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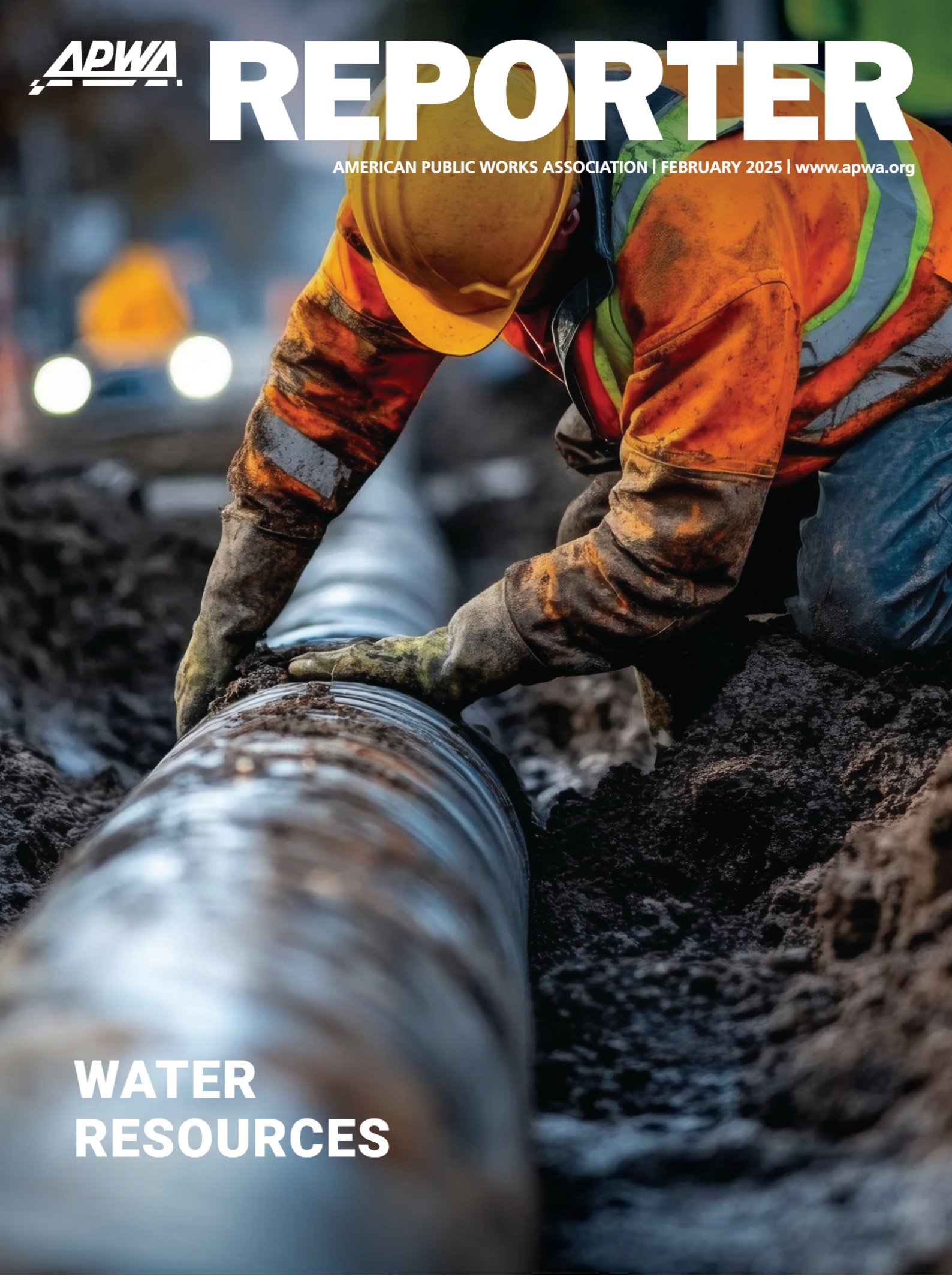

WATER RESOURCES

ONE UTILITY'S PERSPECTIVE USING AI IN SEWER INSPECTIONS

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Artificial intelligence (AI) has been a hot topic for the past few years and has made its way into our industry's toolbox for capturing inspection information. Before digging into how AI is being used, it's important to start with some general understanding of how AI relates to condition assessments.

AI starts with machine learning. Mass amounts of training data, such as photographs or videos of known defects, are used to improve the software through iterative trial-and-error experiences. The machine learns to progressively identify defects observed within individual images or videos. This stage of AI is called automated defect recognition (ADR). Machine learning and ADR are being used for sewer condition assessments.

The next level of AI is advanced analytical processes, which focus on analyzing and leveraging information in large data compilations. In sewer networks, an example could be deterioration analysis of specific pipe material and the age of pipes.

Given these advancements in AI, the National Association of Sewer Service Companies (NASSCO), an industry association for trenchless technology education, resources, and advocacy, released a position paper, "Artificial intelligence for sewer systems from a PACP perspective" (PACP stands for Pipeline Assessment Certification Program). In the paper, the NASSCO AI workgroup recognized the following uses for AI-collected inspection data:

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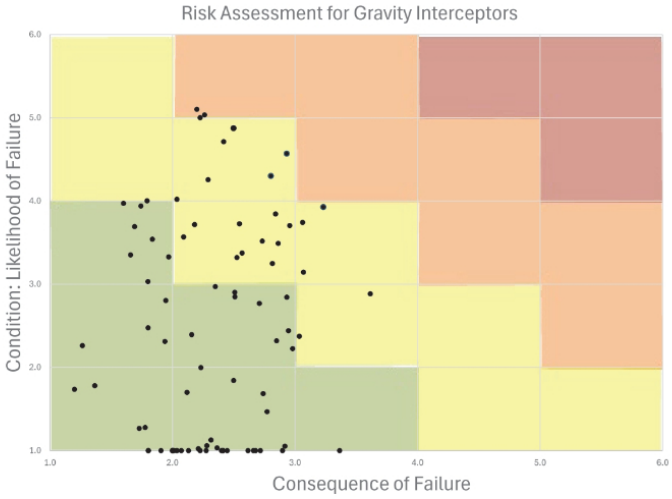
- Training aid to supplement and improve PACP coding for novice inspection personnel or operators who are becoming familiar with code classification for pipe types for which they do not have experience coding.
- Improved workflows whereby an AI algorithm is used as the first inspection, followed by manual operator checks to correct missing or inaccurately coded defects/features.
- Quick coding of legacy inspection video for benchmarking purposes
- Cross-bore identification
- Embedment of NASSCO quality control guidelines for automated quality validation



NASSCO's committees continue to work on determining the best approach for assessing and rating ADR software products and their level of accuracy.

In 2019, Madison Metropolitan Sewerage District (District) learned that the software it used to manage sewer inspection data would no longer be supported. Staff started by identifying issues to develop software requirements. While most of the requirements could be met by many software vendors, the biggest challenge the District identified was inconsistency in condition ratings by staff and contractors, resulting in uncertainty about how to use the scores for project prioritization.

That's when the idea of using AI entered the discussion. ADR provides consistent condition scoring. Certainty in the ability to compare the entire system improves as more segments are inspected using ADR to generate condition ratings.

Implementing AI in sewer inspections wasn't initially well received by all. The first concern raised was whether AI would replace employees. Absolutely not! AI, or in this case, ADR, helps create efficiency and frees up time that can be used more productively. The computer can't score a defect it can't see, so the camera operator still needs to take quality videos and know what to look for. With ADR, the operator doesn't need to pause and type in the series of codes for each defect. Inspections take less time, but it doesn't mean that we don't still need people to do the work. Additionally, all inspections need to be reviewed for quality by staff to correct missing or inaccurately coded defects/features.

For example, a new operator submitted a video with significant fogging, which impeded ADR coding; as such, very few defects were noted because the computer couldn't see them. The reviewer added a comment about the fog and rejected the inspection, and the contractor inspected the pipe again when conditions allowed for the capture of a better-quality video. This mistake was

Table 1. Televising contracts comparison for 2020–2024

YEAR	Defect Coding Method	Bid Televising Length (ft)	Contract Price ($)	Cost ($/ft)
2020	Field Operator	45,936	$98,586	$2.15
2021	Field Operator	50,555	$130,794	$2.59
2022	Automated Defect Recognition	48,823	$165,820	$3.40
2023	Field Operator	57,706	$98,684	$1.71
2024	Automated Defect Recognition	75,587	$134,338	$1.78

caught within two weeks. Previous workflows took months to get through the review process.

Converting the historical data into the new software platform took two years. The District discussed processing the most recent inspection for each pipe through ADR to establish a benchmark for evaluating the entire system. While the District decided not to benchmark all inspections, ADR was used to improve the legacy data. If the most recent inspection for a pipe was missing, that video was submitted to be scored using ADR. Inspections that had been questioned previously were replaced with ADR condition ratings.

In 2022, the District was ready to implement ADR for sewer inspections, but there was concern about whether we would get enough bids by requiring AI. For two years, the contract allowed either method. The low bid in 2022 used ADR, but in 2023, the contractor opted for traditional field defect scoring.

The District was ready to commit to requiring the use of ADR for the 2024 televising and cleaning contract. To address the concern of limiting bidding competition, the District provided a field uploader license for the contractor to use. This eliminates the barrier of a contractor having to purchase multiple software licenses. Videos and inspections were directly uploaded into the District's account and immediately available for review—no more mailing USB sticks or large file transfers. Additionally, contractor administration time was significantly reduced. The owner has assurance in the quality of the videos and knows exactly how much work has been completed.

While our program has made many improvements, some of the best improvements are evidenced in the contract pricing and total lineal feet inspected over the past five years (Table 1), when the District transitioned to using AI for sewer inspections. Overall, televised length has increased, yet the total contract price has decreased.

Improving the process was a significant benefit, but using AI in sewer inspections has also helped the District address the primary challenge it identified: inconsistency in condition ratings and uncertainty in the scores for project prioritization. With improved consistency and confidence in the data, the District compiled the condition ratings and completed a risk assessment on all gravity sewers (Figures 1 and 2). The next goal is to make the risk assessment a more efficient process to update the evaluation annually. Through this, we can provide more intelligent data for the capital improvements plan to support project prioritization and better chart the future of District projects and capital investments.

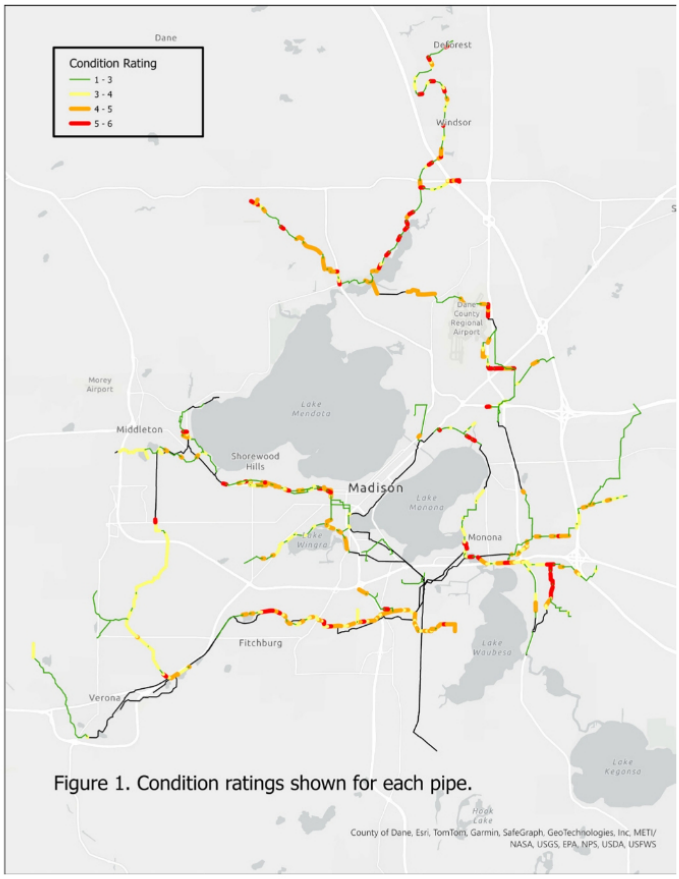


Figure 1. Condition ratings shown for each pipe.

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