InfoSense, Inc

Optimizing Sewer System Maintenance

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Agenda

- The Problem We Solve
- The Benefits We Provide
- Current Industry Maintenance Strategies
- Condition-Based Maintenance
- Enabling Technology Overview
- Case Study – Little Rock Arkansas

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The Problem We Help Solve

- Providing fast cost-effective data to better direct cleaning and CCTV resources
- Enabling a Condition-Based Maintenance Program
- Optimizing cleaning – clean the right pipe at the right time

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The Benefits Our Customers See

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Conventional Sewer Maintenance Strategies

Reactive Cleaning

- Run-to-Failure
- Often with a "Hot Spot" program

Time-Based Cleaning

- Cleaning and Inspection Requirements 12 – 120 Months
- Select Neighborhood(s) and Clean
- Often enhanced with a "Hot Spot" program

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Time-Based Strategy

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Transitioning to a New O&M Model

Time-Based Cleaning Maintenance Protocol

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Condition-Based Cleaning Maintenance Protocol

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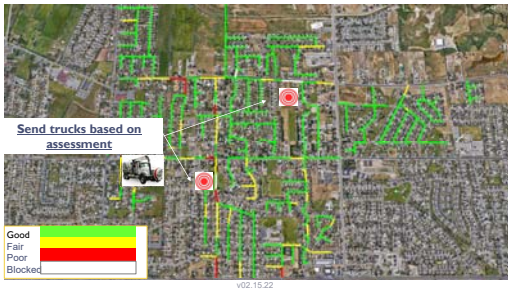
Condition-Based Strategy



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What is the Technology?

Sewer Line Rapid Assessment Tool (SL-RAT®)

- Developed with an NSF Grant
- Released in 2012
- Uses Acoustics to assesses sewer line blockages
- Evaluated by U.S. EPA - 2014
- In use with over 1400 utilities worldwide
- ASTM Inspection Protocol

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How Does Acoustics Fit with Other Inspection Tools?


Manhole Inspection


Zoom Camera


Push Camera

- CCTV/Robotic Camera
- Pipe Wall Defect Scanners
- Pipe Profiling / Robotic Multi-Sensor

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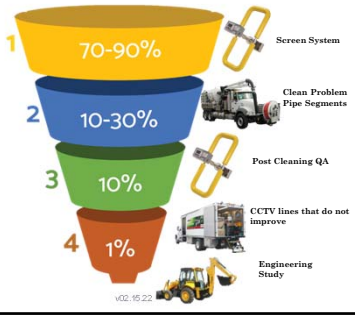
Condition-Based Maintenance Workflow



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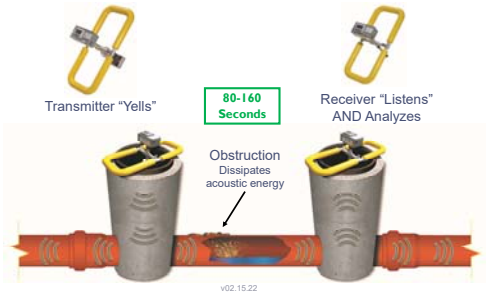
How Does It Work?



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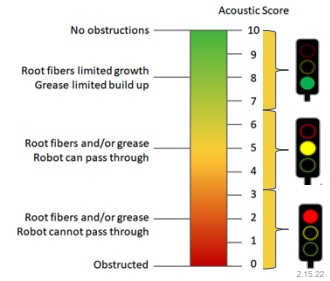
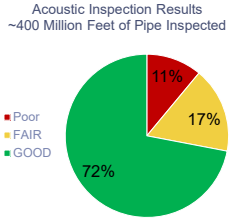
Condition-Based Maintenance Reduces Unnecessary Cleaning





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Little Rock, Arkansas

Objectives

- Transition from Time-Based to a Condition-Based Program
- Reduced Maintenance Expense
- Improved System Performance

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Overview

Little Rock

- Population: 200,000
- 1100 miles gravity mains ≤ 18 inch

Acoustic Screening Program

- 12 acoustic inspection devices
- Condition-Based maintenance strategy
- Increase annual maintenance from 40% to 100%
- Effectively deploy resources
- Reorganize current staff
- Add post-cleaning quality assurance

LRWRA Non-Capacity SSO's (before acoustic inspection)

LRWRA Non-Capacity SSO's	
2012	57
2013	50
2014	43
2015	49
2016	60

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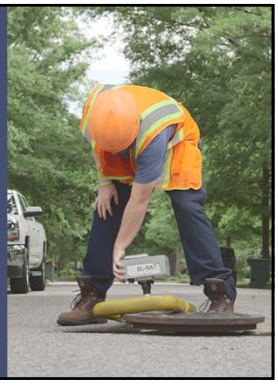
Keys to Successful Implementation

Little Rock

- Restructure staff OR outsource work
- Develop workflow procedures
- Identify starting point and plan
- Abort time-based PM's



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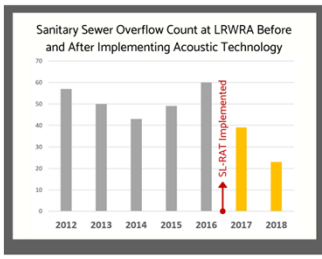
Results – Cleaning Effectiveness Improved



Does it work?

Comparing Little Rock's maintenance program performance from 2016 to 2017

- 35% Reduction in SSO's (64% reduction in 2018)
- 32% Reduction in linear feet cleaned
- 116% Increase in cubic yards of debris removed
- 0% Change in number of personnel

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Acoustic Inspection Applications

- Focus Cleaning Effort – Reduce Cleaning by Over 50% and Enable Condition Based Maintenance
- Post Cleaning – Quality Assurance
- Reduce Pre-Cleaning for CCTV inspection
- Quick Collection System Condition Assessments When Taking Over New Areas

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Implications

- Adopting Condition-Based Maintenance Makes Sense
- Enabled by the SL-RAT®
- Reduces Unnecessary Cleaning
- Improves System Performance
- Lowers Maintenance Costs
- Reduces SSO and backup claim risk

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Questions?

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Appendix

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Issues with Reactive Cleaning	Issues with Time-Based Cleaning
➢ Run-to-Failure can be very costly – SSO's, back ups, etc	➢ Clean every pipe segment regardless of condition
➢ Often does not meet regulatory requirements	➢ Unable to provide a quantified assessment of the pipe conditions
➢ System problems/emergencies drive resource allocation	➢ The only cleaning tools available have been slow, expensive, and high-risk heavy equipment
➢ Managing hot spots is costly and time consuming	➢ Managing associated hot spots is costly and time consuming
➢ Not pro-active	

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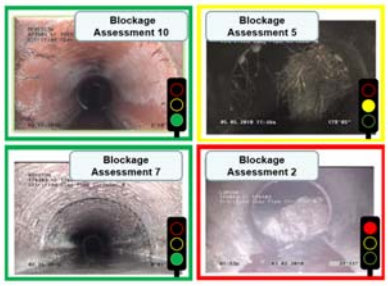
Visual Comparison



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Limitations of Acoustics

- What acoustic inspection does NOT tell you:
  - Type of blockage
    - Could be one big thing, or a lot of small things
    - Aggregate score of entire pipe segment
  - Location of blockage
  - Presence of small structural defects (fine cracks, joints, etc.)

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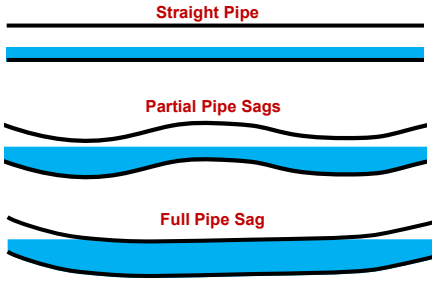
Impact of Pipe Sags



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Impact of Pipe Diameter

- Comparison of open surface area at various pipe diameters
  - Assume pipe is ¼ full with flow, obstruction is 18 sq. inches

Diameter	6 inches	10 inches	18 inches	24 inches
Total surface area (sq.in)	28.3	78.5	254.5	452.4
% blocked	89%	48%	32%	29%

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Validated by U.S. EPA Study

- "The results of this demonstration of the SL-RAT show promise for the application of this technology as a tool for cost-effective, pre-cleaning assessment and post-cleaning quality assurance. The application of this technology in an overall collection system O&M program should enable wastewater utilities to optimize their sewer cleaning efforts and free up valuable resources to more effectively implement critical CMOM and asset management programs."
- "Rapid assessment approaches and tools provide an avenue to significant pre-cleaning inspection cost savings that could be achieved through reduced inspection and non-productive cleaning costs."

Source: U.S. EPA "**Demonstration of Innovative Sewer System Inspection Technology: SL-RAT™" June 2014**

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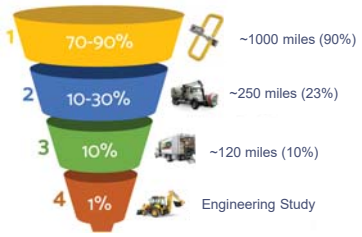
Screened 90% of System in First Full Year

Maintenance Operations Over 1st Year of Implementation



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City of Lindon, UT

Objectives

- New director partnering with service provider (R.H. Borden) to establish understanding of system health
- Transitioning institutional knowledge from retiring operators

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Results

- Inspected entire system in one month, as opposed to cleaning the entire system, which would take three years
- Manhole conditions were documented systematically
- System needs were documented in ArcGIS cloud Data dashboard.

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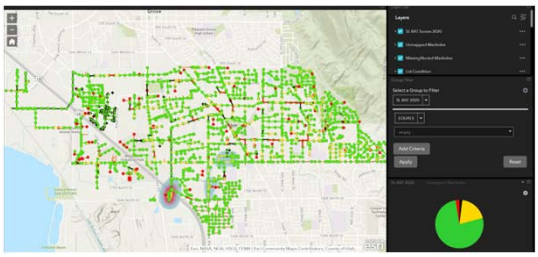
Data Dashboard



https://rhborden.maps.arcgis.com/apps/webappviewer/index.html?id=a8def08815894b6f9994ad78dddde481

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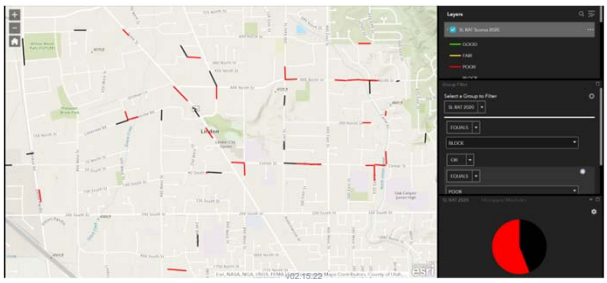
Data Dashboard – Filtered view



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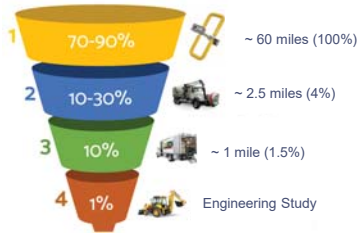
Screened 100% of System in One Month

Maintenance Operations Over 1st Year of Implementation



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- Risk Comparison
- Water Usage Comparison
- Effectiveness Comparison
- Cost Comparison

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Risk Comparison – Rotational vs Conditional

Risk Area	Rotational Clean + CCTV	Condition Based SL-RAT-Clean-CCTV
Percentage of System Maintained Each Year	20%	100%
Blockages Removed From System Each Year	20%	100%
Manhole Inspections / High Risk Manholes Cleaned	20%	100%
Focused CCTV On High-Risk Areas	No	Yearly
Full System CCTV Over Time	7 year	10-12 year
Insights (Missing/Buried Manholes, Infiltration, Photos, Map Updates)	No	Yes
Historical System Performance Data/Documentation	Paper/Spreadsheet	ArcGIS Dashboard
Funds Remaining For Identified Capital Repairs	X	✓

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Cost/Time Comparison – Traditional vs Conditional

	Cleaning	CCTV	Service
System Size	100 Miles	100 Miles	100 Miles
Equipment Cost	$50,000	$30,000	0
Maintenance Cost	$10,000	$5,000	0
Fuel Cost	$30,000	$20,000	0
Labor Cost	$160,000	$160,000	$95,000
Total Cost	$240,000	$210,000	$95,000
Cost / Foot	**$0.45**	**$0.40**	**$0.18**
Time to Complete	**264 days**	**396 days**	**27 days**

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Cost/Time Comparison – Traditional vs Conditional

	Cleaning	CCTV	Service
System Size	33 Miles	33 Miles	100 Miles
Equipment Cost	$50,000	$30,000	0
Maintenance Cost	$5,000	$5,000	0
Fuel Cost	$10,000	$8,000	0
Labor Cost	$50,000	$50,000	$95,000
Total Cost	$115,000	$93,000	$95,000
Cost / Foot	**$0.66**	**$0.53**	**$0.18**
Time to Complete	**88 days**	**132 days**	**27 days**

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