Indian Health Service

Water Loss Program:

AWWA M36 Workshop
Day 3

March 17, 2022

CAVANAUGH
Stewardship Through Innovation

Agenda – Day 3

Review from Day 2

Breakout Exercise

Common Exercise – Data Validity Grades

Review of Common Exercise and Interpreting Water Audit Results

Break

Mock Level 1 Validation

Common Recommended Next Steps

Supply Meter Testing

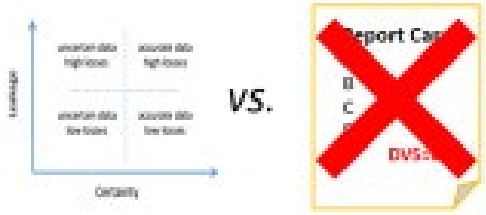
Customer Meter Testing

Summary Review & Wrap-Up

Review from Day 2

Step 1 – Assemble the Supporting Documents

The BEST(?) Number



The BEST(?) Number

100

The Big Picture

Supporting Documentation

provides more detail on key values

REQUIRED	SUPPLEMENTAL
☐ Volumes from Own Sources (meter down by month and meter)	☐ Customer Meter Inaccuracy Estimation
☐ Water Imported (meter down by month and meter)	☐ Average Operating Pressure Estimation
☐ Water Exported (meter down by month and meter)	☐ Customer Retail Unit Cost Estimation
☐ Supply Meter Test Records (for all supply meters, if conducted)	☐ Variable Production Cost Estimation
☐ Volume of Metered Consumption (meter down by month and use type/code)	☐ System Schematic (showing locations of supply and export meters)

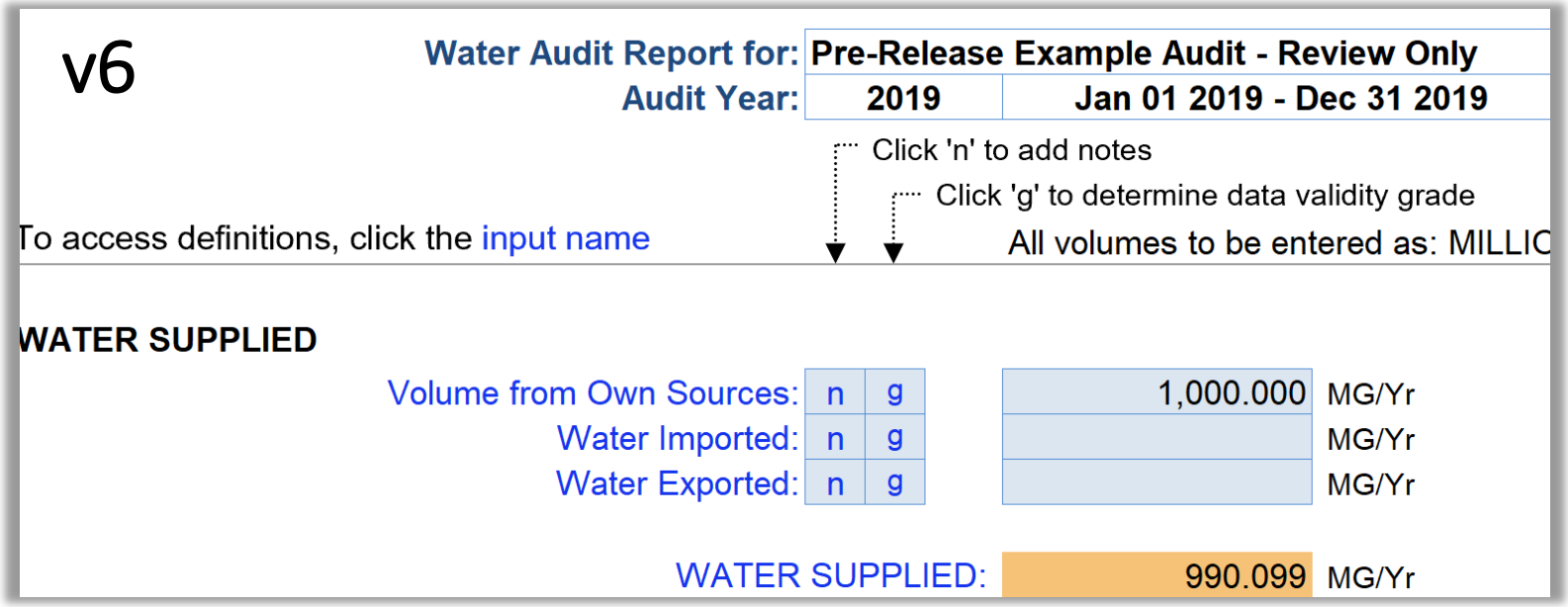
Step 2 – Develop the Inputs

- **Develop the Input**
  - Trace from billing reports
  - Trace from Plumbing (etc) tracker
- **Look for potential errors**
  - Billing report
  - Possible counting Water Exported in Billed Metered
  - Possible counting Unbilled Metered in Billed Metered
  - Including/leaks (Tornado in Unbilled Unmetered)

Step 3 – Check the Metrics

- **Metrics versus Practices**
  - Inside the range – are they high, mid, or low?
  - How does that compare to the water loss management practices?

Data Validity Grading



v6

Water Audit Report for: Pre-Release Example Audit - Review Only

Audit Year: 2019 Jan 01 2019 - Dec 31 2019

Click 'n' to add notes

Click 'g' to determine data validity grade

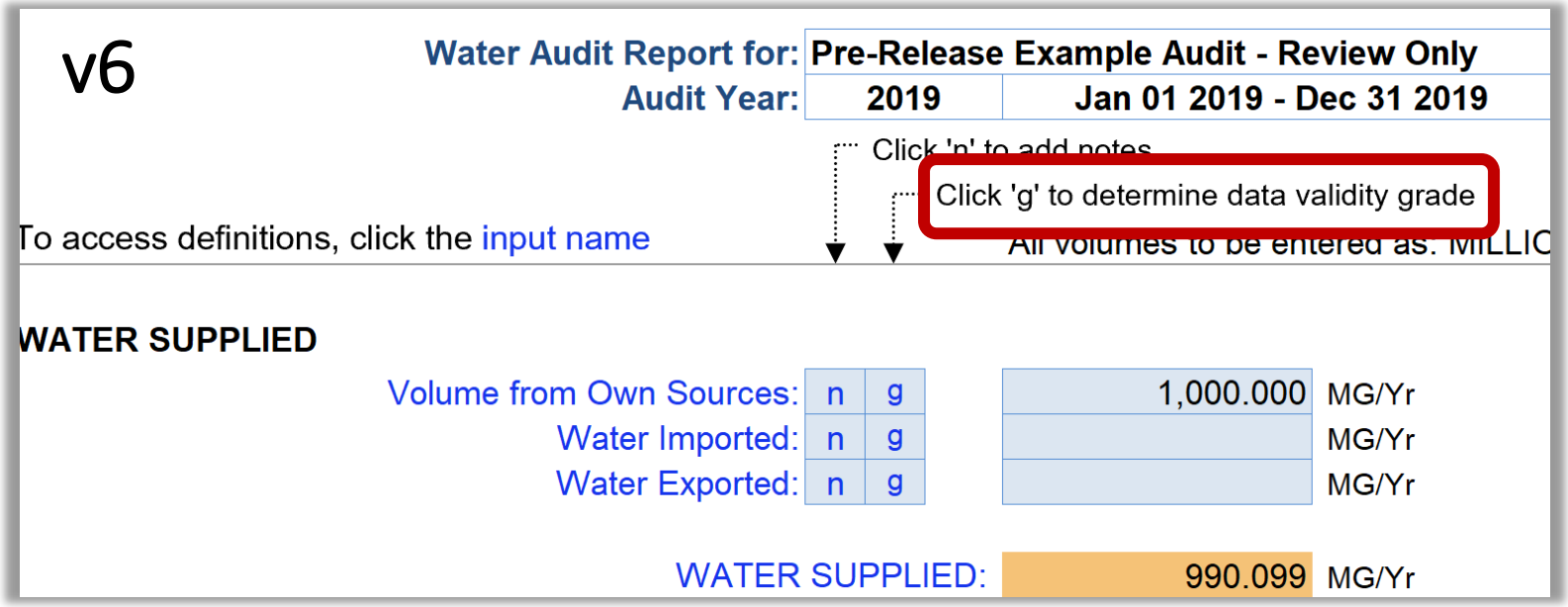
To access definitions, click the input name

All volumes to be entered as: MILLIC

WATER SUPPLIED

Volume from Own Sources:	n	g	1,000.000	MG/Yr
Water Imported:	n	g		MG/Yr
Water Exported:	n	g		MG/Yr
WATER SUPPLIED:			990.099	MG/Yr

Data Validity Grading



Data Validity Grading

v6

Test Utility
2019

White = incomplete
Orange = complete
Use acronyms for navigation

AWWA Free Water Audit Software: Interactive Data Grading

VOS | VOSEA | WI | WIEA | WE | WEEA | BMAC | BUAC | UMAC | UUAC

SDHE | CMI | UC | Lm | Nc | Lp | AOP | CRUC | VPC

acronym key

Limiting criteria (see Start Page for details)

go to input

Volume from Own Sources (VOS) - Data Grading Criteria

go to notes

vos	Criteria Question	Select Best-Fit Answers to All Visible Questions
vos.0	Did the water utility supply any water from its own sources during the audit year?	Yes
vos.1	What percent of own supply volume is metered?	>99%

For questions 2-10 below: Choose the answer that applies for those meters that measure >90% of the finished water volume.
In-situ flow accuracy testing refers to a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location.
Electronic calibration refers to a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).
Secondary device can include meter transmitter, DP cell, chart recorder or similar instrumentation.
Tertiary device can include SCADA, historian or other computerized archival system.

vos.2	What is the frequency of electronic calibration?	Annually
vos.3	What level of data transfer errors are checked as part of the electronic calibration process?	Data transfer errors are checked at secondary device(s) AND tertiary device(s)
vos.4	Is the most recent electronic calibration documentation available for review?	Yes
vos.5	What is the frequency of in-situ flow accuracy testing?	Less than annual but within last 5 years
vos.6	Is the most recent in-situ flow accuracy testing documentation available for review?	Yes
vos.7	What are the total volume-weighted average results of in-situ flow accuracy testing (during or closest to audit year)?	
vos.8	Have testing and calibration procedures been closely scrutinized for compliance with procedures described in the AWWA M36 and/or M33 Manual(s)?	
vos.9	Which best describes the frequency of finished water meter readings?	
vos.10	Which best describes the frequency of data review for anomalies/errors? These can include numbers that are outside of typical patterns, and zero or 'null' values that may reflect a gap in data recording.	

At ±6% or greater
Between ±3% to ±6%
At or within ±3%

FINAL DATA GRADE FOR THIS AUDIT INPUT:

Data Validity Grading

v6

Test Utility
2019

White = incomplete
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AWWA Free Water Audit Software: Interactive Data Grading

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go to input

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vos.5	What is the frequency of in-situ flow accuracy testing?	Less than annual but within last 5 years	Limiting
vos.6	Is the most recent in-situ flow accuracy testing documentation available for review?	Yes	
vos.7	What are the total volume-weighted average results of in-situ flow accuracy testing (during or closest to audit year)?	At or within ±3%	
vos.8	Have testing and calibration procedures been closely scrutinized for compliance with procedures described in the AWWA M36 and/or M33 Manual(s)?	Yes	
vos.9	Which best describes the frequency of finished water meter readings?	Continuous	
vos.10	Which best describes the frequency of data review for anomalies/errors? These can include numbers that are outside of typical patterns, and zero or 'null' values that may reflect a gap in data recording.	Daily	
	FINAL DATA GRADE FOR THIS AUDIT INPUT:	**7**	

Test Your Knowledge

Data Validity

Breakout Exercise

Common Exercise – Data Validity Grades

Review of Common Exercise and Interpreting Water Audit Results

Break

Mock Level 1 Validation

Common Recommended Next Steps

Supply Meter Testing

Customer Meter Testing

Supply Meter Verification Methods

The Big Picture

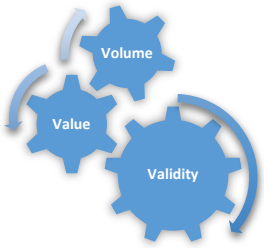
Annual Water Balance

Annual M36 water audit

Apparent & Real Loss volumes

Level 1 validation

baseline



Stage 1

Loss Profiling & Uncertainty

Advanced Validation
- Level 2 Analytics
- Level 3 Field Study
- Margins of Error

Apparent Loss Profile
- Theft
- Meter Inaccuracy
- Data Handling

Real Loss Profile
- Reported Leakage
- Unreported Leakage
- Background Leakage

technical analysis

Stage 2

Cost-Benefit & Targets

Costs of losses
- by subcomponent
- in aggregate
- wholesale & retail

Costs of intervention strategies

Program design

System-specific

economic analysis

Stage 3

Intervention

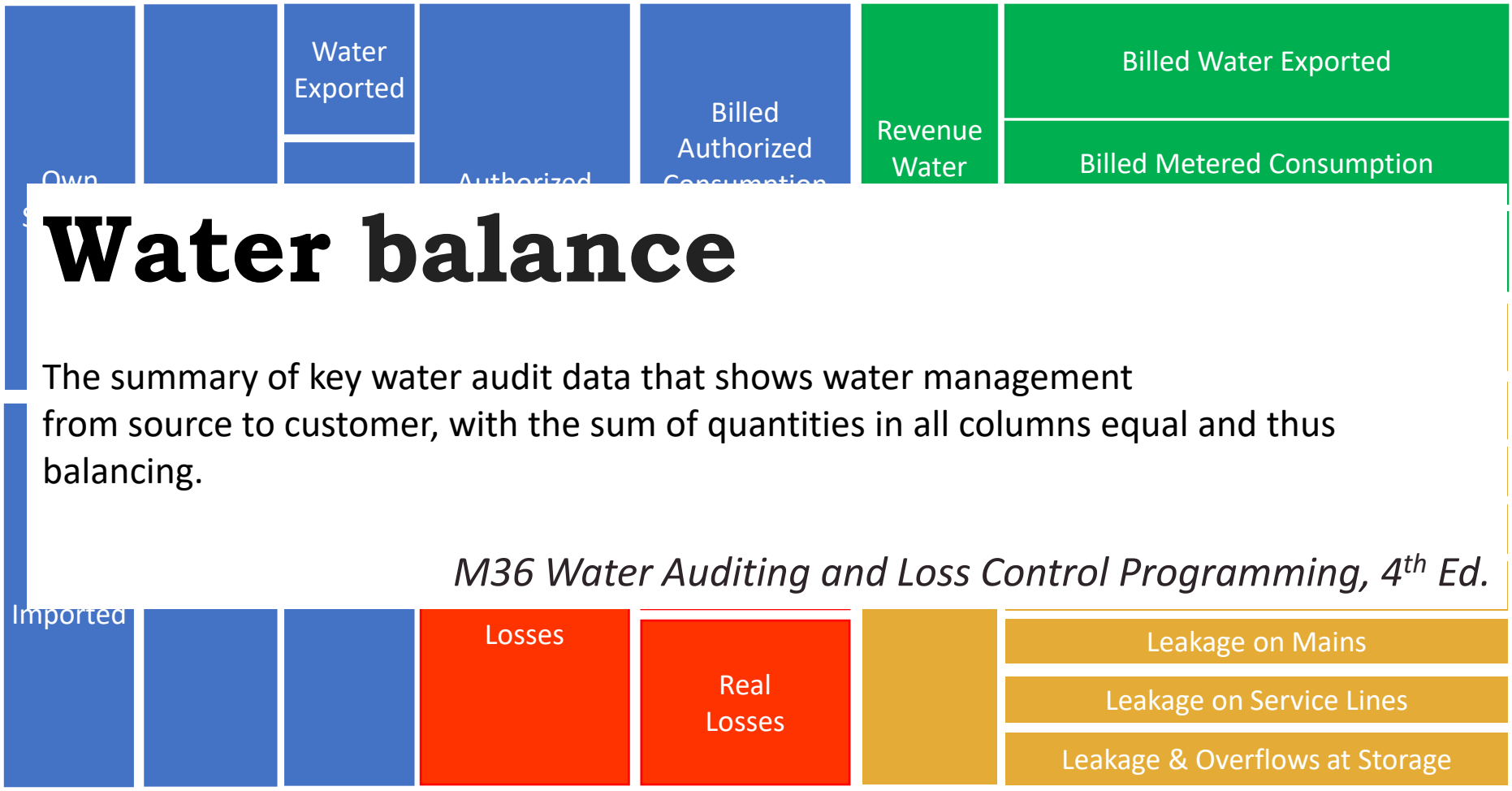
Leakage Management:
- Active Leak Detection
- Pressure Optimization
- Repair Time Reduction
- Network Renewal

Revenue Protection:
- Theft Mitigation
- Meter Optimization & Renewal
- Billing Data System Integrity
- Revenue Recovery

cost-effectiveness

Stage 4

The Water Balance & Water Auditing

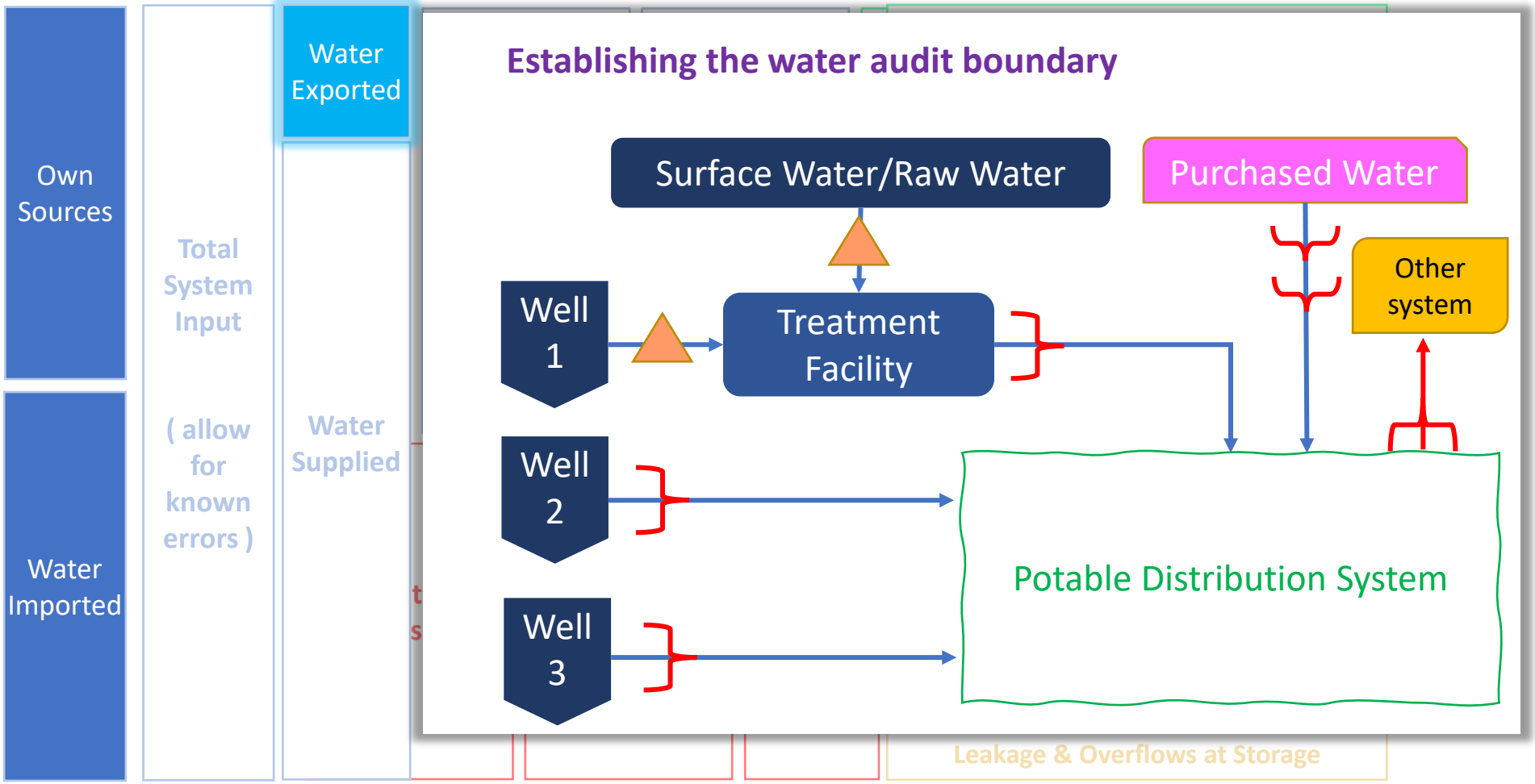


Water balance

The summary of key water audit data that shows water management from source to customer, with the sum of quantities in all columns equal and thus balancing.

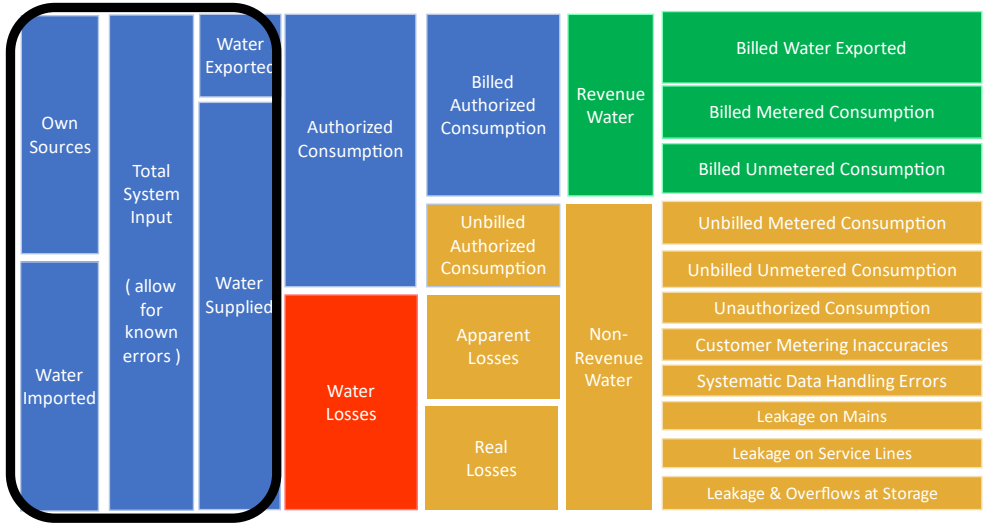
M36 Water Auditing and Loss Control Programming, 4th Ed.

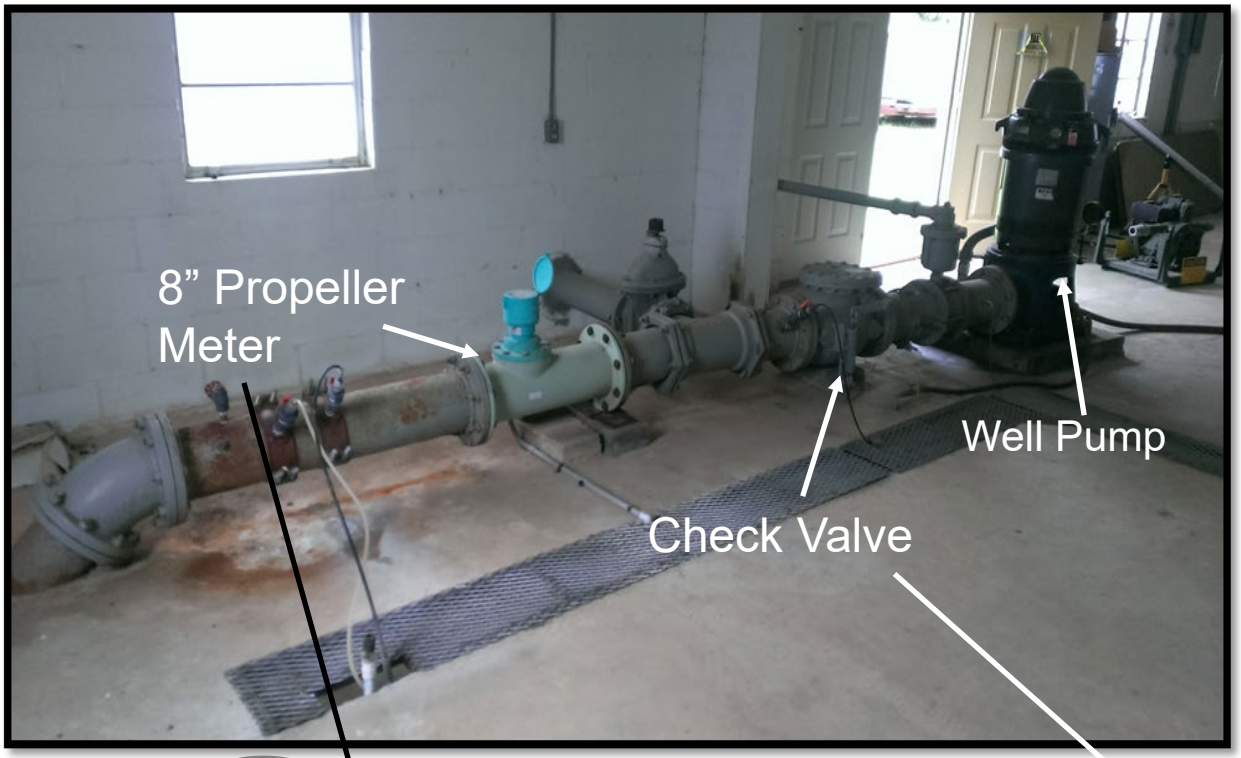
The Water Balance & Water Auditing



Potential Errors in Water Supplied

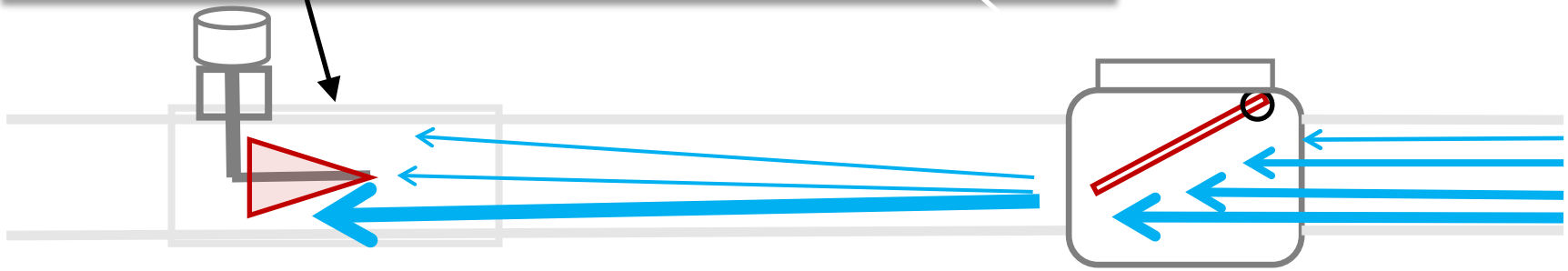
- Meter wear
- Meter location
- Meter selection
- Meter data transfer
- Flow data archiving





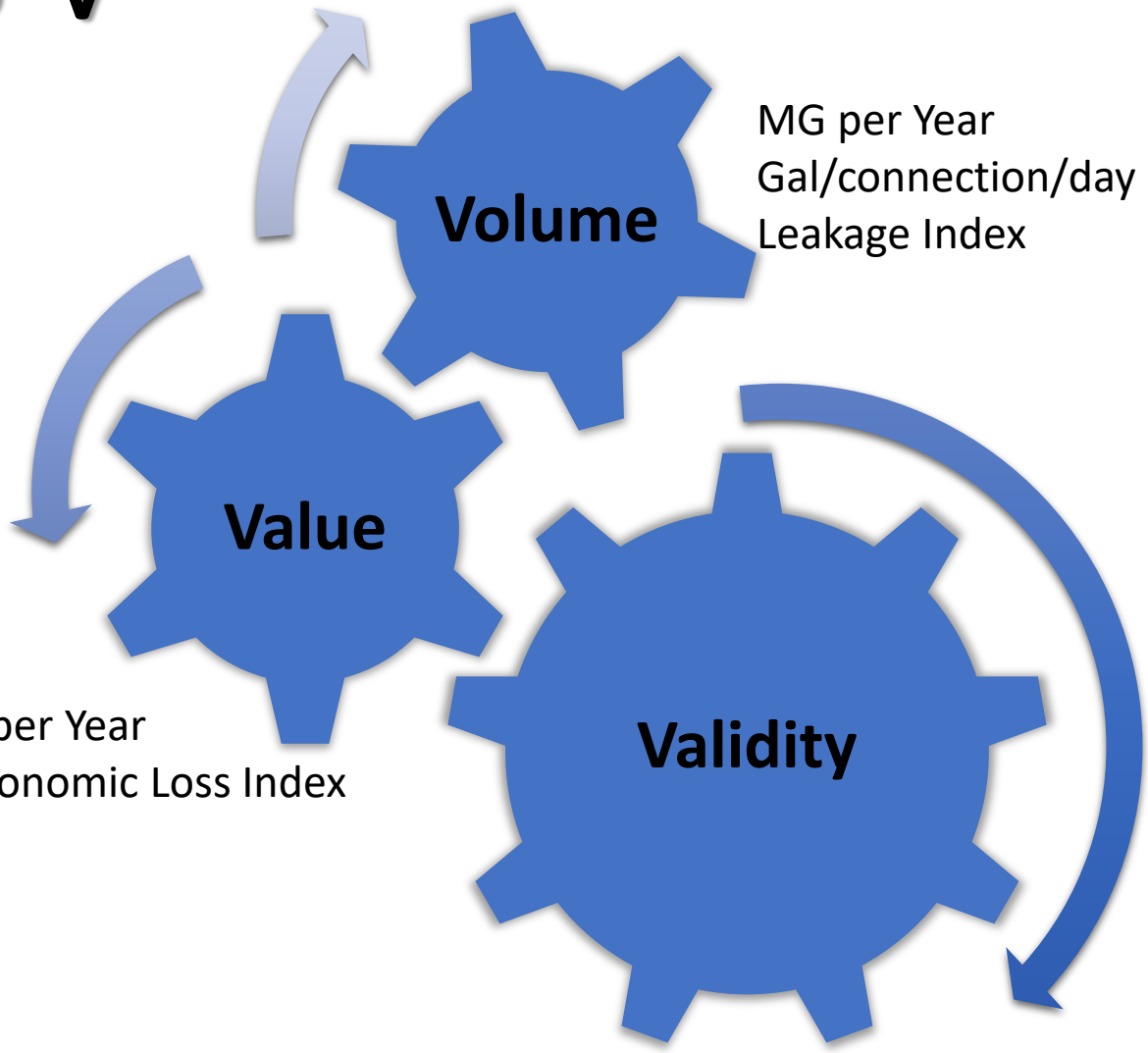
Accuracy results from MFR test bench: 99.5%

Accuracy results from in-situ test: 142.2%



Courtesy MESCO

3-V



MG per Year
Gal/connection/day
Leakage Index

$ per Year
Economic Loss Index

Water Audit Data Validity Score
95% Confidence Limits
Key Data Input Grades

Supply Metering

High flowrate applications

Venturi, Orifice, Magnetic, Ultrasonic

Medium, low flowrate applications

Turbine, Propeller, Positive Displacement

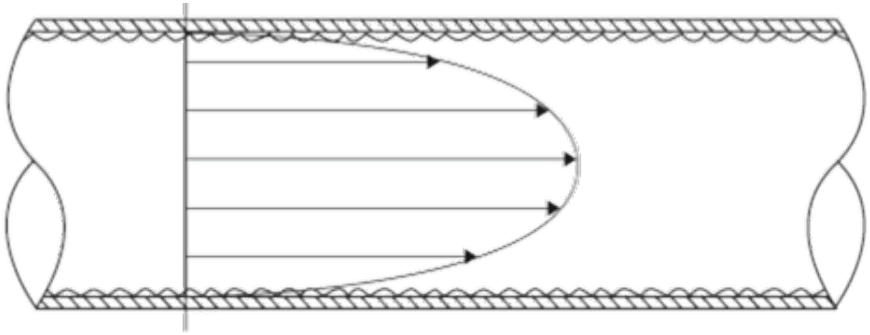
36-inch Venturi Meter
(Source: Primary Flow Control)

60-inch magnetic flowmeter being installed in Philadelphia, PA

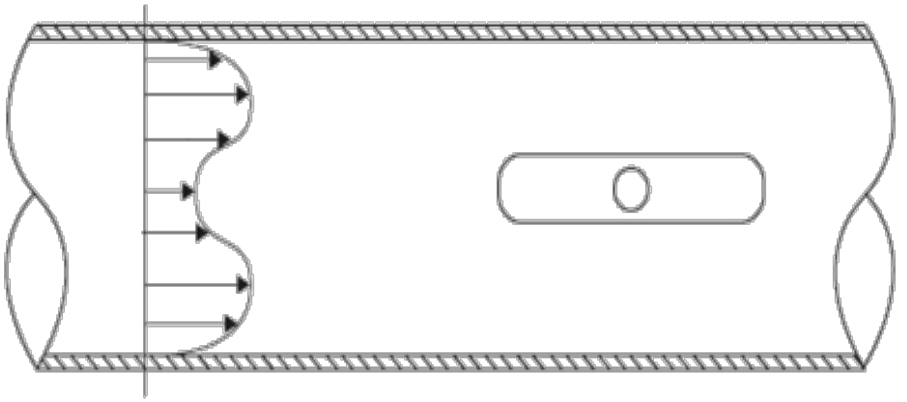
Insertion magnetic flowmeter in use on a 30-in. pipeline in Birmingham, Al

Basic Pipeline Hydraulics

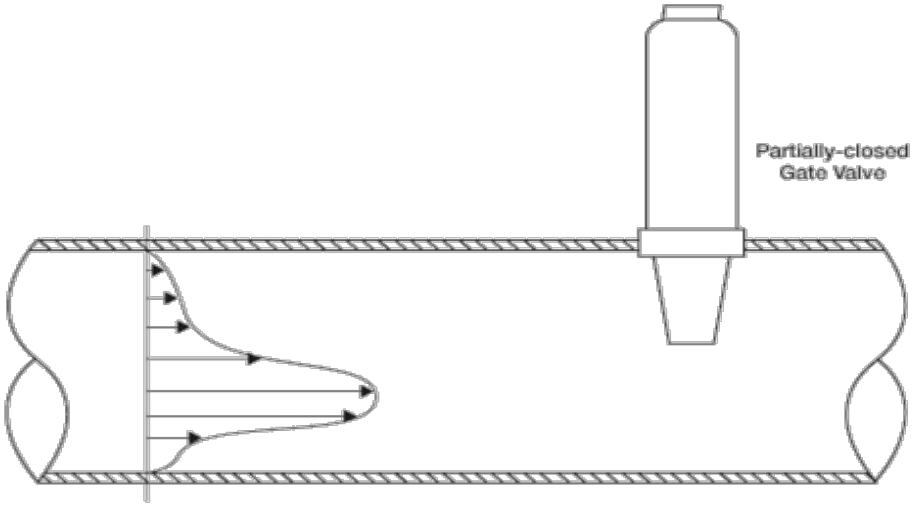
(Source AWWA M36 Publication, 4th Ed.)



Parabolic velocity profile with rough interior wall
This bullet-shaped profile is typical of many older pipelines that remain in service



Velocity profile skewed by butterfly valve located closely downstream



Velocity profile is shifted due to downstream flow obstruction

Proper Meter Siting

Flowmeter Type	Recommended Lengths of Straight Pipe* (stated in terms of number of upstream pipe diameters for the given metering application)
Venturi	4–10 diameters—depending on the type of any flow-disturbing obstruction in the pipeline
Orifice	5 diameters
Flow tube	4–10 diameters—depending on the type of any flow-disturbing obstruction in the pipeline
Pitot tube	10 diameters
Propeller	10 diameters
Turbine	25 to 30 diameters
Turbine (with flow-straightening device)	10 diameters
Magnetic	5 diameters
Ultrasonic (Doppler shift)	7–10 diameters
Ultrasonic (pulse transmission†)	7–10 diameters (and 5 diameters downstream)

*Information is based on engineering judgment and conservative best practice observed in the water industry by AWWA Water Loss Control Committee members (Source: AWWA M36 Publication, 4th Ed.)

†Includes transit time flowmeters

Proper Meter Siting

Proper Meter Siting

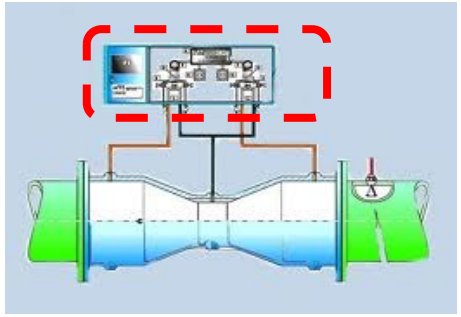
What Constitutes a Meter?

Primary Device: Measuring Element

Conducts the measurement

Secondary Device: Register, Transmitter

Converts, communicates the measurement



Tertiary Device: Remote Database

Records, archives the measurement

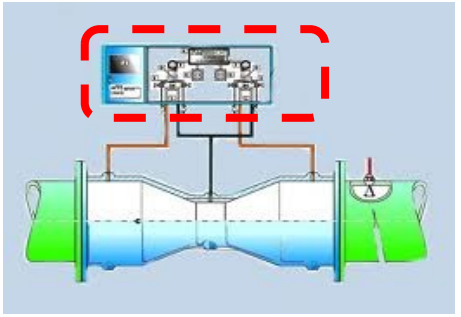
Accuracy Testing v. Calibration

Primary Device: Accuracy Testing

Independent measurement for comparison

Secondary Device: Calibration

Checks alignment of primary measurement to register and signal output



Tertiary Device: Calibration

Checks alignment of secondary signal to SCADA output

Supply Meter Testing

Insertion type

Clamp-on

Comparative apparatus

Volumetric displacement

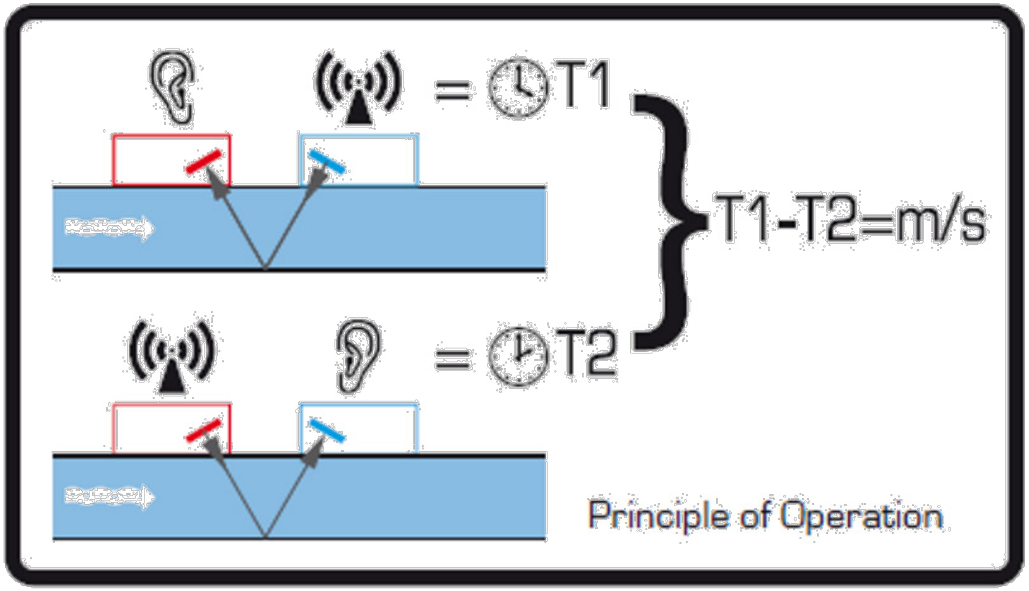
Factory bench test

Supply Meter Testing

Insertion type

Supply Meter Testing

Clamp-on



Supply Meter Testing

Comparative apparatus

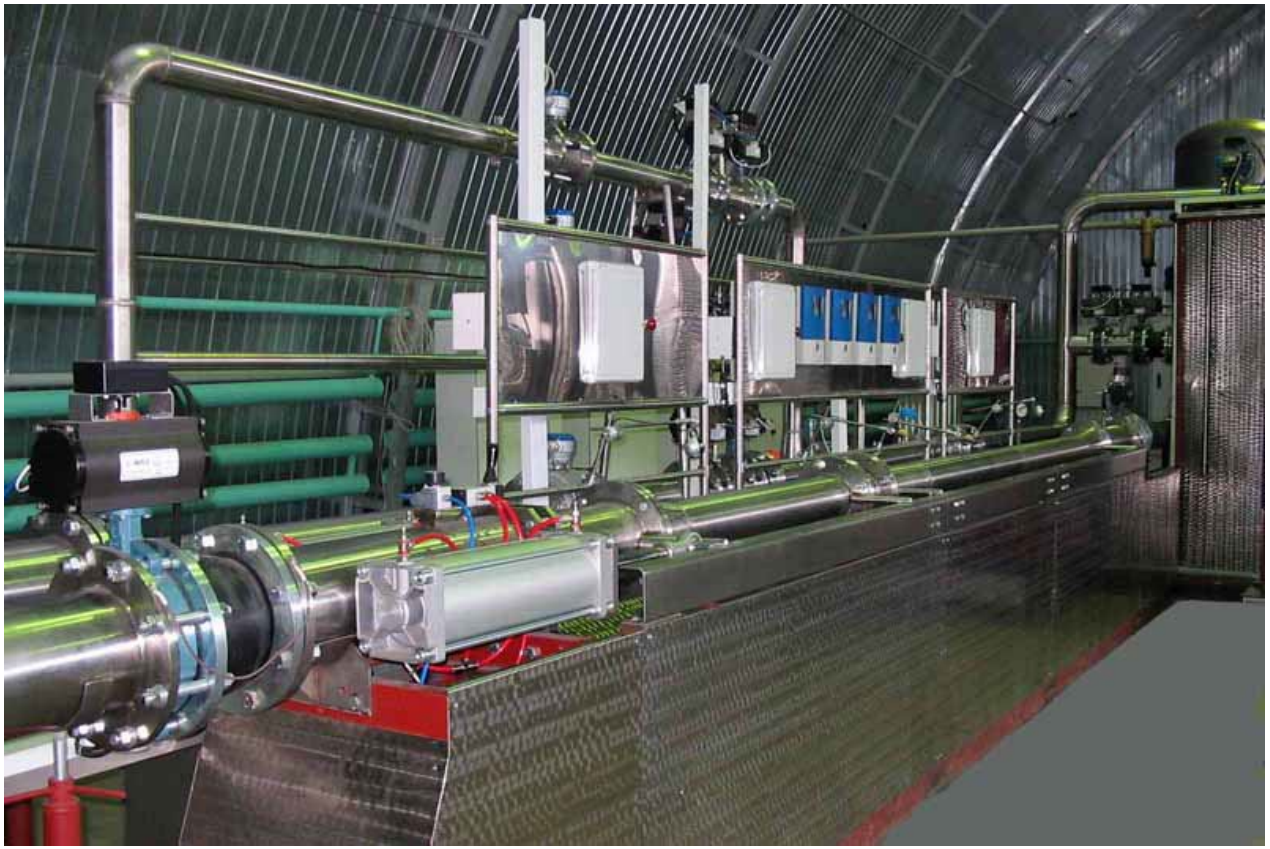
Supply Meter Testing

Volumetric displacement

Reservoir or clearwell adjacent to a water treatment plant

Supply Meter Testing

Factory bench test

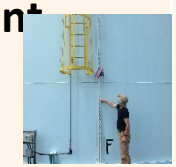
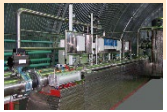


Supply Meter Testing

Other considerations

- Flow rates
- Test location (if insertion or clamp-on)
- Test duration

Supply Meter Testing -- Summary

Method	Advantages	Limitations
Insertion type 	Minimize the unknowns by verifying the flow condition and inside area of the pipe, can make this a very reliable method No interruption to operations	Requires a good test site! Lower test flowrates can affect uncertainty Specialized equipment and expertise required
Clamp-on 	Easier to do, no tap required No interruption to operations	Requires a good test site! Signal distortion depending on pipe material can affect accuracy, and there's no verification of flow conditions via flow profile or of inner diameter
Comparative apparatus 	More control over the flow condition and the test reliability	Typically, only practical for small to medium flowrate applications. If no bypass, supply is interrupted during test
Volumetric displacement 	Can be reliable method Potentially done internally and frequently	Requires a reservoir nearby, reliable field verification of reservoir geometry, including internal components (baffles etc) and all associated plumbing/valves Level sensing must be calibrated and reliable Production is typically interrupted during test
Factory bench test 	Get to test it under ideal conditions	Only tested under ideal conditions! Not practical for larger meters Meter is out of service for test

Test Your Knowledge

Supply Meter Testing

Customer Meter Testing Overview

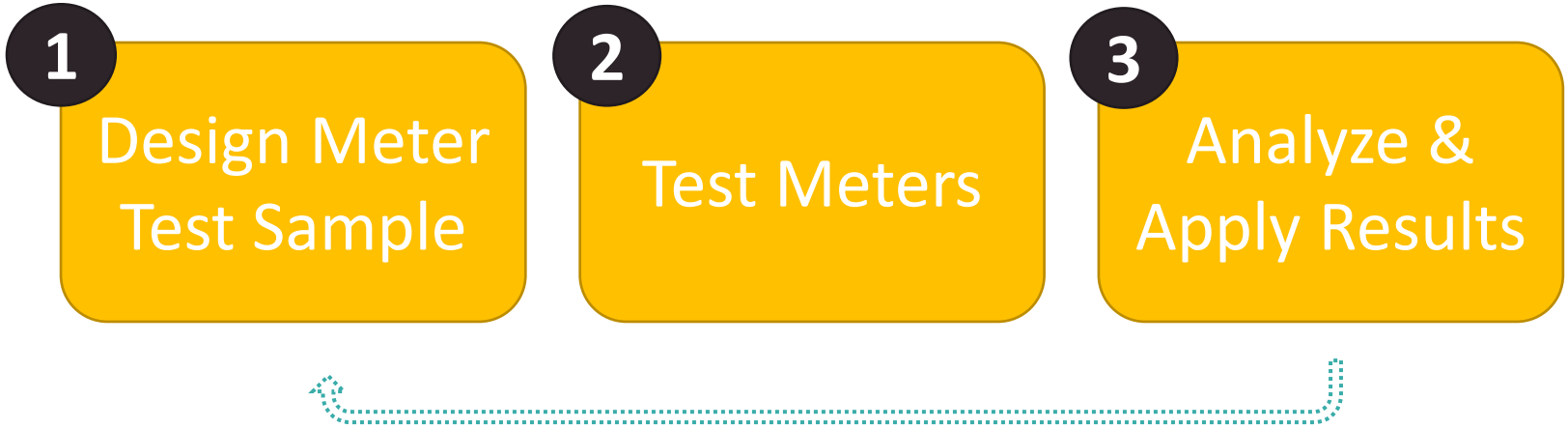
Customer Meter Testing

Goals:

- Study accuracy of the meter stock
- Calculate an Apparent Loss volume* due to metering inaccuracy
- Inform proactive management of meter stock's accuracy

in the Water Balance, our understanding of Apparent Losses directly impacts our understanding of Real Losses

Small Meter Testing Programs



Small Meter Testing Programs

1 Design Meter Test Sample

- Representative and random meter sample

- What sample size is big enough?

*remember our goal is to appreciate the accuracy of the **whole population***

Small Meter Testing Programs

2 Test Meters

- Careful with meter transport
- Test at low, medium, and high flows
- Document thoroughly
  - include reference volume, testing flow rate, meter totalizer reads, all meter information
  - compile data in analysis-friendly format

Small Meter Testing Programs

3

Analyze & Apply Test Results

- Organize all test results
- Analyze accuracy findings *
- Consider confidence limits
- Calculate Apparent Loss Volumes

Small Meter Testing Programs

Meter Size	Meter Population	Test Sample Size	Volume-Weighted Average Accuracy	95% Confidence Limit of Accuracy
5/8”	13,548	66	92.0%	4.0%
3/4”	1,392	10	98.5%	0.4%
1”	2,145	20	96.9%	2.3%
1-1/2”	311	5	94.0%	3.8%
2”	391	13	97.6%	1.7%

Small Meter Testing Programs

- Value of random sampling
- Average across different flow rate results
- Add layer of consumption to calculate Apparent Losses due to meter inaccuracy

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- Appreciate spread of results, confidence limits
- Tread carefully re: correlations
- Continue to test for more insight

Large Meter Testing Programs

- Fewer, more important meters!
- Individual assessment
- Prioritize by consumption
- Flow profiling is key

1. Design Meter Test Sample
2. Test Meters
3. Analyze & Apply Results

Test Your Knowledge

Customer Meter Testing

Summary Review & Wrap-Up

Workshop Evaluation