

# Using Acoustic Inspection to Prioritize Sewer Cleaning



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# PRESENTATION OUTLINE

- Acoustic Inspection Overview
- Acoustic Inspection Economics
- Case Studies
- Conclusion

# WHAT IS THE PROBLEM?

- Overflows are a Symptom – Not the Problem



# PROBLEM: INFORMATION



- Cleaning a pipe costs about the same as inspecting a pipe
- >80% of pipes less than 12", accounts for >90% of SSOs
- Historical GIS – Helpful – But Insufficient
- Where & When to Deploy Cleaning Resources
- Cost Effective & Timely Condition Information

# INSPECTION METHODS



Manhole Inspection



**ACOUSTIC**



Zoom Camera

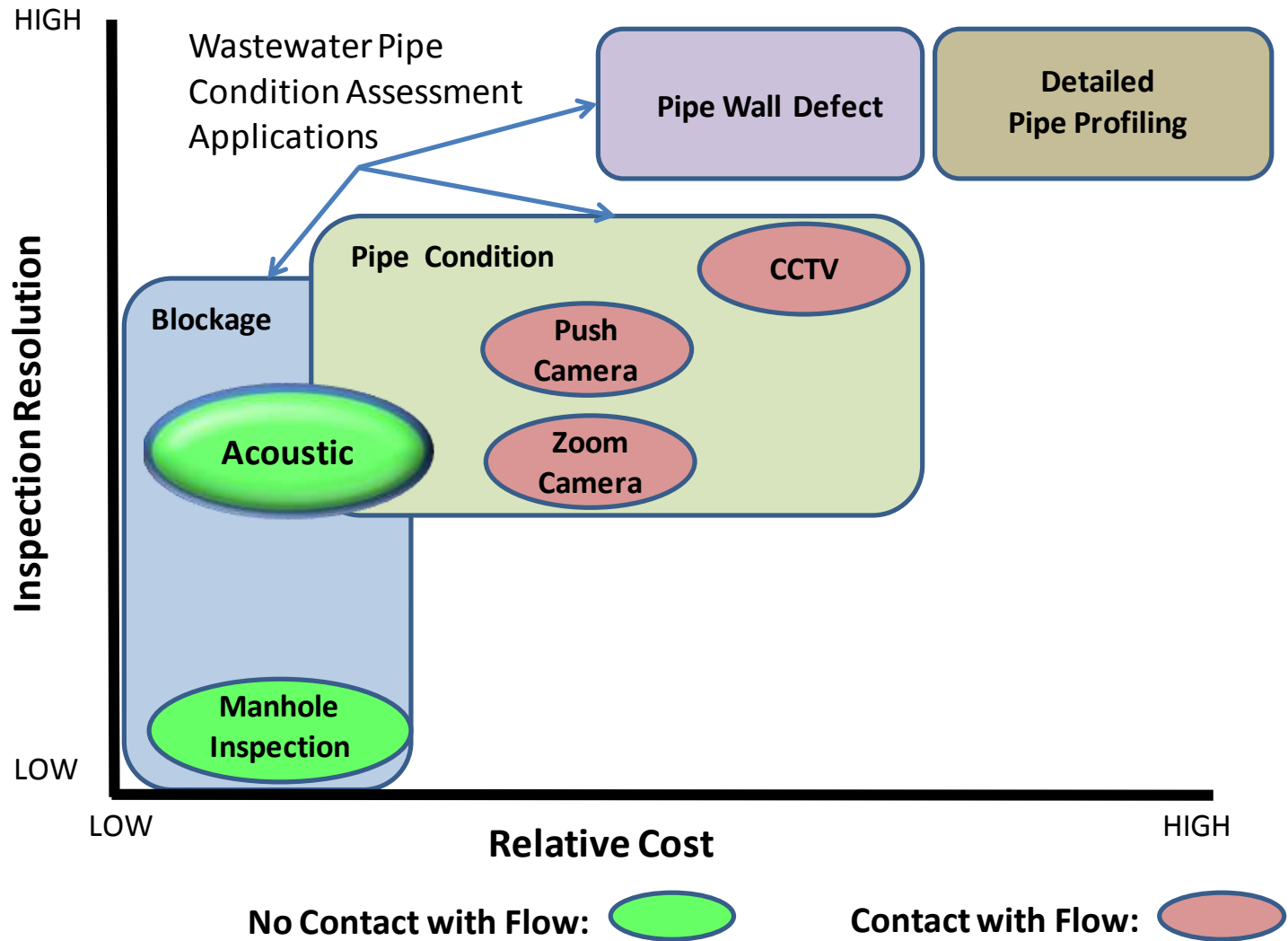


Push Camera



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

# INSPECTION METHODS



# ACTIVE ACOUSTIC PIPE INSPECTION BACKGROUND

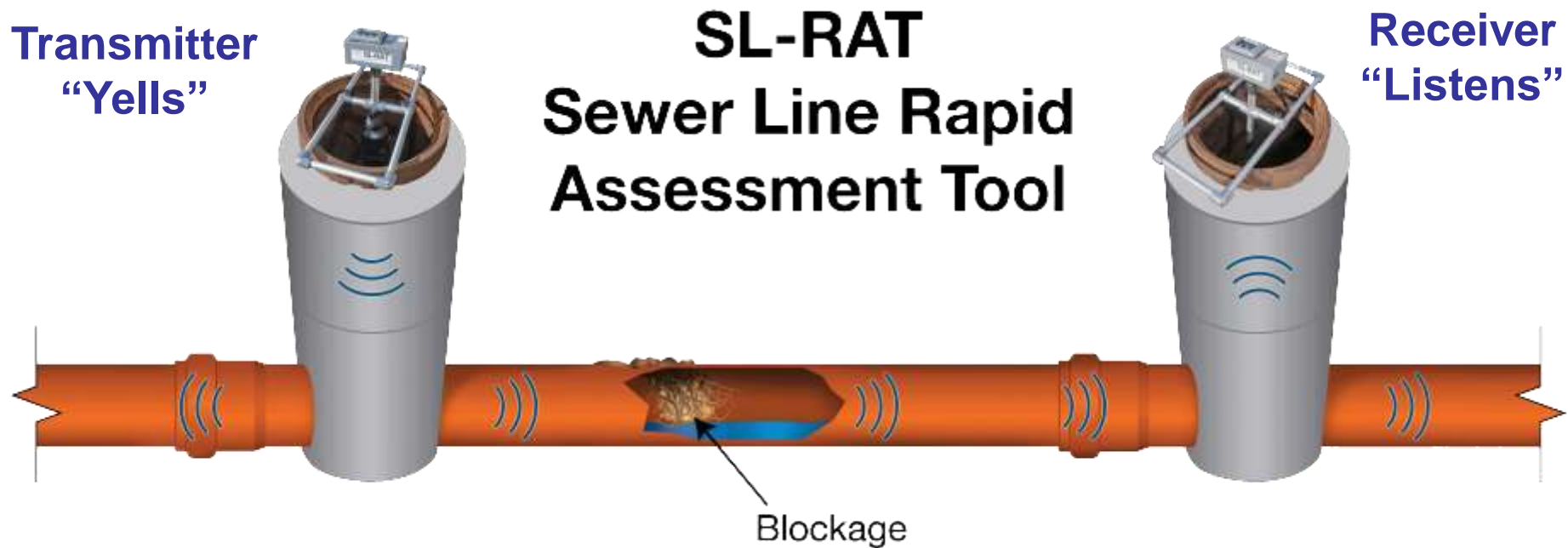
- Patented technology
- Gravity-fed sewer focus
- Developed in Charlotte with CMUD as key partner



- Over 20M feet inspected
- Rapid assessment helps better focus cleaning and CCTV resources

# ACOUSTIC INSPECTION TECHNOLOGY

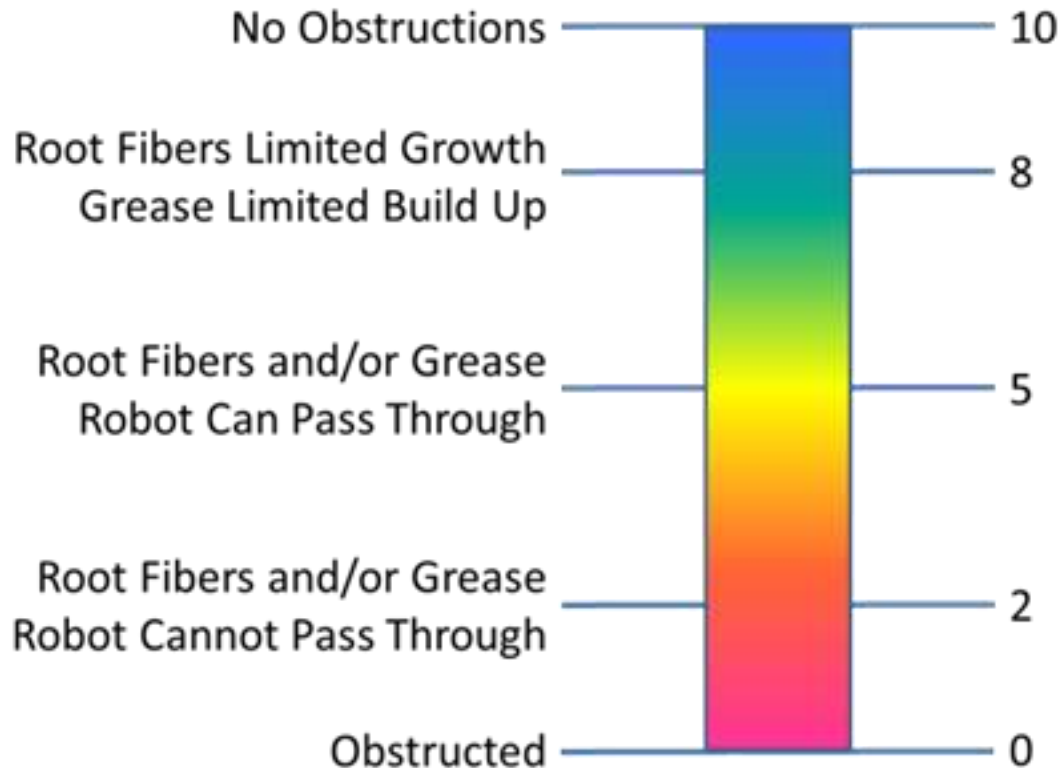
- How Does it Work?





# ACOUSTIC INSPECTION TECHNOLOGY

- Scoring System



# ACOUSTIC INSPECTION TECHNOLOGY

- Scoring System



CCTV Robot was Able to Pass Through Root Fibers



# ACOUSTIC INSPECTION TECHNOLOGY

- 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.)

# IMPACT OF PIPE SAGS

## Straight Pipe



## Partial Pipe Sags

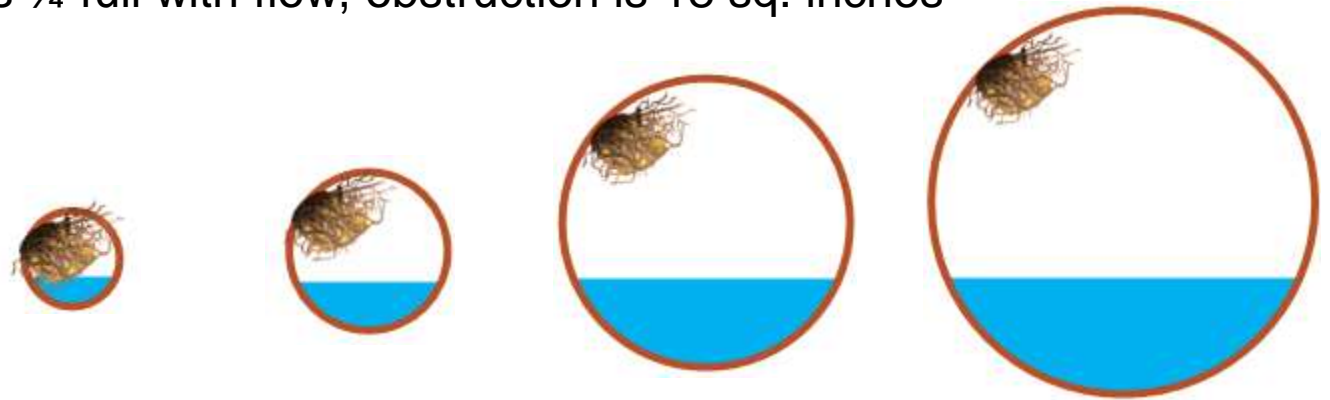


## Full Pipe Sag



# IMPACT OF PIPE DIAMETER

- Comparison of open surface area at various pipe diameters
  - Assume pipe is  $\frac{1}{4}$  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%

# IMPACT OF PIPE DIAMETER

- At larger diameters, more surface area available for sound to travel through and around blockages
- Roots, FOG, and other obstructions still reflect and absorb sound
- Acoustic inspection is still viable, but may need to be more conservative on acoustic values at larger pipe diameters
- Should focus on pipe diameters 6"-12", especially when first using the technology

# KEY FEATURES OF ACOUSTIC INSPECTION



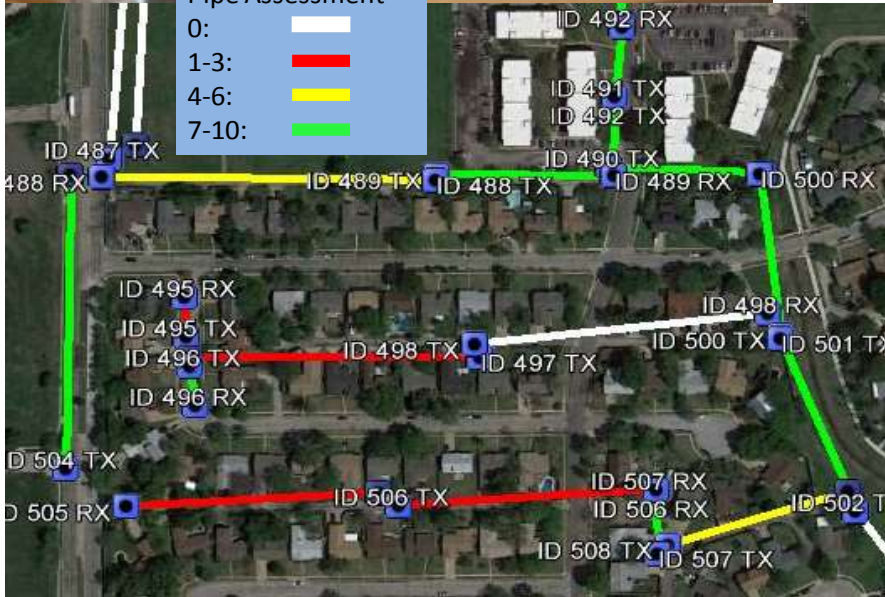
- No Flow Contact / No Confined Space Entry
- Simple to use – train operators in minutes
- Low Cost–Pennies/foot
- Rapid Onsite Results – Under 3 min./segment
- Portable < 30 lbs
- GIS Integration – GPS Enabled
- Archive Pipe Segment Blockage Assessments

# HISTORICAL ARCHIVE – SL-DOG



Legend:  
SL-RAT In Field  
Pipe Assessment

0:	White
1-3:	Red
4-6:	Yellow
7-10:	Green



- Sewer Line Diagnostic Organizer – SL-DOG
- Convert Assessment Data to Actions
- Better Scheduling of Cleaning Activities
- Better Management of Inspection Activities
- Improve Collection Cleaning Effectiveness



# ACOUSTIC INSPECTION APPLICATIONS

- Focus Cleaning Effort – Reduce Cleaning by Over 50% and Enable Condition Based Maintenance
- Eliminate Repeat and Downstream Overflows
- Post Cleaning – Quality Assurance
- Quick Collection System Condition Assessments When Taking Over New Areas

# **ACOUSTIC INSPECTION ECONOMICS**

- **In order for rapid pipe inspection to be economical, two conditions must be satisfied:**
  - **Substantially cheaper than current inspection methods**
  - **Significant number of pipes do not require immediate attention**

# COST EVALUATION

## SL-RAT Acoustic Inspection Cost

- U.S. EPA Study (June 2014)  
\$0.149/ft
- Less than 1/10<sup>th</sup> the cost of CCTV inspection cost performed in same study
- Cleaning cost is typically \$1.00/ft

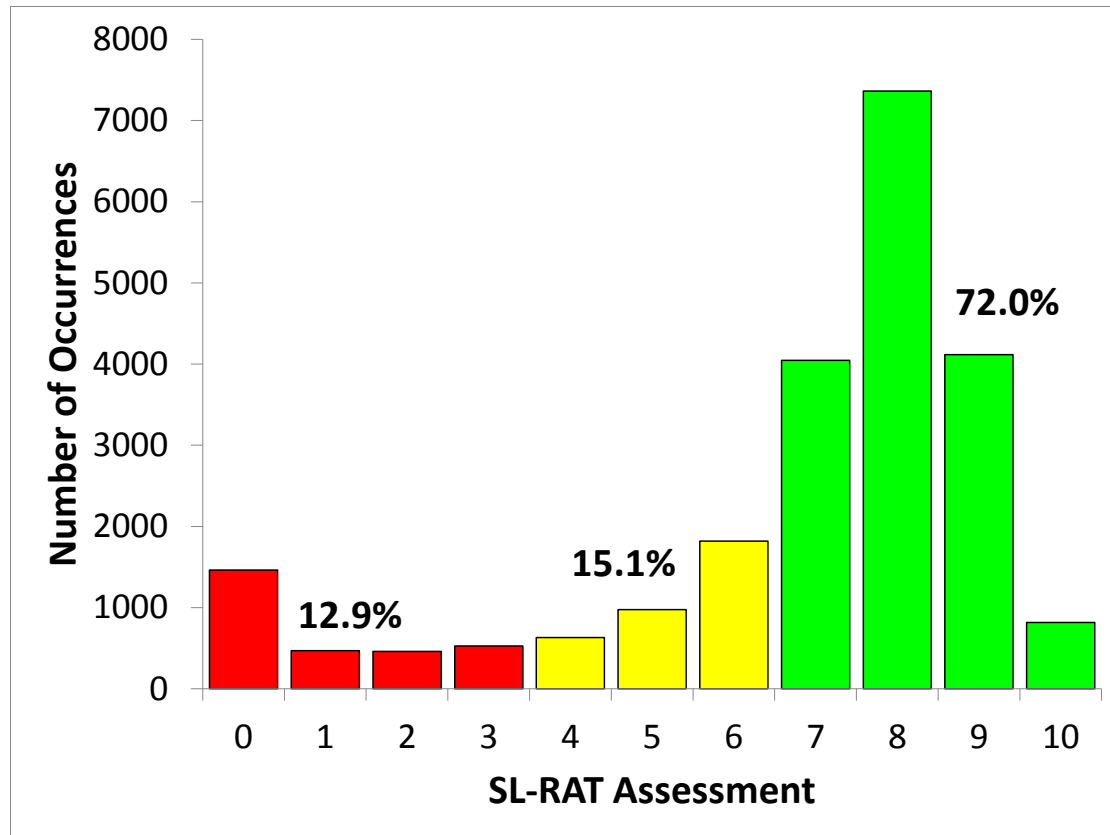


EPA Study available for download at:

<http://nepis.epa.gov/Adobe/PDF/P100IY1P.pdf>

# HOW MUCH CLEANING IS WASTED?

## Acoustic Inspection Results ~6 Million Feet of Pipe



- Target Historical Problematic Areas
  - **>70% Pipes Essentially Clean**
  - **<10% Need Immediate Action**
- Cleaning a Clean Pipe ⇒ Wastes Resources
- Not Cleaning a Dirty Pipe ⇒ SSO

# FINANCIAL IMPACT

- **Assumptions:**
  - **Cleaning cost is \$1.00/ft**
  - **Acoustic inspection cost (SL-RAT) is \$0.15/ft**
  - **Inspect 10,000 linear feet of sewer pipe per day (using acoustic inspection)**
  - **50% reduction in cleaning**

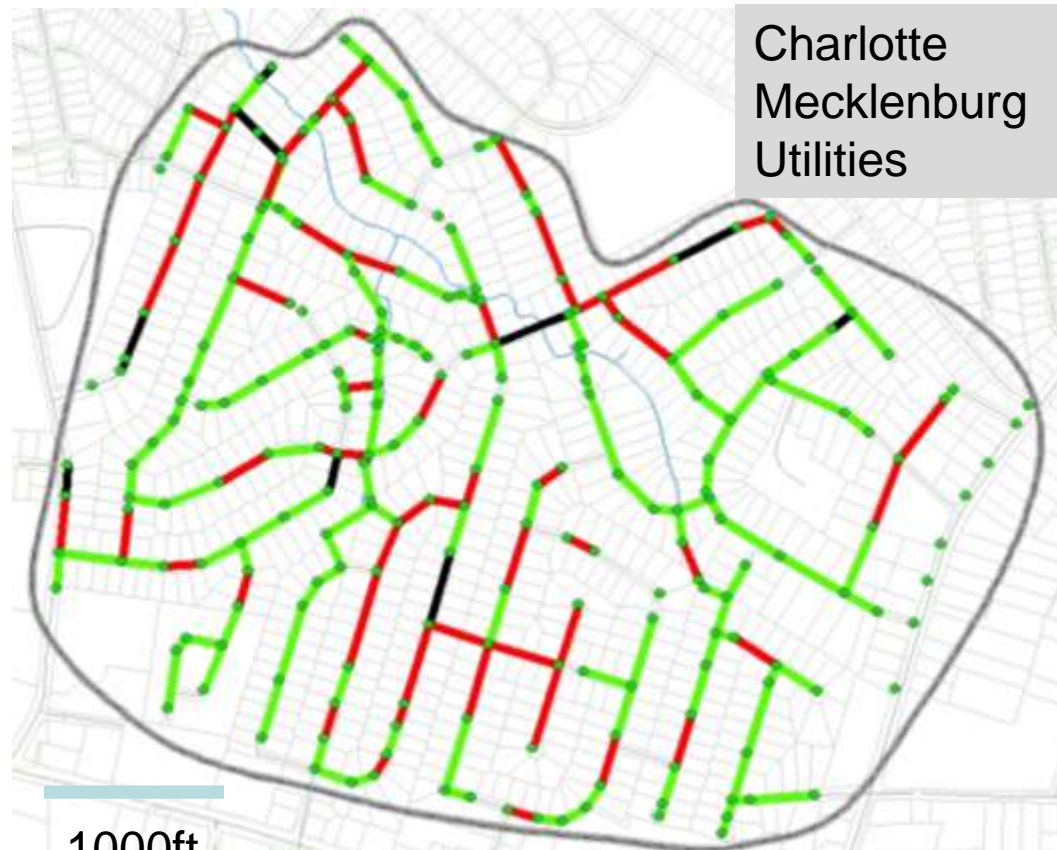
# FINANCIAL IMPACT (cont'd)

- Upfront equipment cost **~\$25,000**
- 10,000 ft/day of inspections → 50,000 ft/week  
Acoustic operating cost – **\$7,500/week** (@\$0.15/ft)
- Cleaning reduction (50%)  
25,000 ft/week → **\$25,000/week** (@\$1.00/ft)
- **PAYBACK PERIOD of LESS THAN TWO WEEKS**

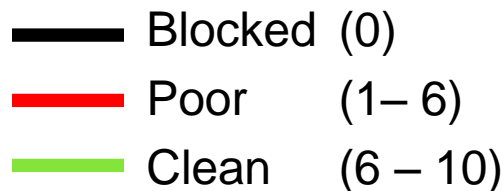
# **CASE STUDIES**

- **Charlotte, NC**
- **Augusta, GA**
- **Virginia Beach, VA**
- **METRO – Nashville, TN**

# CHARLOTTE, NC



SL-RAT  
Assessment



- **Goal:** Improve Cleaning Efficiency
- **Approach:** Acoustic Inspection Directed Cleaning
- **Effectiveness:**
  - 52,000 ft Basin
  - 30,000 ft Assessed by SL-RAT as “Clean”
  - 22,000 ft Below Threshold & Cleaned
- **58% Cleaning Reduction**



# CHARLOTTE, NC



**“You can see immediately what needs to be cleaned, so it takes the guesswork out and focuses your efforts.” – CharMeck Engineer**

- ▶ **Goal:** Prep Downtown Charlotte, North Carolina prior to DNC
- ▶ **Approach:** Use SL-RAT to quickly identify/prioritize cleaning needs for crews
- ▶ **Effectiveness:**
  - 2 SL-RAT crews inspected 143k ft of pipe in ~ 2 weeks
  - Saved \$100k + versus traditional approach
  - Focused on 10-15% of pipes that are the most blocked & prioritized the remainder

# AUGUSTA, GA

- **Founded 1822**
- **Combined operations with Richmond County in 1996**
- **Population Served 190,000**



- **1,040 miles of sewer pipe**
- **Covers 280 square miles**
- **Under GA EPD Consent Order**

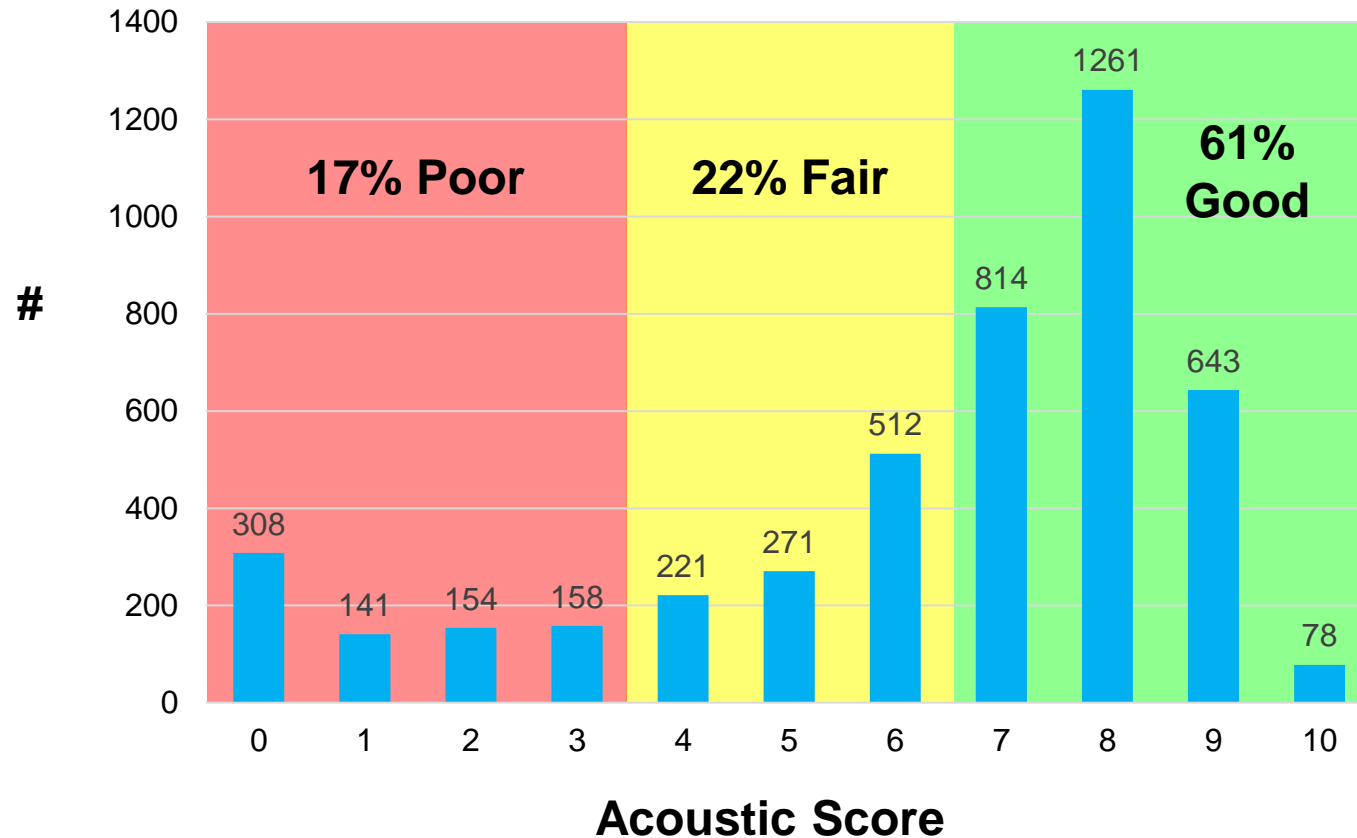
# AUGUSTA, GA

- Using SL-RAT since February 2013
- Currently using 3 devices
- 20,000 segments inspected
- Over 5 million feet of pipe (950 miles)



# AUGUSTA, GA

## Histogram of Acoustic Scores



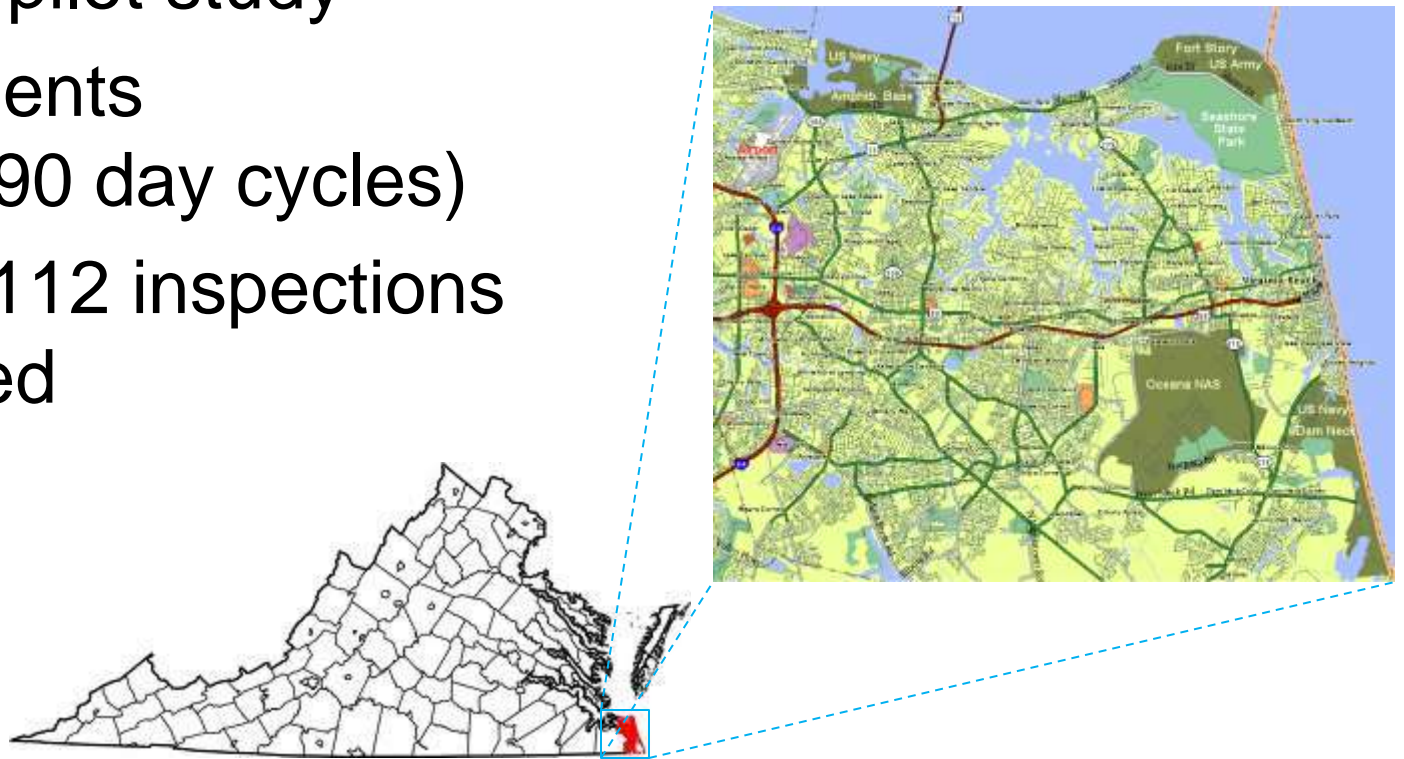
# VIRGINIA BEACH, VA

- 1,200 miles of gravity sewer mains
- “Hot Spot” program created in 2006 to reduce SSOs
- Cleaning cycles range from 30 days to 1 year
- Current program includes 813,000 ft
- 68,000 ft need cleaned per month



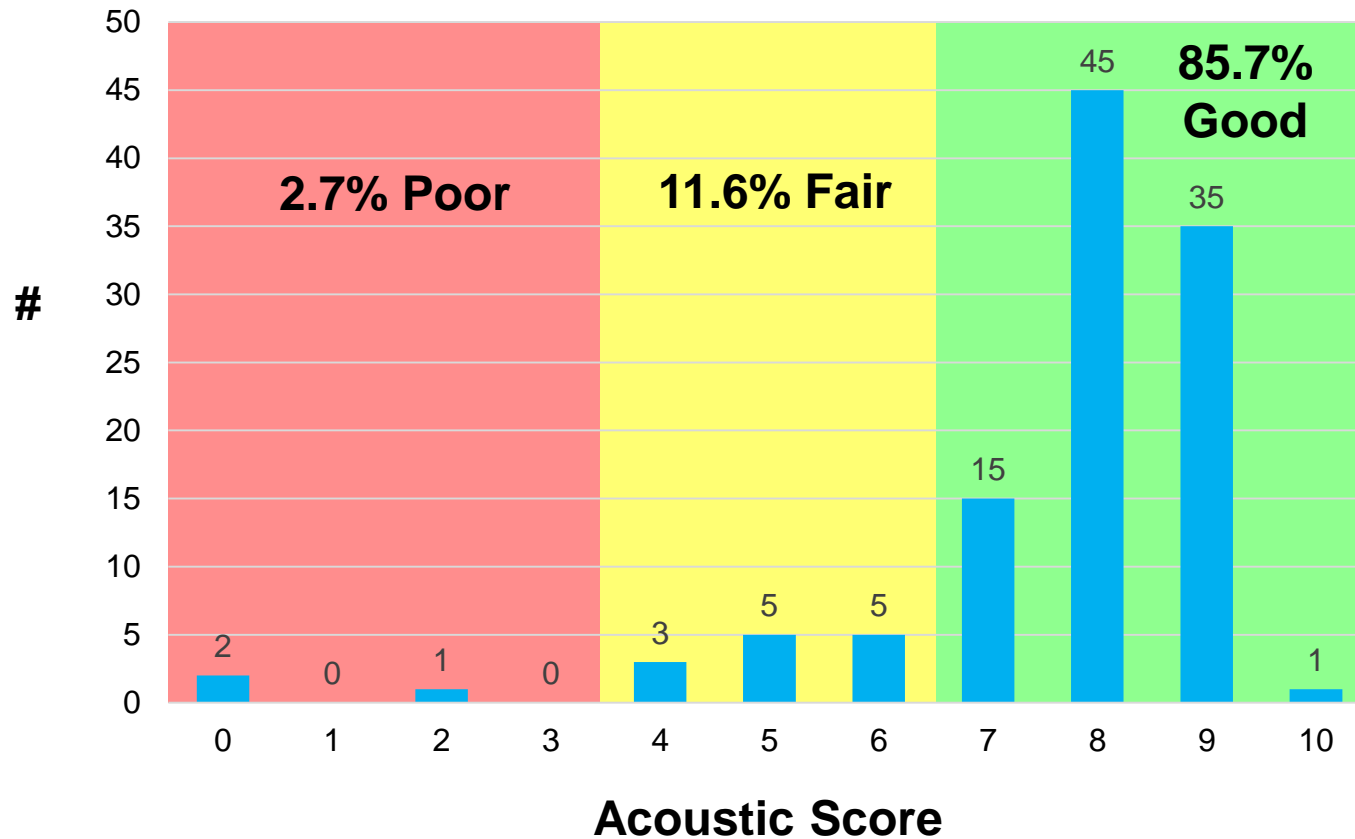
# VIRGINIA BEACH, VA

- 4 month pilot study
- 62 segments  
(30, 60, 90 day cycles)
- Total of 112 inspections performed



# VIRGINIA BEACH, VA

## “Hot Spot” Pilot Study Histogram of Acoustic Scores



# METRO – NASHVILLE, TN ACOUSTIC PROJECT



- METRO under consent decree by EPA
- Bio-Nomic Services/Ace Pipe has inspected over 4,000,000 ft. since 2013
  - Expected 15 million ft. by 2017
- 6 Acoustic crews running daily
  - Averaging 50-70K ft. per day





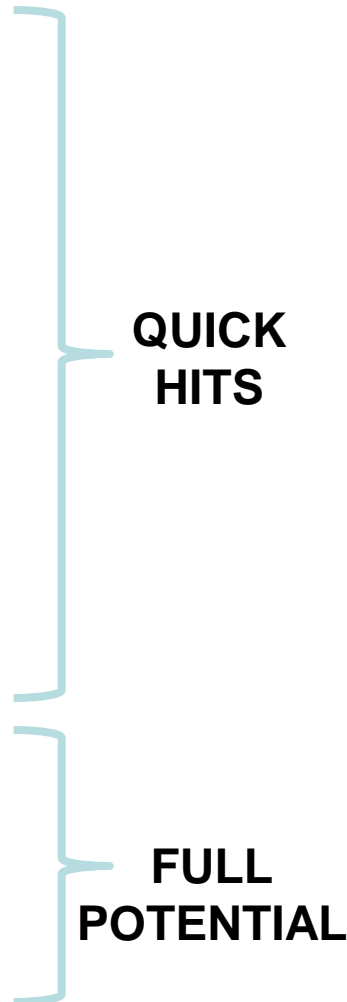
# METRO – NASHVILLE, TN ACOUSTIC PROJECT

- SSO's down an estimated 60%!
- Approximately 4,000,000 feet tested to date
  - 10% scored 5 or lower
  - 90% scored 6 or higher
  - Less than 1% received a score of zero
- CCTV dollars saved:  
At \$1/ft = \$3,600,000 savings
- In one month crews were able to test 800,000ft of pipe.
- Found an absolute need for GIS tracking and 3 tier data validation. GPS/TimeSheets/Maps
- CCTV 4M' @ 2000' per day, 2 crews = 4 years



# APPLICATION OF ACOUSTIC INSPECTION

Application Area	How to Use Acoustics
Pre-Cleaning Assessment	Prioritize/focus cleaning often see >50% cleaning reduction – “focus on cleaning the dirtiest pipes”
Condition Surveys	Quickly & economically assess large areas for asset management & planning
Cleaning Interval Determination	Only clean specific segments when below blockage threshold
Post-cleaning QA	Low-cost method to check cleaning effectiveness and prevent downstream SSO's
Optimize SSES Contract Resources	Use acoustics to prioritize pre-cleaning & camera resources for contract advantage
Performance-Based Contracting	Use acoustic inspection to enable SSO targets in cleaning/inspection contracts
Condition Based Maintenance Program	The “holy grail” – economics of acoustics enables a CBM strategy to focus maintenance activity



# CONCLUSION

- Inspection is much Cheaper than Cleaning
- Acoustic Inspection is an Effective Method to Make Blockage Assessments
  - Quick
  - Cheap
  - Easy / Safe
- Acoustic Inspection Enables CBM Capability
- Acoustic Inspection Does Not Replace Cleaning or Detailed Inspection
  - Helps Determine how to Effectively Deploy Cleaning and CCTV resources

# QUESTIONS?



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