kamstrup

NON-REVENUE WATER:

A SMARTER PATH TO MANAGING WATER LOSS

Non-Revenue Water (NRW)

water produced but not billed due to leaks, metering inaccuracies, or theft

Non-Revenue Water (NRW) is a critical challenge for North American utilities. In the U.S., the EPA estimates household leaks waste over 10,000 gallons annually per household, driving significant NRW. These losses drain utility budgets, strain water resources, and complicate operations

Kamstrup, with over 30 years of ultrasonic metering expertise, offers innovative solutions to combat NRW

Our smart meters, equipped with ultra-low flow accuracy and Acoustic Leak Detection (ALD), combined with advanced analytics, reduce water loss, promote sustainability, and enhance revenue.

This e-book explores the critical role of NRW in effective water management, highlighting that NRW encompasses both Apparent Loss and Real Loss, as defined by the American Water Works Association (AWWA). Through U.S. case studies, videos, and links, the e-book showcases Kamstrup's transformative impact while examining innovative strategies to reduce water loss and improve utility operations.

Water Loss: Why it Matters

TOTAL Water Supplied	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Non-Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	**Unbilled** Metered Consumption	
			Unbilled Unmetered Consumption	
	Water Loss	Apparent Losses	**Inaccurate** or Old Meters	
			Unauthorized Consumption (Theft)	
		Real Losses	**Leaks** on Distribution Water Mains	
			Leaks on Service Connections	

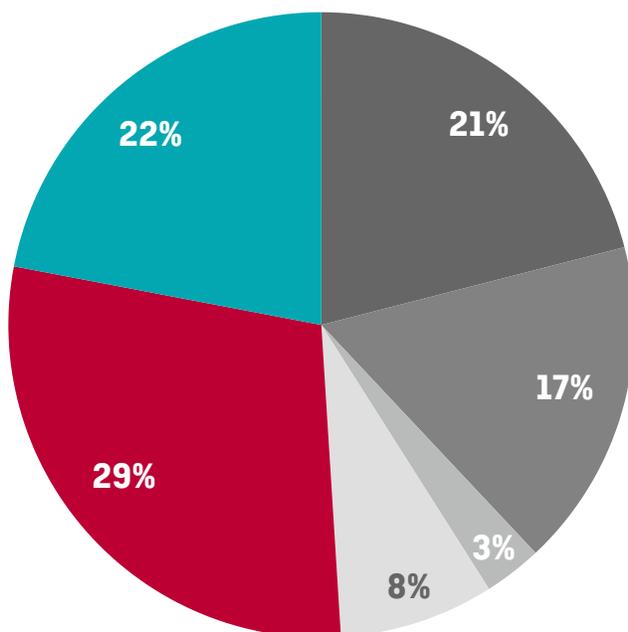### New Mechanical Water Meters
start registering consumption at

1/8th – 1/4th GPM

Kamstrup Ultrasonic Water Meters
start registering consumption at

1/125th GPM

Lowest accurate starting flow rate in the industry (0.008 GPM)

Distribution Non-Revenue Water

- ● Other: Includes Unbilled Metered Consumption & Storage Loss
- ● Unbilled Unmetered Consumption
- ● Unauthorized Consumption [Theft]
- ● Inaccurate or Old Meters
- ● **Leaks** on Distribution Water Mains
- ● **Leaks** on Service Connections

Based on an independent survey of 30+ US water utilities

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APPARENT LOSSES

## Apparent losses occur when delivered water isn't accurately measured or billed.

They are often due to metering inaccuracies, manual reading errors, or theft.

These losses erode revenue and obscure consumption patterns, creating chronic issues for utilities. Addressing apparent losses through precise metering and data management is a crucial first step in comprehensive NRW reduction. Discover how Kamstrup ultrasonic smart meters tackle apparent losses with ultra-low flow accuracy and near real-time Advanced Metering Infrastructure (AMI) data.
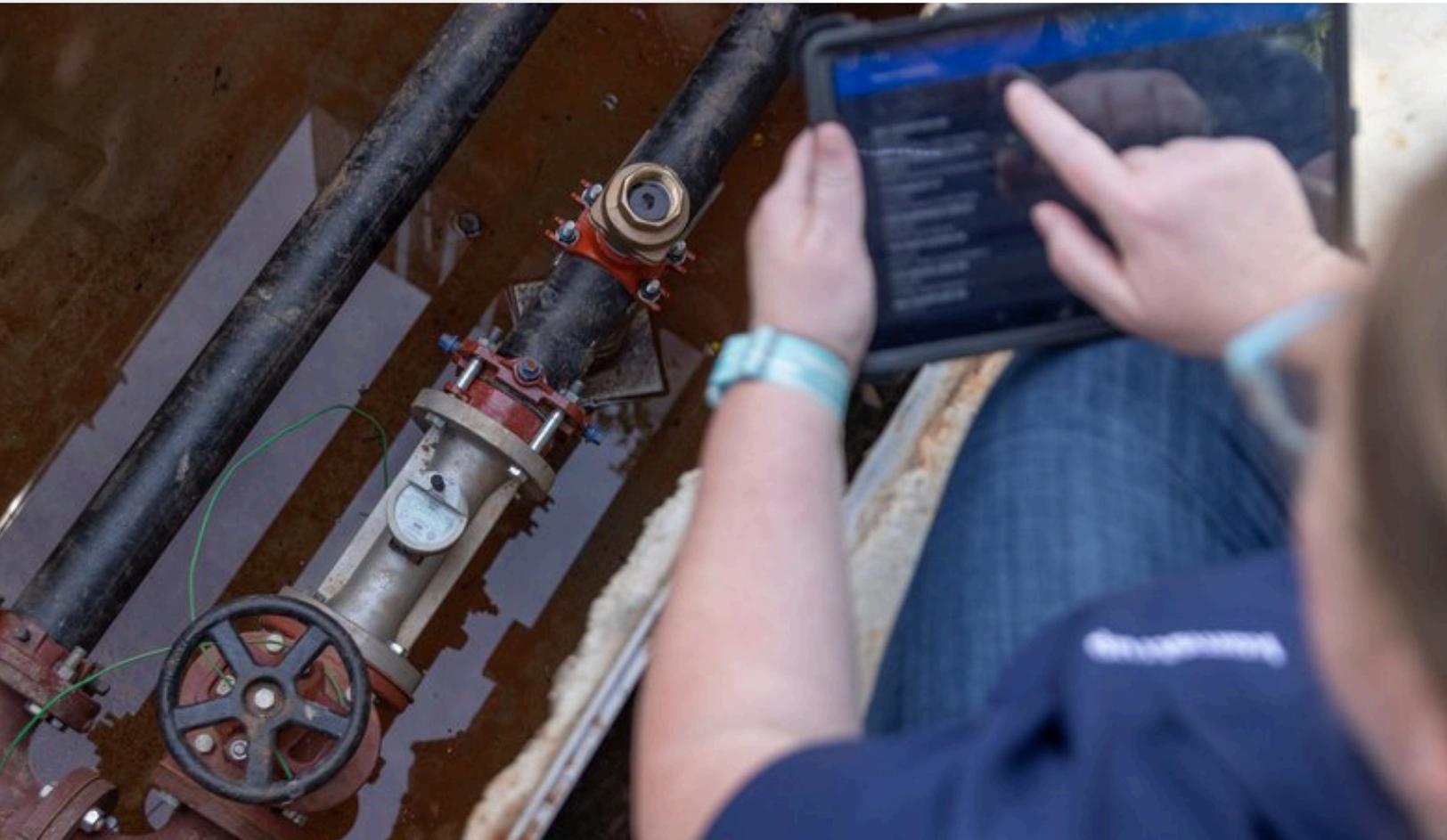
The Hidden Value of Low Flow

Revolutionizing Smart Water Management

Kamstrup, a leader in ultrasonic water metering solutions, has conducted an eye-opening study that reveals the surprising significance of low flow measurements. Based on a random sampling of 1,088 meters across five customers, with an average installation time of 575 days (approximately 1.5 years), the results are compelling:

- The average water usage across these meters is **180 gallons per day.**
- More than **6 gallons per day** were measured at **flow rates below 1/10 of a gallon**.
- This low flow usage represents about **3% of daily consumption.**

3% These findings suggest that utilities could **increase their billing consumption by 3%** by accurately measuring low flow rates. The implications are profound, especially when scaled up to the level of an entire utility.

2,190,000

Gallons of Unbilled Water Each Year

6 GPD   x   365   =   2,190 G
Low Flow   Days   Per Customer Annually

2,190 G   x   1,000   =   2,190,000 G
Per Customer Annually   Customer Accounts   **Unbilled Water Each Year**

Consider a small utility with 1,000 customer accounts:

- 6 GPD of low flow multiplied by 365 days equals 2,190 gallons per customer annually.
- This amounts to 2,190,000 gallons of unbilled water each year.
- This volume is equivalent to about 4.5 Olympic swimming pools.

The environmental impact is equally significant:

The energy required to annually treat and distribute this water is approximately

3,285 kWh

This wasted energy could **power an average household** for roughly 1/3 of a year.

The carbon footprint is about **0.33 metric tons per year**, approaching the emissions from a month of driving a car.

$28,791,004
Loss in Potential Annual Revenue

To illustrate the potential financial impact, let's examine a large city, roughly the size of Los Angeles: With 681,000 water customers (assuming 95% are residential), we're looking at 646,950 customers.

646,950	=	$78,879.47
Residential Customers		Uncaptured Low Flow Per Day

$78,879.47	x	365	=	$28,791,004
Uncaptured Low Flow Per Day		Days		Loss in Potential Annual Revenue

- Assuming water and sewage rates of $15.20 per 748 gallons, the **uncaptured low flow** represents $78,879.47 per day in lost revenue.
- Annually, this amounts to a staggering **$28,791,004 in potential lost revenue.**

These figures underscore the critical importance of accurate low flow measurement in modern water management. The ability to capture this data not only represents a significant revenue opportunity but also aligns with broader sustainability goals:

Financial Impact
Recouping nearly **$29 million** annually could fund **substantial improvements in infrastructure**, customer service, or conservation programs.

Energy Savings
By reducing water waste, **utilities can significantly decrease the energy** required for treatment and distribution.

Water Conservation
Accurately measuring low flow helps **identify leaks and inefficiencies**, supporting targeted conservation efforts.

Environmental Stewardship
Lower energy consumption translates to a reduced carbon footprint, aligning **water management with climate action goals.**

Customer Engagement
Precise usage data, including low flow information, empowers customers to better understand and manage their consumption.

Infrastructure Planning
Comprehensive flow data informs more accurate capacity planning and infrastructure investments.

The impact of measuring low flow extends beyond mere numbers.

It represents a fundamental shift in how utilities approach water management.
By leveraging advanced metering technology capable of accurately measuring all flow rates, utilities can:

Detect and address leaks more quickly, preventing water loss and property damage.

Implement more effective water conservation strategies based on comprehensive usage data.

Improve operational efficiency through a better understanding of system-wide water flow patterns.

Enhance customer service by providing more accurate and detailed consumption information.

As water scarcity becomes an increasingly pressing global issue, the ability to account for every drop of water becomes paramount. Kamstrup's focus on low flow detection highlights a critical area where utilities can make significant strides in water management and conservation.

T**he message is clear: low flow is not inconsequential.** It can have a significant impact, especially on residential water meters. As utilities continue their water journey, embracing advanced metering technology capable of accurately measuring low flow will be vital to unlocking new levels of efficiency, sustainability, and financial performance. The future of smart water management lies in the details, and those utilities that recognize the value of every drop will be best positioned to lead the industry into a more sustainable future.

An AMI Water Solution that Paid for Itself

Location: Tennessee **Start Date:** 2018
MPs: 15,000+ **Solution:** AMI/ALD

Milcrofton Utility District in Franklin, Tennessee, faced 22% water loss in 2017 due to aging mechanical meters and high purchased water costs. Kamstrup's AMI system with flowIQ® 2200 meters increased revenue by $1.6 million in three years via low-flow accuracy, reduced water loss to 17.46%, cut operating expenses by 7%, and enabled 24-hour leak notifications.

Revenue Increase

$1.6M

Reduced Water Loss To

17.46%

Watch Milcrofton's Transformation

Case Study: Milcrofton, TN

"

Our guys had basically lost faith in the meters we had."

Mike Jones
General Manager, Milcrofton Utility District

Real losses refer to physical water lost through leaks, bursts, or surges.

They account for 51% of NRW, with 50% occurring at service connections, often on private property.

Kamstrup's Acoustic Leak Detection (ALD) technology, built into our ultrasonic meters, provides continuous, cost-effective leak monitoring.

Beyond Smart Meters

Engineering a 20-Year Total Water Loss Solution

By Graham Mattison, Solution Manager

In the early 2010s, as water utilities adopted AMI technology, expectations ran high. Inspired by the rapid progress of smart electric meters, the industry anticipated similar breakthroughs. Water utilities asked, **"What else could we do with this network?"**

Unlike electric meters, water meters must run on battery power, limiting communication frequency and onboard data collection. Traditional mechanical meters had one job—to measure consumption—and one sensor to do it. Making water meters "smarter" meant adding sensors and capabilities, but every addition came at a cost: reduced battery life, compromised reliability, and a shorter meter lifespan.

Still, the promise of smart water meters was compelling: faster, more accurate billing, customer transparency, and quicker leak detection. In theory, this would free up utility staff for field work like leak repairs. But as manufacturers raced to add more features — from pressure and temperature sensors to integral shut-off valves — they often traded meter longevity and accuracy for limited incremental value.

In many cases, these added sensors didn't justify their power draw or costs. For example, in-meter pressure sensors were designed to validate pressure models once, not for ongoing monitoring. And because these components share the meter's power source, they drain batteries faster and are often warranted separately, reducing overall reliability.

Utilities need meters they can depend on for 20 years. However, they also need tools to manage water loss, particularly the **51% of non-revenue water attributed to leakage.** While several standalone solutions exist, such as acoustic noise loggers, they are costly, power-intensive, and not truly fixed-base when deployed in limited numbers.

Enter Built-In Acoustic Leak Detection

In 2020, Kamstrup engineers introduced a solution that leverages our meters' existing ultrasonic technology to detect leaks without sacrificing accuracy, battery life, or performance.

Using the same ultrasonic sensor that measures flow to detect acoustic signals from leak noise, Kamstrup meters can serve a dual purpose: accurate consumption metering and continuous leak detection.

This technology, known as Acoustic Leak Detection (ALD), is built into every Kamstrup flowIQ® 2200 and 3200 meter (2" and below). It enables utilities to monitor for leaks at every service connection, where 50% of distribution system leaks occur. These leaks generate sound energy (a hiss or whoosh), which the meter's ultrasonic sensor can detect without impacting flow measurement.

Unlike traditional acoustic loggers that listen briefly each night, ALD listens throughout the day and flags when background noise levels stay elevated. This provides continuous monitoring with minimal false positives. **ALD takes 26 daily samples and stores the lowest value to establish a noise floor**. When that floor rises and doesn't return to normal, it's indicative of a leak, even in the noisiest environments.
This approach enables utilities to detect leaks earlier and investigate faster. The density of ALD-equipped meters (spaced every 50 to 100 feet) eliminates the need for remote audio correlation and speeds up fieldwork. Utility crews can use ground microphones to pinpoint leaks without walking off distances or downloading audio files — a process that limits battery life in standalone loggers.

Because ALD is integrated into every meter, utilities get ten times the sensor coverage per mile compared to traditional leak detection solutions, with no extra hardware or setup required.

10x Sensor Coverage
Per Mile with No Extra Hardware Setup
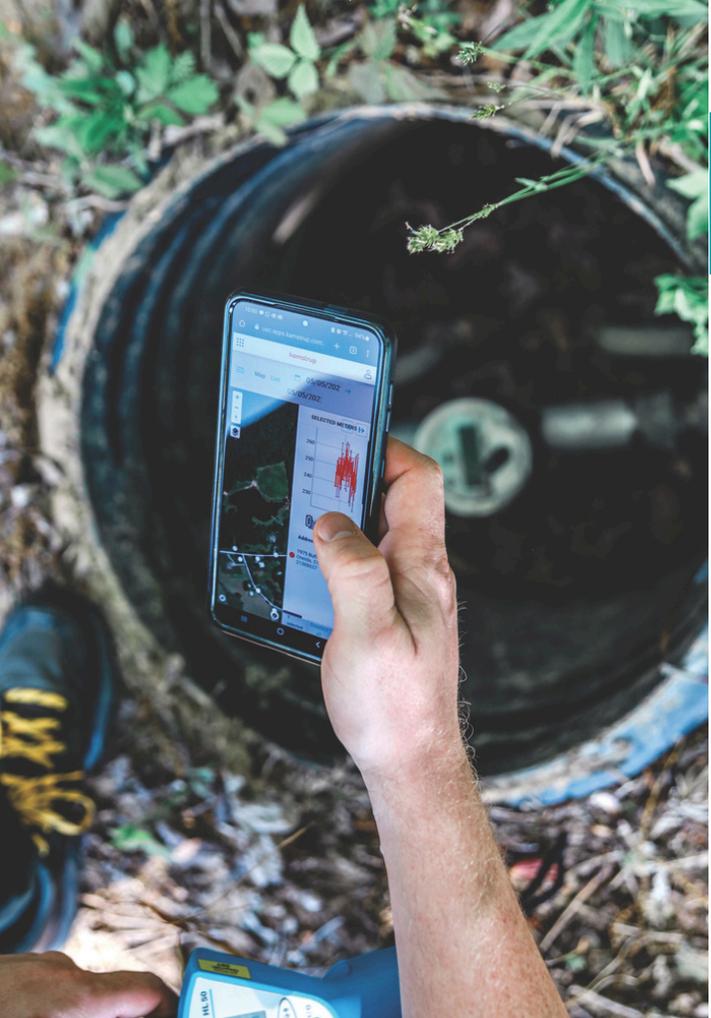
Smarter Software, Better Decisions

Back at the utility, ALD data is displayed in user-friendly software. Meters that exceed a noise threshold are flagged and mapped, helping utilities prioritize inspections. Each meter includes a detailed acoustic noise history, making it easier to determine if a leak is growing or stable. This enables proactive repairs based on actual data rather than waiting for emergencies.

Beyond normal operations, ALD also supports infrastructure resilience. For example, after hydrant flushing, ALD meters can detect damage caused by sudden flow changes. During construction or seasonal events, they can highlight system stress before it results in visible failures. By comparing the noise floor before, during, and after these events, utilities can track changes and intervene early.

ALD in Action: Real Results

In 2019, Oneida, Tennessee, faced a daunting challenge: 51% water loss. Producing 400 million gallons annually, the town was losing over 200 million gallons a year to leaks. The cost? More than $186,000 in lost revenue and a treatment plant running up to 16 hours daily.

To address the issue, Oneida replaced 4,620 mechanical meters with Kamstrup ALD meters across its 118-square-mile service area. When activated, 77 meters immediately flagged potential leaks, many previously hidden by inaccurate consumption data. Oneida then launched a leak recovery program using the ALD data, identifying and repairing more than 70 active leaks.

In just 3 months, water loss dropped to 28%. Of that reduction, 10.7% occurred as a result of meter change out, while the remainder was a direct result of finding and repairing leaks. One notable case: a minor leak, initially low-priority, escalated. When crews investigated, they found a service line leak 50 feet from the meter that had run undetected for at least 135 days, losing over 777,000 gallons and costing the utility $21,000 annually. Post-repair data confirmed the fix.

$186K
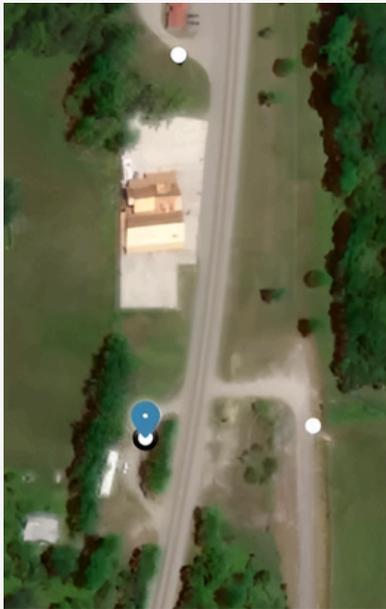Lost in Revenue

77 Meters
Flagged for Leaks

10.7%
Immediate Reduction after Installation

Today, Oneida's water loss is down to 15%, saving $140,000 in lost revenue and reducing treatment plant operation by 3 to 4 hours per day.

Working Days Gained
Utility staff also gained 36 working days annually to reinvest in system improvements.

Other utilities across the U.S. are seeing similar results. In Oregon, ALD identified a 180 GPM leak in a 6" AC main line and later detected a second minor leak at the same location. In Good Thunder, Minnesota, ALD meters in drive-by mode detected a non-surfacing leak draining into a sewer line. This allowed a timely repair before the ground froze, **cutting repair costs by 30% and avoiding customer service interruptions.**

A Simpler, Smarter Solution

Kamstrup is proud to be the first meter manufacturer to offer integrated ALD technology at scale. With a 20-year battery life, unmatched accuracy, and built-in leak detection, our ultrasonic meters deliver more value without complexity. Utilities don't just need more sensors—they need the right tools, designed to solve real-world problems.

With Kamstrup's ALD solution, utilities can take control of their distribution systems, recover lost water, and build a smarter, more sustainable future.
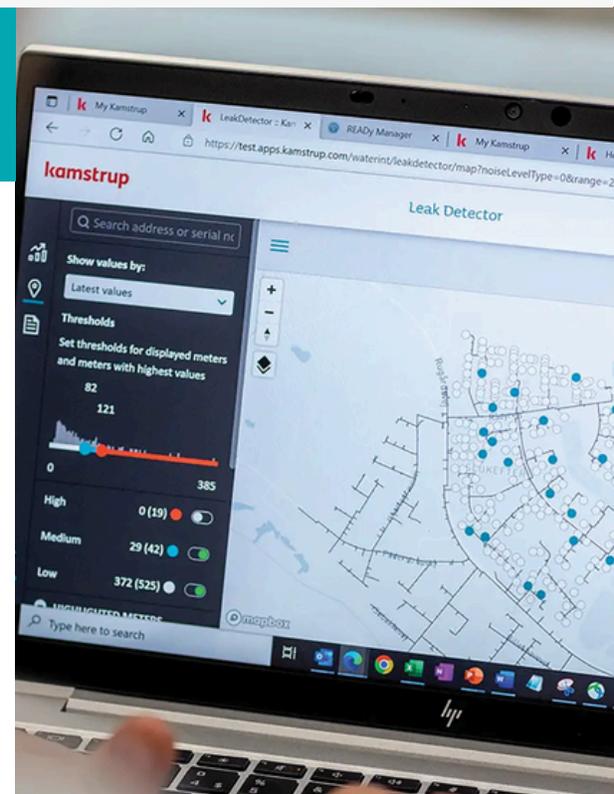
Kamstrup's Breakthrough: ALD

ALD integrates leak detection into the flowIQ® 2200, using the same ultrasonic sensor for flow measurement to detect leak noise, ensuring no compromise on battery life or accuracy.

Key features include:

Continuous Monitoring: 26 daily samples, 24/7, reducing false positives.

High Sensor Density: Meters 50–100 feet apart offer 10x coverage of loggers.

Advanced Analytics: Flags persistent noise (e.g., hiss/whoosh) via baseline noise floor.

User-Friendly Software: Maps flagged meters and provides noise histories.

System Resilience: Detects stress post-hydrant flushing or construction.
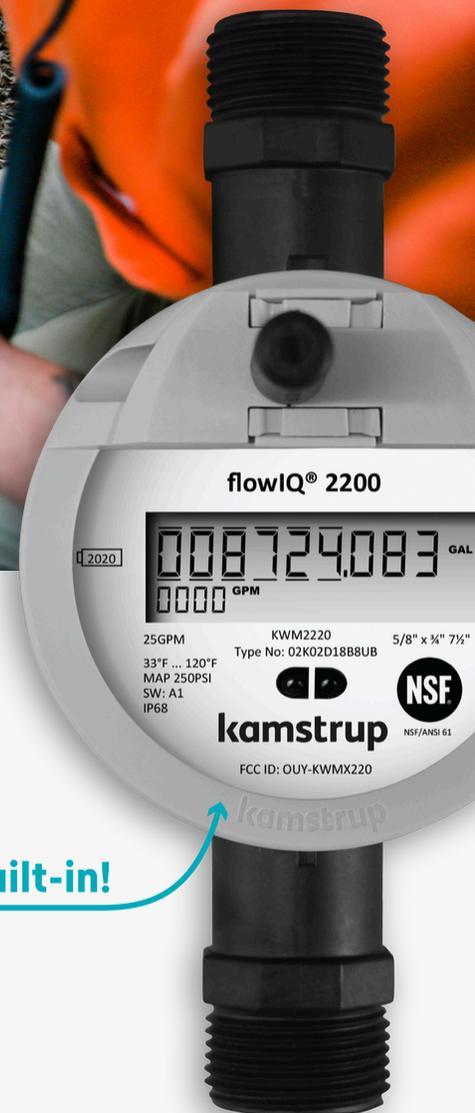
The flowIQ® 2200 maintains a 20-year battery life, combining flow measurement and leak detection in one device.

Benefits of ALD

- **Early Detection:** Identifies leaks before they surface.
- **Cost Efficiency:** Eliminates separate loggers.
- **Scalability:** Monitors service lines to mains.
- **Sustainability:** Reduces water/energy waste.
- **Operational Insight:** Supports infrastructure planning.

ALD redefines smart metering, addressing 51% of NRW through continuous monitoring.

It's all built-in!

flowIQ® 2200
008724.083 GAL
0000 GPM
2020
25GPM
33°F ... 120°F
MAP 250PSI
SW: A1
IP68
KWM2220
Type No: 02K02D18B8UB
5/8" x ¾" 7½"
kamstrup
NSF
NSF/ANSI 61
FCC ID: OUY-KWMX220

Reversing Water Loss in a Rural Municipality

Location: Tennessee **Start Date:** 2019
MPs: 5,000+ **Solution:** AMI/ALD

In 2019, Oneida, Tennessee, faced 51% water loss, costing $186,000 annually. Deploying 4,620 flowIQ® 2200 ALD meters, Oneida reduced loss to 28% in three months and 15% today, saving $140,000 in lost revenue yearly and cutting treatment plant operations by 3 to 4 hours daily. ALD detected over 70 leaks, including a 4 GPM PVC leak costing $21,000 annually.

Annual Savings
$140K

Water Loss Reduced From
51% → 15%

Watch Oneida's Transformation

Case Study: Oneida, TN

> **We were in trouble. We didn't know what to do. We didn't know what to buy."**

Jack Lay
Mayor of Oneida, Tennessee

Leak Diaries

Kamstrup's ALD technology doesn't just find leaks—it redefines how utilities tackle real losses

The following Leak Diaries showcase ALD's versatility across diverse scenarios in rural and urban settings, from small service line leaks to major main line issues. Each entry highlights how ALD's continuous monitoring and high sensitivity detect hidden or distant leaks, saving water, costs, and resources.
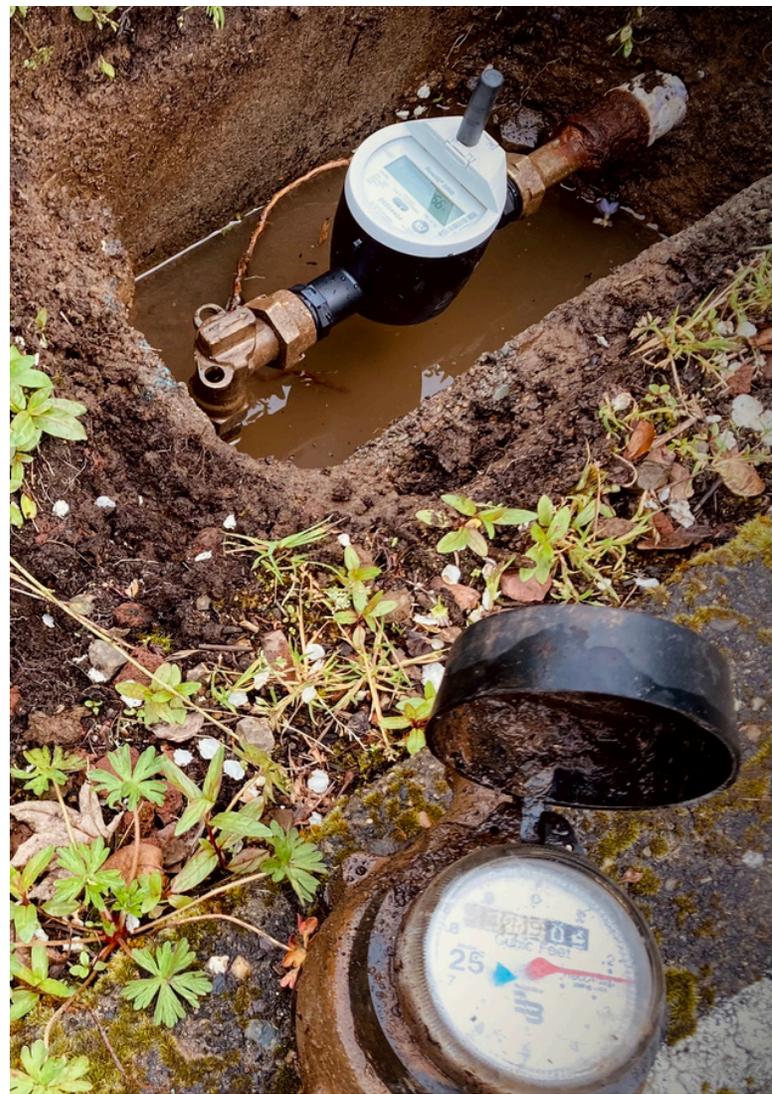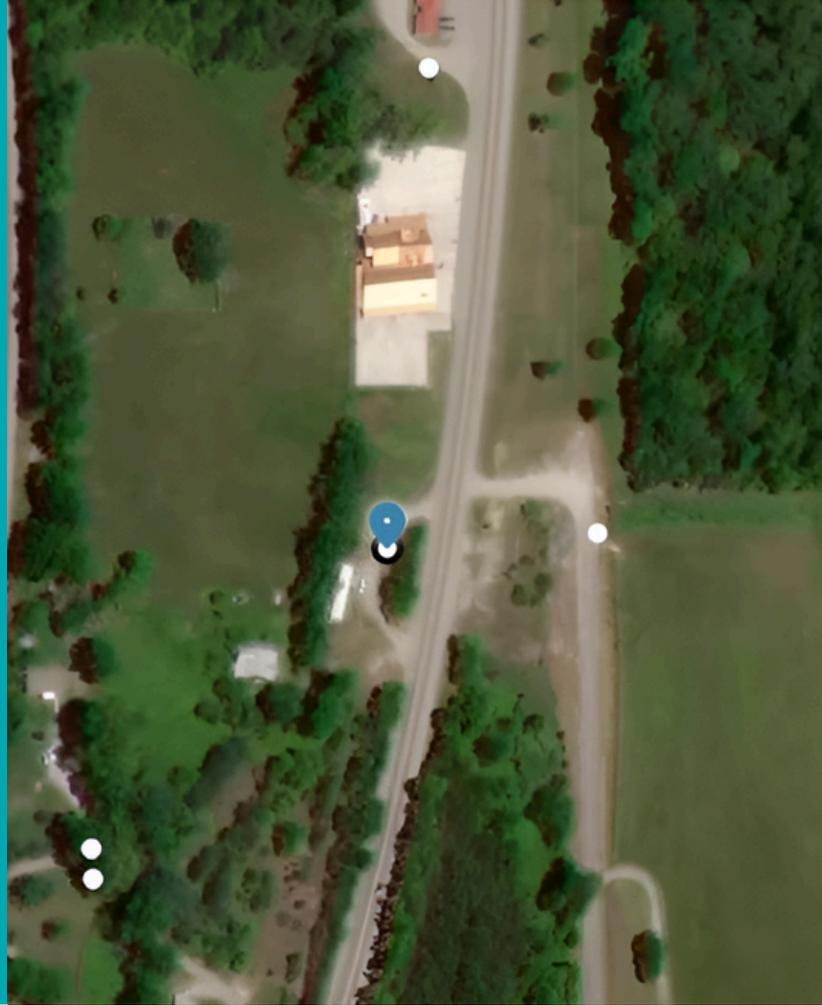
Oneida, TN

Single Meter Detects Leak on Poly Line

Read Oneida's Success Story
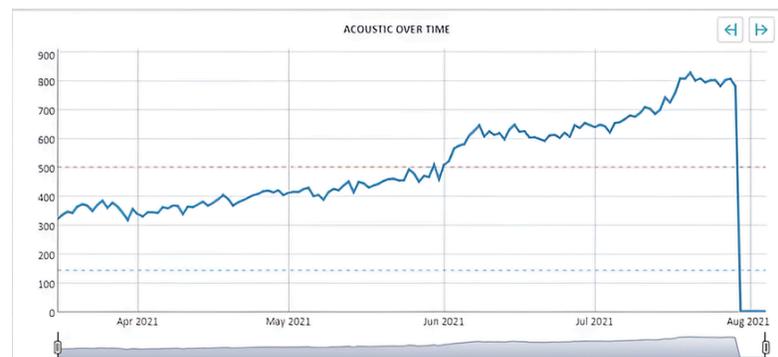
➕ Learn More

Details

A flowIQ® 2200 detected a utility-side leak, located 50 feet upstream from the meter on a polyethylene service line. At 4 GPM, this leak was losing 111,600 gallons daily, costing $21,000 annually.

Impact

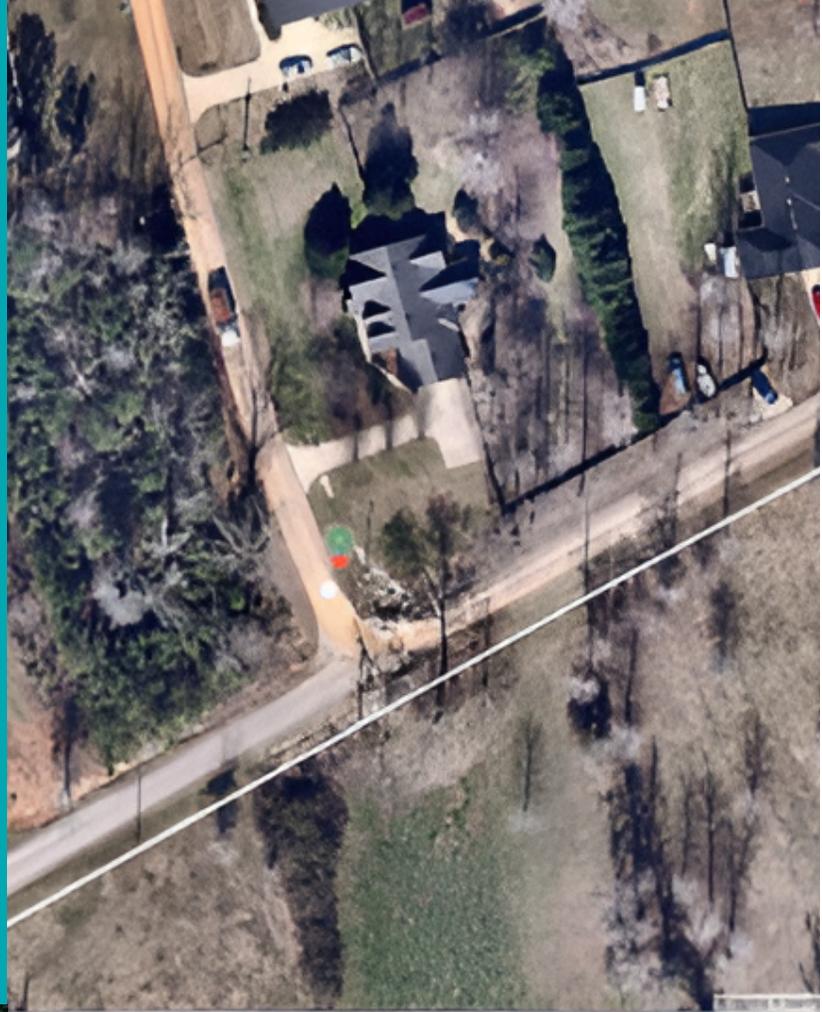ALD's sensitivity enables early leak detection, even on plastic pipe.

ACOUSTIC OVER TIME

📍 **Madison County, AL**

Non-Surfacing Leak Detected

Read Madison County's Success Story

➕ Learn More

Details

In 2023, Madison County Water Department found a 5 GPM polyethylene service line leak, 6 feet from a flowIQ® 2200 meter, which had been running for two months, losing 432,000 gallons. Absorbed by a nearby creek, it never surfaced, but ALD's continuous monitoring prevented 2.6 million gallons of annual loss.
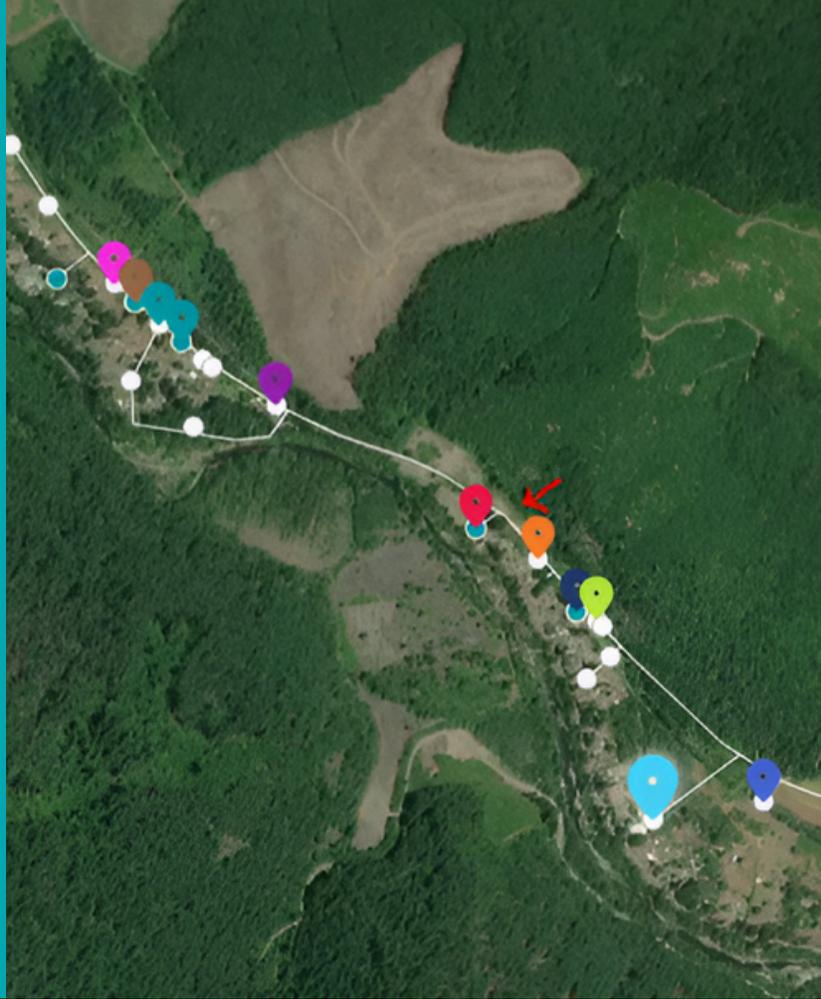
Impact

ALD excels at detecting hidden leaks and enhancing efficiency.

📍 **Row River Valley, OR**

Main Line Leak Heard ½ Mile Away

➕ Learn More

Details

On August 3, 2021, a 30 GPM leak on a 14" main in Dorena, OR, was detected by ALD meters half a mile away. Repairs prevented significant loss.

Impact

Long-range detection scales to network-wide monitoring.

SELECTED METERS

600

400

200

Aug 2021   Sep 2021

03

THE NEXT STEP IS YOURS

Reduce non-revenue water and secure significant savings with Kamstrup's smart metering solutions.

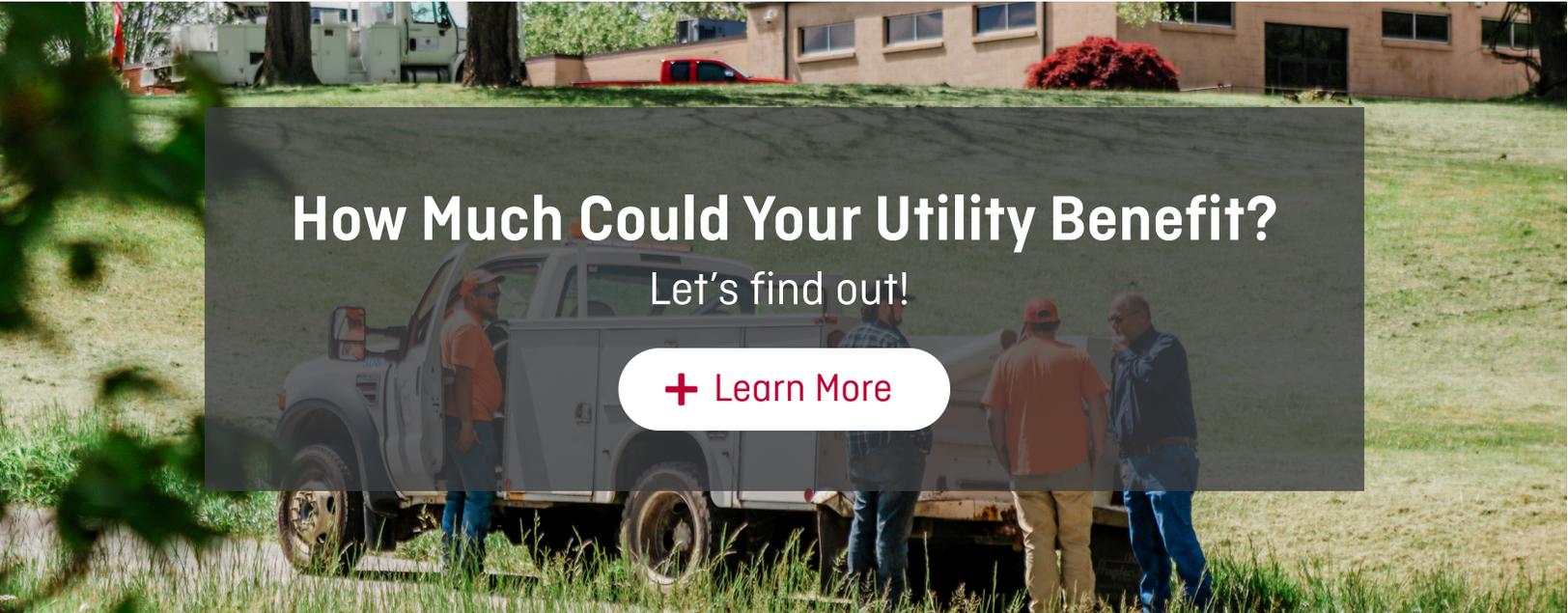## By Capturing Low Flows

Annually, Cities the Size of L.A. Could Save

$1.6M

Milcrofton Boosted Revenue By
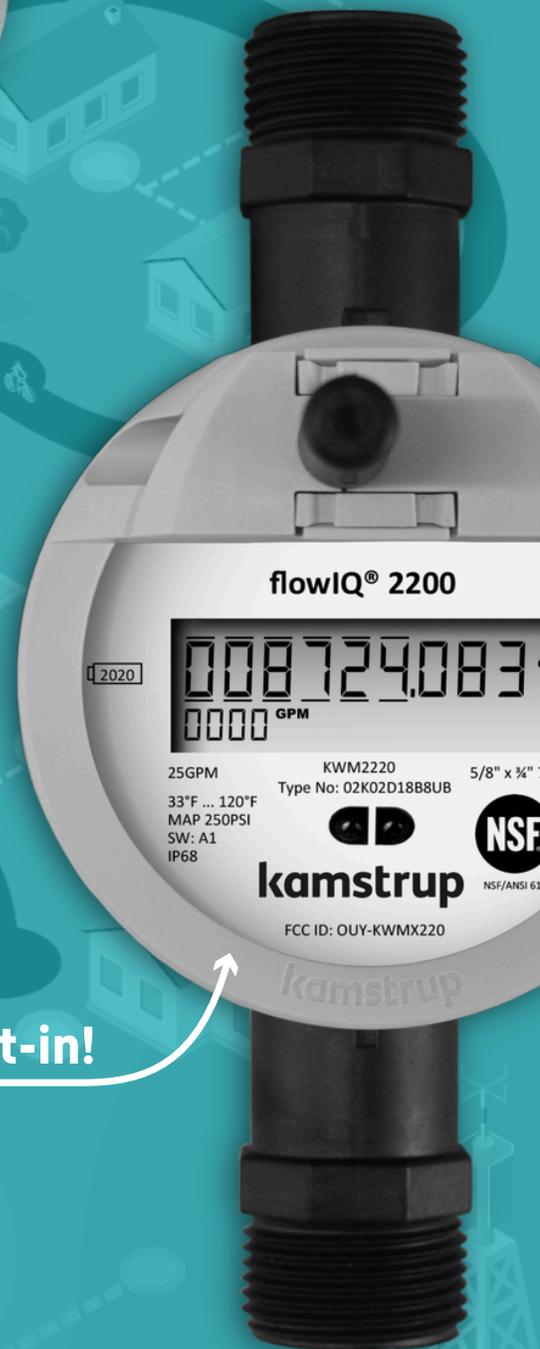
$140K

Oneida Reduced Water Loss By

36%

How Much Could Your Utility Benefit?
Let's find out!

+ Learn More

![kamstrup logo]

flowIQ® 3200

flowIQ® 2200

2020

008724.083

0000 GPM

25GPM   KWM2220   5/8" x ¾"
33°F ... 120°F Type No: 02K02D18B8UB
MAP 250PSI
SW: A1
IP68

kamstrup

NSF

FCC ID: OUY-KWMX220

kamstrup

flowIQ® 4200

0002628.14

It's all built-in!