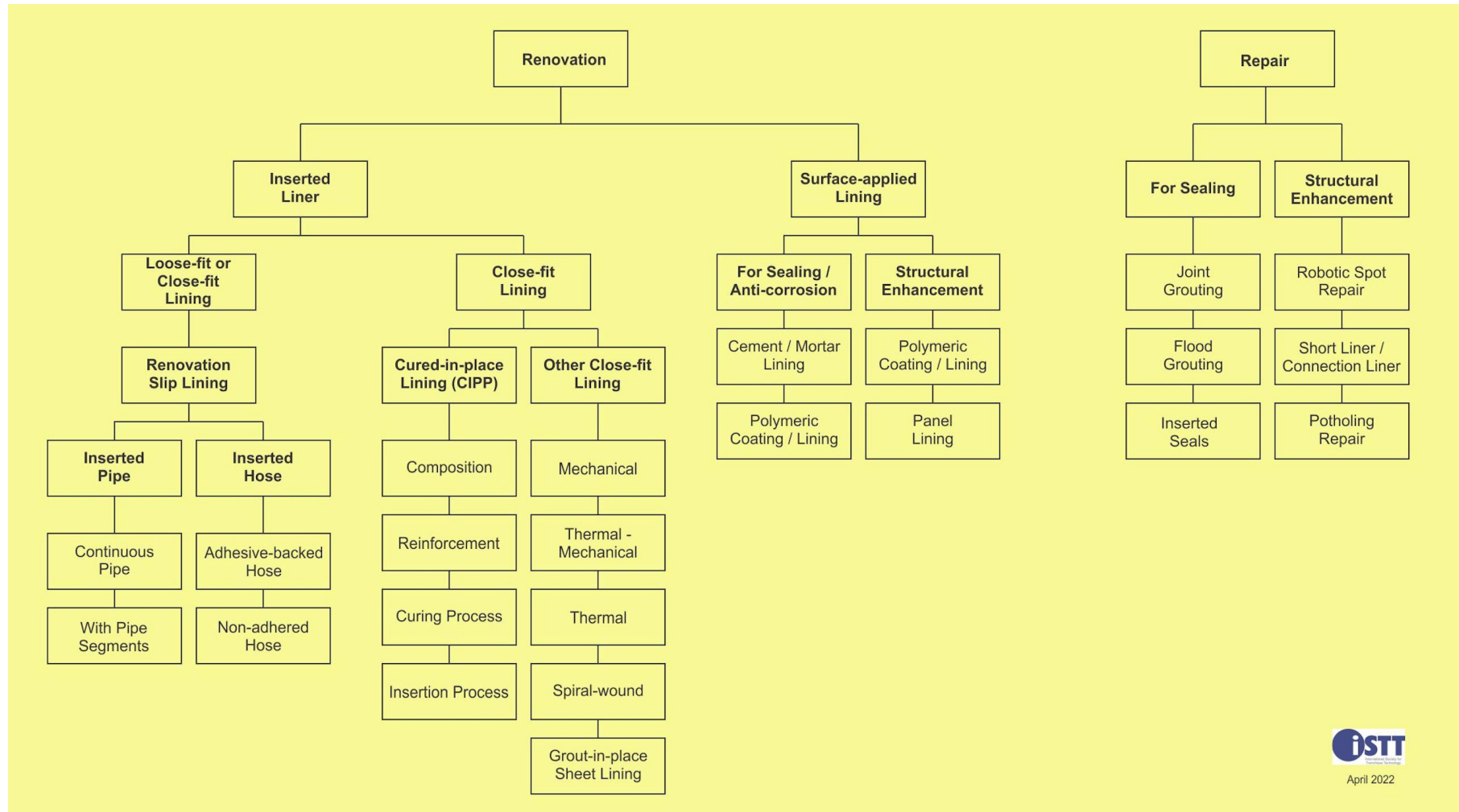


# Multi-Sensor Technology

Multi-sensor robotic evaluations



# Rehabilitation Technology





# Switz City, IN Asset Management Plan

- Small town (population less than 300)
- Complete water system and sewage system
- Aging system
- No budget for developing asset management plan



AMP Developed By:



# WWTF INFLUENT MONITORING DATA ANALYSES for **SWITZ CITY**

**ANALYSIS PERIOD: OCTOBER 01, 2021, to OCTOBER 30, 2022**

**I/I as a Percent of Annual Flow:**

**76%**

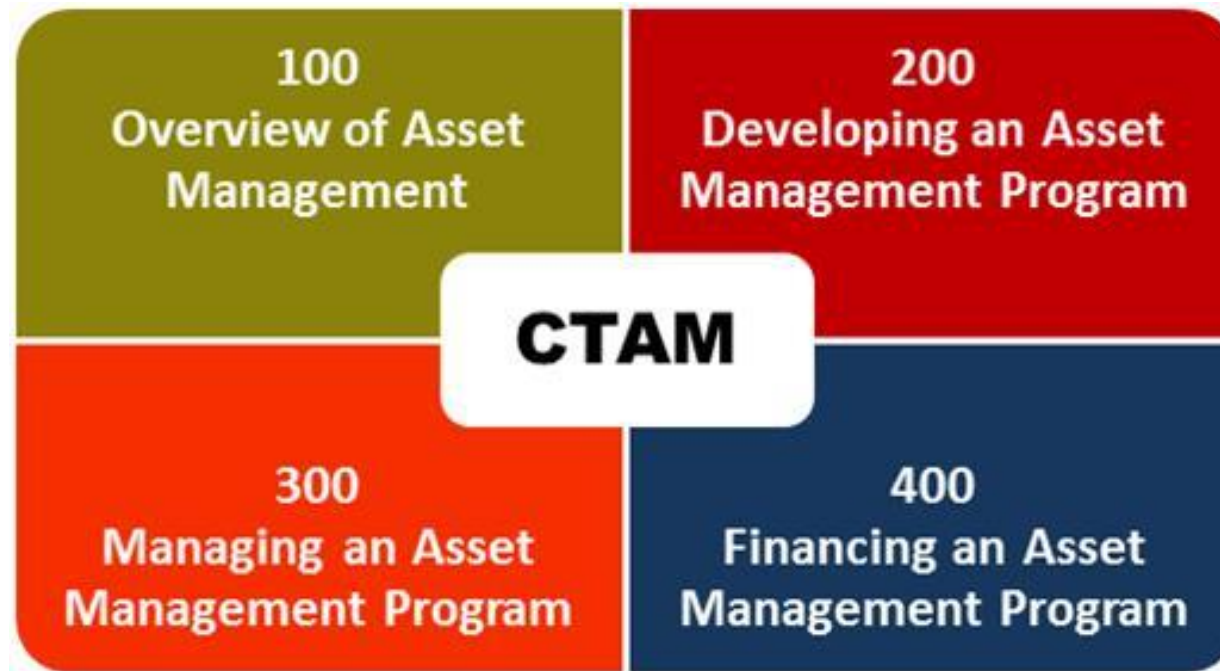
Calculated using ADDWF - 7-day low flow

**Estimated Annual I/I Cost: \$10,000 Years to Payback: 10.5 (After 50% Reduction)**

by: George E. Kurz, P.E., DEE



## Main Source:



# Thanks for your attention!

## Questions?

### Contact information

Tom Iseley

[diseley@purdue.edu](mailto:diseley@purdue.edu)

Wei Liao

[liao186@purdue.edu](mailto:liao186@purdue.edu)



Construction Engineering  
and Management

