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Webcast

AMI Meter Data Analytics

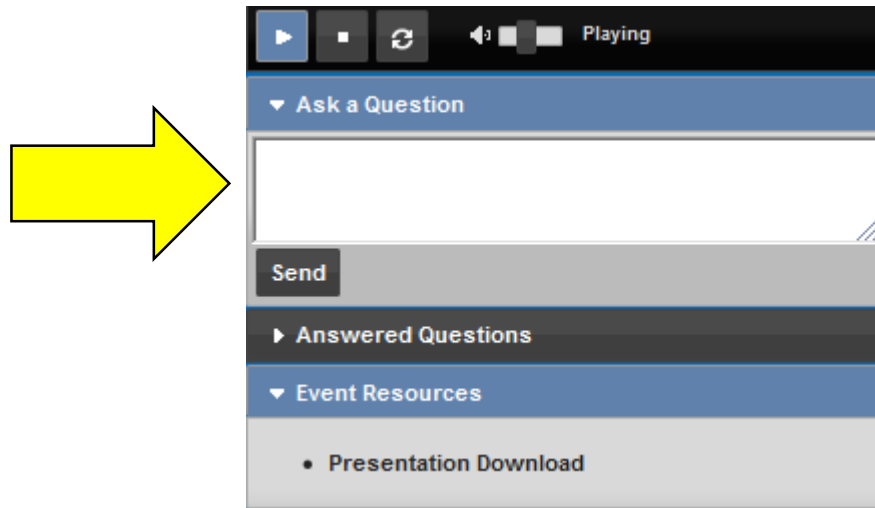
September 29, 2020



Housekeeping Items

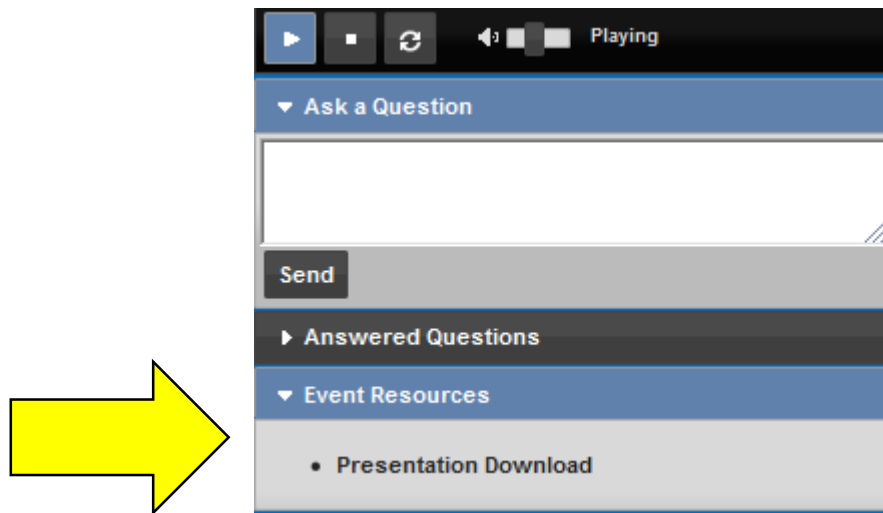
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Project #4741

AMI-Meter Data Analytics

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Date Started
OCT 1, 2017

Principal Investigator
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Research Manager
MS. MARY SMITH

Contractor
EMA, INC.

Related Topics
WATER USE & EFFICIENCY
CUSTOMER RELATIONS &
STAKEHOLDER ENGAGEMENT

Research Investment: \$515,155

Completion Year: 2020

IN PROGRESS

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i-meter-data-analytics



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Journal AWWA: Water and Electric AMI Differences: What Water Utility Leaders Need to Know

PROJECT PAPER 06/25/2018

06/25/2018

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AMI-Meter Data Analytics

SCOPE OF WORK 08/15/2017

08/15/2017



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Terrance M. Brueck, CEO
EMA, Inc.



Webcast Agenda

1. Project Background and Research Approach
2. Utility Participant Practices and Examples
3. Meter Testing and Performance Analysis
4. Leading Practice Examples and Utility Recommendations
5. Additional Research and Use of Results



SECTION 1

Project Background and Research Approach

Project Purpose: Identify Leading Practices for Leveraging AMI* Data

- 1. To improve interactions with utility customers**, including questions on billing, water use alerts, and customer information to enable changes in water use habits.
- 2. To improve processes and accuracy of water accounting** for water audits and gain insights into apparent and real water losses including water theft (by meter tampering).
- 3. To improve meter management practices**, including meter maintenance and replacement strategies based on actual meter performance and accuracy.

*Advanced Metering Infrastructure – meter reading via fixed-network radio, cellular, LoRa, etc., typically two-way communications.

WRF and EMA Project Team

(WRF Project #4741)

Water Research Foundation Project Manager

- Mary Smith

Principal Investigator, EMA

- Terry Brueck

Research Track Leads, EMA

- Jon Varner, AMI Data
- Claude Williams, Meter Performance

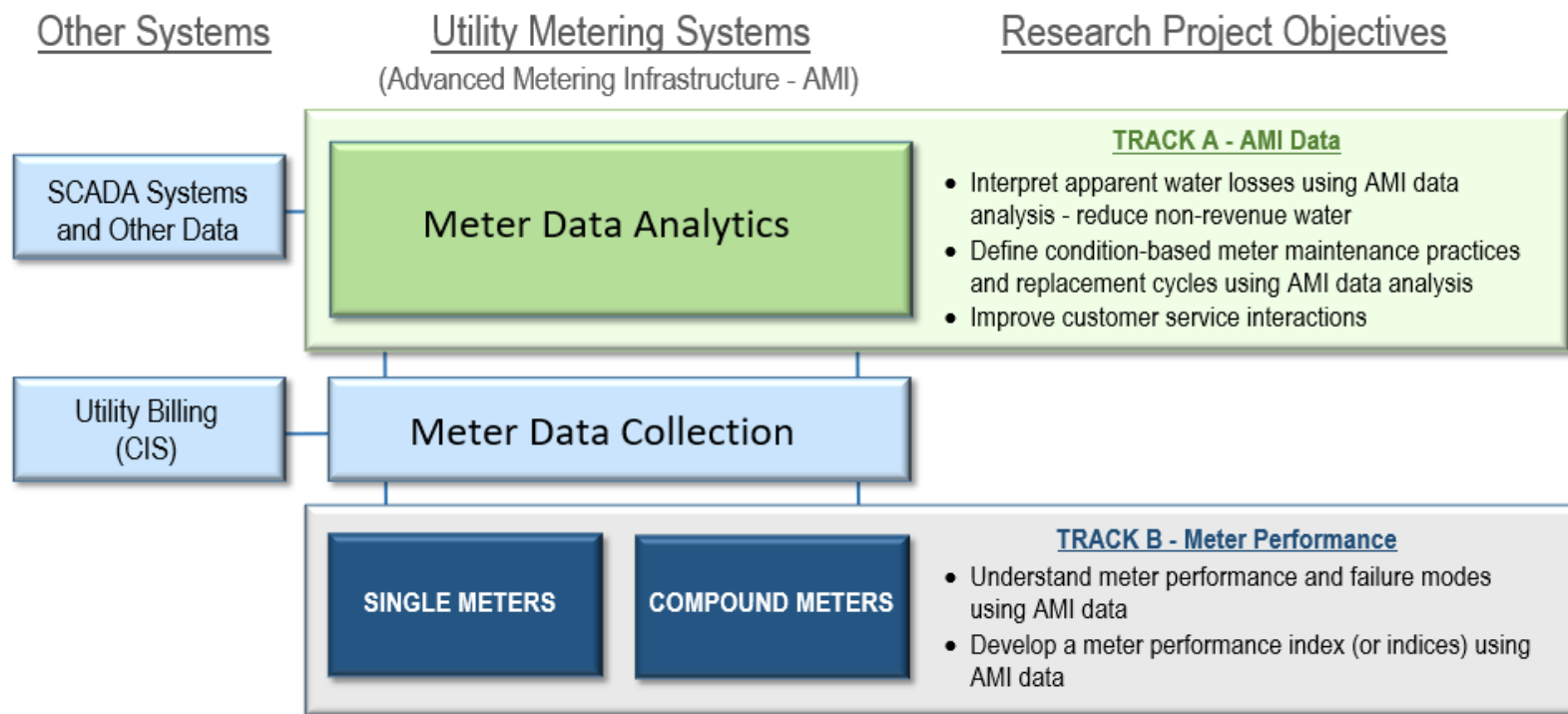
Project Coordinator, EMA

- Penny Brink

Participating Utilities Included Years of AMI Meter Data Use

- Toronto Water (Sponsor)
- DC Water (Co-Sponsor)
- Albuquerque Bernalillo County Water Utility Authority
- City of Baltimore Department of Public Works
- Great Lakes Water Authority
- Suez NJ
- Toho Water Authority
- University of Florida (Program for Resource Efficient Communities – PREC)

Approach and Objectives Were Based on 2 Tracks of Research



Approach Analyzed Existing AMI Data and Metering Practices

- Existing methods and leading practices were defined from utility use of AMI systems/data
- Meter test data was analyzed to correlate with AMI data using routine testing

- Web Conference
- Utility Survey

- Review Survey
- Confirm with Utilities

- Web Conference
- Data Collection

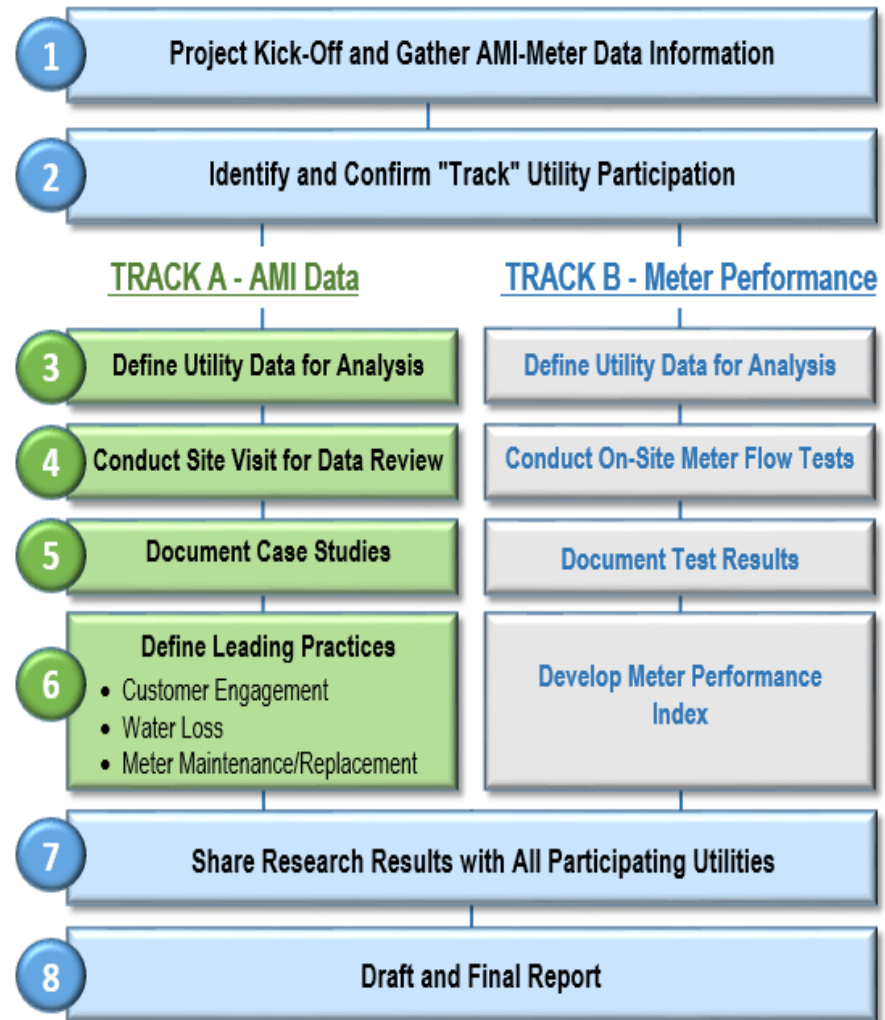
- Utility Visits

- Web Conference Presentation

- Prototype and Validate

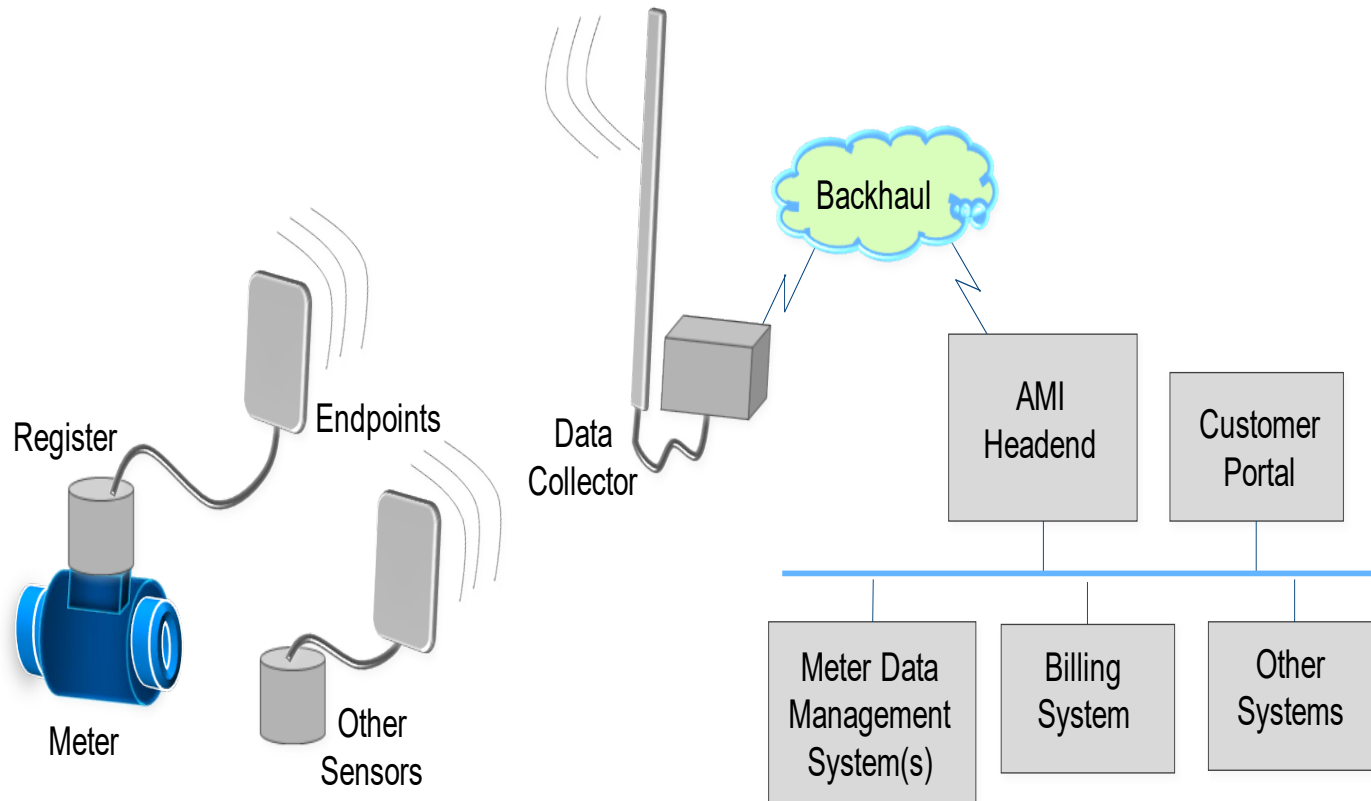
- Two-Day Results Workshop

- Subscriber Webinar

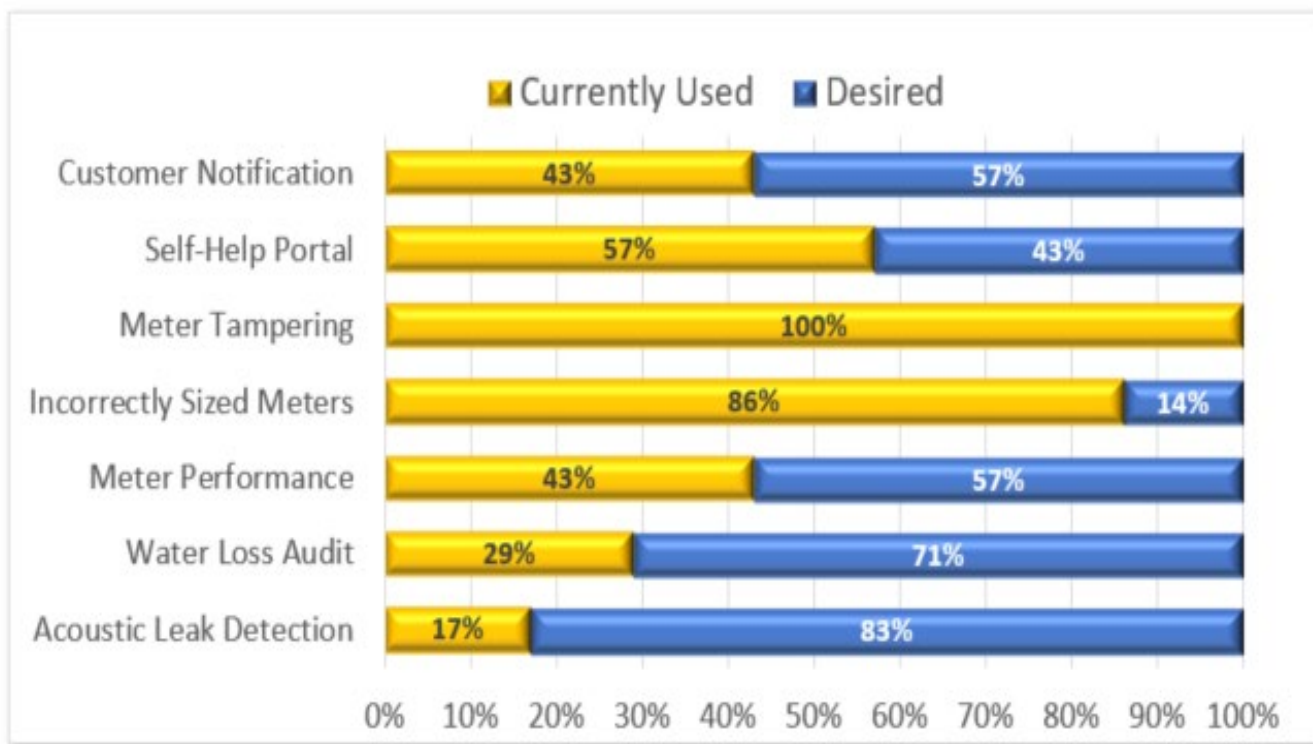


Utility Participants Had Various AMI Technology and Meter Vendors

AMI Meter Data Included Hourly, 4-Hour, and 6-Hour Readings



Utilities Initially Defined “Currently Used” and “Desired” Practices



Customer Notification
Self-Help Portal
Meter Tampering
Incorrectly Sized Meters
Meter Performance
Water Loss Audit
Acoustic Leak Detection

- Notify customer of inside leaks (leaks downstream of their meter) - establish email/text alert notifications
- Implement a self-help portal - show consumption (daily) with comparison to prior usage and/or typical usage
- Identify meter tampering / water theft
- Identify incorrectly sized meters (including large meter mis-applied meter analysis)
- Use AMI data to determine when maintenance is required for a meter based on performance
- Improve Water Loss Audit processes using Daily and Monthly Consumption Quantification
- Acoustic Leak Detection (in distribution system)

Track A Defined Utility Participant Use of AMI Data and Analytics

Surveys and Case Studies included:

1. Customer interactions
2. Water Accounting
3. Meter Management



Track B Analyzed Meter Testing to Correlate with AMI Data

Selected Sizes/Types – Single and Compound

- Gather AMI data: meter readings at the lowest available time frequency
- Gather background data for the meter including meter size, meter type, meter manufacturer, installation date, dates of meter rollover
- Measure meter accuracy on certified test benches following AWWA standard procedures (M6)
- Assess meter condition and test data



SECTION 2

Utility Participant Practices and Examples

Utility Practices Use AMI Data For Customer Interactions



SIGNIFICANT PRACTICE



SOME/LIMITED PRACTICE

Report Section	Topic	Utility						
		Albuquerque Bernalillo County Water Utility Authority	City of Baltimore Department of Public Works	DC Water	Great Lakes Water Authority	Suez NJ	Toho Water Authority	Toronto Water

CUSTOMER INTERACTIONS								
4.4.1	Water Usage Alerts							
4.4.2	Customer Inquiry Support							
4.4.3	On-Site Service Dispatch							
4.4.4	Water Conservation							
4.4.5	Conservation Mandates							
4.4.6	Leak Detection							
4.4.7	Water Usage Information for Customers							
4.4.8	Bill Accuracy							
4.4.9	Reducing High Bill Complaints							

AMI Data and Analytics For Customer Interactions

- Improve response to customer inquiries about water usage and billing
- Proactively notify customer of high consumption / leaks
- Help customers comply with water conservation policies

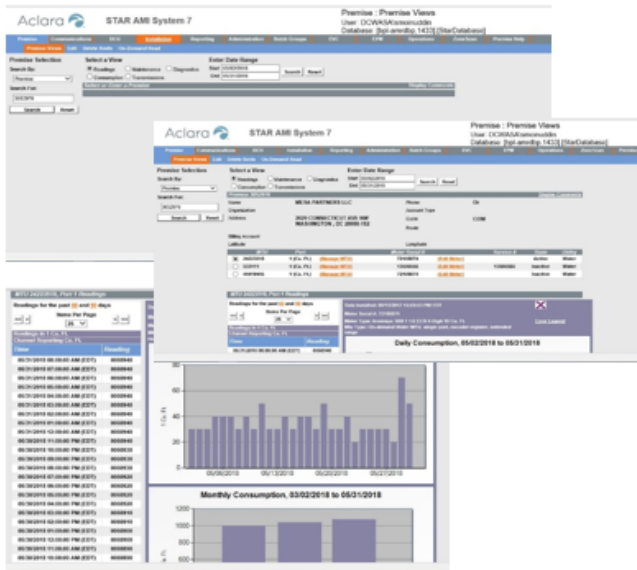
DC Water Leverages Customer Portal System to Notify Customer of High-Usage



HUNA

DC Water's High Usage Notification Application (HUNA) leverages AMI data to enhance the customer experience. Usage can be viewed hourly, daily or month and download detailed read data for offline analysis. Customers can also compare their usage against their neighbors (on the block, zip code or ward) or the entire rate class.

HUNA also analyzes new reads as they are collected against individual customer historical usage patterns and if it detects high usage conditions it will call, text and/or email customers an alert. Customers can set their own usage thresholds and can set up to 4 text, phone and/or email addresses to be notified when usage anomalies are detected. This is especially useful for rental properties when an owner, tenant and/or management company needs to be contacted.



From: Customer Service
Sent: Sunday, December 24, 2017 12:15 PM
To: [Redacted]
Subject: High Usage Detected at your Address - 3415 13th St NW

Dear Valued Customer:

The District of Columbia Water and Sewer Authority (DC Water) implemented an automated meter reading (AMR) system to improve its service delivery to you. DC Water collects daily AMR readings, which helps us monitor and track usage across the entire distribution system. One extended feature of AMR is our ability to trend your usage to help detect potential problems. Few, if any water utilities are doing this today so we are breaking new ground in providing value added services to our customers. Between 12/19/2017 and 12/21/2017, we have observed a significant increase in your daily usage that may be indicative of a problem with your internal plumbing or higher weekend usage. We strongly urge you to check your internal fixtures such as a toilet, sink, or water heater to ensure there are no leaks. You should also check your outside hose bib for leaks. This email message is not meant to alarm you however, leaking fixtures left unchecked can cost consumers hundreds of dollars over the course of a month. If you have any questions please contact our customer service professionals at (202) 394-3600, Monday through Friday from 8:00 AM - 5:00 PM, and they will gladly assist you. Please reference premise number "3029899" (or address - 3415 13th St NW) when calling.

Thank you,
DC Water Customer Service

To stop notifications like this or to change your preferred method of notification, please go to <https://www.dcwater.com/> and login to your account. Click on 'Water Usage History' and then 'AMR Usage History'. You may choose not to receive notifications or choose to be called instead.

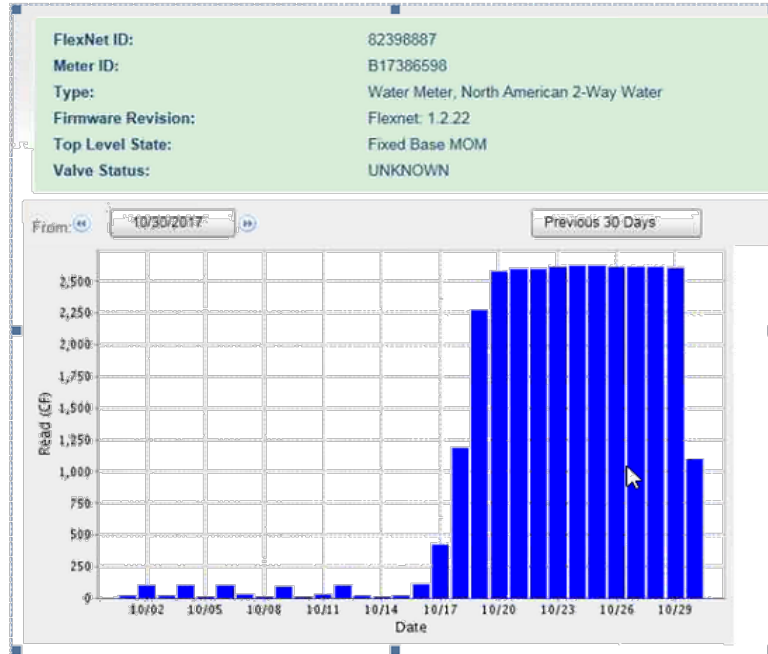


AMI Data Identifies Customer Leaks More Quickly in Albuquerque

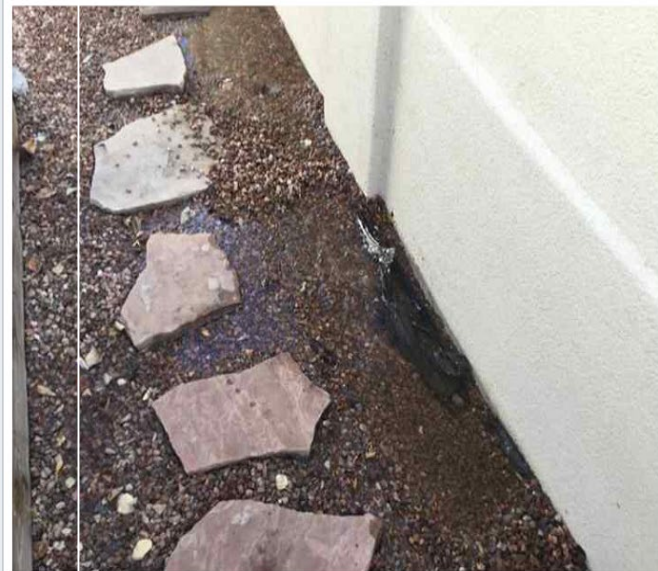
AMI report suggested a
large (continuous) leak

Field workers checked the meter (okay)
then located the leak - irrigation system

Looks like it started around on 10-17-2017



Read is 393 and dials are turning, and programmed correctly. Located leak at irrigation system and made customer contact. Here is a picture of the leak.



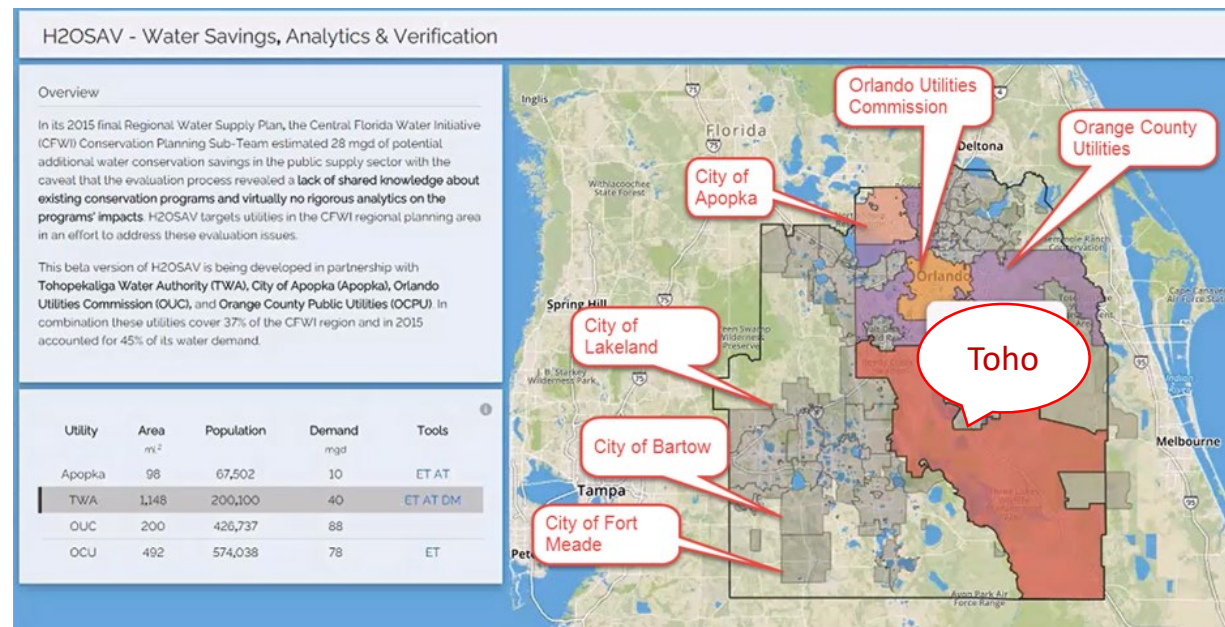
11206 SPYGLASS HILL LN NE

10-17-2017

AMI Data Is Improving Water Conservation in Central Florida

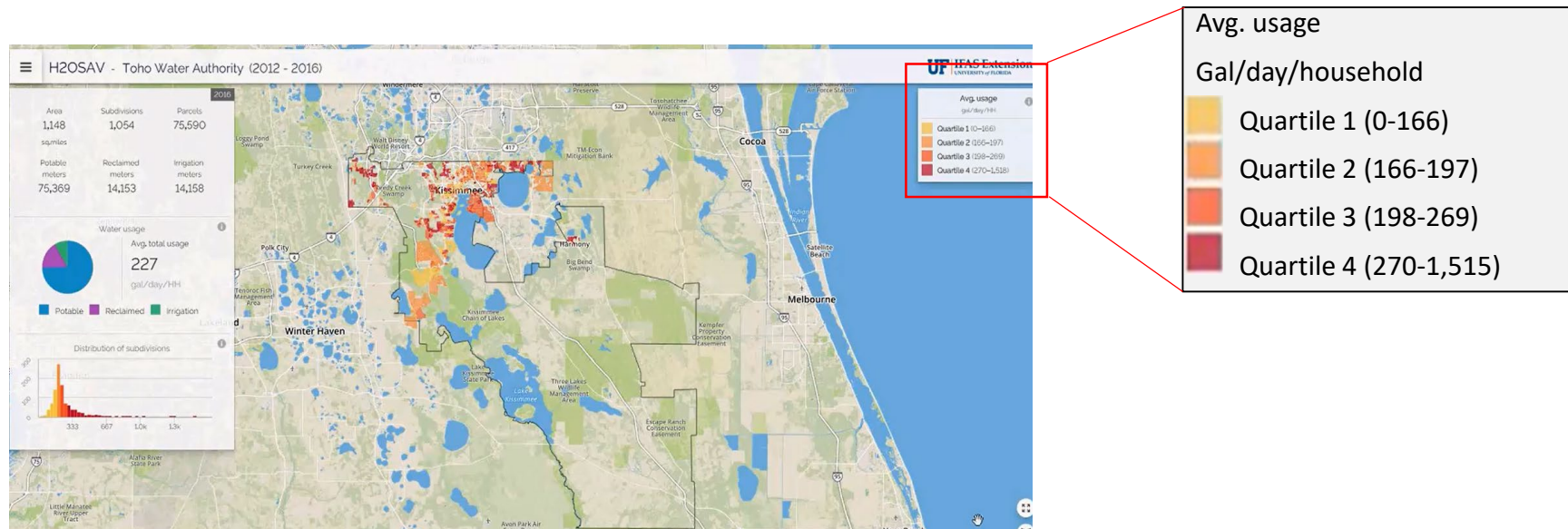
- Planning and modeling assessments indicate that central Florida is facing a water shortage in the near future

Toho Water Authority is working with University of Florida team to develop analytical tools for water conservation



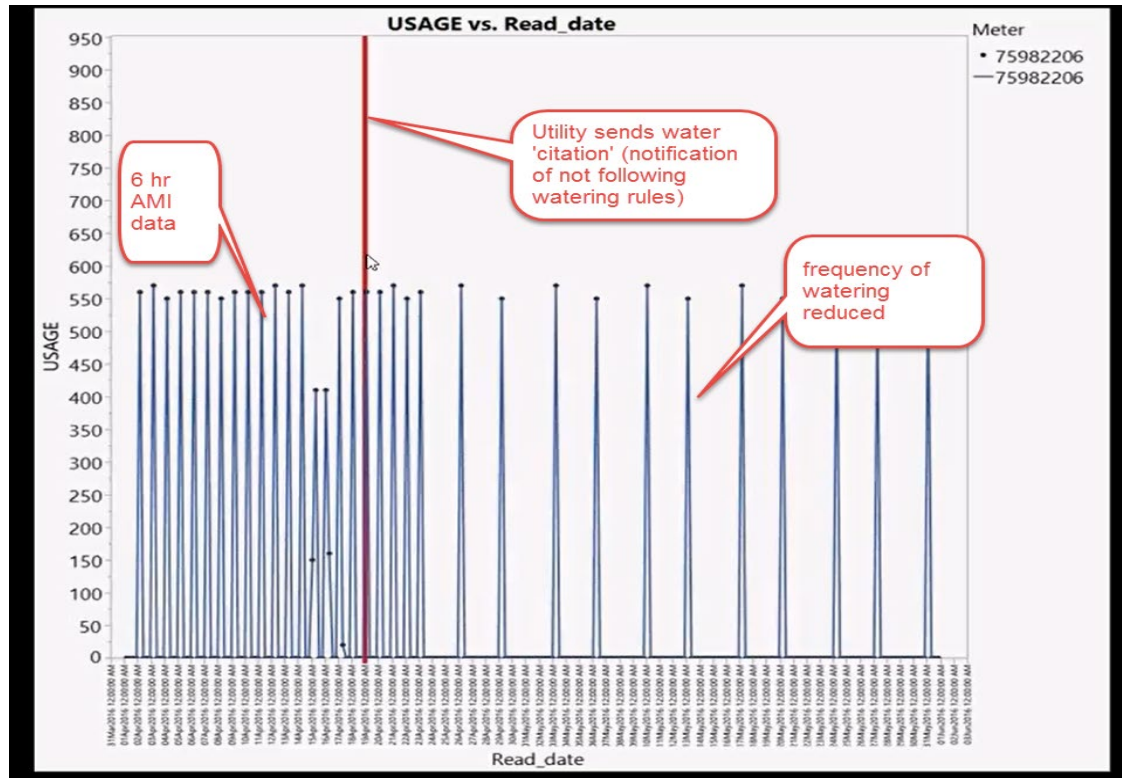
Analytics Using AMI Data Expose the Highest Water Users

- Spatial tools show the customers and subdivisions using the most water.



Citations Trigger Customers to Reprogram Their Irrigation Systems

- Toho issues citations to customers that water more than the mandated 2 days per week
- Utility workers help customers reprogram their irrigation systems



Utility Practices Use AMI Data for Water Accounting



SIGNIFICANT PRACTICE



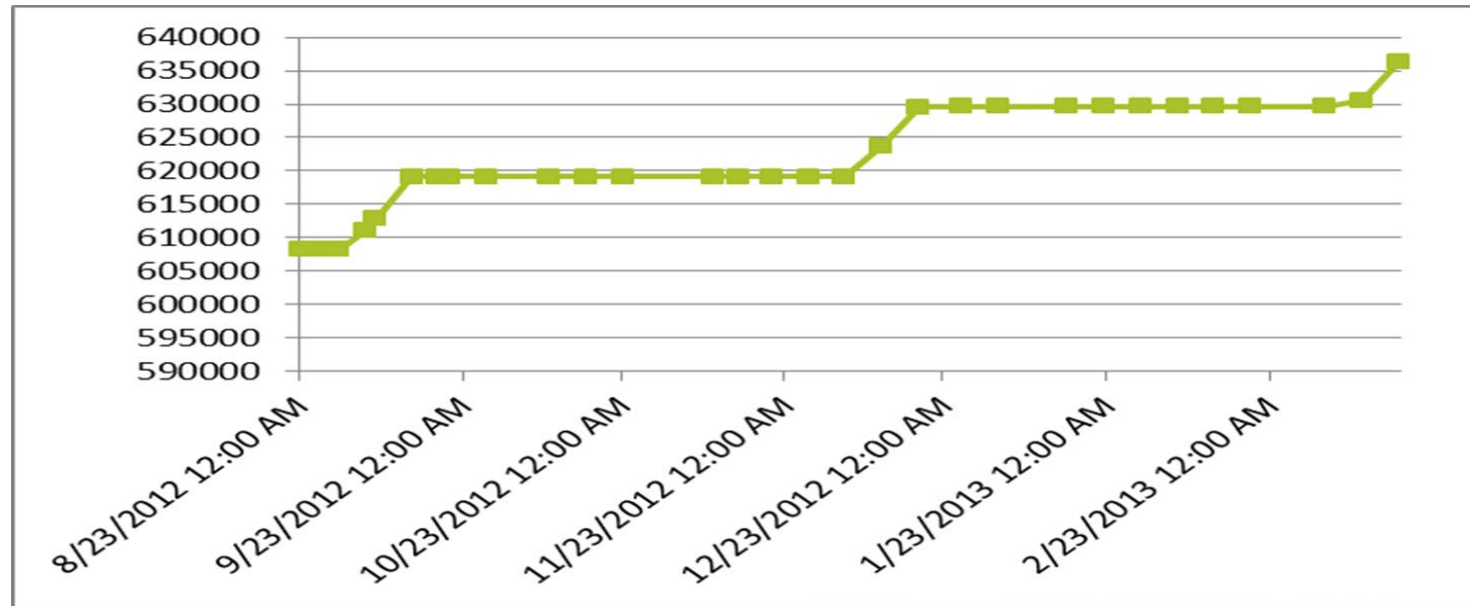
SOME/LIMITED PRACTICE

		Utility						
Report Section	Topic	Albuquerque Bernalillo County Water Utility Authority	City of Baltimore Department of Public Works	DC Water	Great Lakes Water Authority	Suez NJ	Toho Water Authority	Toronto Water
WATER ACCOUNTING								
4.5.1	Water Theft, Meter Tampering and Reverse Flow							
4.5.2	Multiple Meter Situations							
4.5.3	Distribution Area Management							
4.5.4	Apparent Versus Real Water Loss							
4.5.5	Water Audits							
4.5.6	Pressure Management Strategies Using AMI Data							

AMI Data and Analytics for Water Accounting

- Meter Tampering Detection
 - Reduce water theft by recognizing and addressing usage patterns that suggest meter tampering
- District Metering Analysis (DMA or zonal metering)
 - Prioritize infrastructure investments through district or zone meter area analysis
 - Identify areas of highest real water loss by comparing hourly “water-in to water-out”

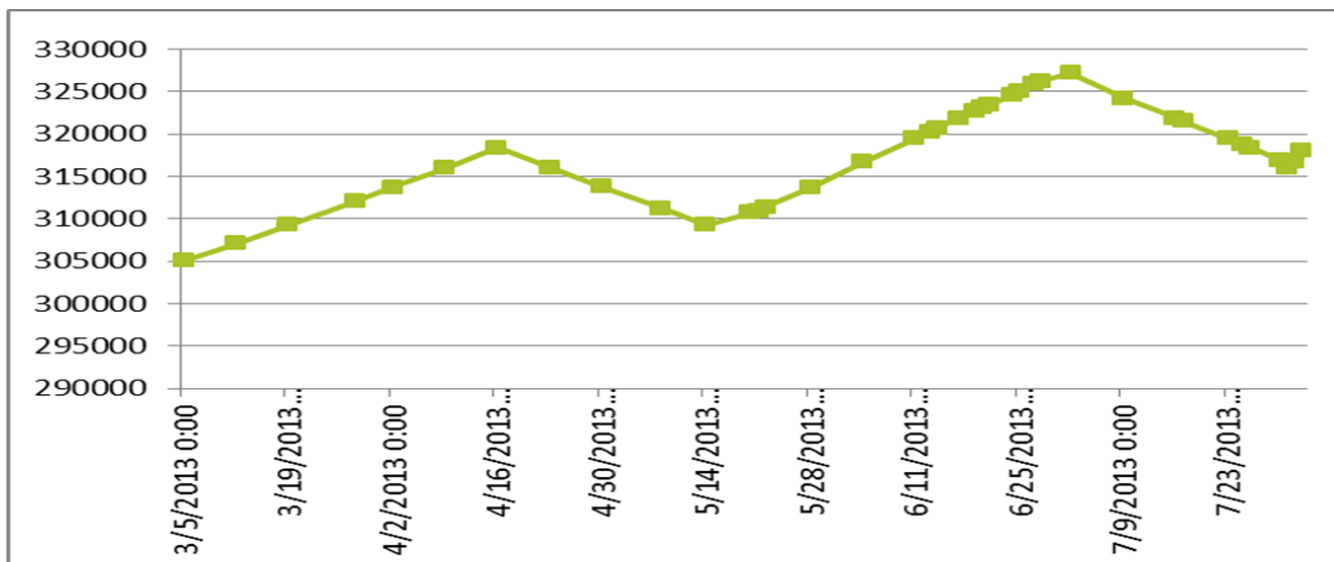
Suez NJ AMI Data Shows Tampering - Periodic Register/Meter Removal



- Apartment Building with 1" meter
- Uses ~6000 gallons per day
- **Back-billed \$61,000**



Suez NJ AMI Data Shows Tampering - Periodic Reversing of the Meter



- Apartment Building with 3/4" meter
- Uses ~2500 gallons per day
- **Back-billed \$27,000**

4/2/2013 10:16	313700	17
4/9/2013 10:13	316005	23
4/16/2013 10:50	318405	24
4/23/2013 11:05	316030	-24
4/30/2013 10:42	313790	-22
5/8/2013 10:53	311280	-25
5/14/2013 10:54	309260	-20
5/20/2013 15:08	310700	14

Utility Practices Use AMI Data for Meter Management



SIGNIFICANT PRACTICE



SOME/LIMITED PRACTICE

Report Section	Topic	Utility						
		Albuquerque Bernalillo County Water Utility Authority	City of Baltimore Department of Public Works	DC Water	Great Lakes Water Authority	Suez NJ	Toho Water Authority	Toronto Water

METER MANAGEMENT								
4.6.1	Small and Intermediate Meter Replacement							
4.6.2	Large Meter Maintenance							
4.6.3	Compound Meter Maintenance							
4.6.4	Register Maintenance							
4.6.5	Meter Testing Management							
4.6.6	Meter Sizing							
4.6.7	Meter Maintenance Program Management							

AMI Data and Analytics for Meter Management

- Meter Sizing for Large Use Customers
 - Use AMI data to properly size meters for improved flow measurement accuracy
- Reducing “Truck Rolls”
 - Minimize visits by field workers for meter reads and for other investigations related to meters
- Meter Maintenance/Replacement
 - Use meter performance to define maintenance frequency and drive replacement cycles

AMI Data Improves Responses to Customer Questions for Baltimore

- Before AMI - “If someone had a spike in consumption ... the assumption was we did something wrong. When we received a high bill complaint, the first thing would be to roll a truck.”
- After AMI – “**Now the first step is to look at the AMI data** and often we see a continuous consumption pattern – then ask the property owner check for leaks, check toilets, things like that – **before we go out.**”

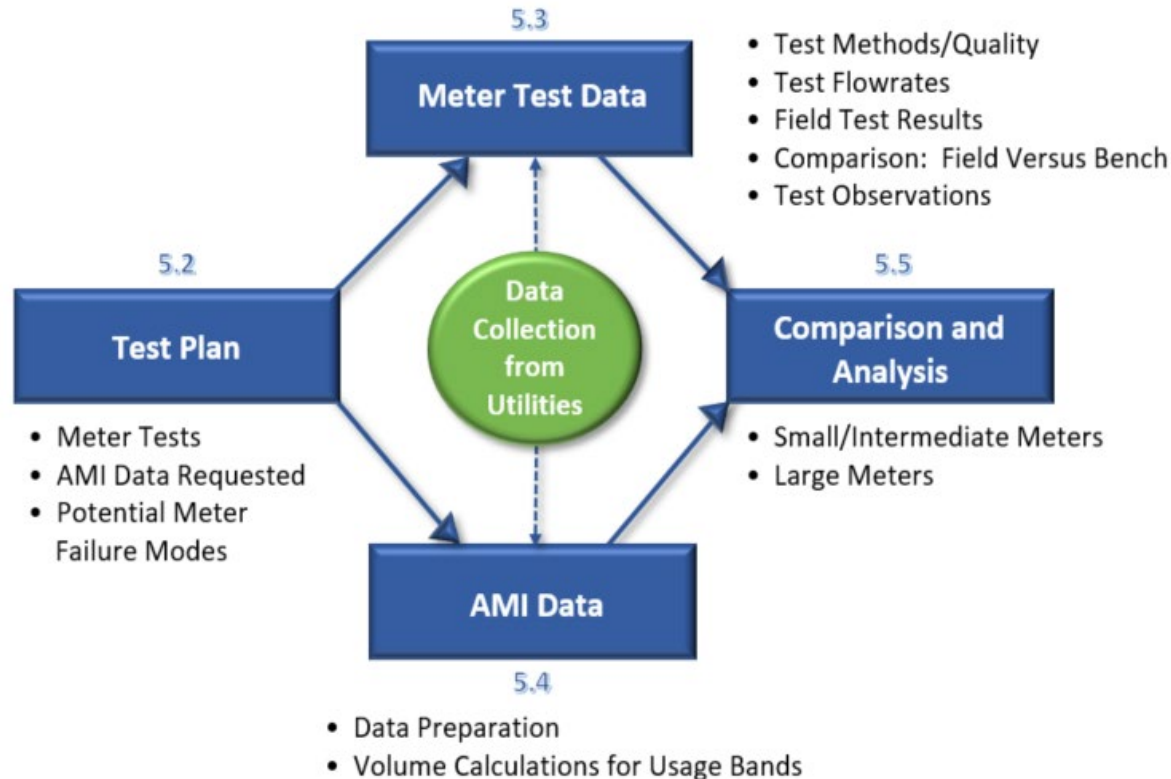


SECTION 3

Meter Testing and Performance Analysis

Meter Performance Analysis

Correlated AMI History With Test Data

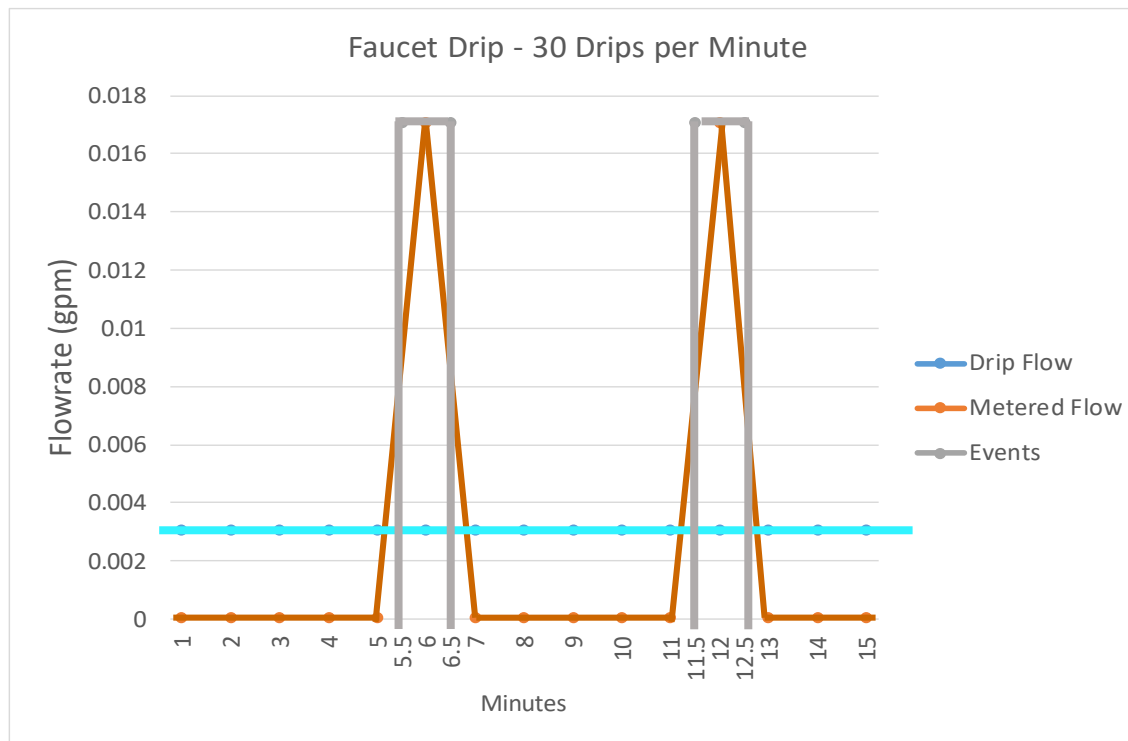


Utility participant's test data was from their routine meter testing programs, except for some testing at low-low flowrates. No specialized or independent meter testing was conducted.

Small and Intermediate Meter Challenges

- Includes Residential (1-4 families) or Light Commercial
- Usage is mostly in short-duration events
- Challenges for AMI data analytics
 - Reading intervals are less frequent than most usage events
 - Reading resolution is often less than most usage events
 - Low-low and low band continuous usage may indicate leakage – not always present in AMI data
 - Other usage bands may represent meter performance/accuracy at higher rates
- Meter accuracy typically degrades at low flows for mechanical meters (e.g. nutating disc type)

Small Leaks May Not Be Detectable With AMI Data – Example Faucet Drip

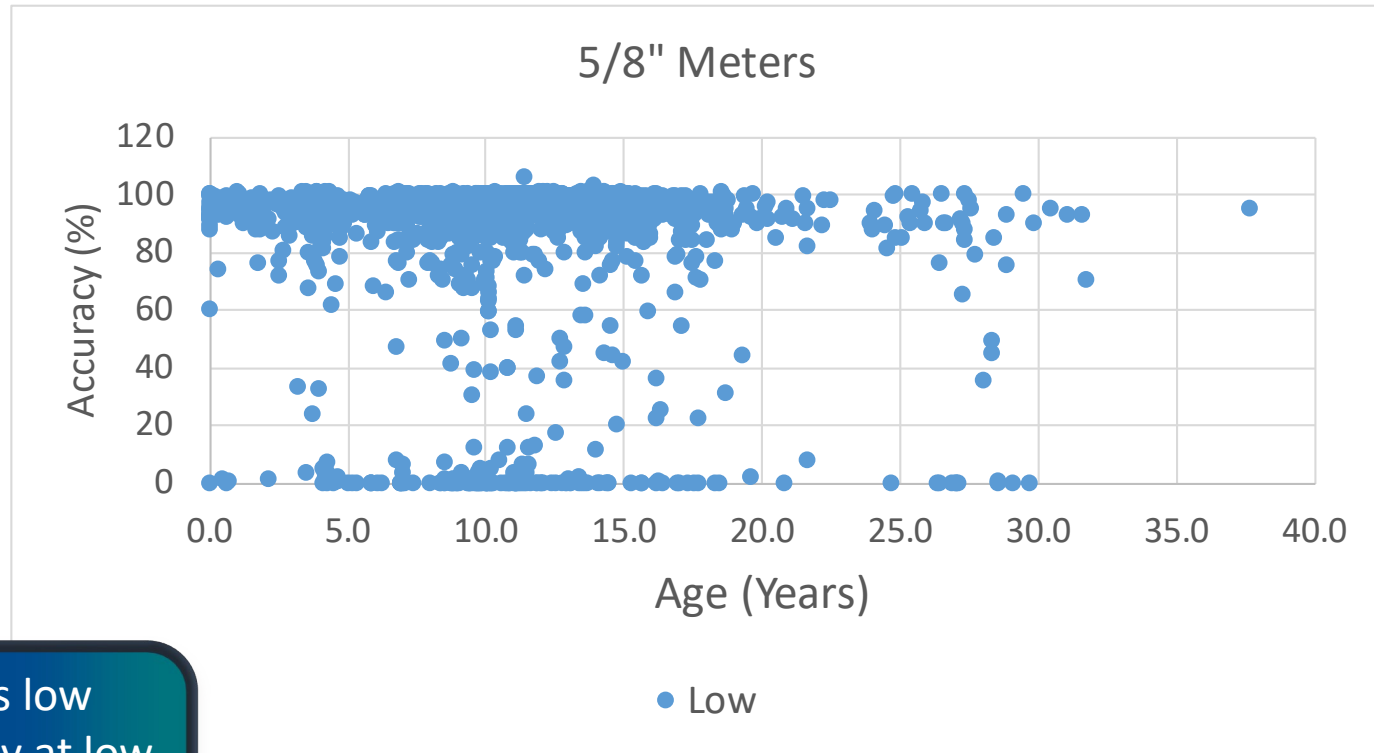


Assumes Meter
Registers 100% of
Leakage

0.1 gal in 34 min
0.1 cf in 250 min
Low-low Range

- A continuous leak appears as spikes (rotations) of metered flow.
- Some AMI meter endpoints include internal diagnostics with data flags for continuous low flow, reverse flow, low battery, cut wires, register malfunction, etc.

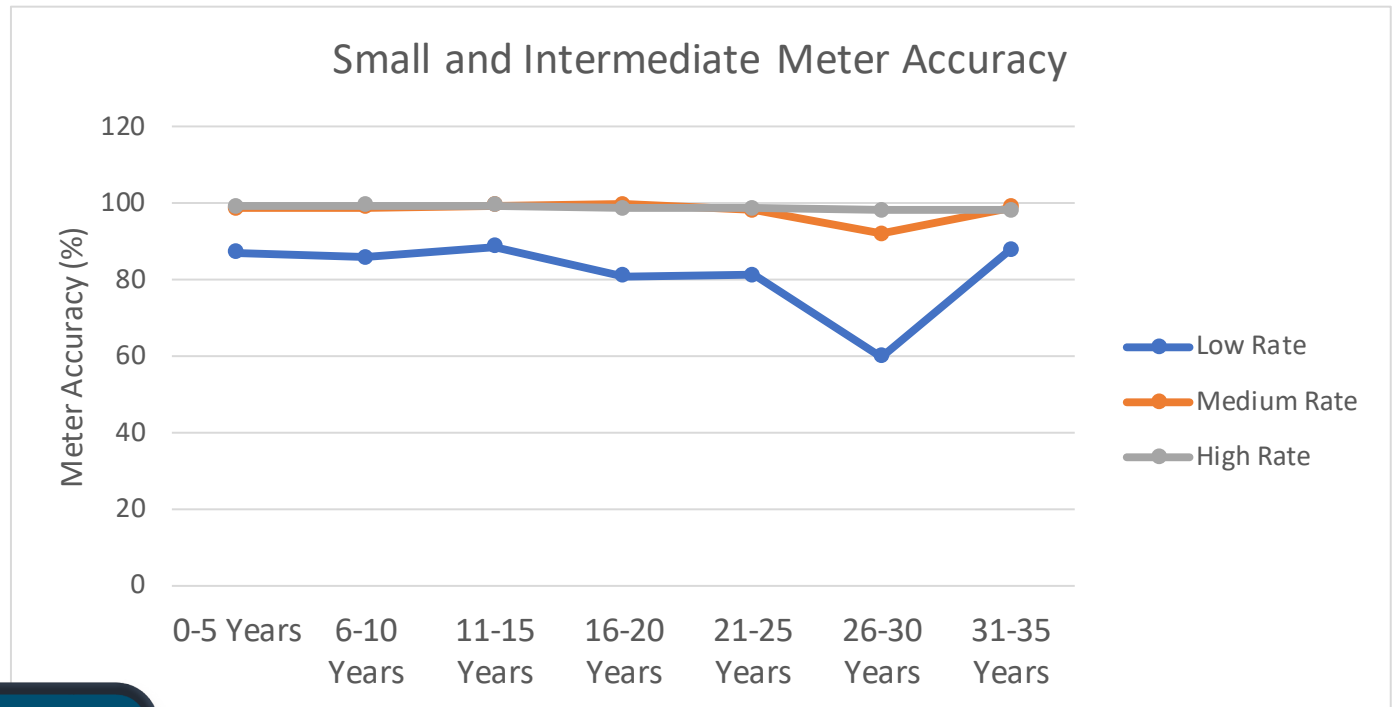
Example Small Meter Test Data Showed Variable Low Flow Accuracy



Does low
accuracy at low
rate affect
metered total?

Compare customer usage AMI data before and after meter replacement to show if low flow accuracy significantly affects metered usage (potential revenue)

Example Small/Intermediate Meter Accuracy Was Slightly Age Dependent



Overall accuracy declines slightly over 35 years

Meter accuracy (M6) is defined by weighted flow rates, from research conducted in 1982:

- 15% Low
- 70% Medium
- 15% High

Customer Usage Changes (AMI Data) Did Not Correlate With Meter Accuracy

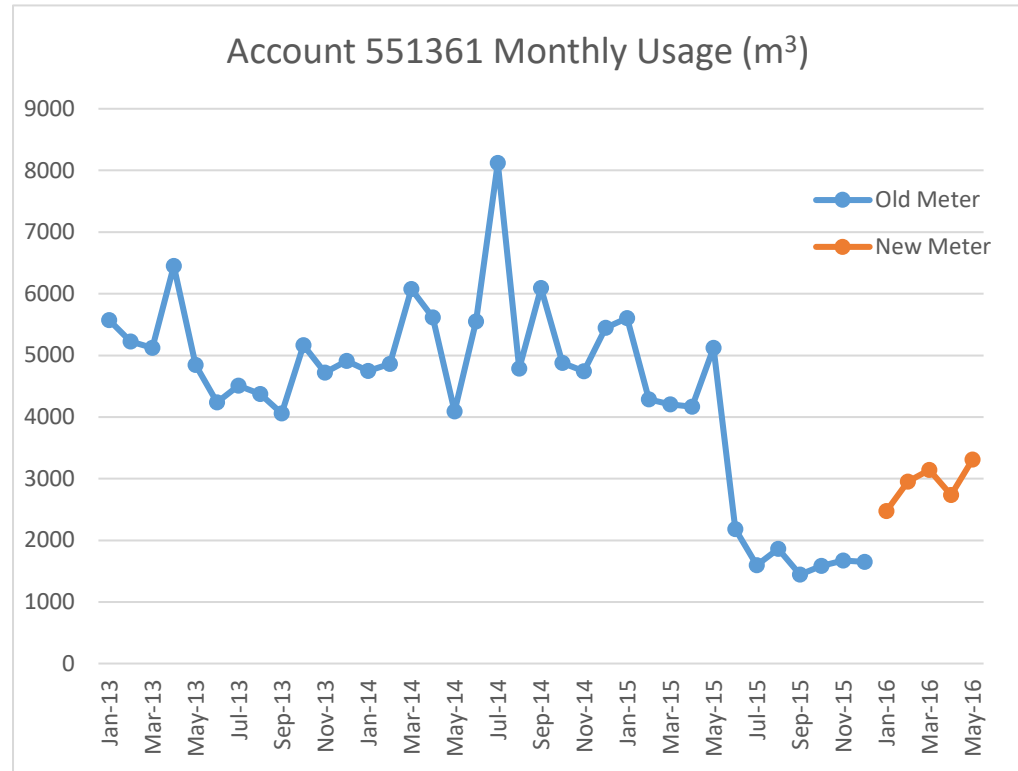
Utility ABC	Decrease > 20%	Decrease >0% to 20%	Increase
% of Meters	57%	10%	33%
Meters with low accuracy	43%	50%	58%

Utility XYZ	Decrease > 20%	Decrease >0% to 20%	Increase
% of Meters	46%	15%	31%
Meters with low accuracy	0%	0%	0%

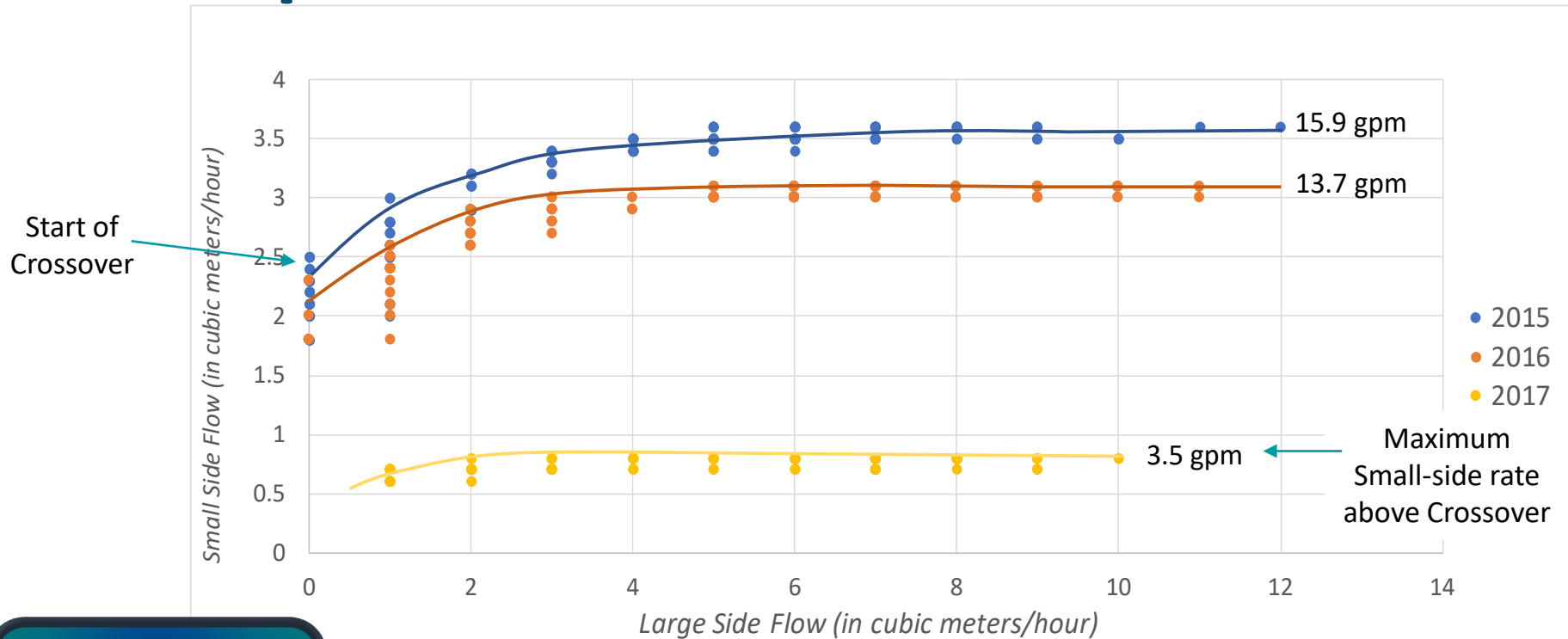
- With data sets available for small/intermediate meters (age 10-15 years), ***no correlation*** between customer ***usage trend*** and ***meter accuracy***
- The AMI Analytics Challenge:
Customer usage changes mask changes in meter performance

One Example: Drop in Total Usage Did Indicate Loss of Meter Accuracy

- Large drop in consumption needs to be sustained before taking action
- Before and after replacement shows change in customer usage



Crossover Rate Change Is Valid Indicator of Compound Meter Performance



'Curve' is not dependent on user demand

Compound meter analytics require AMI data transmission of both metered flow signals, to show large-side and small-side flows.

Example Compound Meter Crossover Determines Maintenance Requirement

Size	Crossover (GPM)	Number of Meters	Low Accuracy Meters	% of Low Accuracy
3" x 5/8"	>9.0	19	3*	16%
	5 to 9	11	8	73%
	<5.0	7	7	100%
4" x 3/4"	>10.0	27	1	4%
	7 to 10	3	0	0%
	<7.0	2	2	100%
6" x 2"	>40.0	1	0	0%
8" x 2"	>40.0	39	0	0%
10" x 2"	>40.0	28	0	0%

*These meters had low accuracy at crossover and were read at 4-hour intervals.

- AMI data show Crossover (max small-side flow above crossover) **is a reliable indicator of meter condition/accuracy**
- Data shown in the table are from five utilities

Research Results From AMI and Meter Test Data

For small and intermediate meters

- With the data sets available, the research found ***no correlation*** between customer ***usage trend*** and ***meter accuracy***
- Changes in customer usage levels and test quality mask changes in meter performance
- Many meters have acceptable performance after 20 years
- Meter replacement decisions should include before/after usage comparisons (otherwise revenue recovery may be optimistic)

For large compound meters

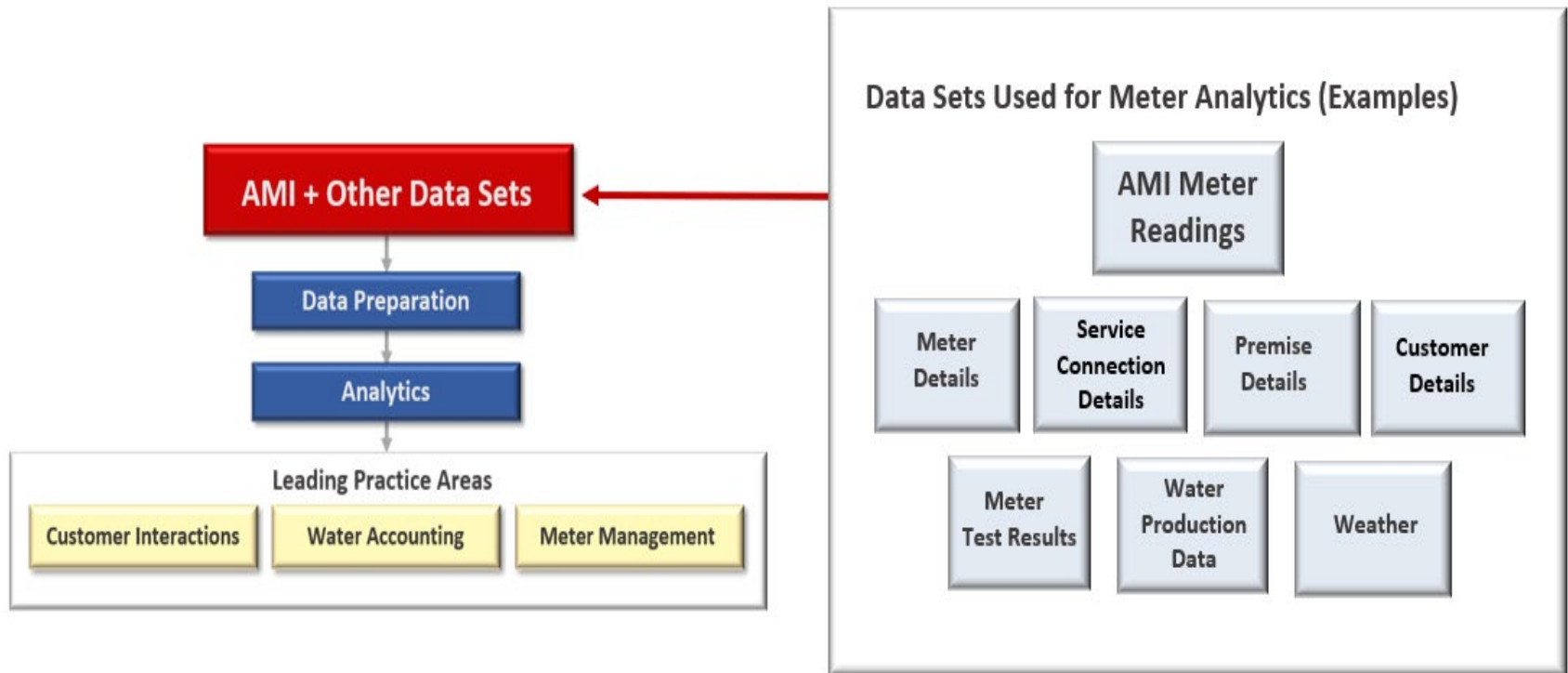
- Changes in crossover point is reliable indicator of meter performance/accuracy and likely source of apparent water loss (significant revenue recovery)



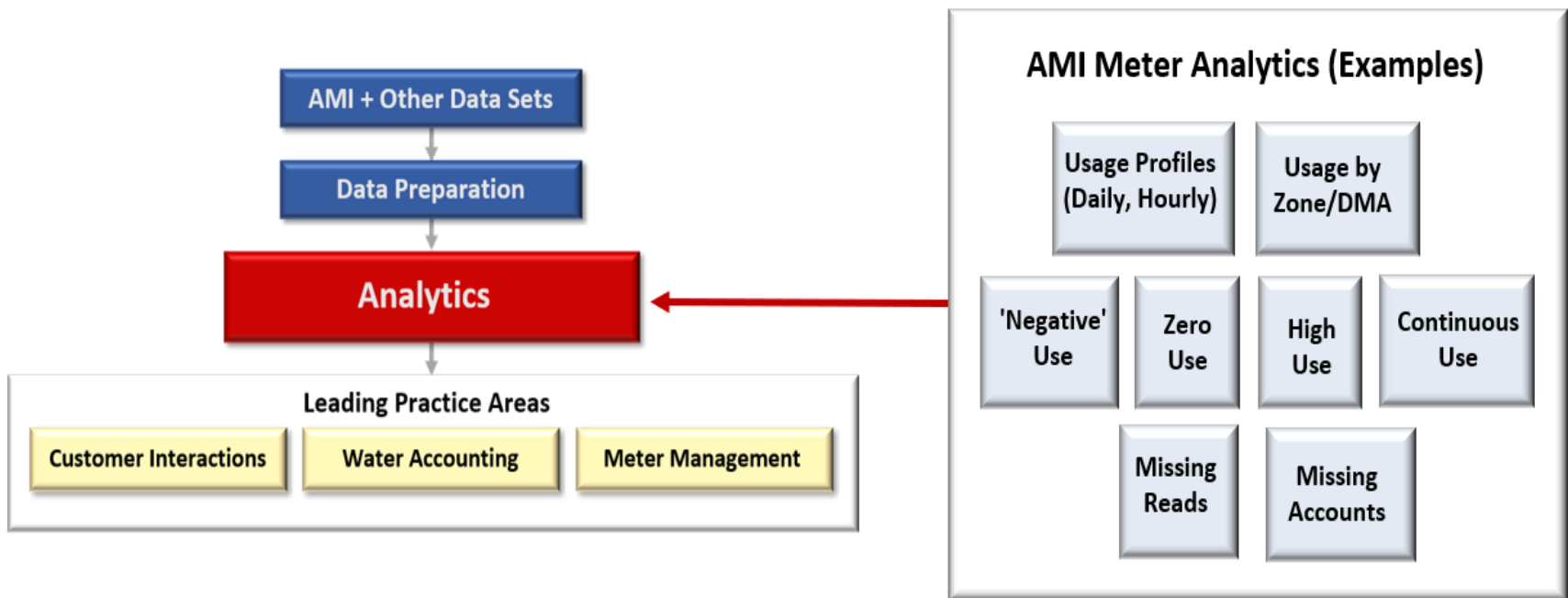
SECTION 4

Leading Practice Examples and Utility Recommendations

Example Data Sets Used for Meter Analytics



Examples of AMI Data Analytics Developed by Water Utilities

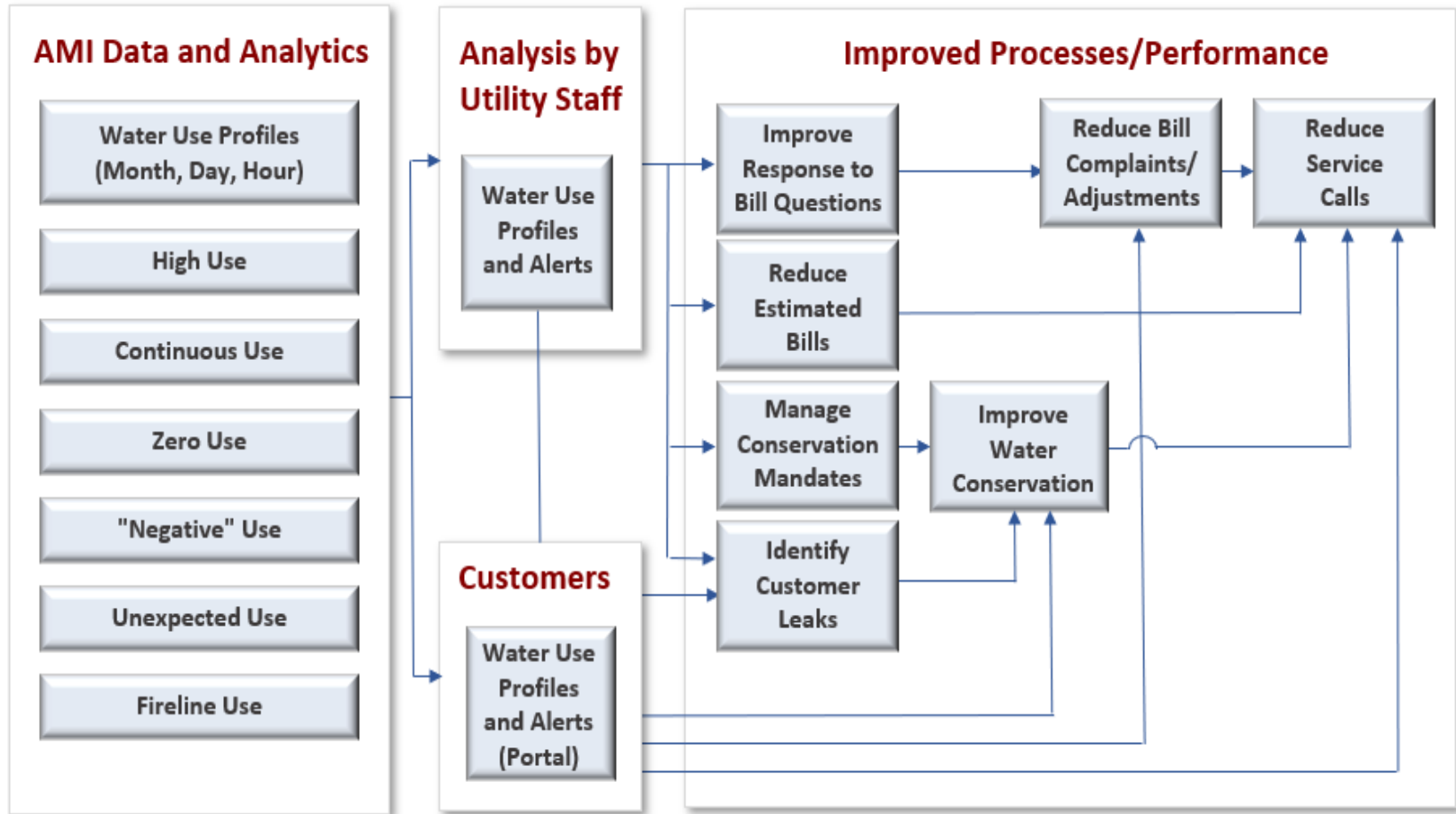


Recommendations to Improve Customer Interactions

- Make AMI data available to utility staff for resolving customer water usage questions or billing disputes.
- Link water usage information to a customer portal for usage trends and alerts – allow for customer-specific alert limits to avoid nuisance alerts.
- Water conservation or residential efficiencies can be encouraged by comparative usage data for similar neighboring properties and irrigation usage alert messages.



AMI Data Analytics Improve Utility Processes for Customer Interactions



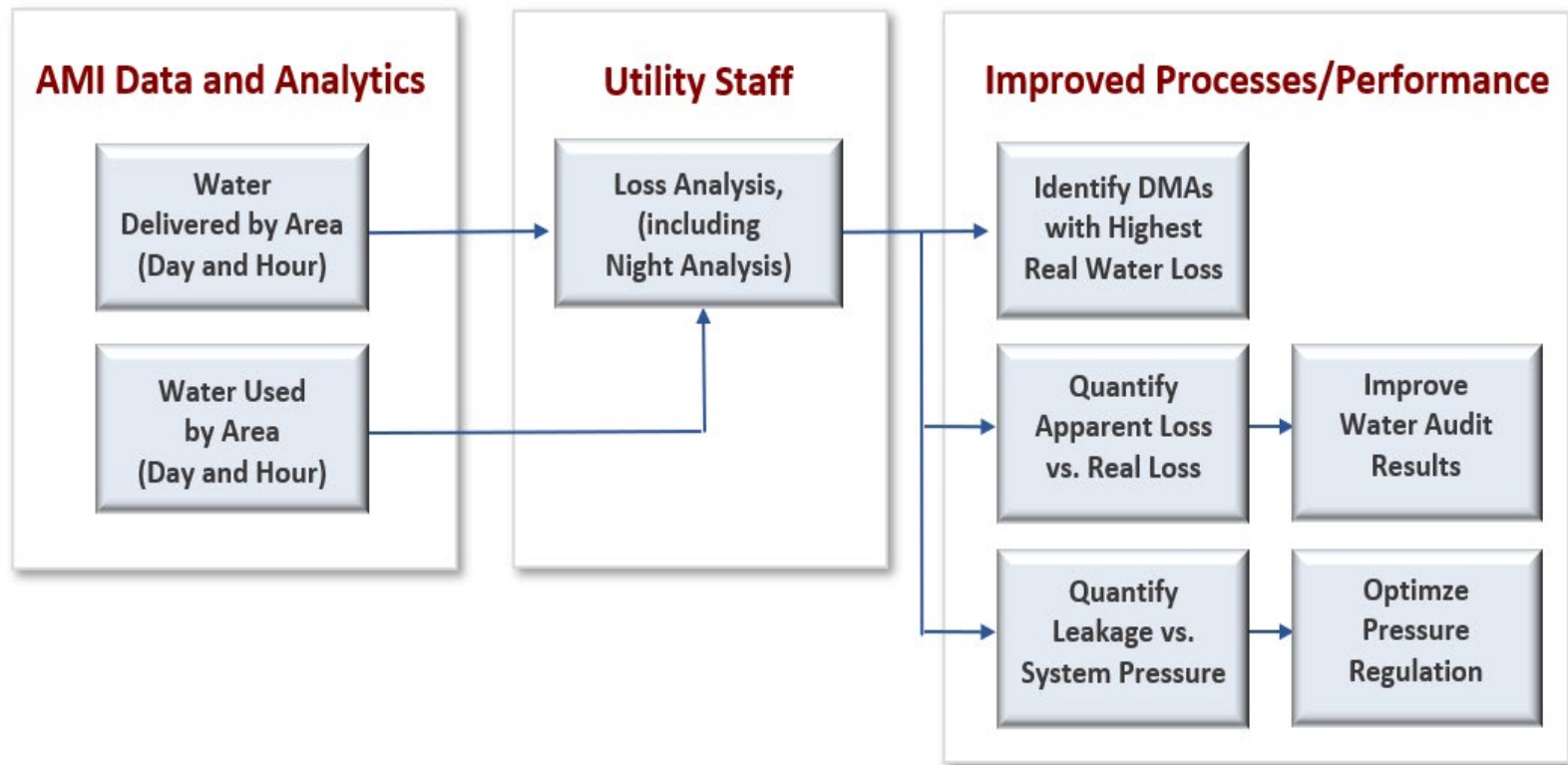
Recommendations to Improve Water Accounting



- Use AMI analytics to identify water theft, including zero usage and other anomalies compared to historical patterns.
- Using AMI data to better understand distribution system performance:
 - Enable water mass balances in District Metered Areas (DMAs) to measure water losses with increased frequency (e.g. daily accounting)
 - Differentiate between apparent and real water losses
 - Improve water audits with more accurate usage data and frequency of audit processes
 - Following main breaks or system flushing, identify meters showing zero usage caused by debris entrained in the meters
- Consider use of AMI system for pressure monitoring to improve pressure regulation, leak management, and infrastructure renewal

District Metering Analysis (DMA)

Quantifies Water Loss Using AMI Data

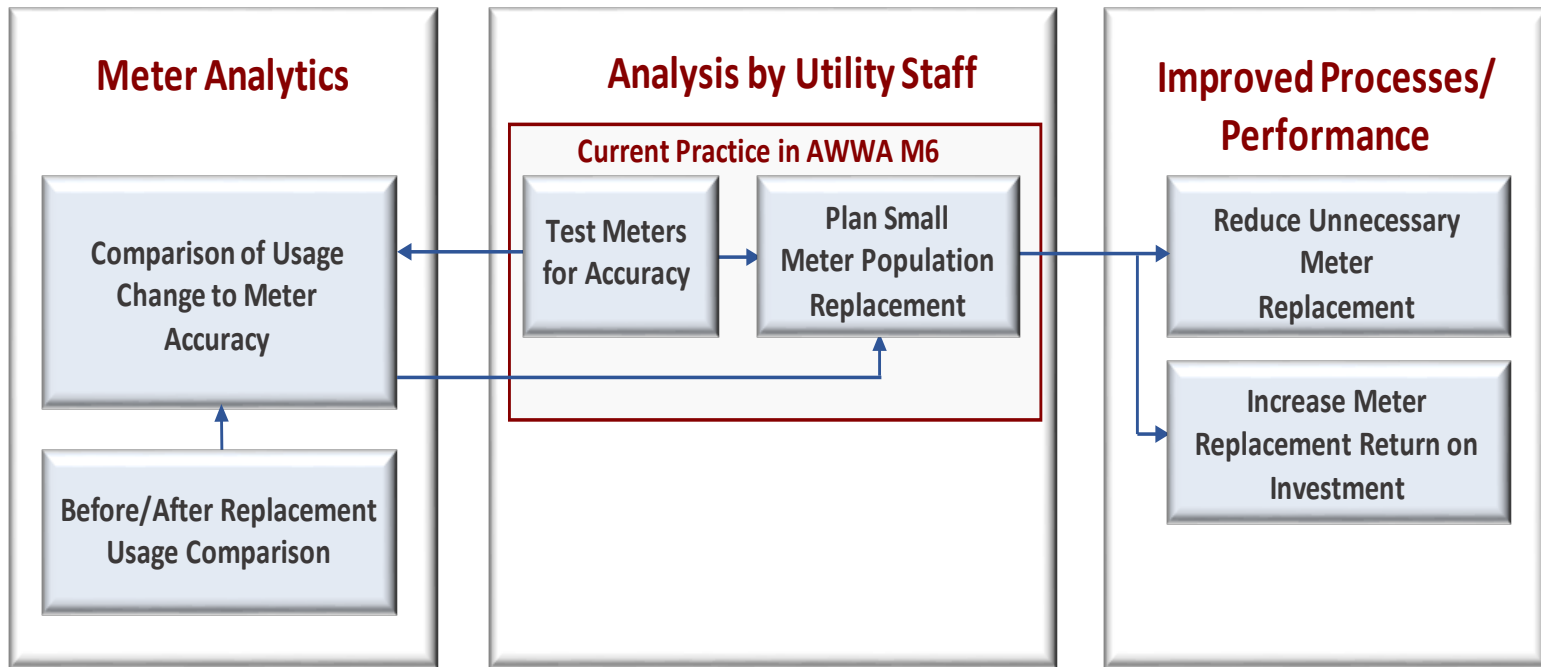


Recommendations to Improve Meter Management

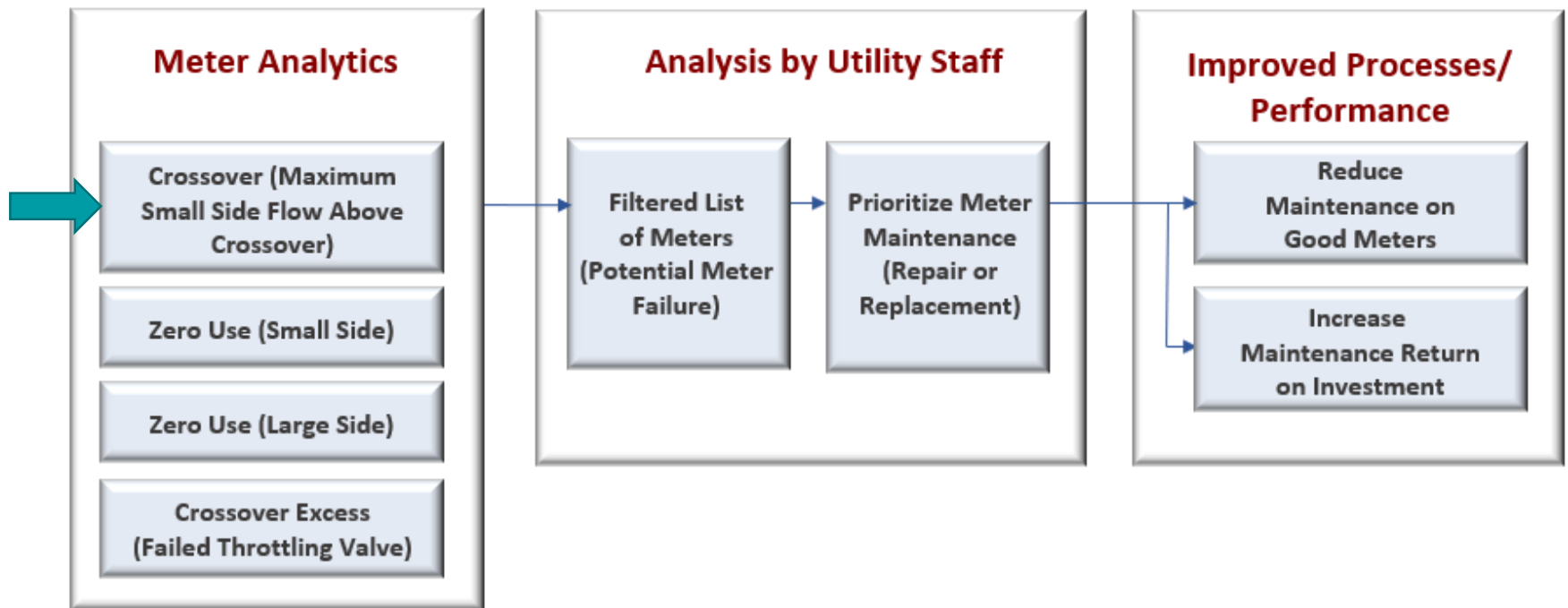


- Use AMI data of customer usage patterns to “right size” when replacing meters
- Differentiate between under-registering meters (loss of accuracy) and reductions in actual usage (e.g. water conserving appliances, reduced occupancy, usage behaviors, etc.) by customer interactions
- Compare customer usage AMI data before and after meter replacement to show if meter accuracy significantly affects customer usage (potential revenue)
- Statistically sample and test in-service meters based on throughput or age to create a cohort of meter accuracy
- Use AMI data analytics to track the performance of compound meters - adjust maintenance and calibrations schedules accordingly

AMI Data (before/after comparison) Can Improve Replacement of Small Meters



AMI Analytics for Compound Meters Do Indicate a Need for Maintenance – Using the Crossover Point



Recommendations to Improve Meter Testing



- Perform quality control and quality assurance on meter testing - include repeatability (duplicate tests) as well as flow ramp-up and ramp-down
 - Reliability of test results is important in resolving customer disputes and in making sound business decisions on meter replacement
 - Comparing consumption before and after meter replacement should be used as part of quality assurance for meter testing
- In-service meters removed for testing should be protected through proper handling, packaging, transport, storage, and set-up prior to testing
 - Bench test results are susceptible to error from change in meter condition after removal from service
- For large meters, the reliability of test results (repeatability or leakage in field tests) needs to be considered in conducting maintenance or replacing meters



SECTION 5

Additional Research and Use of Results

Additional Recommended Research



- **Customer Interactions** - given differing customer profiles, what methods and tools are most effective in use of AMI data to achieve different objectives (e.g. leak alerts, conservation behavior, billing inquiry, etc.)?
- **Water Accounting** – to better understand water losses (real and apparent), what practices for AMI data will improve and extend the use of water audits and DMAs?
- **Meter Management** – what practices using AMI data and other data sets will optimize the total economic lifecycle of meters, considering replacement efficiencies and sample testing of in-service meters?
- **Meter Testing** – what meter testing and handling practices need to be improved or updated in M6 to provide utilities with consistent, accurate test results for correlation with AMI data analysis?

How to Leverage the Research Results

- AMI Analytics Improve the Business Case
 - Improve the business case for AMI by including benefits of data analytics for customer interactions, water accounting, meter management, and correlating AMI data with meter test results
- Clarify Upfront What You Want From:
 - Meter Data Management (MDM) System
 - Customer Portal System
- Manage every meter as an asset (revenue source) to be maintained/tested
 - Implement a meter management program - statistically sample/test in-service meters based on throughput or age to create a cohort of meter accuracy
 - Compare usage data with meter test results, including before and after meter replacement
 - Use AMI data, meter maintenance and test results to drive replacement plans
- Plan for new staff roles and responsibilities
 - Technicians for AMI system to assure high read-success-rate for all meters
 - IT specialists and data scientists for evolving AMI data analytics and customer portal capabilities
 - Metering specialists for accurate bench and in-situ maintenance/testing





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Questions?





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Thank You

Comments or questions, please contact:

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msmith@waterrf.org

For more information, visit

www.waterrf.org

