Optimizing Performance & Accessing Funding to Improve Small Systems

A Special Training Program for Small Systems

Made Possible through the Collaborative Efforts of

American Water Works Association

PARTNERSHIP FOR CLEAN WATER

USDA

USDA Rural Development

Webinar Agenda and Learning Objectives

- Pre-Test
- Introductions and overview
- Introduction to Water Loss Control
- Conducting a Preliminary Self-Assessment
- How to apply for USDA funding
- Where to go for additional assistance after this workshop
- Post Test

Pre-Test

Application of Water Loss Control Practices

Water Loss Challenges of Small Systems

- Limited staffing – possibly no full-time employees
- Small customer/revenue base
- Long lengths of underground piping that serve relatively few customers
- Limited access to funding for capital improvements

Treated water reservoir in a small Pennsylvania system serving a population of 380 people

Non-revenue Water (NRW) Impacts

NRW doesn't return revenue to the water utility

NRW is comprised of:

- **Unbilled Authorized Consumption**
- **Apparent Losses**: the non-physical (paper) losses
- **Real Losses**: the physical losses (mainly leakage)

Losses cost money – with larger relative impacts on small systems

You are paying for your losses everyday!

Customer water meter illegally replaced with a "straight" pipe or meter "jumper"

Source: AWWA M36 Publication

The AWWA Standard Water Balance

A diagram that shows how the water flows – from source to customer: left to right

<table>
<tr><td rowspan="10">Volume from Own Sources (corrected for known errors)

Water Imported (corrected for known errors)</td><td rowspan="10">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="9">Water Supplied</td><td rowspan="3">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Customer Meter Inaccuracies</td></tr>
<tr><td>Unauthorized Consumption</td></tr>
<tr><td>Systematic Data Handling Error</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Water Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the point of customer metering</td></tr>
</table>

Note: All data in volume units for the period of reference, typically one year. The summed volumes in each column total to the water withdrawal volume for the audit year.

Unbilled Authorized Consumption

Water legitimately used at no charge

- Free water
- Allowable based upon your utility **policy** and/or **practices**

Fire hydrant flushing
Source: AWWA

Defining Apparent Losses

- Apparent Losses are the customer, or non-physical, losses that occur due to:
  - Customer metering inaccuracies
  - Systematic data handling errors in billing systems
  - Unauthorized consumption

Source: itthing.com

Defining Real Losses (leakage)

- **Real Losses: water unintentionally escapes the pressurized water distribution system, including:**
  - Transmission/Distribution system leaks
  - Leaks and overflows at storage tanks
  - Leaks on customer service connections

Source: AWWA M36 publication

Water Losses = Apparent Losses + Real Losses

***All* water utilities have losses – both real and apparent – only the extent and costs of the losses vary.**

Cast Iron pipe joint leak

Tampered AMR meter reading device

Photos Source: Philadelphia Water Dept.

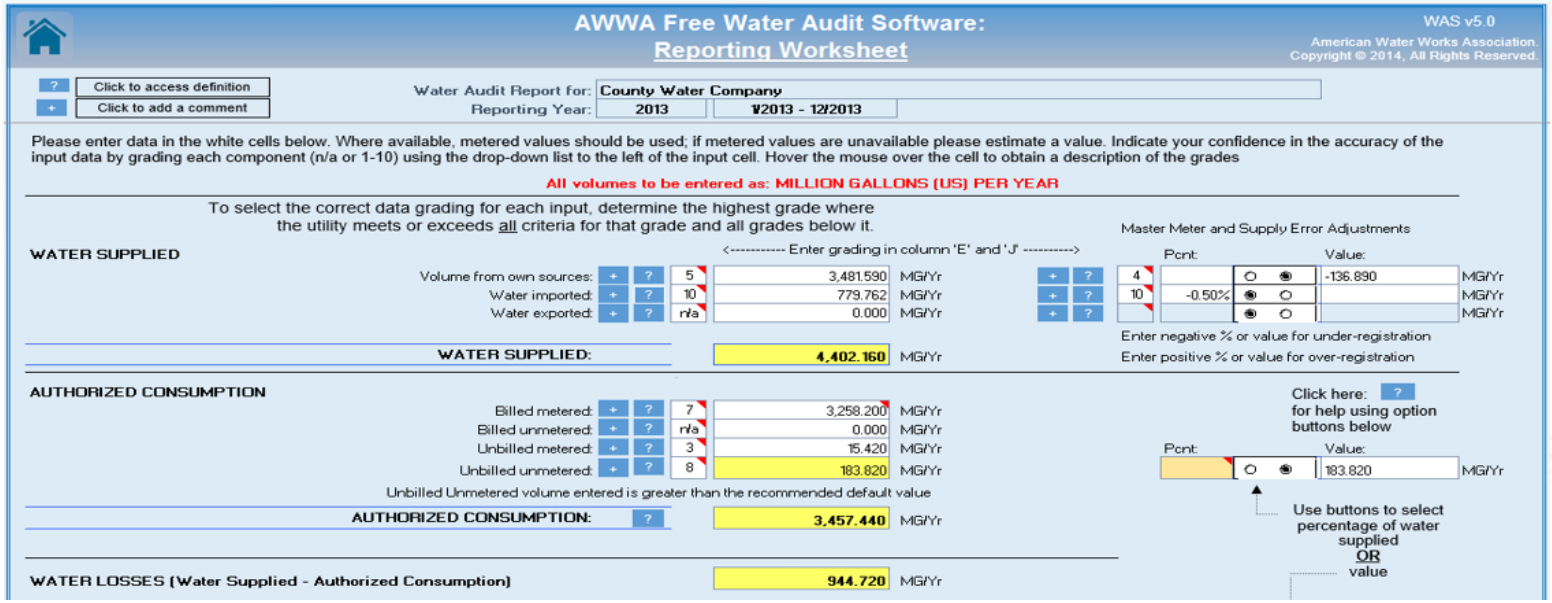
The Water Audit

The "Water Audit" is defined as:

- A method that tracks water supply volumes, customer consumption, and losses in a water utility. The key inputs:
  1. Annual volume supplied to the water system (from production flowmeters)
  2. Annual volume billed to customers (from customer meters/billing system)
  3. Subtract item 2 from item 1 to calculate Non-revenue water
- Water Audit reveals the type, amounts, and costs of utility losses

AWWA Free Water Audit Software

Reporting Worksheet (Top Portion)



AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association.
Copyright © 2014, All Rights Reserved.

? Click to access definition
+ Click to add a comment

Water Audit Report for: County Water Company
Reporting Year: 2013 ¥2013 - 12/2013

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

<---------- Enter grading in column 'E' and 'J' ---------->

Master Meter and Supply Error Adjustments

WATER SUPPLIED				Pcnt:	Value:	
Volume from own sources:	5	3,481.590	MG/Yr	4	-136.890	MG/Yr
Water imported:	10	779.762	MG/Yr	10 -0.50%		MG/Yr
Water exported:	n/a	0.000	MG/Yr			MG/Yr
WATER SUPPLIED:		4,402.160	MG/Yr			

Enter negative % or value for under-registration
Enter positive % or value for over-registration

AUTHORIZED CONSUMPTION			
Billed metered:	7	3,258.200	MG/Yr
Billed unmetered:	n/a	0.000	MG/Yr
Unbilled metered:	3	15.420	MG/Yr
Unbilled unmetered:	8	183.820	MG/Yr
AUTHORIZED CONSUMPTION:		3,457.440	MG/Yr

Unbilled Unmetered volume entered is greater than the recommended default value

Click here: ? for help using option buttons below

Pcnt: Value: 183.820 MG/Yr

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption) 944.720 MG/Yr

A free spreadsheet tool from the AWWA website: used to compile the standard water audit

Google "Water Loss Control" (Training on the AWWA Free Water Audit Software is provided in other training classes)

Application of Water Loss Control Practices

Water Audit Performance Indicators

How much water loss do you have?

10%?

- 10%

Negative water loss? (Sorry, this is not physically possible!)

20%?

Historically, this question was answered using a percentage

50%?

100%?

0%

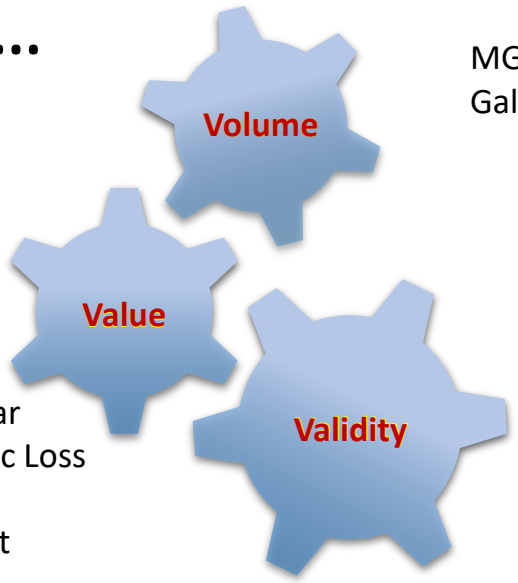
"we have no loss!"

But percentages don't work because:

- *They are mathematically skewed by changes in customer consumption*
- *They don't reveal the individual components of (NRW)Non-revenue water – the annual volume of Apparent and Real Losses*
- *They reveal nothing about the cost impacts of the Losses*
- *Percentages are not actionable – a percentage doesn't tell you which loss to control and to what degree*

Better Way to Assess Water Loss and its Impacts

The Three V's…



MG per Year
Gal/connection/day

$ per Year
Economic Loss
Real and
Apparent

AWWA Free Water Audit Software's
Data Input Grading
Water Audit Data Validity Score

Measuring Water Loss: Volume and Cost

- Assessing annual loss volumes
  - **Apparent Losses**
  - **Real Losses**
- Assessing annual cost impacts of losses
  - **Apparent Loss costs**: **potential uncaptured revenue**
  - **Real Loss costs**: **usually excessive production costs**

	Apparent Losses:	208.225	MG/Yr
+	Real Losses:	736.495	MG/Yr
=	**Water Losses:**	**944.720**	MG/Yr

Example of AWWA Free Water Audit Software listing annual Apparent and Real Loss volumes

Example of AWWA Free Water Audit Software listing annual Apparent and Real Loss cost impacts

Annual cost of Apparent Losses:	$821,449	
Annual cost of Real Losses:	$139,934	Valued at **Variable Production Cost**
		Return to Reporting Worksheet to change this assumpiton

Recommended NRW Performance Indicators

"per customer" approach – losses divided by # of customer service connections

- **Apparent losses normalized**, gal/service connection/day - **median value 5.40 gal/conn/day***
- **Real loss normalized** (2 forms: standard and low connection density)
  - gal/service connection/day: for more than 32 service conn per mile - median value 66.47 gal/conn/day*
  - gal/mile of pipeline/day: for less than 32 conn per mile (*low service connection density* utilities, which includes many small water utilities) - **median value 1,401.4 gal/mile/day***

Ideally, each water utility should target a low loss level that is economic for them

However, Atlanta, GA region set leakage goals at 60 gal/connection/day or 35 gal/connection/day for medium-sized and large utilities to reach by 2025.

***From a validated dataset of 24 small Pennsylvania water utilities**

Application of Water Loss Control Practices

Quiz 1

Quiz 1

1. Non-revenue Water is comprised of:

_____

_____

_____

Quiz 1

1. Non-revenue Water is comprised of:

Unbilled Authorized Consumption

Apparent losses

Real losses

Quiz 1

2. Apparent Losses are comprised of:

_____

_____

_____

Quiz 1

2. Apparent Losses are comprised of:

Unauthorized consumption

Customer metering inaccuracies

Systematic data handling error

Quiz 1

3. Real Losses are comprised of:

_____

_____

_____

Quiz 1

3. Real Losses are comprised of:

Transmission and distribution piping leaks

Leaks and overflows on storage tanks and reservoirs

Leaks on customer service connections

Quiz 1

4. True or False: all water distribution systems incur some amount of leakage

   A. True

   B. False

Quiz 1

4. True or False: all water distribution systems incur some amount of leakage

   A. True

   B. False

Application of Water Loss Control Practices

Production Flowmeters and Supply Data Management

Production Flowmeters Used in Water Utilities

- **Meters used in high flowrate applications**
  - Venturi meters
  - Orifice meters
  - Magnetic meters
  - Ultrasonic meters
- **Meters used in medium/low flowrate applications**
  - Turbine
  - Propeller
  - Positive Displacement

12-inch venturi meter

Differential Pressure (DP) cell, or transmitter

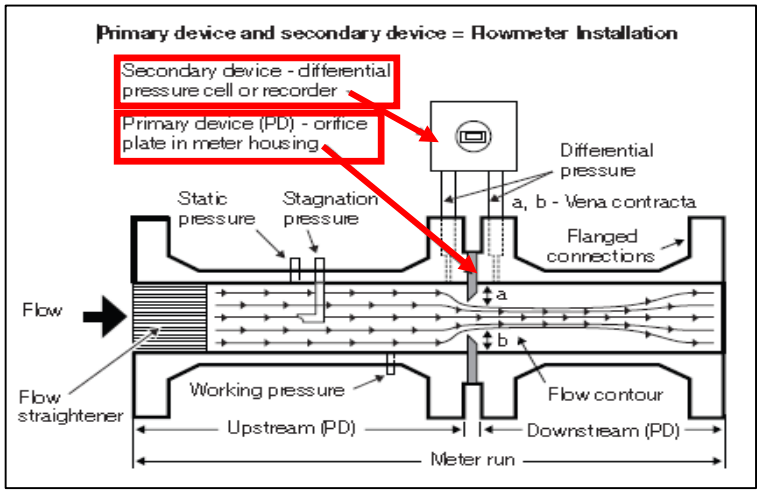
4-inch floating ball turbine meter installed in 2018

Production Meters
Selection, Installation and Accuracy Testing

- **Many production flowmeters installations are:**
  - The wrong type of flowmeter
  - Poorly sited
  - Lacking maintenance of the meter
  - Seldom tested for accuracy
  - Producing questionable data that is taken verbatim as accurate

Upstream and downstream 90-degree bends cramp 2-inch turbine meter layout

Flowmeter Accuracy Testing



Orifice Plate Flowmeter components
(Source: AWWA M36 Publication)

Verification vs. Calibration

- **Verification** confirms the accuracy of the primary device that measures the flow of water
- **Calibration** confirms the function of the secondary device: a differential pressure cell, chart recorder, or similar device
- Many water utilities calibrate their secondary devices, but do not verify the primary device by meter accuracy testing.

Bank of Differential Pressure Cells connected to flowmeters
(Courtesy of Louisville Water Company)

Flowmeters Need Sufficient Unobstructed Space

- Best to have ample upstream and downstream distance free from obstructions for smooth flow
- Throttling line valves is not good practice!
  - Best to install a regulating valve (pressure reducing valve or similar) at sufficient distance downstream of the flowmeter if you need to significantly vary flows into the distribution system

Partially closed butterfly valve immediately downstream of flowmeter – not a good practice

Venturi flowmeter

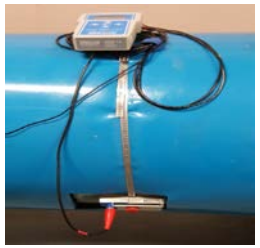
Testing Flowmeters for Accuracy

Accuracy testing is very important because:

- These meters measure the largest volume in the water audits
- Even a small degree of error can affect water audit numbers

Testing techniques

- Large flowmeters - use insertion or strap-on portable meters in series with host meter
- Smaller flowmeters – can use truck mounted meter tester (same as testing large customer meters), or
- Small flowmeters – rotate out and test at meter accuracy test bench (although in-situ conditions are lost)



Portable strap-on ultrasonic meter to measure flow to compare with host meter

Meter testing via truck mounted apparatus (Courtesy of Louisville Water Company)

Data Error in a Small System

Utility was double-counting production water volumes – adding the same reading from 2 output devices connected to a single flowmeter in a chamber.

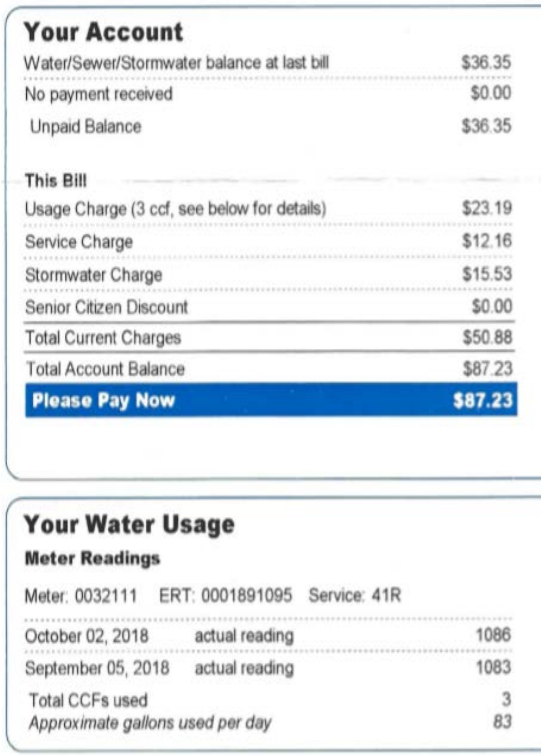
- A small system was double-counting their production flows, making their reported losses appear to be extremely high
- Confirm that your production flow values appear to match the reality of the amount of water demand in your system

Application of Water Loss Control Practices

Controlling Apparent Losses: Metering and Billing System Management

Cost of Apparent Losses

- The customer gets water, but the (full) amount is not billed.
- Valued at the Customer Retail Unit Charge (CRUC), in dollars per 1,000 gal, or dollars per 100 cubic feet (ccf)
- Apparent Losses mean:
  - Utilities don't capture all of the revenue they are entitled
  - The total customer consumption for the year is under-stated
  - An equity issue exists: paying customers shoulder the burden of the customers that under-pay, or pay nothing at all



Your Account

Water/Sewer/Stormwater balance at last bill	$36.35
No payment received	$0.00
Unpaid Balance	$36.35
This Bill	
Usage Charge (3 ccf, see below for details)	$23.19
Service Charge	$12.16
Stormwater Charge	$15.53
Senior Citizen Discount	$0.00
Total Current Charges	$50.88
Total Account Balance	$87.23
Please Pay Now	**$87.23**

Your Water Usage

Meter Readings

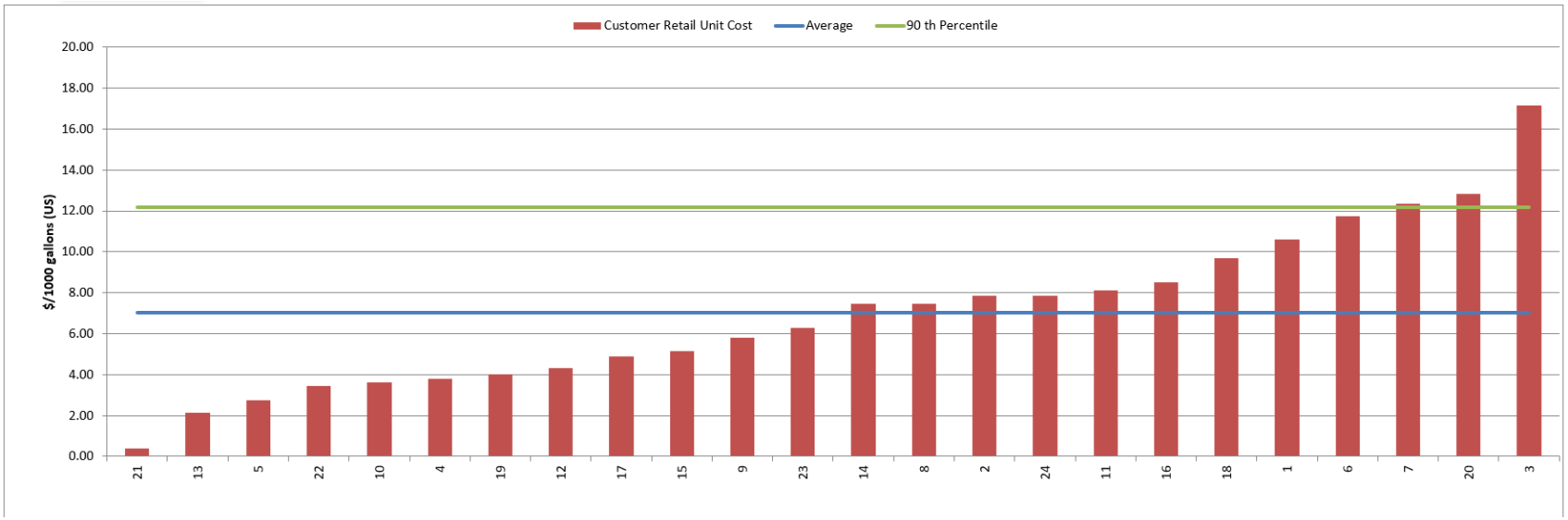
Meter: 0032111 ERT: 0001891095 Service: 41R

October 02, 2018	actual reading	1086
September 05, 2018	actual reading	1083
Total CCFs used		3
Approximate gallons used per day		*83*

Typical monthly water bill in hundred cubic feet, ccf

Customer Retail Unit Charge (CRUC)

for 24 Pennsylvania Small Systems



Average $6.88 per 1,000 gallons

(But the CRUC can vary widely across the USA)

Customer Metering Inaccuracies

Water meters entered use in the USA in the early 1900's

This became common practice in the USA, but not everywhere in the world

Customer metering is beneficial because:

- It attaches a price to the volume of water consumed
- It can limit waste by measuring inordinately high flows
- It provides data on the water using habits of the customer population needed for planning and operational purposes

Source: Badger Meter

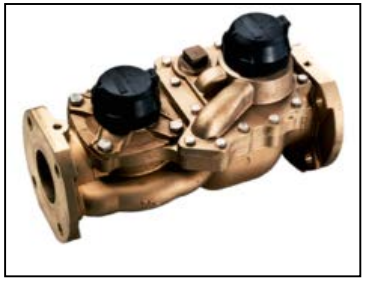
Customer Metering Inaccuracies

Water Meters are Important Assets to be Managed

Accurate metering depends on:

- Proper meter type, selection and installation
- Proper meter sizing
- Periodic maintenance, accuracy testing, and repair or replacement of the meter

Positive Displacement Meter



Compound Meter

Apparent Losses – Unauthorized Consumption

What is shown in this photo?

A network of unauthorized connections in a developing country

Other examples: tampering with fire hydrants, tampering with customer meters, unauthorized opening of bypass valves around large customer meters, illegal restoration of shut-off services

Apparent Loss Control in Small Systems

1. **Residential customers, typically 5/8-inch water meters in small systems**
   - Expect water use around 3,500 – 3,800 gallons per month per connection
   - Low consumption (under 3,000 gal/month/customer) may indicate under-registering water meters
   - It may be time to replace customer meters, especially if they are old (over 20 years)
2. **Large meter customers, larger than 1-inch (commercial, industrial)**
   - Look at 2-inch, 3-inch, and larger older, traditional turbine meters, which may be over-sized and under-register low flows – **these can cost you considerably in missed revenue due to under-billing.**
   - Solid state meters (magnetic, ultrasonic) and “floating ball” turbine meters are more accurate at low flows

Application of Water Loss Control Practices

Controlling Real (leakage) Losses: Leakage and Pressure Management

Leaks occur due to:

- Inferior or defective materials
- Poor workmanship or materials handling
- Corrosion (of metallic piping)
- Operational errors (quick hydrant or valve closing)
- Cold or hot air/water temperatures
- Poor quality of leak repair work
- Issues with fittings & appurtenances
- Accidental or deliberate damage
- Changing stresses in the pipe environment

All water distribution systems experience leakage – only volumes, costs vary

Leakage Management

- ***Reactive Leakage Management***: wait until water is visible then fix it
- ***Proactive Leakage Management***: look for hidden leaks and fix them while they are small – ***avoid disruptive and expensive water main breaks!***
- ***A Proactive Leakage Management Program is best***

Challenging leak detection conditions on plastic pipe under vegetation in rural Tennessee.

Source: Water and Wastewater Authority of Wilson County, TN

Leakage Management Methods

- **Active Leakage Control**: acoustic leak detection and monitoring of system flows
- **Speed and Quality of Repairs**: practices to ensure timely and lasting repairs
- **Pressure Management*:*** better controlling excessive pressure which aggravates leakage and water main breaks
- **Water Main Replacement**: Infrastructure ages and must eventually be replaced or rehabilitated

Acoustic leak detection is the most common method of leakage control

Source: Fluid Conservation Systems

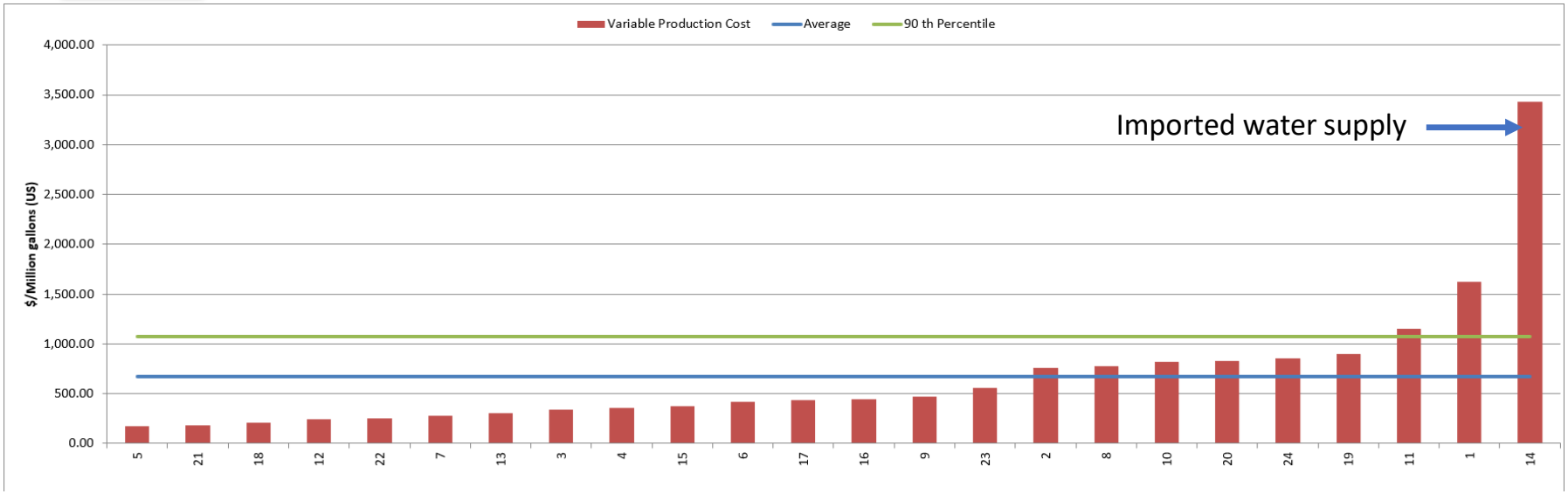
Putting a Cost to Leakage

Leakage means utilities must produce more water than their customer population needs

- Leakage is usually valued at the **Variable Production Costs** (**VPC**), or the cost to produce the next incremental volume of water supplied
  - For water systems that buy (import) bulk water, the VPC = Imported water unit cost
  - ***Imported bulk water supplies are always expensive!*** Leakage is more expensive if you import most or all of your water supply
- If source water is limited – and may not meet future demands – then it is appropriate to value real losses at the **Customer Retail Unit Charge** (**CRUC**), **making leakage extremely expensive!**

Variable Production Cost (VPC)

for 24 Pennsylvania Small Systems



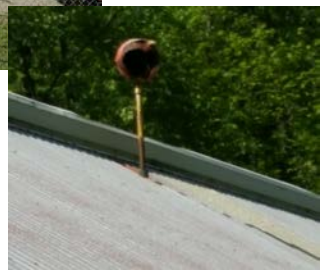
Average $683.80 per million gallons

Leakage Control in Small Systems

Leakage control in small systems has a few advantages over large systems

1. Monitor storage tanks levels closely
   - If tanks fall suddenly a sizeable leak or break may have sprung
   - If tanks struggle to fill, new smaller leaks may have emerged
2. Monitor nighttime supply flow from 2 - 4 AM:
   - Night flows that slowly increase over several days can indicate new leakage
3. Acoustic leak detection can be done for the whole system in days or weeks in a small system (might take years in a very large system)
4. Step-testing (temporarily closing valves to one section of the system at a time) may allow the section with the leak to be identified quickly
5. Contracted services for acoustic leak detection are available and reasonably priced

Covered water storage reservoir in a small system in Pennsylvania



Visible floating ball indicates a full reservoir level – a lowered ball indicates a high water demand (as from a leak)

Application of Water Loss Control Practices

Quiz 2

Quiz 2

1. For production flowmeters, the process of confirming the flow-measuring accuracy of the *Primary Device* is known as _____.

Quiz 2

1. For production flowmeters, the process of confirming the flow-measuring accuracy of the *Primary Device* is known as **Verification**.

Quiz 2

2. Water utilities should also conduct regular maintenance on the secondary instrumentation connected to many types of production flowmeter installations. The process of performing this type of maintenance of *Secondary Devices* is known as _____.

Quiz 2

2. Water utilities should also conduct regular maintenance on the secondary instrumentation connected to many types of production flowmeter installations. The process of performing this type of maintenance of *Secondary Devices* is known as **Calibration**.

Quiz 2

3. Name three (3) purposes for water utilities to meter their customers:

_____

_____

_____

Quiz 2

3. Name three (3) purposes for water utilities to meter their customers:

It attaches a price to the volume of water consumed

It can limit waste by measuring inordinately high flows

It reveals customer water use habits to assist planning and operational purposes

Quiz 2

4. List three (3) good water utility practices to maintain accurate customer meters:

_____

_____

_____

Quiz 2

4. List three (3) good water utility practices to maintain accurate customer meters:

Proper meter type, selection, and installation

Proper meter sizing

Periodic maintenance, accuracy testing, and repair/replacement of the meter

Quiz 2

5. True or False: acoustic leak detection is very complex, expensive, and out-of-reach for most small water utilities

   A. True

   B. False

Quiz 2

5. True or False: acoustic leak detection is very complex, expensive, and out-of-reach for most small water utilities

   A. True

   B. False

Quiz 2

6. Water utilities that wait until a leak or main break is reported and then repair it are practicing _____ leakage management.

   A. Innovative
   B. Proactive
   C. Scientific
   D. Reactive

Quiz 2

6. Water utilities that wait until a leak or main break is reported and then repair it are practicing _____ leakage management.

   A. Innovative
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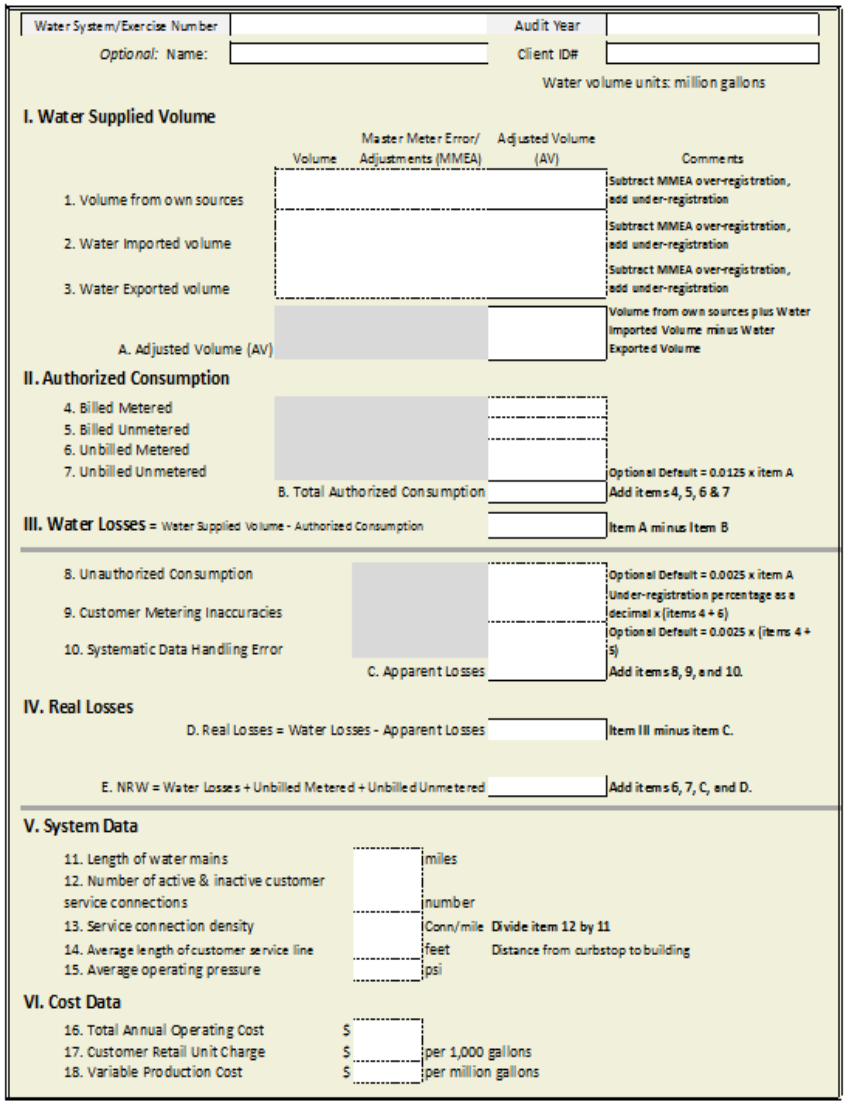
Water Audit Exercise

- Compiling the AWWA water audit for a small water utility
- Complete the audit form. Follow instructions on the form. *(this form is similar to the AWWA Free Water Audit Software in its structure)*.
- Instructor to form teams of 2-3 persons
- Each team works with one of two utility "scenarios"



AWWA Small Systems Workshop
Water Audit Exercise Worksheet

Water System/Exercise Number		Audit Year	
Optional: Name:		Client ID#	

Water volume units: million gallons

I. Water Supplied Volume

	Volume	Master Meter Error/ Adjustments (MMEA)	Adjusted Volume (AV)	Comments
1. Volume from own sources				Subtract MMEA over-registration, add under-registration
2. Water Imported volume				Subtract MMEA over-registration, add under-registration
3. Water Exported volume				Subtract MMEA over-registration, add under-registration
A. Adjusted Volume (AV)				Volume from own sources plus Water Imported Volume minus Water Exported Volume

II. Authorized Consumption

4. Billed Metered			
5. Billed Unmetered			
6. Unbilled Metered			
7. Unbilled Unmetered			Optional Default = 0.0125 x item A
B. Total Authorized Consumption			Add items 4, 5, 6 & 7

III. Water Losses = Water Supplied Volume - Authorized Consumption — Item A minus Item B

8. Unauthorized Consumption		Optional Default = 0.0025 x item A
9. Customer Metering Inaccuracies		Under-registration percentage as a decimal x (items 4 + 6)
10. Systematic Data Handling Error		Optional Default = 0.0025 x (items 4 + 5)
C. Apparent Losses		Add items 8, 9, and 10.

IV. Real Losses

D. Real Losses = Water Losses - Apparent Losses		Item III minus item C.
E. NRW = Water Losses + Unbilled Metered + Unbilled Unmetered		Add items 6, 7, C, and D.

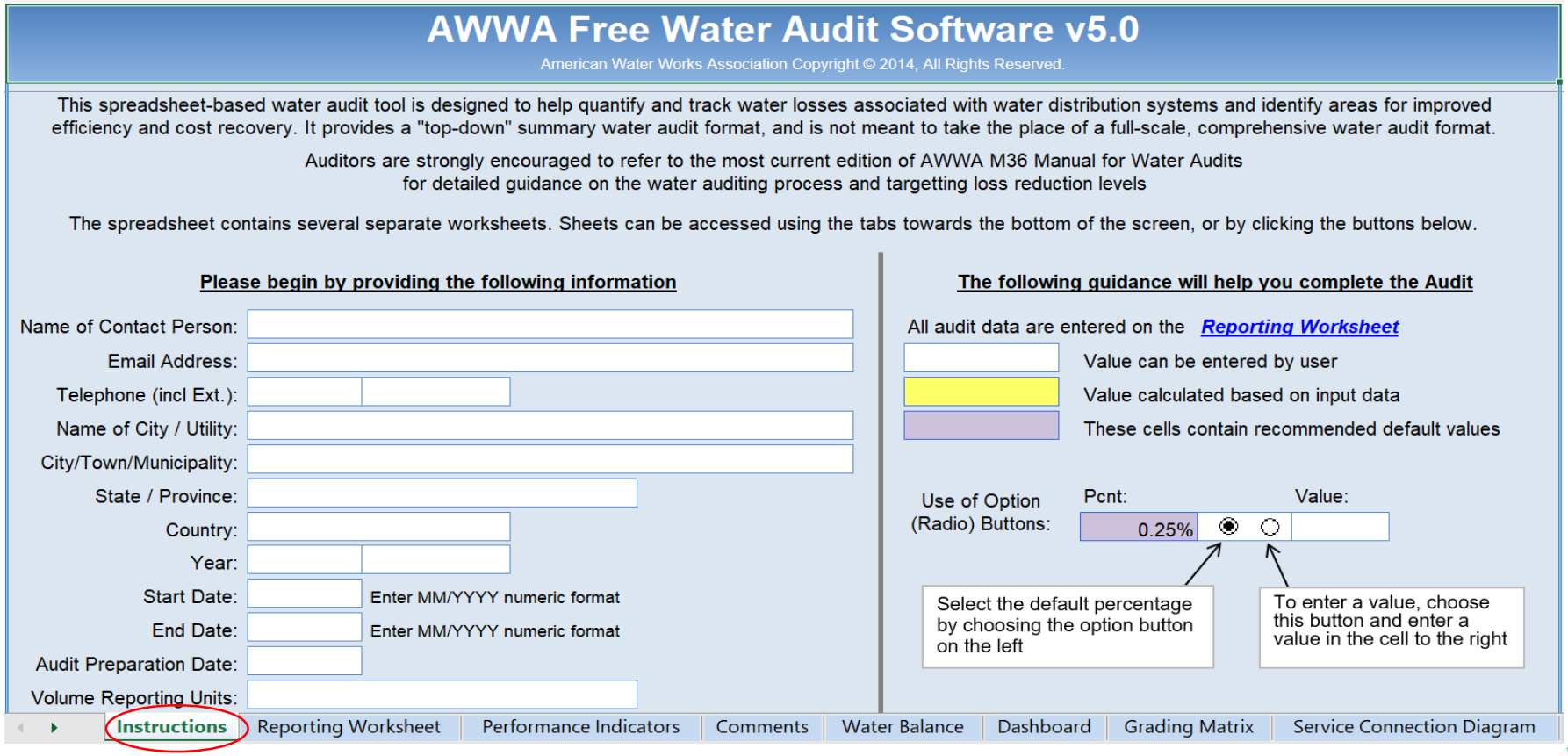
V. System Data

11. Length of water mains		miles	
12. Number of active & inactive customer service connections		number	
13. Service connection density		Conn/mile	Divide item 12 by 11
14. Average length of customer service line		feet	Distance from curbstop to building
15. Average operating pressure		psi	

VI. Cost Data

16. Total Annual Operating Cost	$	
17. Customer Retail Unit Charge	$	per 1,000 gallons
18. Variable Production Cost	$	per million gallons

AWWA Free Water Audit Software



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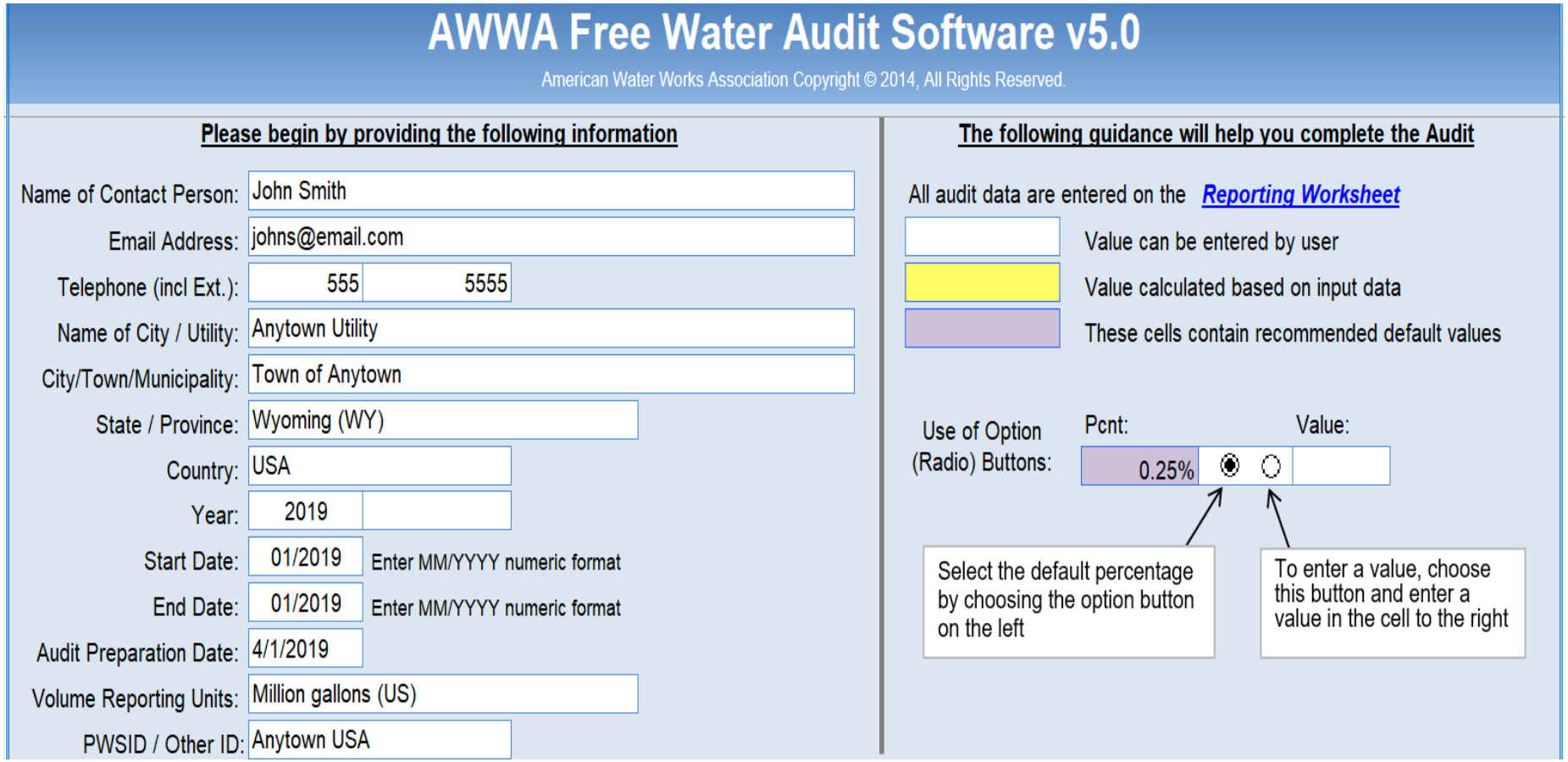

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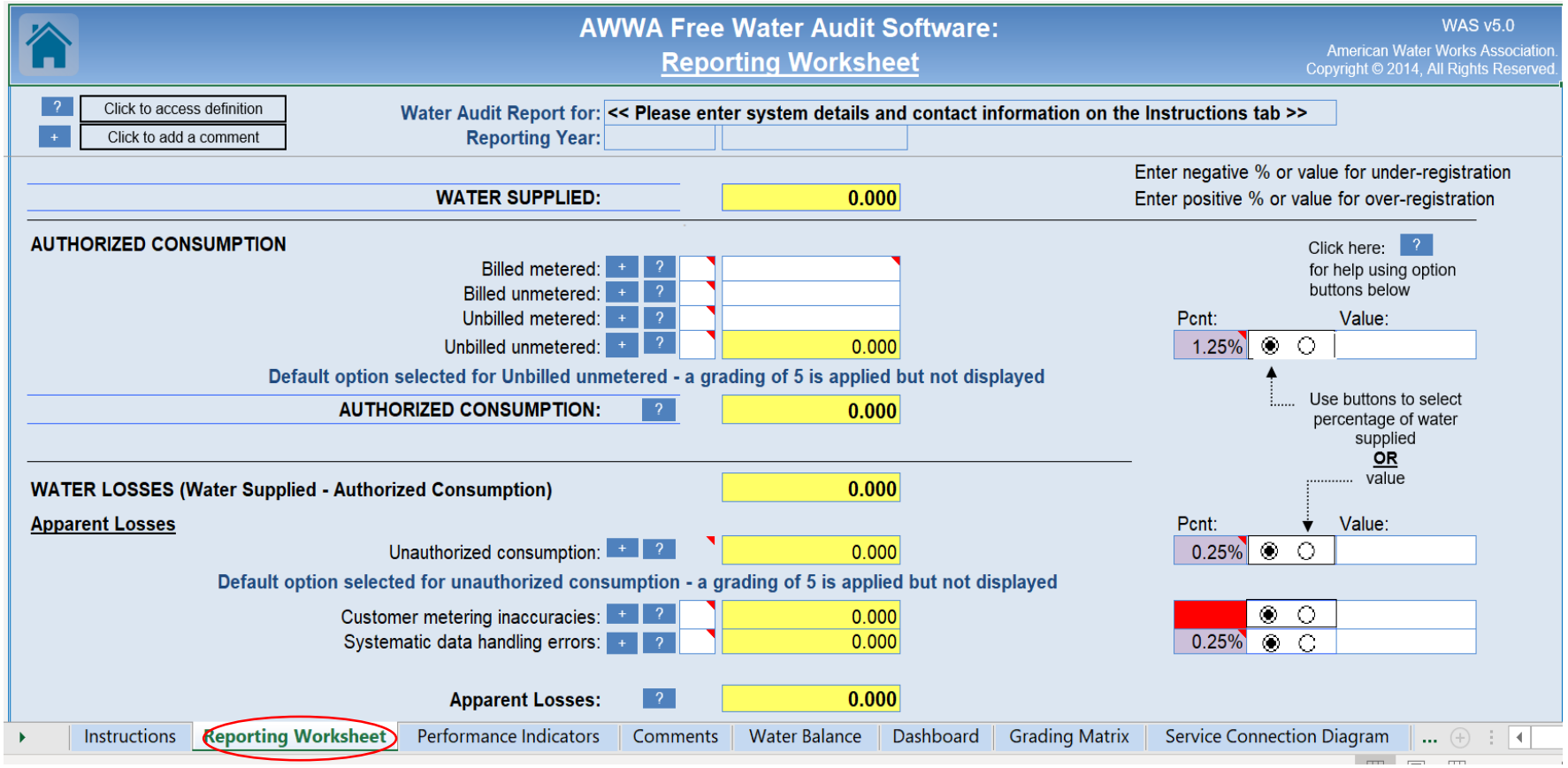


AWWA Free Water Audit Software

AWWA Free Water Audit Software: Grading Matrix

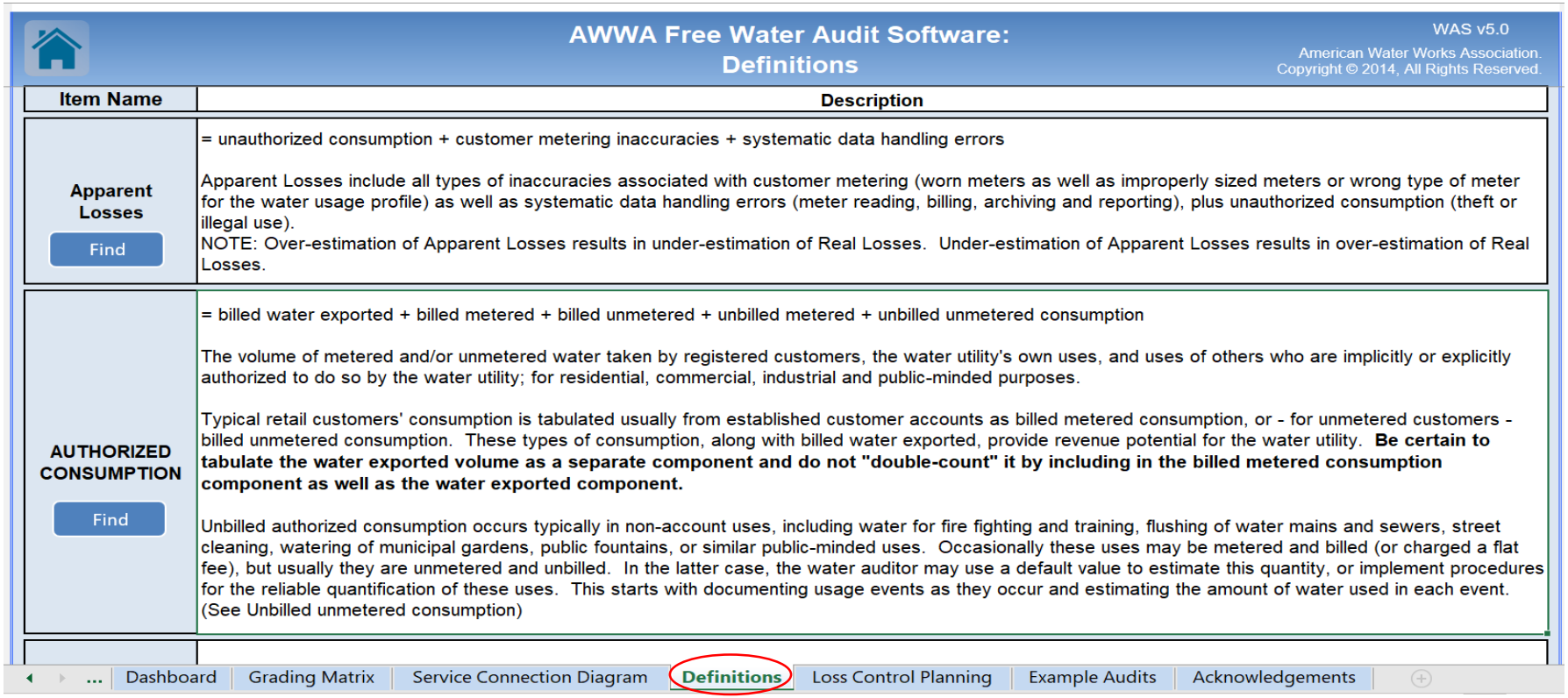
American Water W

e grading assigned to each audit component and the corresponding recommended improvements and actions are highlighted in yellow. Audit accuracy is likely to be improved by prioritizing those items shown

Grading >>>	1	2	3	4	5	6	7	8
	WATER SUPPLIED							
Volume from own sources:	Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing or electronic calibration conducted.	25% - 50% of treated water production sources are metered; other sources estimated. No regular meter accuracy testing or electronic calibration conducted.	Conditions between 2 and 4	50% - 75% of treated water production sources are metered, other sources estimated. Occasional meter accuracy testing or electronic calibration conducted.	Conditions between 4 and 6	At least 75% of treated water production sources are metered, or at least 90% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy
Improvements to attain higher data grading for "Volume from own Sources" component:	to qualify for 2: Organize and launch efforts to collect data for determining volume from own sources	to qualify for 4: Locate all water production sources on maps and in the field, launch meter accuracy testing for existing meters, begin to install meters on unmetered water production sources and replace any obsolete/defective meters.		to qualify for 6: Formalize annual meter accuracy testing for all source meters; specify the frequency of testing. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.		to qualify for 8: Conduct annual meter accuracy testing and calibration of related instrumentation on all meter installations on a regular basis. Complete project to install new, or replace defective existing, meters so that entire production meter population is metered. Repair or replace meters outside of +/- 6% accuracy.		to qualify for 10: Maintain annual meter accuracy test related instrumentation for all meter in replace meters outside of +/- 3% accu meter technology; pilot one or more innovative meters in attempt to further in
Volume from own sources master meter and supply error adjustment:	Inventory information on meters and paper records of measured volumes exist but are incomplete and/or in a very crude condition; data error cannot be determined	No automatic datalogging of production volumes; daily readings are scribed on paper records without any accountability controls. Flows are not balanced across the water distribution system: tank/storage elevation changes are not employed in calculating the "Volume from own sources" component and archived flow data is adjusted only when grossly evident data error occurs.	Conditions between 2 and 4	Production meter data is logged automatically in electronic format and reviewed at least on a monthly basis with necessary corrections implemented. "Volume from own sources" tabulations include estimate of daily changes in tanks/storage facilities. Meter data is adjusted when gross data errors occur, or occasional meter testing deems this necessary.	Conditions between 4 and 6	Hourly production meter data logged automatically & reviewed on at least a weekly basis. Data is adjusted to correct gross error when meter/instrumentation equipment malfunction is detected; and/or error is confirmed by meter accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a balanced "Volume from own sources" component, and data gaps in the archived data are corrected on at least a weekly basis.	Conditions between 6 and 8	Continuous production meter data is logged automatically & reviewed each business day. Data is adjusted to correct gross error from detected meter/instrumentation equipment malfunction and/or results of meter accuracy testing. Tank/storage facility elevation changes are automatically used in "Volume from own sources" tabulations and data gaps in the archived data are corrected on a daily basis.

Instructions | Reporting Worksheet | Performance Indicators | Comments | Water Balance | Dashboard | Grading Matrix | Service Connection Diagram

AWWA Free Water Audit Software



AWWA Free Water Audit Software: Definitions

WAS v5.0

Item Name	Description
Apparent Losses Find	= unauthorized consumption + customer metering inaccuracies + systematic data handling errors Apparent Losses include all types of inaccuracies associated with customer metering (worn meters as well as improperly sized meters or wrong type of meter for the water usage profile) as well as 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.
AUTHORIZED CONSUMPTION Find	= billed water exported + billed metered + billed unmetered + unbilled metered + unbilled unmetered consumption The volume of metered and/or unmetered water taken by registered customers, the water utility's own uses, and uses of others who are implicitly or explicitly authorized to do so by the water utility; for residential, commercial, industrial and public-minded purposes. Typical retail customers' consumption is tabulated usually from established customer accounts as billed metered consumption, or - for unmetered customers - billed unmetered consumption. These types of consumption, along with billed water exported, provide revenue potential for the water utility. **Be certain to tabulate the water exported volume as a separate component and do not "double-count" it by including in the billed metered consumption component as well as the water exported component.** Unbilled authorized consumption occurs typically in non-account uses, including water for fire fighting and training, flushing of water mains and sewers, street cleaning, watering of municipal gardens, public fountains, or similar public-minded uses. Occasionally these uses may be metered and billed (or charged a flat fee), but usually they are unmetered and unbilled. In the latter case, the water auditor may use a default value to estimate this quantity, or implement procedures for the reliable quantification of these uses. This starts with documenting usage events as they occur and estimating the amount of water used in each event. (See Unbilled unmetered consumption)

... | Dashboard | Grading Matrix | Service Connection Diagram | **Definitions** | Loss Control Planning | Example Audits | Acknowledgements

AWWA Free Water Audit Software

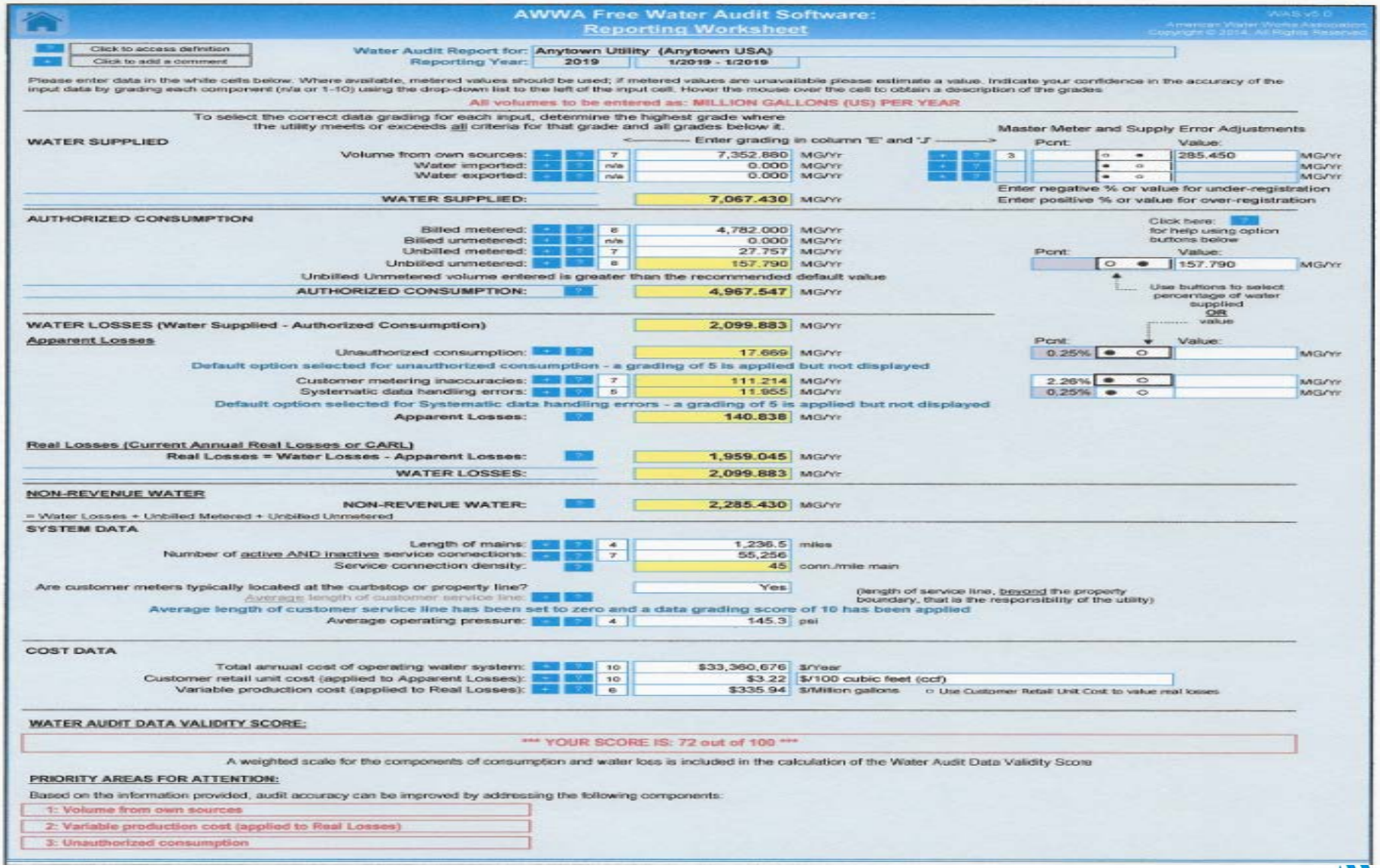
AWWA Free Water Audit Software:
User Comments

WAS v5.0

Use this worksheet to add comments or notes to explain how an input value was calculated, or to document the sources of the information used.

General Comment:	This audit included data from the Water Manager, Meter Tech, Billing Manager, Distribution and Operations Foreman and Utility Engineer (SCADA).

Audit Item	Comment
Volume from own sources:	Gave ourselves a "9" based upon newness of meters (replaced all meters in a five year upgrade). After attending the water loss class in CO we determined we were a "5". Validator gave us a "3" until we complete a frequencey testing per grading matrix. We will purchase testing equipment and calibrate production (well meter and pump station mters) every six months.
Vol. from own sources: Master meter error adjustment:	Gave ourselves "9" since we read weekly and calibrate with SCADA data which are checked daily. Validator gave us an "8".
Water imported:	N/A



AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association
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Click to access definition
Click to add a comment

Water Audit Report for: Anytown Utility (Anytown USA)
Reporting Year: 2019 1/2019 - 1/2019

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

Enter grading in column 'E' and 'J'

Master Meter and Supply Error Adjustments

WATER SUPPLIED

				Pcnt:	Value:	
Volume from own sources:	7	7,352.880	MG/Yr	3	285.450	MG/Yr
Water imported:	n/a	0.000	MG/Yr			MG/Yr
Water exported:	n/a	0.000	MG/Yr			MG/Yr
WATER SUPPLIED:		7,067.430	MG/Yr			

Enter negative % or value for under-registration
Enter positive % or value for over-registration

AUTHORIZED CONSUMPTION

Click here: for help using option buttons below

				Pcnt:	Value:	
Billed metered:	8	4,782.000	MG/Yr			
Billed unmetered:	n/a	0.000	MG/Yr			
Unbilled metered:	7	27.757	MG/Yr			
Unbilled unmetered:	8	157.790	MG/Yr		157.790	MG/Yr
AUTHORIZED CONSUMPTION:		4,967.547	MG/Yr			

Unbilled Unmetered volume entered is greater than the recommended default value

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption) 2,099.883 MG/Yr

Apparent Losses

				Pcnt:	Value:	
Unauthorized consumption:		17.669	MG/Yr	0.25%		MG/Yr
Customer metering inaccuracies:	7	111.214	MG/Yr	2.26%		MG/Yr
Systematic data handling errors:	5	11.955	MG/Yr	0.25%		MG/Yr
Apparent Losses:		140.838	MG/Yr			

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses:	1,959.045	MG/Yr
WATER LOSSES:	2,099.883	MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 2,285.430 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	4	1,236.5	miles
Number of active AND inactive service connections:	7	55,256	
Service connection density:		45	conn./mile main
Are customer meters typically located at the curbstop or property line?		Yes	
Average length of customer service line:			
Average operating pressure:	4	145.3	psi

(length of service line, beyond the property boundary, that is the responsibility of the utility)

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

COST DATA

Total annual cost of operating water system:	10	$33,360,676	$/Year	
Customer retail unit cost (applied to Apparent Losses):	10	$3.22	$/100 cubic feet (ccf)	
Variable production cost (applied to Real Losses):	6	$335.94	$/Million gallons	○ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 72 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Variable production cost (applied to Real Losses)
3: Unauthorized consumption

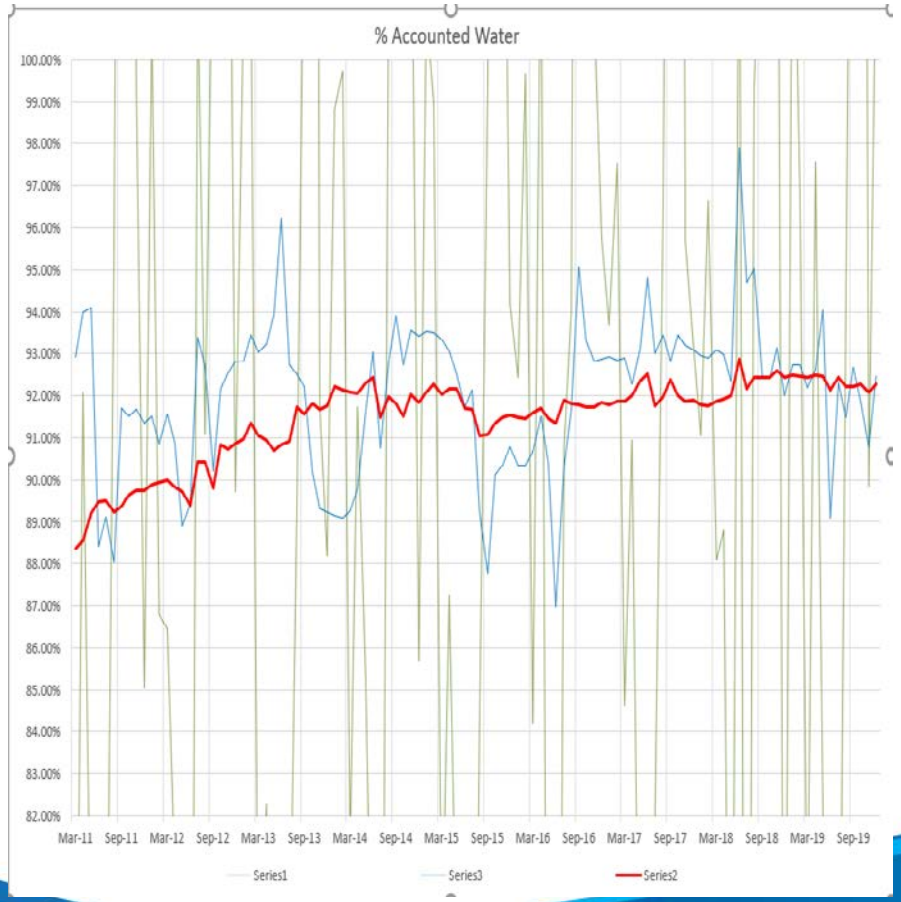
- Fill in your Reporting Worksheet
- The spreadsheet will tabulate a final audit score as well as suggestions for improvements.
- Your score is your starting point……..this is not a grade so much as a number for you to work on over time.

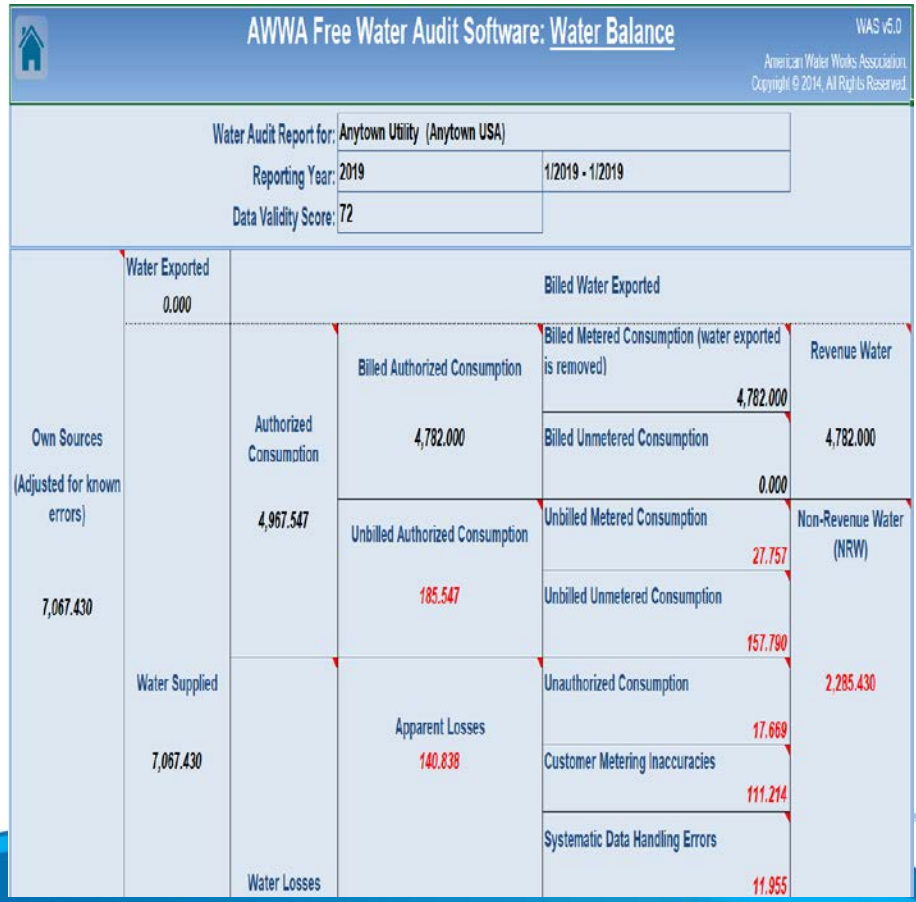
Example of where to start…….

A	B	C	D	E	F	G	H	I	J	K
							net	billed		
	Water	accounted for but not billed					prodection	sales	diane's Williams	
	production	(in gallons)			usage	reading	(1,000's)	(1,000's)		
	(1,000,000's)	flush/break	bulk/free	blds	Fire Dept; parks metes	meter				1 month
Jan-07	80.708						80,708.00	70,235.64		87.02%
Feb-07	80.119						80,119.00	64,689.51		80.74%
Mar-07	79.128						79,128.00	64,506.67		81.52%
Apr-07	78.743						78,743.00	73,901.87		93.85%
May-07	123.563						123,563.00	75,625.28		61.20%
Jun-07	183.489						183,489.00	118,769.37		64.73%
Jul-07	300.567						300,567.00	218,861.44		72.82%
Aug-07	292.69						292,690.00	266,610.99		91.09%
Sep-07	155.69						155,690.00	225,596.80		144.90%
Oct-07	168.57						168,570.00	159,225.39		94.46%
Nov-07	68.29						68,290.00	83,292.88		121.97%
Dec-07	77.3						77,300.00	59,274.37		76.68%
Jan-08	81.72	990000	22409	417000			80,290.59	72,846.00		90.73%
Feb-08	100.55	800000	65900	417000			99,267.10	67,583.34	67584.34	68.08%
Mar-08	68.16	2586000	417000	417000			64,740.00	70,065.97	70099.47	108.23%
Apr-08	65.69	145000	65000	378000			65,102.00	61,591.09	61604.09	94.61%
May-08	96.69	64000	140000	378000			96,108.00	72,136.55	72168.55	75.06%
Jun-08	144.11	75000	140000	378000			143,517.00	81,184.70	91362	56.57%
Jul-08	253.53	167000	140000	378000			252,845.00	192,150.59	181869.59	76.00%
Aug-08	314.481	45000	140000	378000			313,918.00	217,920.98	217801.98	69.42%

AWWA Free Water Audit Software

Gives you an in depth understanding of where your water loss is in your system and what the cost is.





Summary: Water Loss Control in Small Systems

REMEMBER

- The water audit lets you calculate the annual volume and cost of the losses in your system
- You are paying everyday for the losses that exist in your system
- All water systems can take action to control both their apparent and real water losses

Let's Wrap Things Up…. Before We Close

- Session #2 Information
- Post Test
- Evaluation Form
- Closing Comments
- Contact Information

Session #2 Information

- Plant/System Optimization
- Technical assistance
- Community Engineering Corps
- Partnership for Small Systems
- USDA Loan Applications

Post-Test and Evaluation

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