Identifying & Addressing Water Loss Using the AWWA M36 Audit Tools

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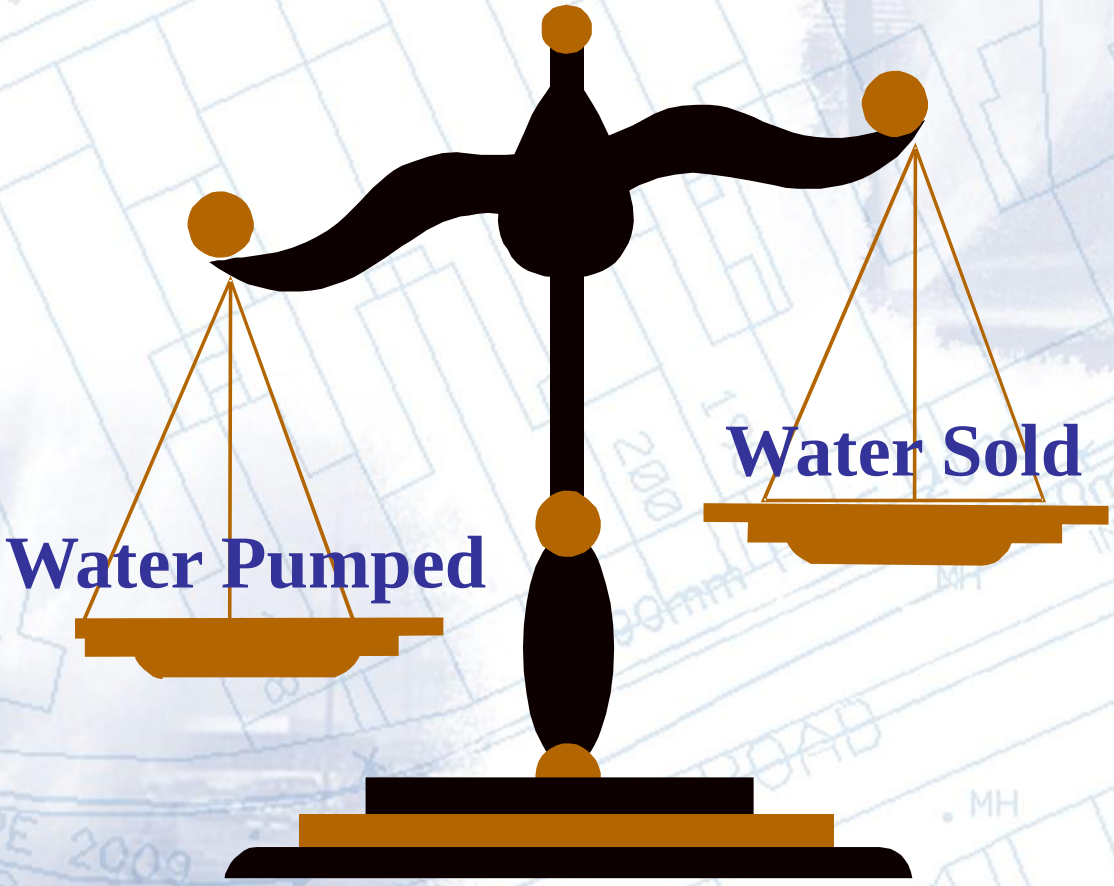
M.E. SIMPSON Co., Inc.

Outline

- Review of Water Audit Process
- Understanding the terminology
- Identifying the issues
- Developing an action plan

WATER LOSS?

Gallons of water being pumped into the distribution system each billing period exceeds the gallons being sold.

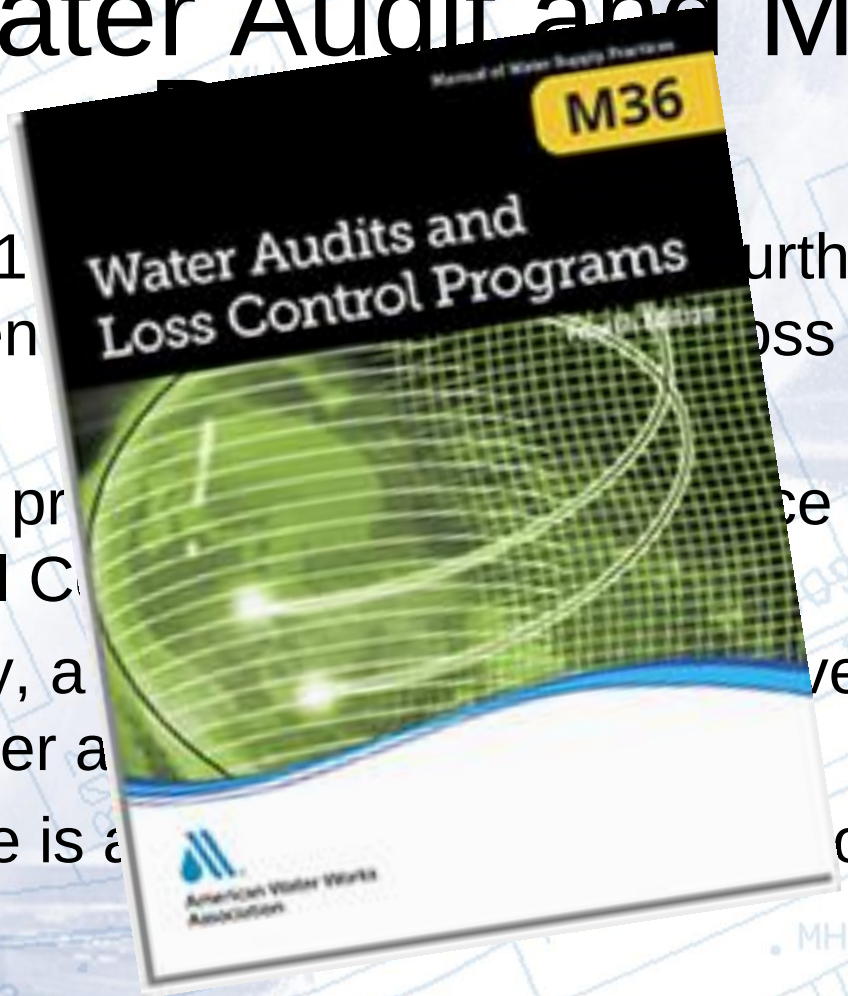


Water Audit Process: A Top Down Approach

- Advantage: quickly pulls together data and information that is readily available.

- Disadvantage: for most water utilities, incomplete or inaccurate data *limits the validity* of the top-down water audit.

Water Audit and M36



- In April, 2021 urth edition of Manual 36 en oss Control Programs
- Manual was pr ce of the Water Loss Control C
- Concurrently, a veloped updated water a
- The software is a on their website

How the Audit Works

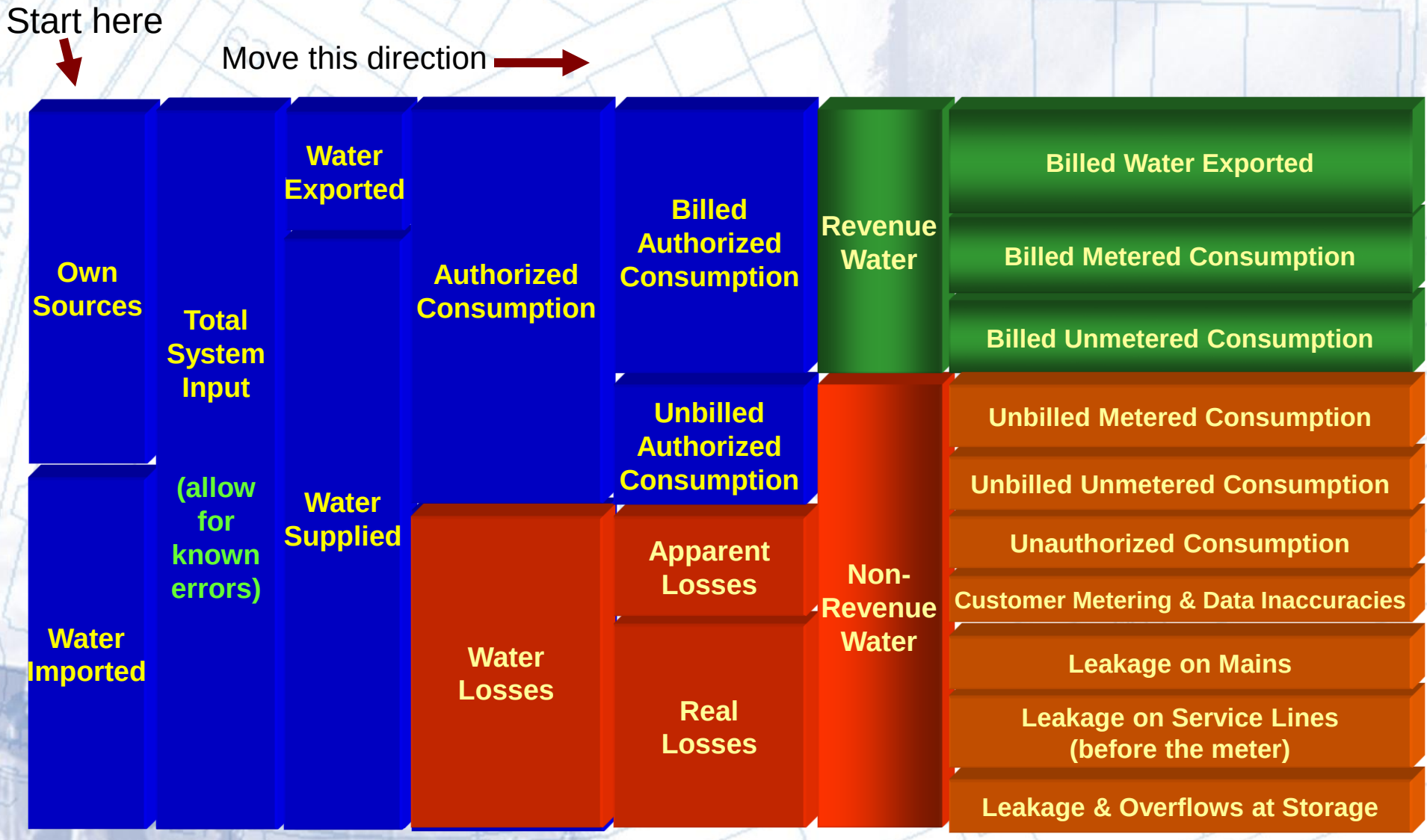
Water Supplied – Authorized Consumption = Water Loss

Authorized Consumption = Billed Metered + Billed Unmetered + Unbilled Metered + Unbilled Unmetered

Water Loss = Apparent Losses + Real Losses

Each area has various components that can be analyzed (Thus the term: Component Analysis)

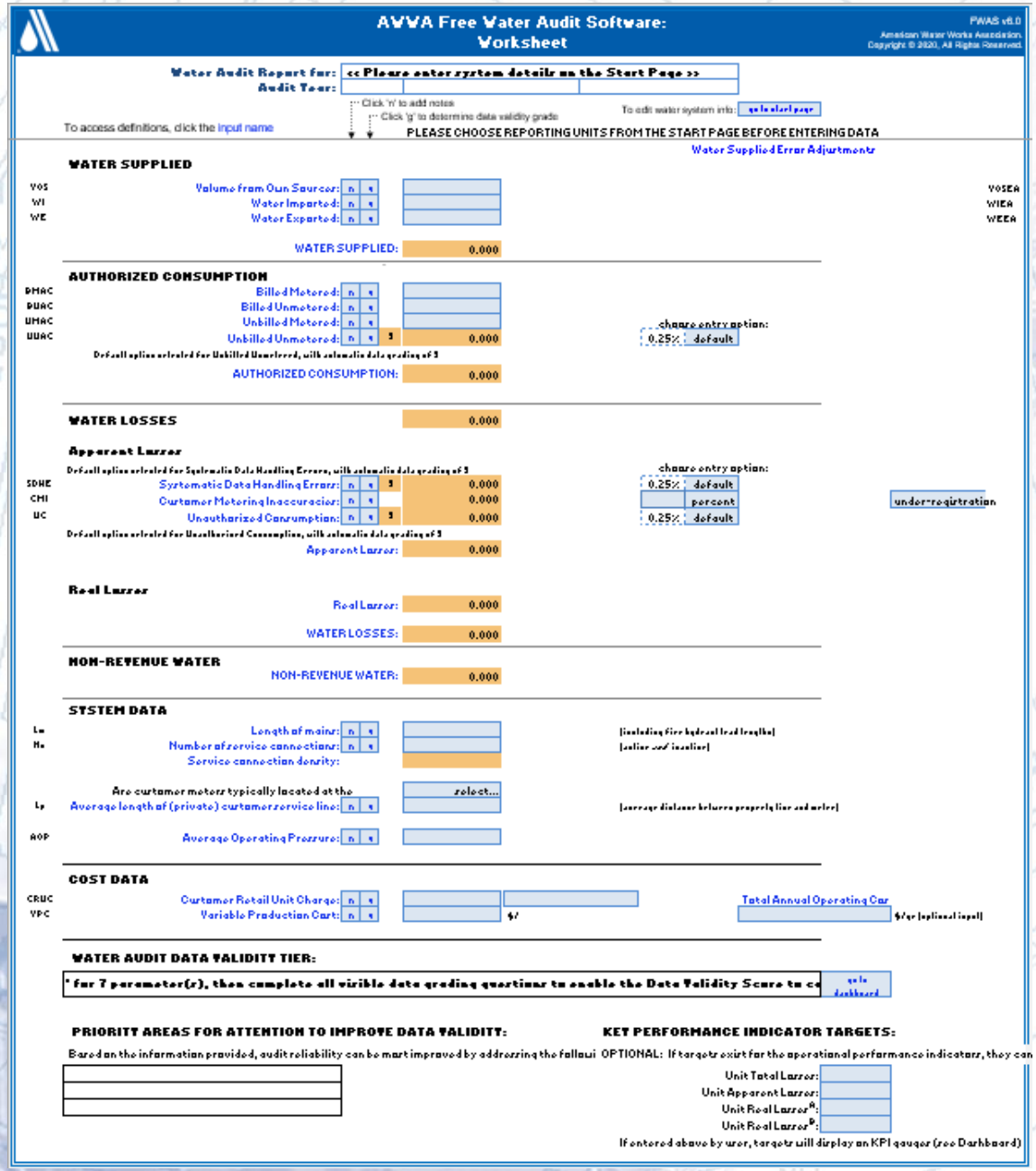
Standard Water Balance Format



FWAS Version 6

- Released in 2020
- Improves the DVG Process
- Improved and Enhanced Dashboard
- Benchmarking Feature

Version 6 Worksheet



AWWA Free Water Audit Software: Worksheet

PWAS v6.0
American Water Works Association.
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Water Audit Report for: << Please enter system details on the Start Page >>
Audit Year:

Click 'n' to add notes
Click 'g' to determine data validity grade
To edit water system info: go to start page

To access definitions, click the input name

PLEASE CHOOSE REPORTING UNITS FROM THE START PAGE BEFORE ENTERING DATA

Water Supplied Error Adjustments

WATER SUPPLIED

VOS	Volume from Own Sources:	n	q		VOSEA
WI	Water Imported:	n	q		WIEA
WE	Water Exported:	n	q		WEEA
	WATER SUPPLIED:			0.000	

AUTHORIZED CONSUMPTION

BMAC	Billed Metered:	n	q		
BUAC	Billed Unmetered:	n	q		
UMAC	Unbilled Metered:	n	q		
UUAC	Unbilled Unmetered:	n	q	0.000	
	AUTHORIZED CONSUMPTION:			0.000	

choose entry option: 0.25% default

Default option selected for Unbilled Unmetered, with automatic data grading of 5

WATER LOSSES 0.000

Apparent Losses

Default option selected for Systematic Data Handling Errors, with automatic data grading of 5

SDHE	Systematic Data Handling Errors:	n	q	0.000	
CMI	Customer Metering Inaccuracies:	n	q	0.000	
UC	Unauthorized Consumption:	n	q	0.000	
	Apparent Losses:			0.000	

choose entry option: 0.25% default; percent; 0.25% default

under-registration

Default option selected for Unauthorized Consumption, with automatic data grading of 5

Real Losses

	Real Losses:			0.000	
	WATER LOSSES:			0.000	

NON-REVENUE WATER

	NON-REVENUE WATER:			0.000	

SYSTEM DATA

Lm	Length of mains:	n	q		[including fire hydrant lead lengths]
Nc	Number of service connections:	n	q		[active and inactive]
	Service connection density:				
	Are customer meters typically located at the			select...	
Lp	Average length of (private) customer service line:	n	q		[average distance between property line and meter]
AOP	Average Operating Pressure:	n	q		

COST DATA

CRUC	Customer Retail Unit Charge:	n	q			Total Annual Operating Cost
VPC	Variable Production Cost:	n	q		$/kL	$/yr [optional input]

WATER AUDIT DATA VALIDITY TIER:

* for 7 parameter(s), then complete all visible data grading questions to enable the Data Validity Score to ca — go to dashboard

PRIORITY AREAS FOR ATTENTION TO IMPROVE DATA VALIDITY:

Based on the information provided, audit reliability can be most improved by addressing the following:

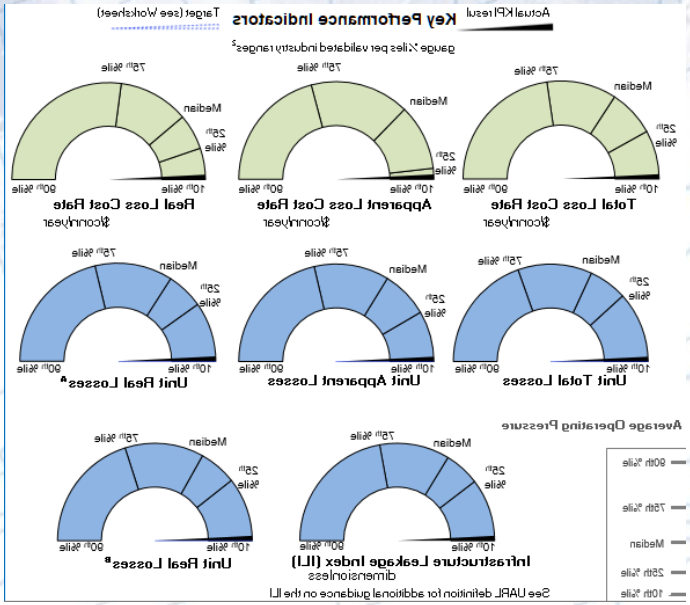
KEY PERFORMANCE INDICATOR TARGETS:

OPTIONAL: If target exist for the operational performance indicators, they can be entered below:

Unit Total Losses:	
Unit Apparent Losses:	
Unit Real Losses[a]:	
Unit Real Losses[a]:	

If entered above by user, targets will display on KPI gauges (see Dashboard)

Performance Indicators



How to Get the Free AWWA Water Audit Software

- Go to awwa.org
- Select Water Loss Control from the Resource and Tools menu
- Scroll down to the Tools for Water Audit Analysis and select AWWA Free Water Audit Software (v6.0 2020)
- Fill out online form (name, address, etc.) to download the FWAS v6

Completing the Water Audit

Decide *who* will be in charge of the Audit for the Utility. Form a Committee. Input needed from:

- Water Production
- Billing
- Distribution
- GIS
- Engineering

Proper input is needed from everyone to ensure success!

How To Calculate Non Revenue Water

- **Step One**: Perform a Water Audit using the AWWA Water Audit Software.
- **Step Two**: Validate the results

What exactly is Non Revenue Water?

Apparent Losses

+

Real Losses

+

Unbilled Metered Consumption

+

Unbilled Unmetered Consumption.

This is water which does not provide ***revenue potential* to the utility.

Term definitions created by the IWA/AWWA

Why is Non Revenue Water a better term to use than “Unaccounted for Water” ?

Apparent Losses
+
Real Losses
+
Unbilled Metered Consumption
+
Unbilled Unmetered Consumption.

(**This is water which does not provide ***revenue potential*** to the utility.)

“Unaccounted for Water” (usually expressed as a % of total water produced as “lost water”) is a term that is confusing.

Does not give a clear understanding of

- What the losses are
- Where the losses are occurring

Definitions

Apparent Losses - unauthorized consumption + customer metering inaccuracies + systematic data handling errors

Apparent Losses are all types of inaccuracies associated with customer metering (worn meters, improperly sized meters, wrong type of meter for the water usage profile), systematic data handling errors (meter reading, billing, archiving and reporting), plus unauthorized consumption (theft or illegal use).

NOTE: Over-estimation of Apparent Losses results in under-estimation of Real Losses. Under-estimation of Apparent Losses results in over-estimation of Real Losses.

Definitions

Real Losses

Physical water losses from water system (water mains and customer service connections) and the utility's storage tanks, up to the point of customer consumption. In metered systems this is the customer meter, in unmetered situations this is the first point of consumption (stop tap/tap) within the property. The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows.

Definitions

Unbilled Authorized Consumption

- Unbilled Metered Consumption

  Metered consumption authorized by the water utility, but, for any reason, is deemed by utility policy to be *unbilled*. This includes metered water consumed by the utility itself in treatment or distribution operations, or metered water provided to civic institutions free of charge. **It does not include water supplied to neighboring utilities (water exported) which may be metered but not billed.**

- Unbilled Unmetered Consumption.

Definitions

Unbilled Authorized Consumption

- Unbilled Metered Consumption
- Unbilled Unmetered Consumption.

Authorized Consumption not billed or metered. Includes water for fire fighting, flushing of water mains and sewers, street cleaning, fire flow tests, etc.

This often includes use at the Utilities facilities- plant, parks, offices, etc.

In most water utilities it is a small component which is very often substantially overestimated.

What data do I need?

Water Supplied

- Well meter data (Million gallons per year)
- Data from meter testing and calibrations and year completed
- Million gallons per year of water purchased (if any)
- Million gallons per year of wholesale water sold (if any)

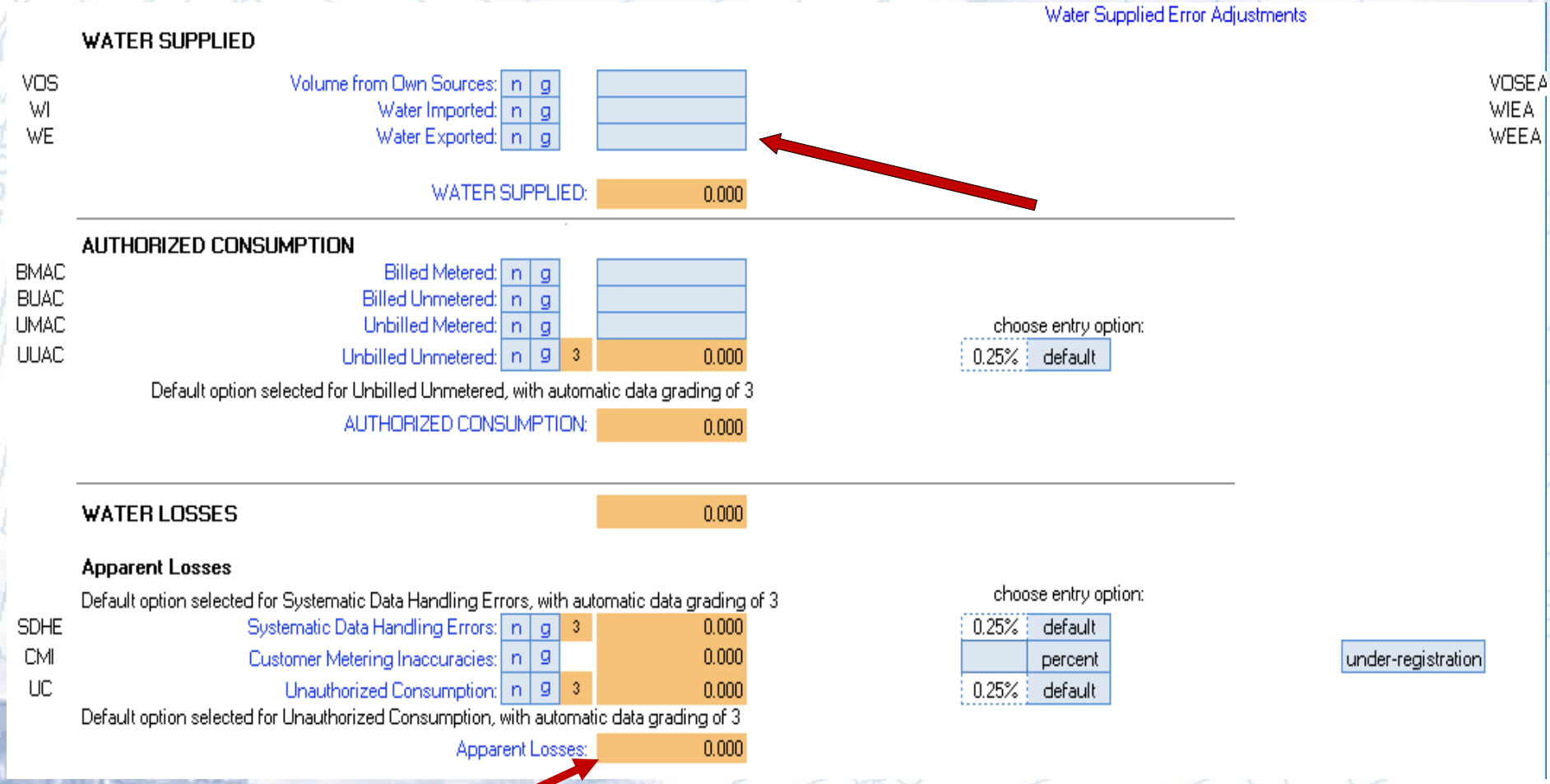
What data do I need?

Authorized Consumptions

- Million gallons per year of water delivered and billed - metered
- Million gallons per year of water delivered and billed – unmetered
- Million gallons per year of water delivered but unbilled – metered
- Million gallons per year of water delivered but unbilled – unmetered

Where is the data entered?

– Look for the light blue boxes in the spreadsheet

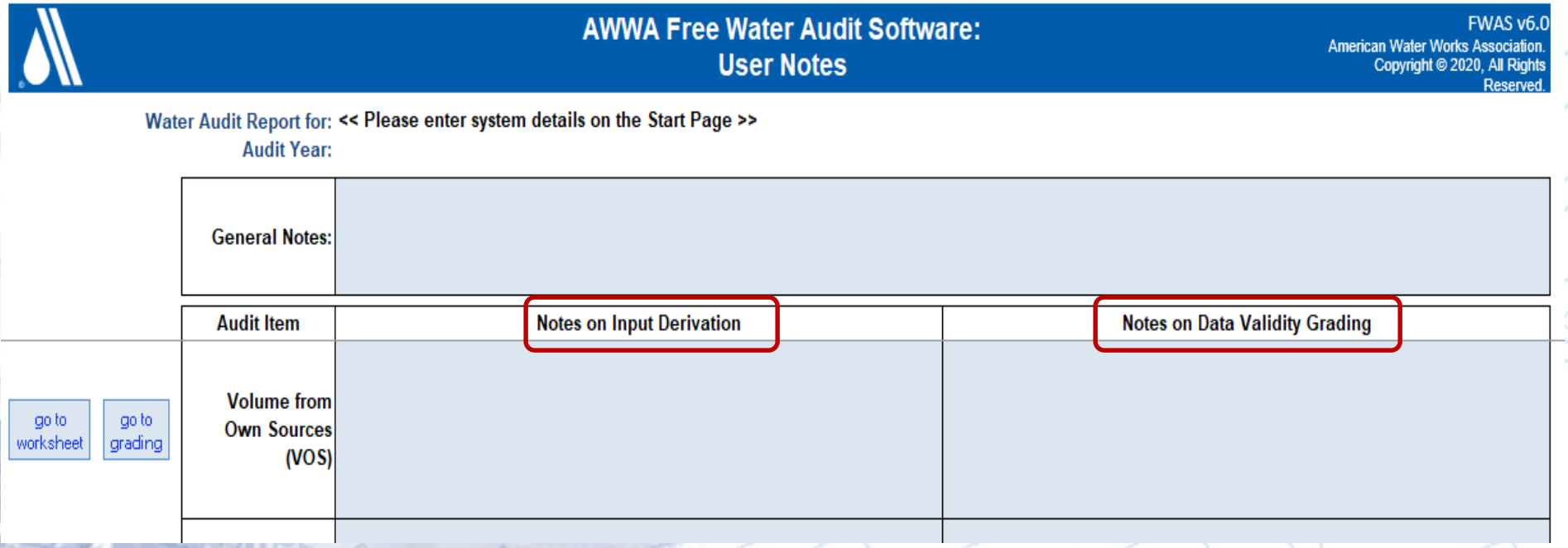


The tan boxes are calculations that will be filled after the data is entered

Keeping Notes on the Data

The “N” stands for Notes. This page opens when the auditor clicks on the “N”.

The Auditor can keep notes on Data Derivation as well as notes on items that affect Data Validity Grading



Grading the Data

By clicking on the “G” box the auditor can grade the data entry.

For V6 there is a different way to grade the data whereby the Auditor can easily grade the data *easier*… than V5.

V6 the new way: Grading the data: an example

- How many miles of mains are in the system?

Enter your data on the worksheet, then Click on the "g" and the *Interactive Data Grading* comes up. Answer a few questions and the data Grade gets scored.

SYSTEM DATA

Length of mains:	n	g	
Number of service connections:	n	g	
Service connection density:			

Some Water
2020

AWWA Free Water Audit Software: Interactive Data Grading

acronym key

VOS	VOSEA	WI	WIEA	WE	WEEA	BMAC	BUAC	UMAC	UUAC
SDHE	CMI	UC	Lm	Nc	Lp	AOP	CRUC	VPC	

Limiting criteria (see Start Page for details)

White = incomplete
Orange = complete
Use acronyms for navigation

go to input

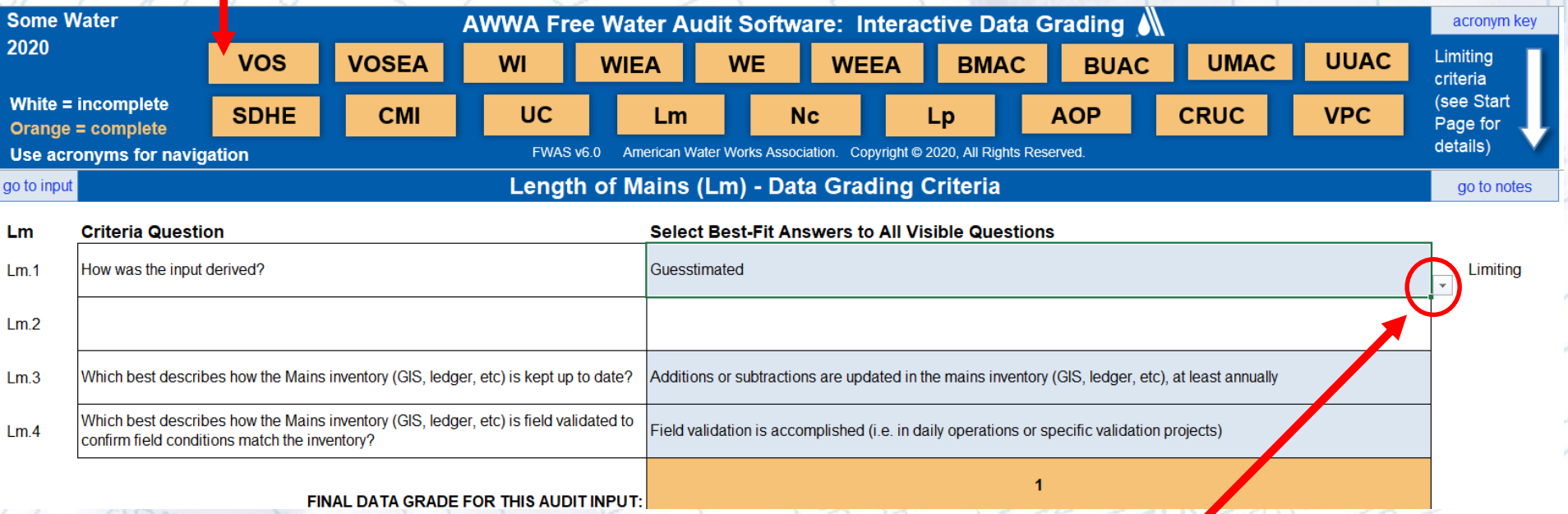
Length of Mains (Lm) - Data Grading Criteria

go to notes

Lm	Criteria Question	Select Best-Fit Answers to All Visible Questions
Lm.1	How was the input derived?	Derived directly from Mains inventory (GIS, ledger, etc)
Lm.2	Are hydrant laterals included in the input derivation?	Yes
Lm.3	Which best describes how the Mains inventory (GIS, ledger, etc) is kept up to date?	Additions or subtractions are updated in the mains inventory (GIS, ledger, etc), at least annually
Lm.4	Which best describes how the Mains inventory (GIS, ledger, etc) is field validated to confirm field conditions match the inventory?	Field validation is accomplished (i.e. in daily operations or specific validation projects)
	FINAL DATA GRADE FOR THIS AUDIT INPUT:	**10**

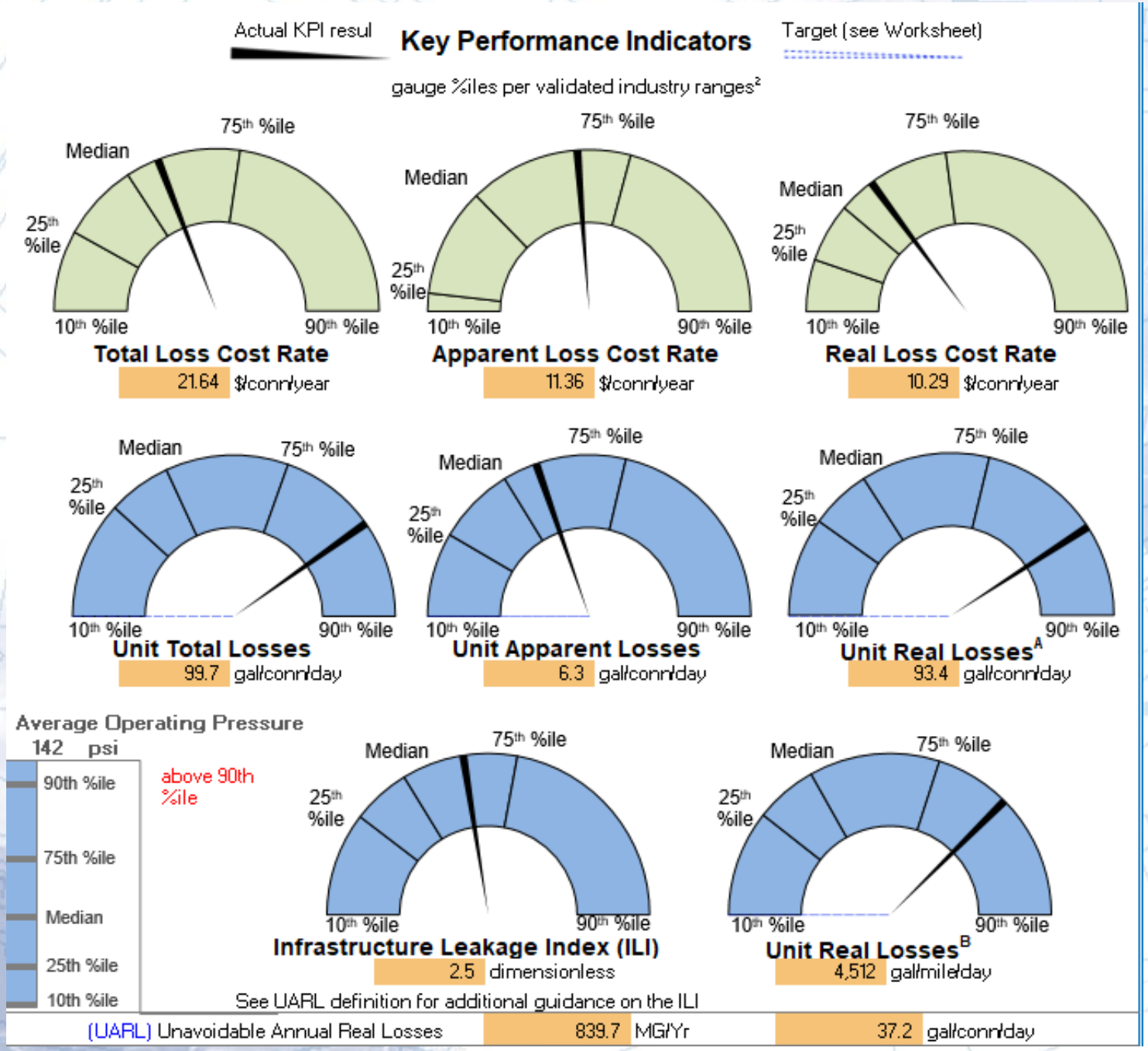
V6 the new way: Grading the data: an example

- Shaded squares when clicked will take you to that particular DVG question page. (Orange = completed, white = incomplete.)



Drop down answer lists for each question provide a list of choices for automatic DVG generation.

New way: 8 Key Performance Indicators



New Key Performance Indicators

Guidance Information for Key Performance

- The eight indicators shown are the recommended suite per the AWWA Water Loss Control Committee 2020 Position on KPIs[1].
- A suite of KPIs is necessary, as no single KPI can holistically communicate water loss performance for a given water system.
- See Table 1 below for Uses and Limitations for each KPI, excerpted from the AWWA Water Loss Control Committee Report (2020)[1], with naming conventions updated.
- Percentiles (%iles) shown on KPI gauges come from Level 1 validated data in the AWWA WLCC Reference Water Audit Dataset (2020)[2].
- KPI %iles shown above are not segregated by cohorts. Limited KPI data by cohorts may be found in WRF 4695 Guidance Manual, Appendix B (2019)[5].
- Actual KPI results that fall below 10th %ile or above 90th %ile do not necessarily imply error, but should be viewed with scrutiny.
- Percentiles not intended to imply targets. Targets may be input by user for operational KPIs, if desired, on Worksheet.
- See UARL and ILI in Definitions tab for discussion of size and pressure limitations.
- Systems that fall on the extreme ends of size or connection density should use caution when interpreting Unit Losses KPIs.

New Key Performance Indicators

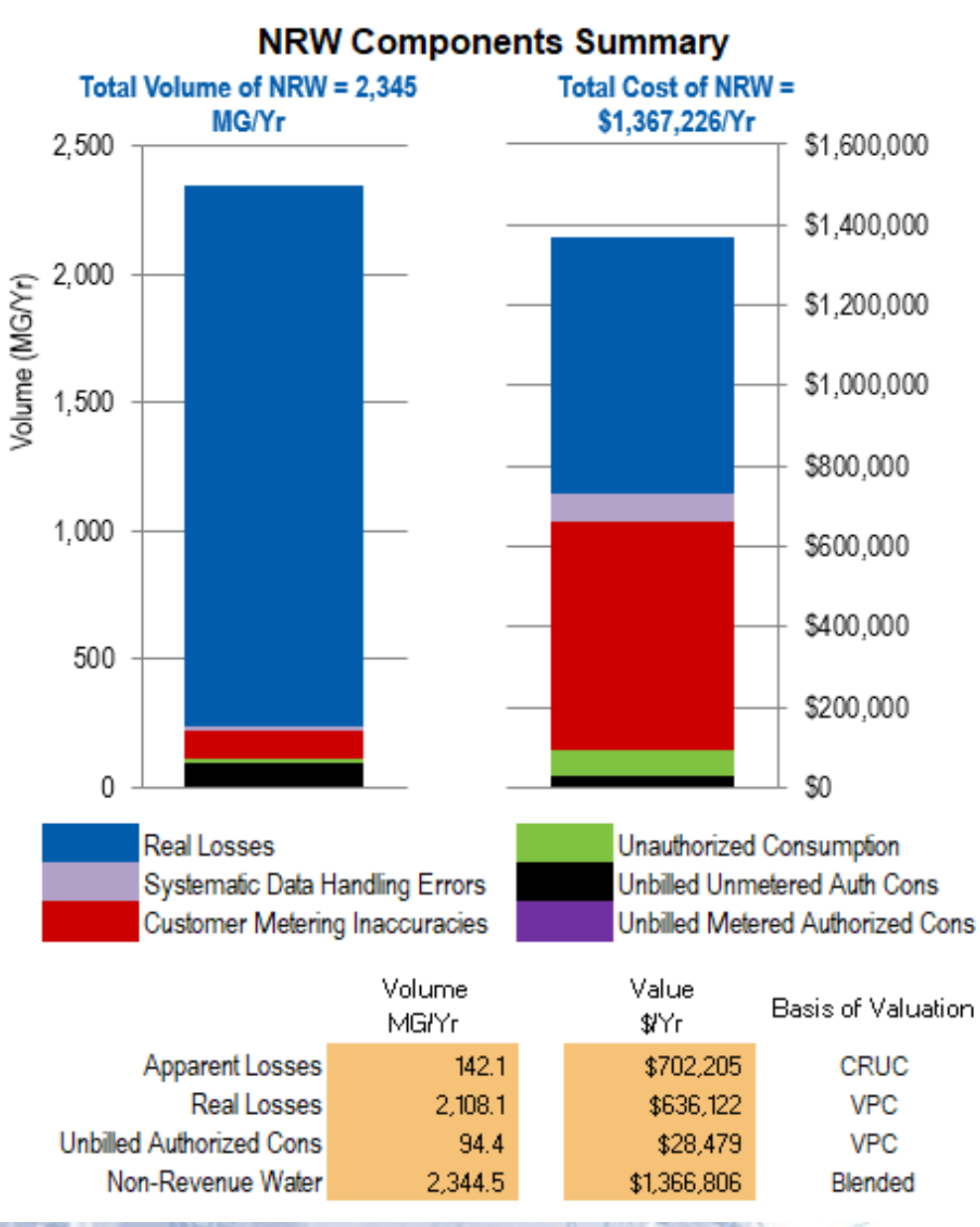
Table 1 Source: AWWA Water Loss Control Committee Report (2020)[1], with naming conventions updated

2020 AWWA Water Audit Method – Water Audit Outputs and Key Performance Indicators: Uses and Limitations

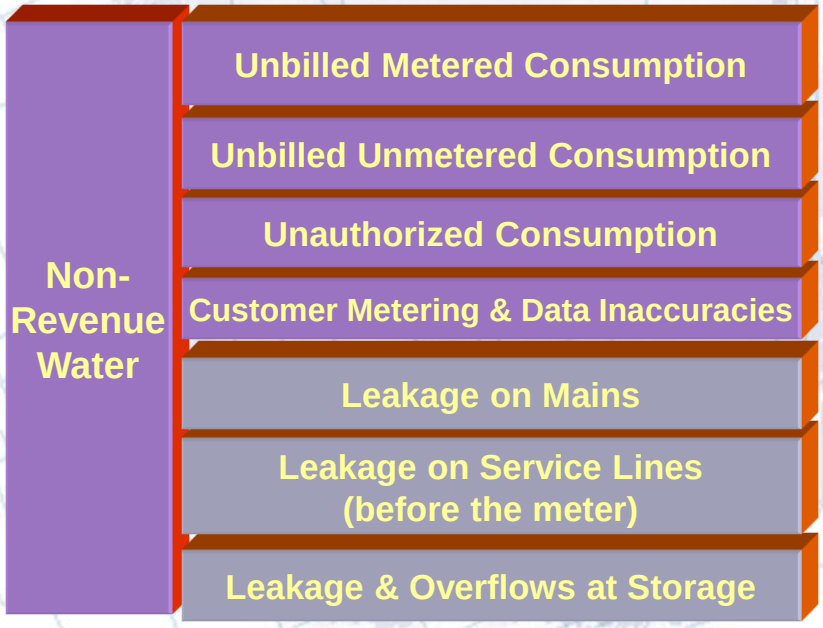
Type	Indicator	Description	Suitable Purposes					Uses and Limitations	Principal Users
			Assessment	Bench-Marking	Target-Setting	Planning	Tracking		
Attribute	Apparent Loss Volume	Calculated by Free Water Audit Software	✓				✓	Assess loss level	Utility, Regulators
	Apparent Loss Cost	Calculated by Free Water Audit Software	✓				✓	Assess cost loss level	Utility, Regulators
	Real Loss Volume	Calculated by Free Water Audit Software	✓				✓	Assess loss level	Utility, Regulators
	Real Loss Cost	Calculated by Free Water Audit Software	✓				✓	Assess loss cost level	Utility, Regulators
	Unavoidable Annual Real Loss (UARL)	Calculated by Free Water Audit Software	✓				✓	Reveal theoretical technical low level of leakage	Utility, Regulators
Volume	Unit Apparent Losses (vol/conn/day)	Strong and understandable indicator for multiple users.	✓	✓	✓	✓	✓	Used for performance tracking and target-setting	Utility, Regulators
	Unit Real Losses[A] (vol/conn/day)	Strong and understandable indicator for multiple users.	✓	✓	✓	✓	✓	Used for performance tracking and target-setting	Utility, Regulators, Policy Makers
	Unit Real Losses[B] (vol/pipeline length/ day)	Strong and understandable indicator for use by utilities with low connection density.	✓	✓	✓	✓	✓	Data collection and assessment of systems with "low" connection density	Utility, Regulators, Policy Makers
	Unit Total Losses (vol/conn/day) **New KPI**	Strong and understandable indicator, suitable for high-level performance measurement.	✓				✓	High level indicator for trending analysis. Not appropriate for target-setting or benchmarking	Utilities, Customers
	Infrastructure Leakage Index (ILI)	Robust, specialized ratio KPI; can be influenced by pressure and connection density.	✓	✓			✓	Benchmarking after pressure management is implemented	Utilities
Value	Apparent Loss Cost Rate (value/conn/year) **New KPI**	Indicators with sufficient technical rigor. Provide the unit financial value of each type of loss, which is useful for planning and assessment of cost efficiency of water loss reduction and control interventions and programs.	✓			✓	✓	Data collection and assessment on AWWA indicators or contextual parameters to use in conjunction with Loss Cost Rates	Utilities, Regulators, Customers
	Real Loss Cost Rate (value/conn/year) **New KPI**		✓			✓	✓		Utilities, Regulators, Customers
Validity	Data Validity Tier (DVT)	Strong indicator of water loss audit data quality, if data has been validated. Tier provides guidance on priority areas of activity.	✓	✓		✓	✓	Assess caliber of data inputs of the water audit	Regulators, Utilities

3 areas of Volume, Value, and Validity are highlighted here.

NRW Components



	Volume MG/Yr	Value $/Yr	Basis of Valuation
Apparent Losses	142.1	$702,205	CRUC
Real Losses	2,108.1	$636,122	VPC
Unbilled Authorized Cons	94.4	$28,479	VPC
Non-Revenue Water	2,344.5	$1,366,806	Blended

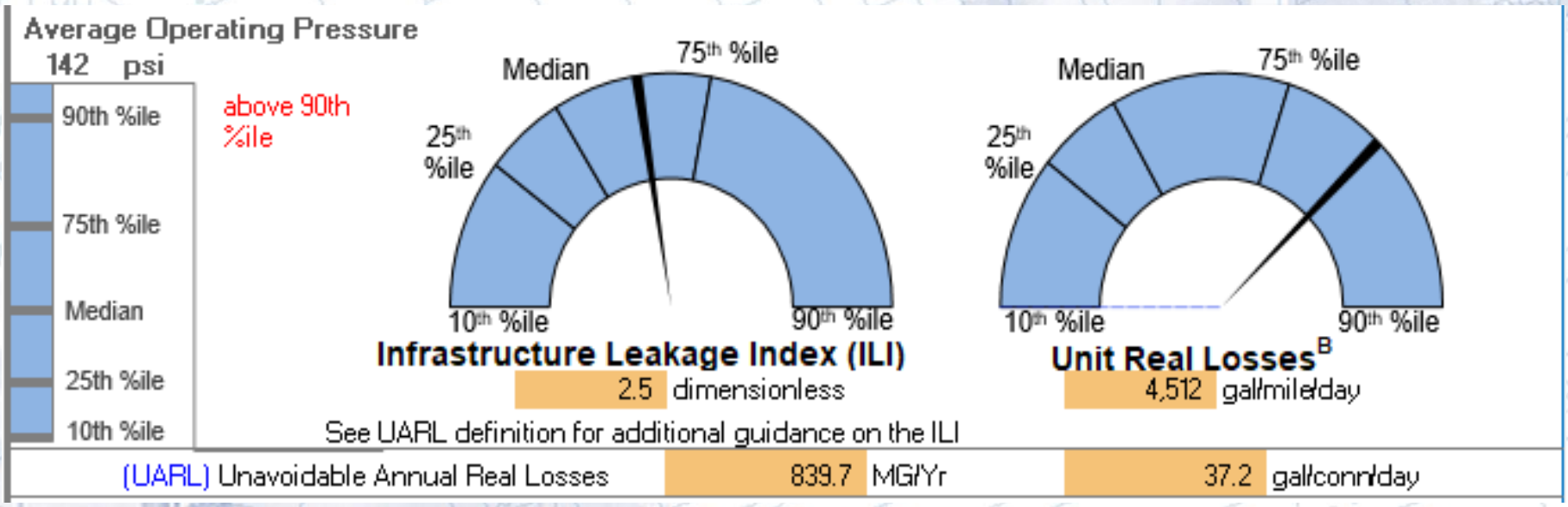


**NRW no longer defined as % of system Volume or as % of cost to operate system

ILI= infrastructure Leakage Index

ILI= CARL / UARL

CARL is taken from the calculated Real Loss for the year
UARL is the theoretical number calculated from PSI, service connection data, length of mains.



Interpreting the Grades: **ILI**

Remember that the ILI is a Ratio your existing Real Losses (CARL) to the theoretical level of Unavoidable Losses (UARL)

So the interpretation of the value of the ILI will be dependent on:

- Financial Considerations
- Operational Considerations
- Water Resource Considerations

*Refer to the Loss Control Planning tab

You should not have an ILI below a “1”.

Why? (you cannot have less Real loss than the Theoretical loss since the Theoretical loss is part of the Real Loss).

Water Balance Filled Out

AWWA Free Water Audit Software — FWAS v6.0

Water Balance

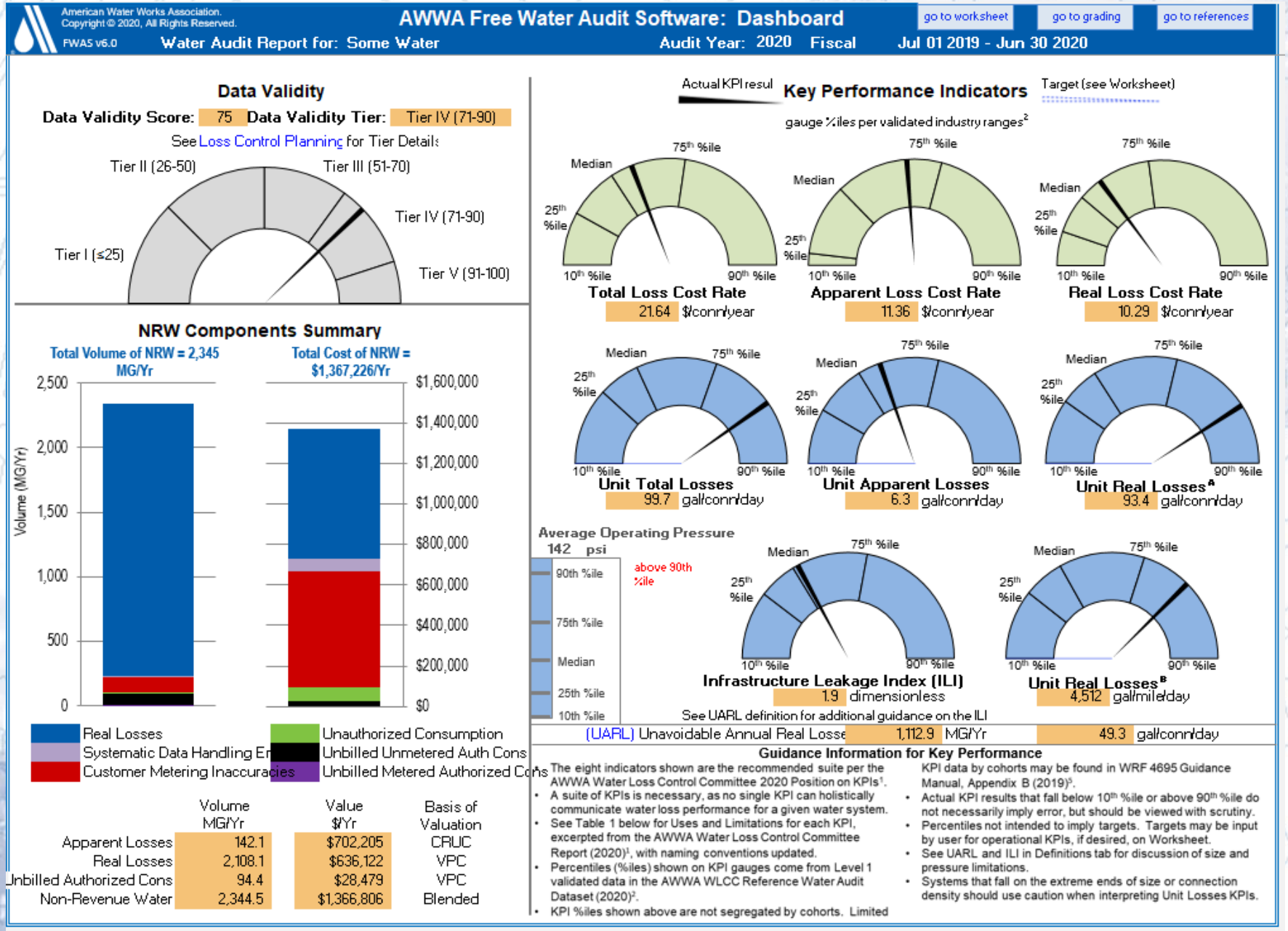
Water Audit Report for: Some Water

Audit Year: 2020 — Jul 01 2019 - Jun 30 2020

Data Validity Tier: Tier IV (71-90)

Volume from Own Sources (VOS) (corrected for known errors) 7,754.365	System Input Volume 7,754.365	Water Exported (WE) (corrected for known errors) 0.000	Billed Water Exported			Revenue Water (Exported) 0.000
		Water Supplied 7,754.365	Authorized Consumption 5,504.203	Billed Authorized Consumption 5,409.823	Billed Metered Consumption (BMAC) (water exported is removed) 5,409.823	Revenue Water 5,409.823
					Billed Unmetered Consumption (BUAC) 0.000	
				Unbilled Authorized Consumption 94.380	Unbilled Metered Consumption (UMAC) 4.260	Non-Revenue Water (NRW) 2,344.542
					Unbilled Unmetered Consumption (UUAC) 90.120	
			Water Losses 2,250.162	Apparent Losses 142.054	Systematic Data Handling Errors (SDHE) 13.525	
					Customer Metering Inaccuracies (CMI) 115.005	
					Unauthorized Consumption (UC) 13.525	
Water Imported (WI) (corrected for known errors) 0.000				Real Losses 2,108.108	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

Audit Dashboard…



Developing Water Loss Mitigation Plans

What do we tackle first?

Do we have “low-hanging fruit”?

Controlling Apparent Losses

- Measurement Technology
  - Accurate customer meters
  - Refined datalogging capability
  - Automatic Meter Reading gaining in use
- Improved Information Management
  - Customer Billing Systems
- Rational Policies
  - Service provision
  - Unauthorized consumption
  - Billing procedures
  - Use of fire hydrants

Apparent Loss VS Real Loss

- Can Apparent Losses be hidden as Real Losses?
- Inaccurate meters (especially for low flow registration)
  - Worn meters
  - Wrong sized meters
  - Fireline meters (DC, Fire meters)
  - Rural Water Systems

Controlling Meter Inaccuracies

- Meter Testing
- Meter Right Sizing
- Meter Change-outs
- Billing and reading errors

Apparent vs Real Losses

- What is that “low-hanging fruit”
- What can I reduce with the right investment?
- The components of Apparent Losses are always your starting point

Questions???

Thank YOU!!

Jeff Cunningham

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