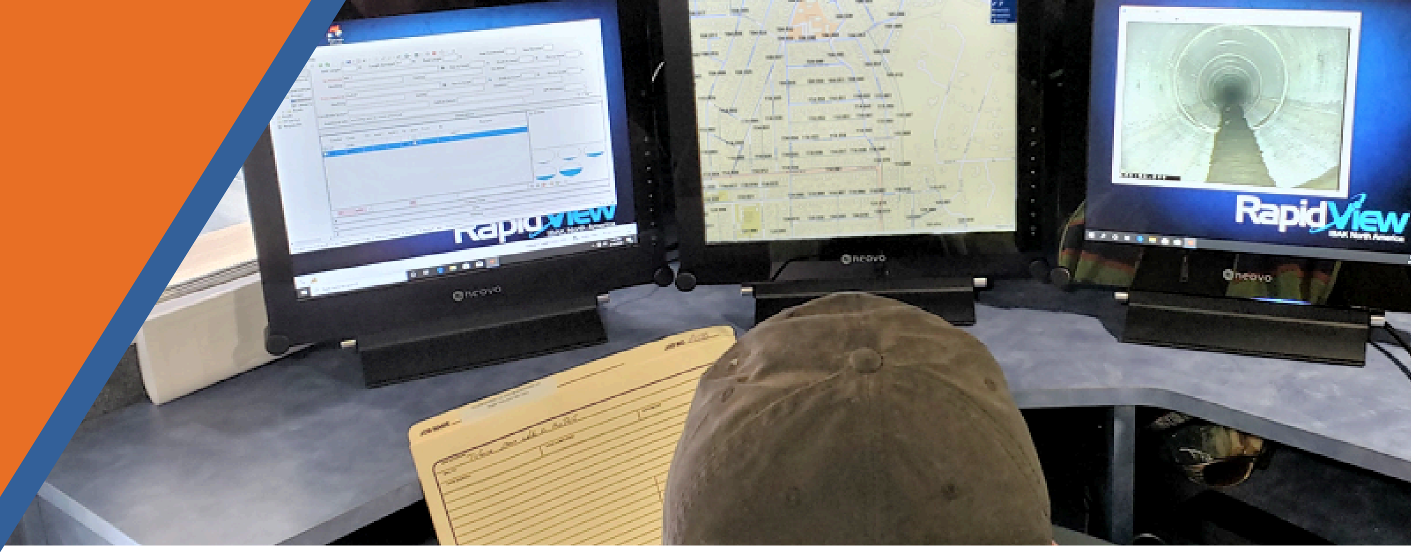
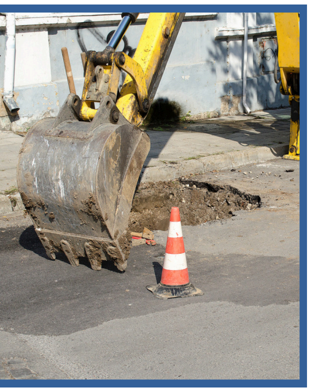
WHITEPAPER

ASSISTED INSPECTION CODING (AIC): FROM REACTIVE TO PROACTIVE WASTEWATER PIPELINE MANAGEMENT



ASSISTED INSPECTION CODING (AIC)
ROADMAP

THE WASTEWATER PIPELINE INFRASTRUCTURE CRISIS IN NORTH AMERICA



The United States is facing a critical challenge with its aging water and wastewater infrastructure. According to the American Society of Civil Engineers' (ASCE) 2021 Infrastructure Report Card, much of the nation's water and wastewater infrastructure is nearing the end of its lifespan. The report highlights that there are over 800,000 miles of public sewers and 500,000 miles of private lateral sewers in the US, with many of these systems being 45 years old on average.

The Environmental Protection Agency (EPA) estimates that there are between 23,000 and 75,000 sanitary sewer overflows (SSOs) per year in the United States, releasing billions of gallons of raw sewage into local surface waters.

These incidents not only pose significant public health risks but also lead to substantial economic losses and environmental damage.

The scale of the problem is further emphasized by the EPA's Clean Watersheds Needs Survey, which indicates that the nation's wastewater and stormwater treatment systems will require $271 billion in investments over the next 25 years to meet current and future demands. This staggering figure underscores the urgent need for more efficient and effective management of sewer infrastructure.

THE CHALLENGE FOR CITIES:
REACTIVE VS. PROACTIVE SEWER ASSESSMENT

In the face of this infrastructure crisis, many average-sized US cities (those with populations between 100,000 and 300,000) are grappling with the challenge of maintaining their sewer networks, which typically span 500 to 1,500 miles. These cities often find themselves caught between two approaches to sewer assessment and maintenance: reactive and proactive.

Traditionally, many cities have employed a reactive approach to sewer management. This method involves addressing issues only after they occur, such as responding to pipe failures, blockages, or sewage overflows. While this approach may seem cost-effective in the short term, it often leads to significant long-term expenses and risks.

Reactive management can typically cost an average-sized city between $5 million to $20 million annually. This includes expenses related to emergency repairs, which are typically 3 to 5 times more costly than planned maintenance. For instance, an emergency sewer repair might cost between $50,000 and $200,000, depending on the severity of the damage.

Moreover, the reactive approach exposes cities to substantial risks. Sewer system failures can lead to overflows, resulting in fines, cleanup costs, and public health hazards. The cost of responding to a significant SSO can range from $100,000 to several million dollars. Environmental contamination from such incidents can incur cleanup costs and potential legal liabilities ranging from $500,000 to $10 million or more.

In contrast, a proactive approach to sewer management involves regular inspections, predictive maintenance, and strategic upgrades. While this method requires upfront investment in technology and personnel, it often results in significant long-term savings and reduced risks.

Available data suggests that proactive sewer pipe asset management for an average-sized US city might range from $2 million to $8 million annually. Proactive sewer pipe management, involving regular inspections, predictive maintenance, and strategic upgrades, offers significant cost benefits for average-sized cities.

While initial investments may be substantial—ranging from $1 million to $3 million annually for routine inspections and maintenance, plus $500,000 to $2 million for advanced monitoring systems—the long-term savings are considerable. Proactive strategies, including the use of trenchless technologies for preventive repairs, can dramatically reduce costs compared to reactive replacements. For instance, preventive repairs might cost $20,000 to $50,000 per segment, versus $100,000 or more for reactive replacements. Moreover, by reducing the frequency and severity of emergencies, proactive management can lead to annual savings of $2 million to $10 million in avoided major incidents and environmental cleanup costs. This approach not only lowers overall expenses but also provides more predictable budgeting for sewer infrastructure management.

Furthermore, proactive management extends the lifespan of sewer infrastructure, delaying the need for costly replacements. Over a decade, this approach could save a city between $30 million to $120 million.

Despite the clear advantages of proactive management, many cities struggle to implement this approach effectively. The primary challenges include:

Limited Resources

Many municipalities face budget constraints that make it difficult to invest in advanced inspection technologies and preventive maintenance programs.

Data Management

Proactive management requires processing and analyzing vast amounts of inspection data, which can be overwhelming for cities with limited technological capabilities.

Workflow Limitations

There's often a shortage of skilled personnel capable of conducting thorough sewer inspections and interpreting the resulting data accurately.

Aging Workforce

The water sector is experiencing a "silver tsunami" of retirements, with the American Water Works Association estimating that one-third of water utility workers could retire in the next decade.

These challenges highlight the need for innovative solutions that can help cities transition from reactive to proactive sewer management more efficiently and cost-effectively.

INTRODUCTION TO
ASSISTED INSPECTION CODING (AIC)

To address these challenges, ITpipes has developed Assisted Inspection Coding (AIC), an innovative solution that leverages artificial intelligence to revolutionize sewer inspection processes. AIC is designed to enhance the efficiency, accuracy, and cost-effectiveness of sewer assessments, enabling cities to adopt a more proactive approach to infrastructure management.

HOW AIC WORKS

1. *Data Collection*: The process begins with high-resolution video inspections of sewer pipes using advanced camera systems. These cameras capture detailed footage of the pipe's interior condition.

2. *AI-Powered Analysis:* The inspection footage is then processed through ITpipes' proprietary AI algorithms. These algorithms have been trained on a vast database of pipe inspection videos, allowing them to recognize and classify various types of defects and anomalies in the pipes after analyzing each pixel in each individual frame in the footage provided.

3. *Automated Coding*: Upon identifying defects, AIC employs its machine learning capabilities to categorize and code these issues in real-time following industry standards (such as NASSCO's Pipeline Assessment Certification Program). This process significantly reduces the time and potential human error involved in manual coding. The software is further designed to learn from previous inspections; as it processes more data, it iteratively adapts and improves its defect detection capabilities. This continuous learning aspect ensures that AIC stays current with evolving defect characteristics and inspection technologies, making it a reliable partner for public works departments.

4. *Human Verification:* While the AI system is highly accurate, human experts still play a crucial role. The system flags areas of low confidence or potential high-risk defects for review by trained operators. This ensures that critical issues are not overlooked and maintains the integrity of the inspection process.

5. *Report Generation*: After verification, the system generates comprehensive reports detailing the condition of the inspected pipes, including defect types, locations, and severity.

6. *Data Integration*: The inspection results can be seamlessly integrated with the city's existing asset management systems, providing a holistic view of the sewer network's condition.

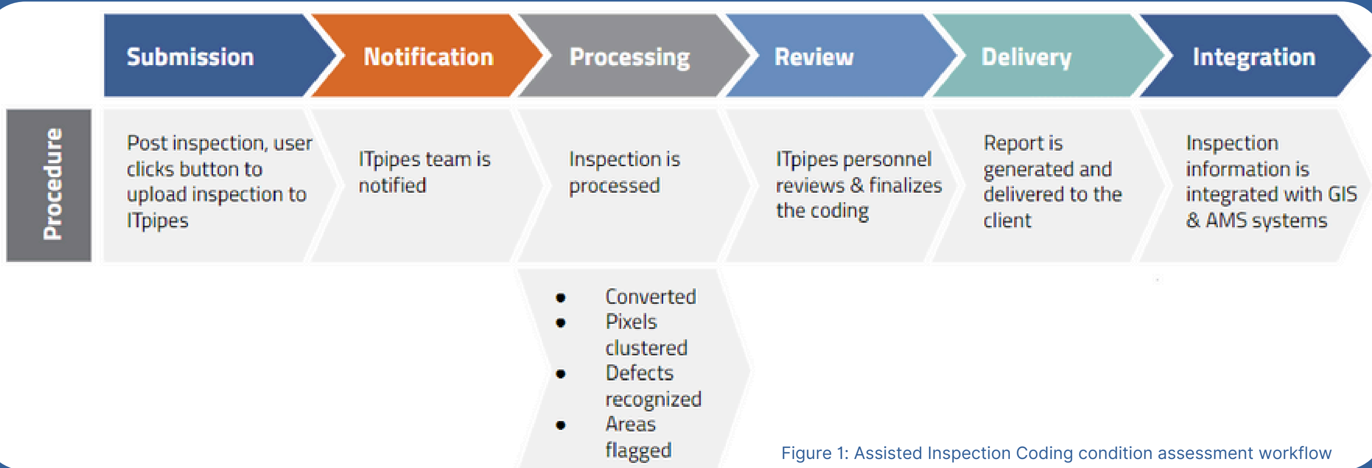


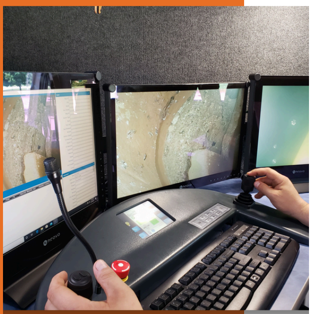
Figure 1: Assisted Inspection Coding condition assessment workflow

KEY FEATURES

ASSISTED INSPECTION CODING (AIC)

HIGH ACCURACY

AIC maintains a 97% accuracy rate in defect detection and classification, surpassing traditional manual inspection methods which have shown accuracy rates in the ranges of 60 to 70% on average.



EFFICIENCY

The system can process inspection footage significantly faster than manual methods, allowing for more rapid assessment of large sewer networks.

CONSISTENCY

AI-powered coding ensures consistent application of inspection standards across the entire network, removing variations that may arise among individual human inspectors.

SCALABILITY

AIC can handle large volumes of inspection data, making it suitable for cities of all sizes.

CONTINUOUS LEARNING

The AI system continuously improves its accuracy as it processes more data while adapting to new types of defects and pipe conditions.

IMPROVING EFFICIENCY, PRODUCTIVITY & ACCURACY **WITH AIC**

The implementation of AIC can lead to increased efficiency, productivity, and accuracy, resulting in significant improvements in various aspects of sewer asset management for average-sized US cities.

EFFICIENCY

AIC dramatically reduces the time required for sewer inspections processing and data analysis. Traditional manual coding methods can be time-consuming, with operators often spending hours reviewing footage and classifying defects. In contrast, AIC can process inspection footage in a fraction of the time.

For example, based on data from ITpipes' client experiences:

- Manual post-process coding: approximately 1 mile of pipe inspection footage typically takes at least 16 hours to code. QA/QC process on that inspection can take from 4 to 6 hours.
- AIC: the same footage can be processed and coded in 4 hours and QA/QC of the AIC inspection takes about the same amount of time .

This represents at least a 50% reduction in coding time, allowing cities to inspect and assess their sewer networks more rapidly.

PRODUCTIVITY

The increased speed of inspections and data processing allows cities and contractors to cover more of their sewer network in less time. This increased productivity can lead to more comprehensive and frequent assessments of the entire system, preventing more SSOs, CSOs and other causes for costly reactive repairs. Reliable data instills confidence, enabling practical budgeting and planning, while significantly reducing wasted time and money compared to using unverified data collection.

AIC allows inspectors to focus on NASSCO standards for video quality, including speed, lighting, position and adequate capturing of defects as they appear, without the need to take the time to classify the defects at the same time.

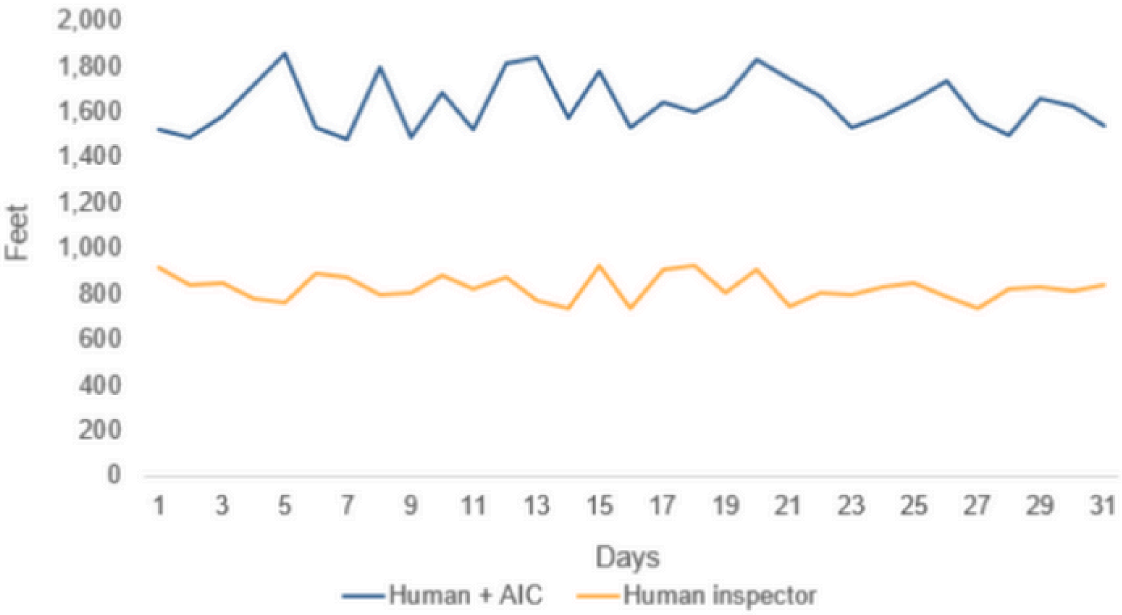


Figure 2: City Inspector Daily Productivity (feet per day) vs. Inspector + AIC on Same Mainline Sections Over a Month. Anonymized Client Data.

Based on average figures for US cities:

- **With traditional methods, a city might inspect 10-15% of its sewer network annually.**
- **With AIC reducing efforts by inspectors in the field, the same resources could potentially inspect 20-30% of the network.**

This increased coverage enables cities to identify and address potential issues more quickly, reducing the risk of unexpected failures and associated costs.

ACCURACY

AIC's 97% accuracy rate in defect detection and classification represents a significant improvement over manual methods (typically ranging from 60 to 70% rates). Human inspectors, even when well-trained, can be subject to fatigue, distractions, and inconsistencies. The AI system, on the other hand, maintains consistent performance across all inspections.

This improved accuracy has several benefits:

- Reduced false positives: Fewer misclassified defects means less unnecessary maintenance work.
- Fewer missed defects: Critical issues are less likely to go unnoticed, reducing the risk of unexpected failures.
- Better prioritization: More accurate condition assessments allow for better prioritization of maintenance and repair work.

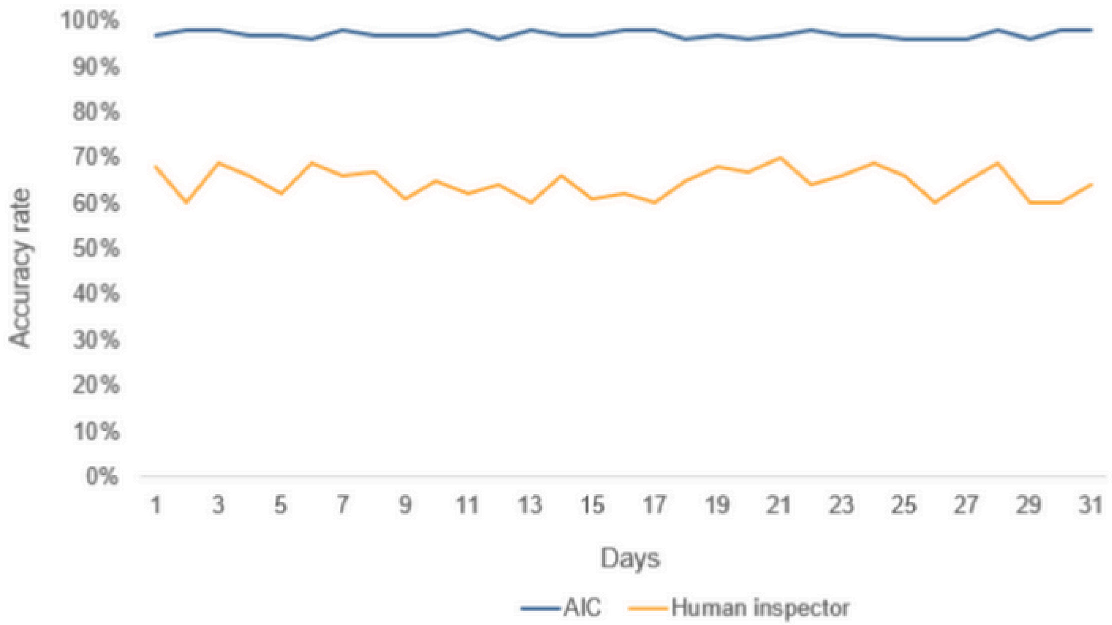
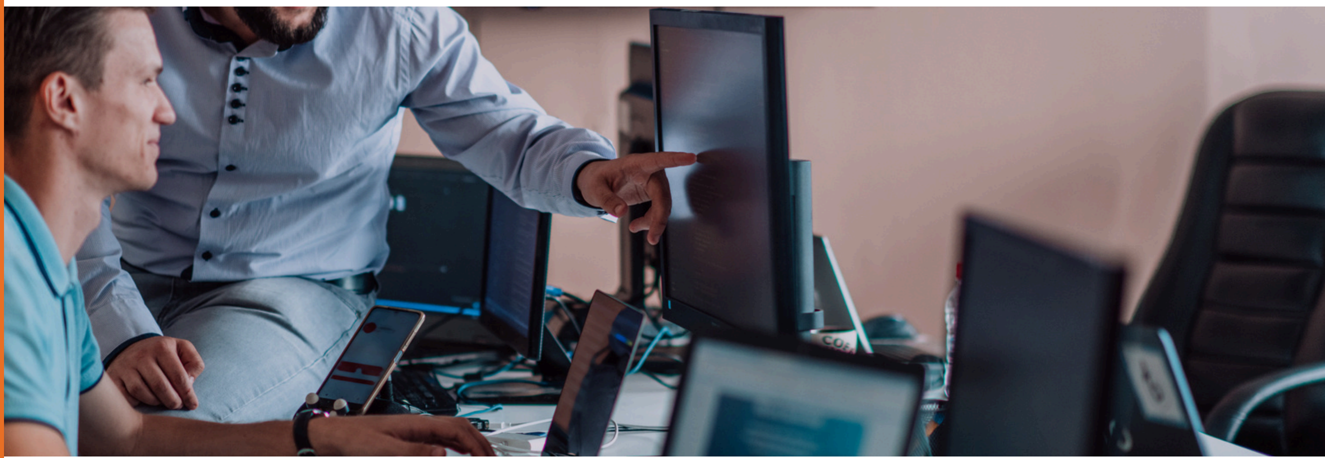


Figure 3: City Inspector Daily Defect Coding Accuracy vs. AIC on Same Mainline Sections Over a Month. Anonymized client data.



COST SAVINGS

The combination of improved efficiency, productivity, and accuracy translates into significant cost savings for cities. Based on the figures previously mentioned and typical experiences with AIC implementation, an average-sized city could face:

- Reduction in annual sewer management costs: from $20 million (reactive approach) to $8 million (proactive approach with AIC)
- Potential annual savings: $12 million
- Projected 10-year savings: $120 million

These savings come from various sources:

- Reduced emergency repair costs
- Lower cleanup and liability costs from prevented sewer overflows
- More efficient use of workforce (reallocation from emergency response to planned maintenance)
- Extended infrastructure lifespan due to timely interventions

THE VALUE OF AIC FOR CITIES & CONTRACTORS

Assisted Inspection Coding represents a transformative technology for sewer asset management in average-sized US cities. By enabling a shift from reactive to proactive management strategies, AIC offers numerous benefits:

1. Substantial Cost Savings

The potential to save millions of dollars annually through reduced emergency repairs, prevented overflows, and more efficient resource allocation.

2. Improved Public Health and Environmental Protection

By facilitating early detection and prevention of sewer issues, AIC helps cities avoid costly and hazardous sewage overflows.

3. Extended Infrastructure Lifespan

Proactive maintenance enabled by AIC can significantly extend the useful life of sewer assets, delaying the need for costly replacements.

4. Enhanced Decision-Making

More accurate and comprehensive data on sewer conditions allows city managers to make informed decisions about maintenance priorities and capital improvements.

5. Workforce Optimization

AIC allows cities to make better use of their skilled workforce, focusing human expertise on critical decision-making rather than time-consuming data processing.

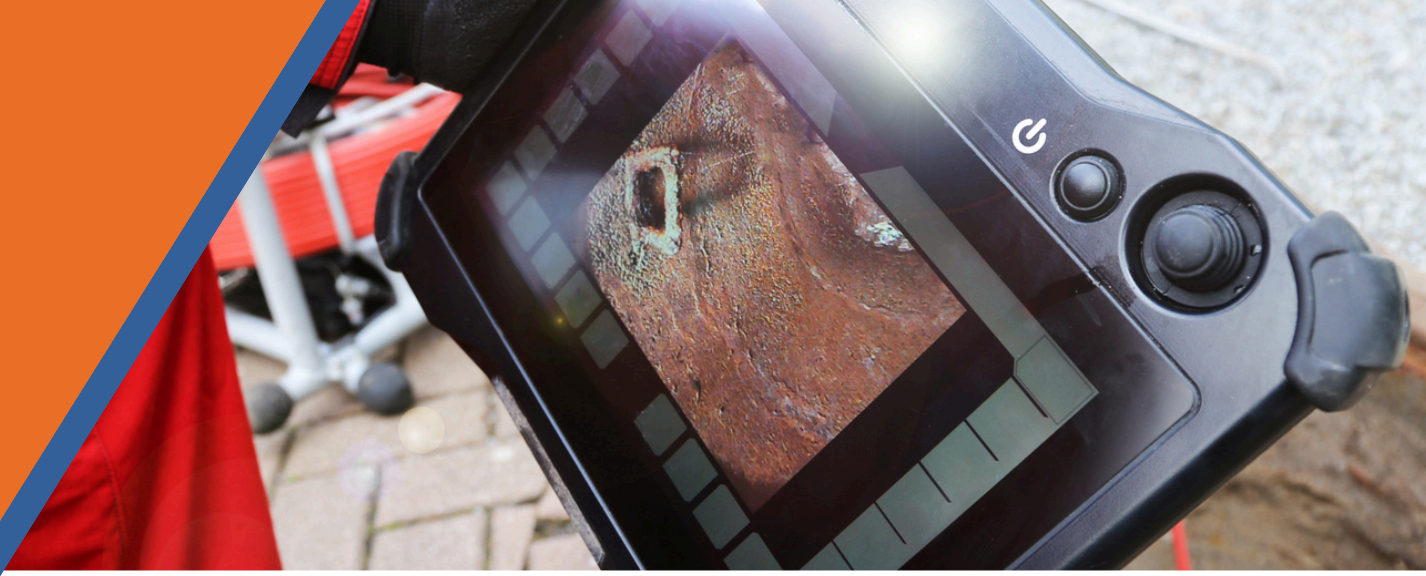
6. Scalability and Future-Proofing

As an AI-based system, AIC continually improves and adapts, ensuring that cities can keep pace with evolving infrastructure challenges.

For contractors working with municipalities, AIC offers the opportunity to provide more value-added services. By leveraging this technology, contractors can:

- Reduce the need for repeated inspections by increasing accuracy, thereby lowering overall cost per asset
- Deliver faster turnaround times on inspection reports
- Increase consistency in condition assessment
- Expand their service capacity without proportionally increasing labor costs

As cities across the United States grapple with the challenges of aging sewer infrastructure and limited resources, Assisted Inspection Coding emerges as a powerful tool to drive efficiency, accuracy, and cost-effectiveness in asset management. By enabling a proactive approach to sewer maintenance, AIC not only helps cities save money but also contributes to building more resilient and sustainable urban environments for the future.



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ABOUT THE AUTHOR

With over 24 years of experience in underground utility management, inspection, and repair, Jax Vollmer has steadily built her career by transitioning from contracting to consulting to better serve asset owners and managers. Her move into software allowed her to focus more on data collection and AI, where her sharp attention to detail in sewer and stormwater CCTV inspections has been invaluable. Jax is also skilled in integrating field-collected data into inventory systems, including GIS, and has over a decade of experience working with the NASSCO standard, making her proficient in database applications like SQL, ESRI, QGIS, and MS Access.

Jax is committed to contributing to the industry by leading the ADR workgroup for NASSCO and serving on several NASSCO committees. Her hands-on expertise in underground utility installation, rehabilitation, and maintenance enables her to provide valuable insights into asset management and cost analysis. Passionate about data accuracy and knowledge-sharing, she remains dedicated to driving meaningful improvements in the industry.

PIPELINE INSPECTIONS.
ACTIONABLE INTELLIGENCE.

For more information on Assisted Inspection Coding and how it can benefit your specific organization, **CLICK HERE**.

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