



Colorado Water  
Loss Initiative



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# New Learner Workshop

June 25, 2025



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# Program Management Team

## Expert Leadership



Drew Blackwell



Isabel Szendrey

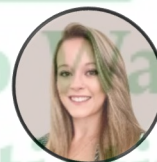


Maher Lugo

## Expert Teachers and Validators



Tory Wagoner



Ashlee Hollifield



Chris Penwell



Larry Lewison



Kevin Burgers





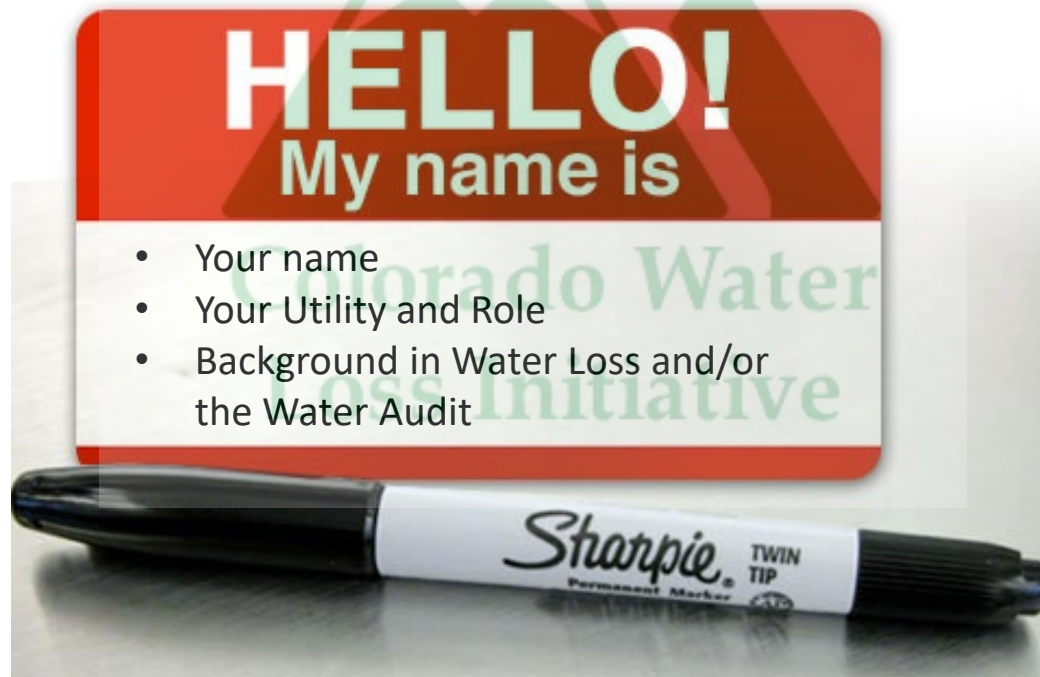
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# Utility Introductions



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# Agenda

Water Loss Initiative:  
Overview & Objectives

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AWWA M36 Foundations,  
Data Sources &  
Developing the Inputs

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Break

AWWA Free Water  
Audit Software

---

Data Validity Grading

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Group  
Exercise:  
Developing Inputs &  
Determining Data Grades

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Level 1 Validation

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Review

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Next Steps

---

Question &  
Answer

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[team@coloradowaterloss.org](mailto:team@coloradowaterloss.org)



# Water Loss Initiative: Overview & Objectives

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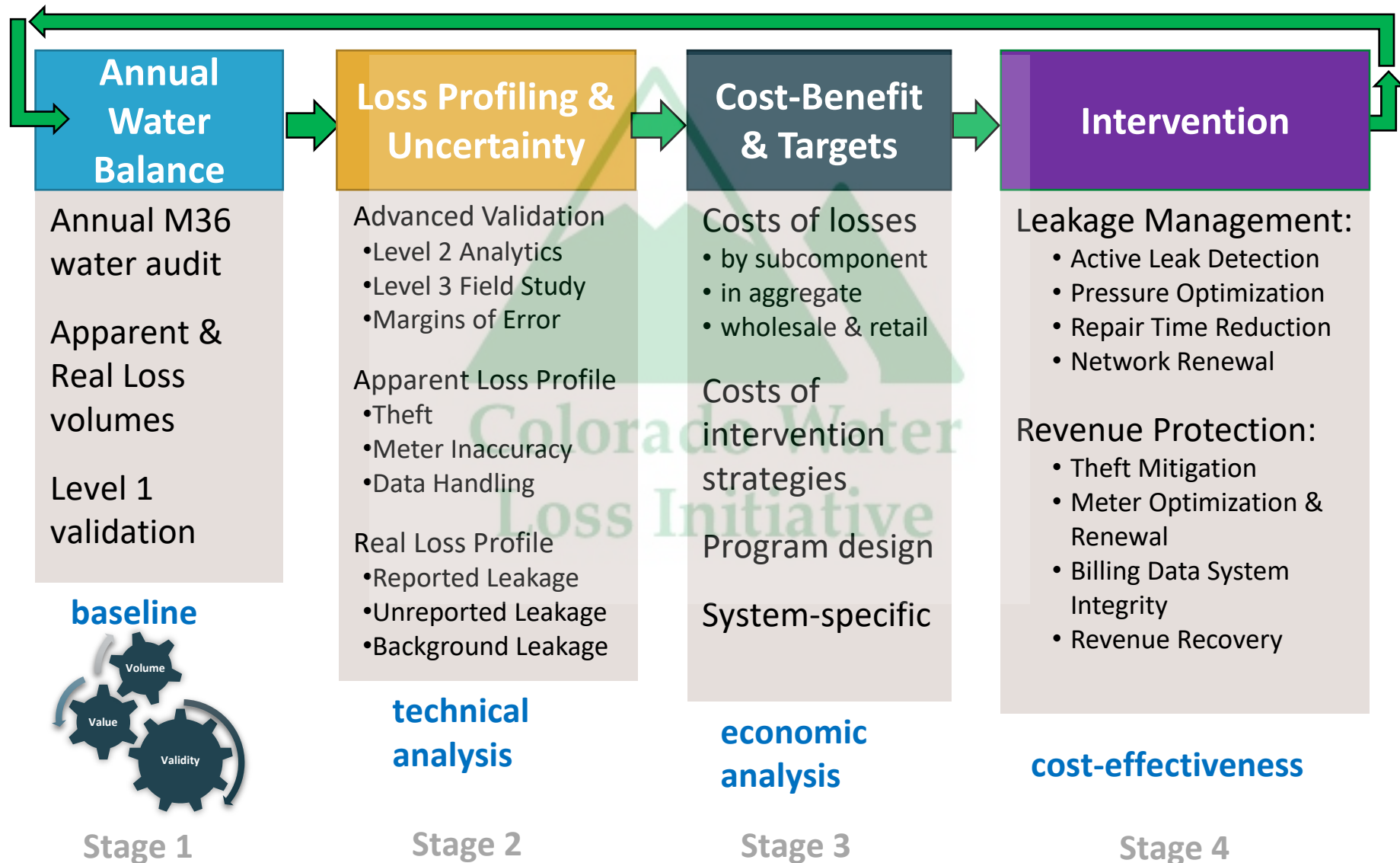
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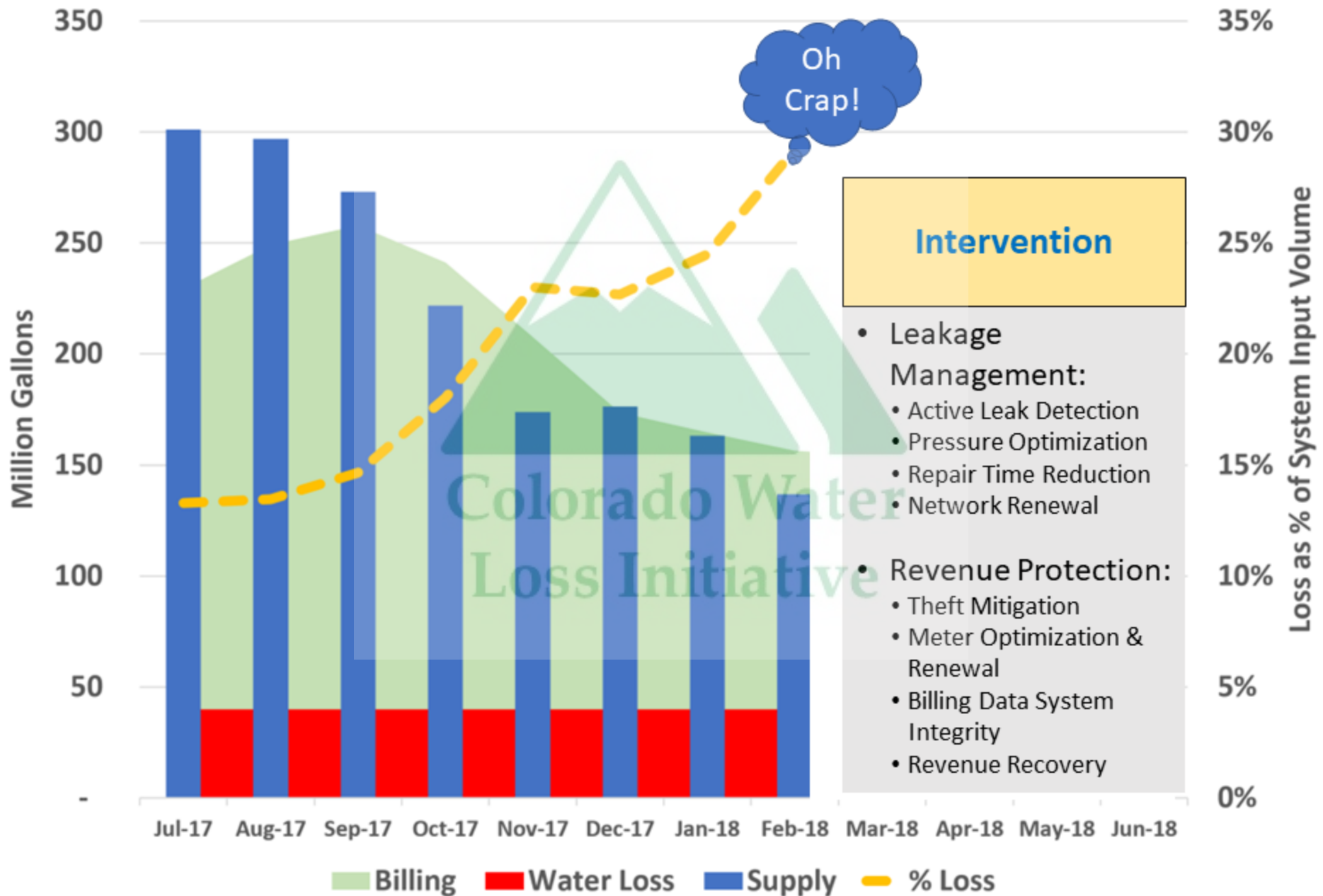
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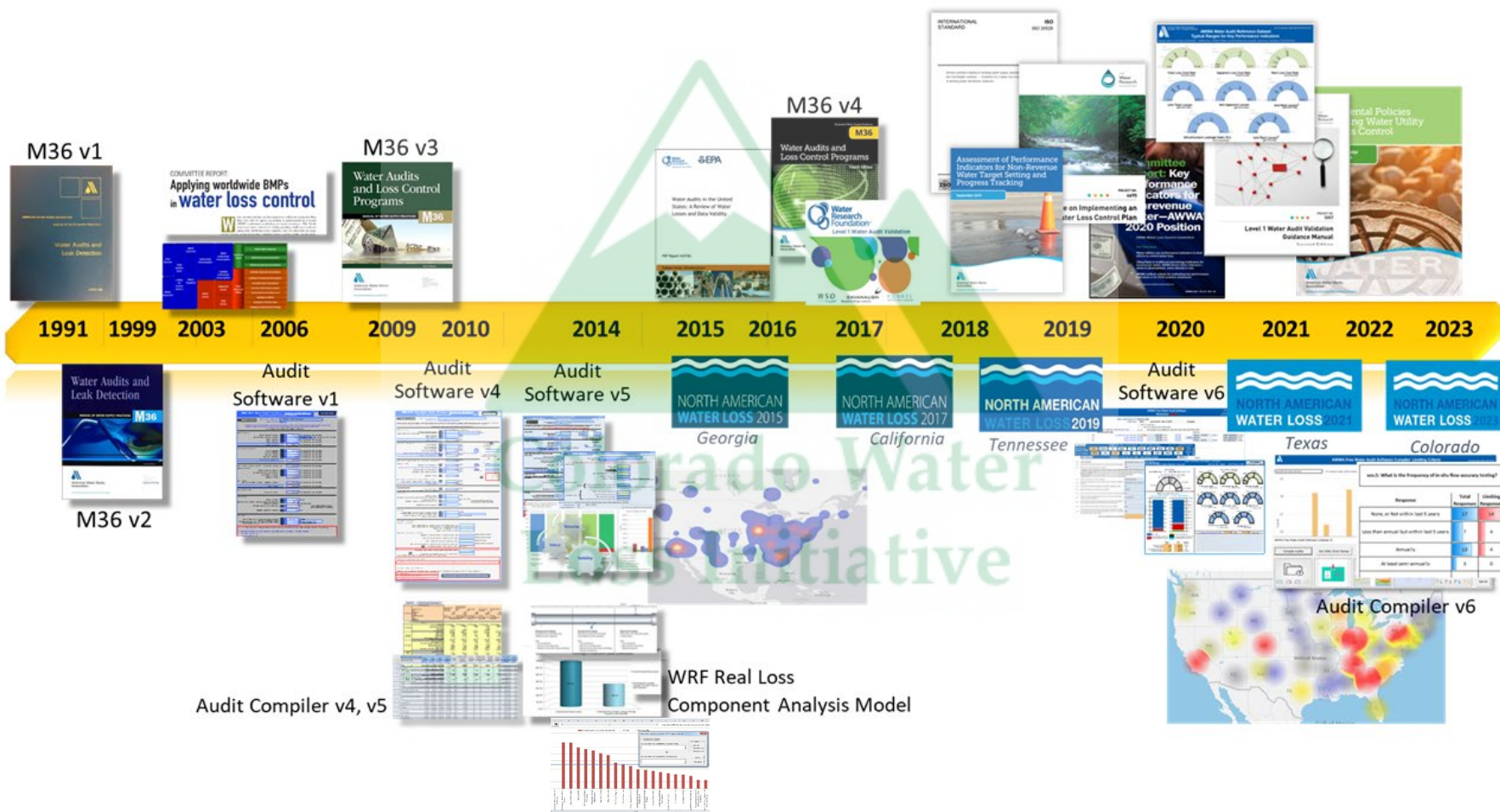
## Loss as % of SIV





# AWWA M36 Methodology – State of the Art Water Auditing & Loss Control

American  
Water Works  
Association





# Water Loss Training and Technical Assistance Programs in North America

Pilot Studies | Statewide Programs | Certification Programs



<https://arcg.is/1nrHTv0>



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# Background

- **2010:** HB10-1051 passed
  - Covered entities selling >2,000 Acre Feet per year
  - Requirement for water use and conservation reporting
  - Includes reporting on water loss
- **February 1, 2012:** CWCB adopts Guidelines and reports to legislature regarding the Guidelines.
- **June 30, 2014 :** Annual covered entity reporting for the previous calendar year began.
- **2015:** Colorado Water Loss Pilot Program
- **2018-2020:** Colorado Water Loss Initiative – Phase 1
- **2021:** Colorado Water Loss Initiative – Phase 2 launch
- **2025:** Colorado Water Loss Initiative – Phase 3 Coming Soon!





# Water Loss Program Benefits

- *Training and assistance to implement the AWWA M36 Methodology*
- *Contribute to broader conservation efforts*
- *Provide insight for utility operation & revenue improvement*

Water Audit Report for: Pre-Release Example Audit - Review Only  
Audit Year: 2019 Jan 01 2019 - Dec 31 2019 Calendar

To access definitions, click the input name

Click 'g' to determine data validity grade

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

Water Supplied Error Adjustments

choose entry option:

over-registration VOSEA  
WIEA  
WEEA

| WATER SUPPLIED                |                                                |
|-------------------------------|------------------------------------------------|
| VOS                           | Volume from Own Sources: n g 7 1,000.000 MG/Yr |
| WI                            | Water Imported: n g MG/Yr                      |
| WE                            | Water Exported: n g MG/Yr                      |
| WATER SUPPLIED: 990.099 MG/Yr |                                                |

choose entry option:

custom 15.000 MG/Yr

| AUTHORIZED CONSUMPTION                |                                        |
|---------------------------------------|----------------------------------------|
| BMAC                                  | Billed Metered: n g 9 850.000 MG/Yr    |
| BUAC                                  | Billed Unmetered: n g MG/Yr            |
| UMAC                                  | Unbilled Metered: n g MG/Yr            |
| UUAC                                  | Unbilled Unmetered: n g 4 15.000 MG/Yr |
| AUTHORIZED CONSUMPTION: 865.000 MG/Yr |                                        |

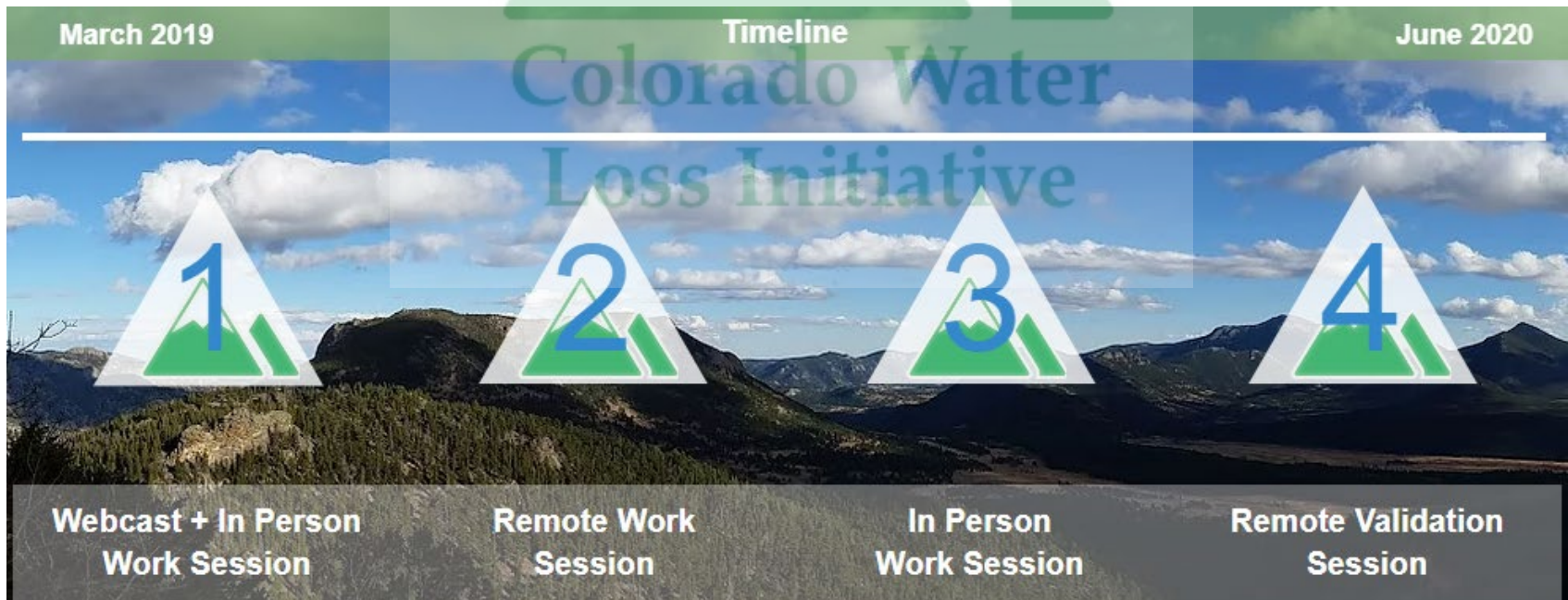
| WATER LOSSES                   |  |
|--------------------------------|--|
| Apparent Losses: 125.099 MG/Yr |  |



# Phase 1 – Program Summary

## Goals:

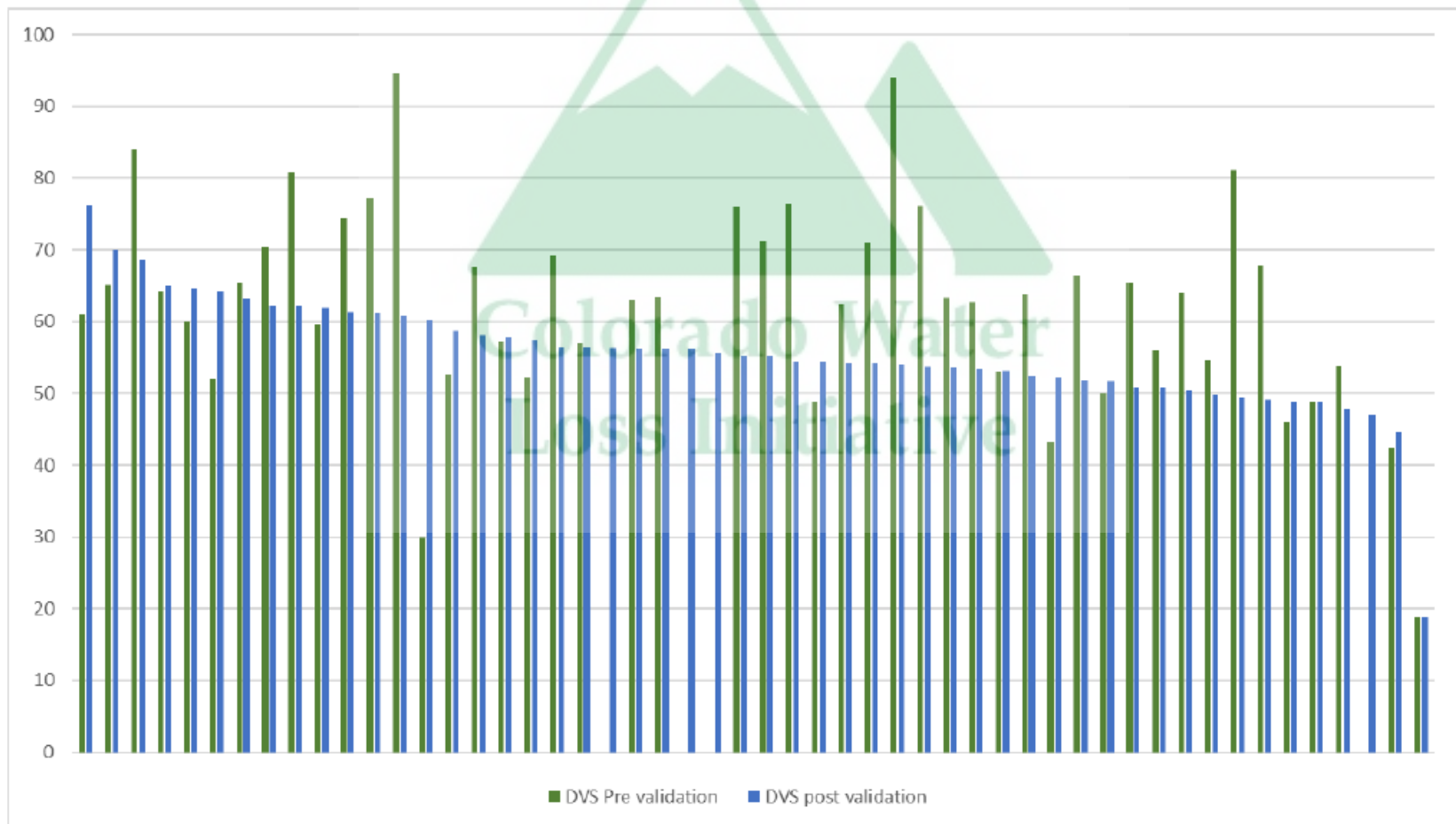
- *Training on AWWA Water Audit Methodology*
- *Level 1 Validation of Water Audits*





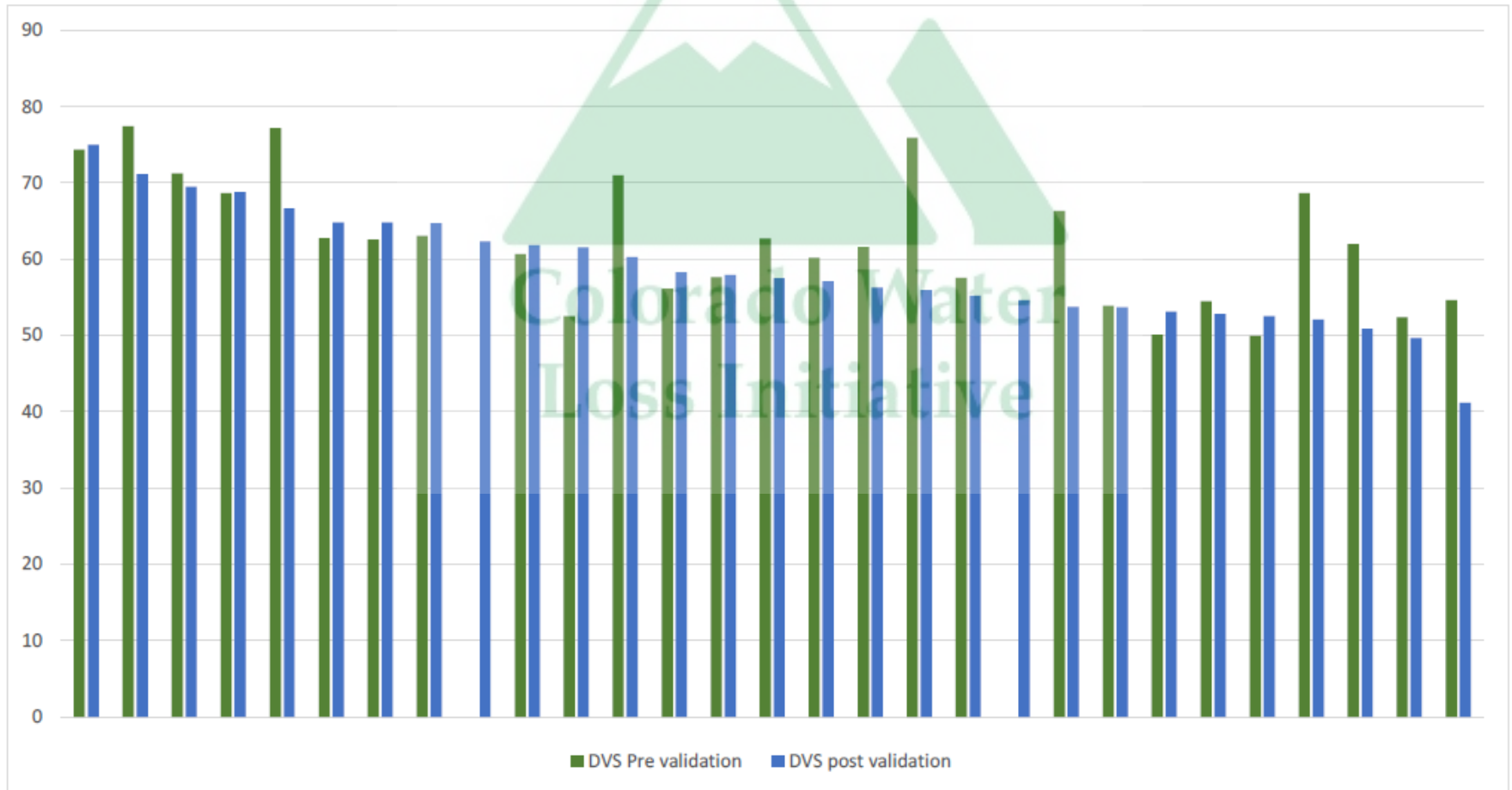


## Stage 2 - Data Validity Scores – Pre and Post Validation





## Stage 4 - Data Validity Scores – Pre and Post Validation





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# Phase 1 – Program Summary

- Voluntary environment
- Key concepts of AWWA M36 methodology
- Importance of Level 1 Validation
- Not over-burdensome
- Most feel they have the capacity to continue
- Appetite for additional training and technical assistance



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## Phase 2 - Program Objectives

- Provide a comprehensive program of basic and advanced training in water loss management
- Prioritized technical review for all participants
  - New Learners: Introduction to the AWWA M36 methodology, Free Water Audit Software, and Level 1 Water Audit Validation
  - Advanced Learners: A focus on more advanced techniques and concepts paired with direct technical assistance





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# Your Water Loss Team

Who should participate from your utility?

Supply &  
Operations

Customer  
Metering

Billing &  
Finance

Management

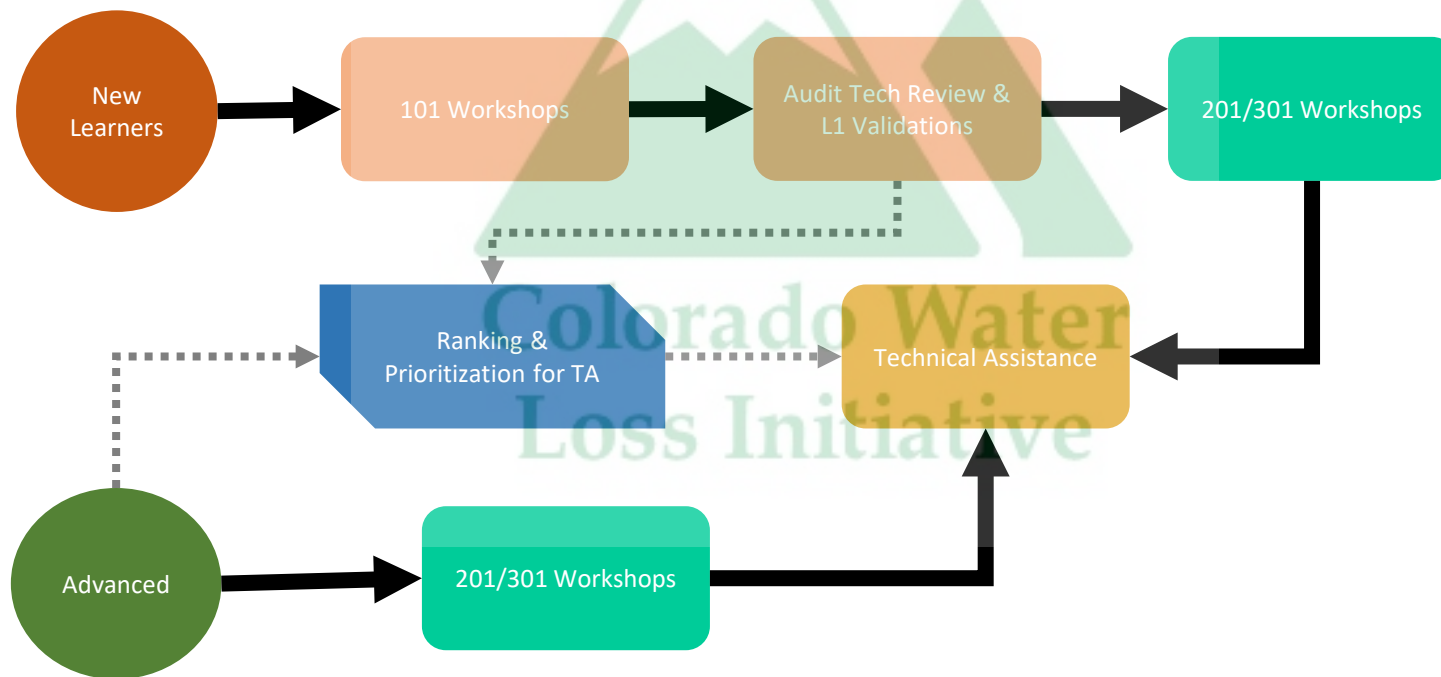
who is responsible for

*supplying audit data?*

*submitting the audit?*

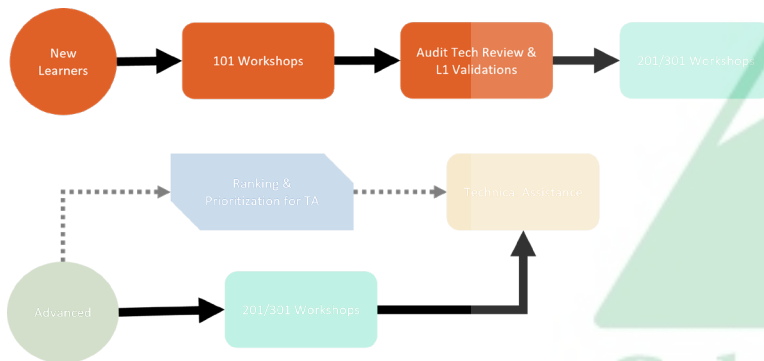
*coordinating schedules?*

# Phase 2 Design





## Phase 2 – New Learners



### Workshop

- AWWA M36 methodology
- AWWA Free Water Audit Software – Ver. 6

### Technical Review

- Gather supporting documentation and compile audit
- Technical review to assess readiness for Level 1 Validation session

### Level 1 Validation

- Conduct Level 1 Validation
- Document results

# Knowledge Check

Which is a possible driver for setting up a water loss program?

- A. Environmental
- B. Public Relations
- C. Regulatory
- D. Economic
- E. All of the above



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# AWWA M36 Foundations, Data Sources & Developing the Inputs

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# AWWA Water Audit :

- What is a water audit?
- What are water audit volumes?



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# Water Audit

1. Systematically account for known water volumes to estimate volumes of **Water Loss**.
2. Evaluate **data source reliability**.
3. **Communicate** water distribution efficiency.



# The Water Balance

## 1. Account for volumes...

| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                        |                                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | WATER LOSSES           | APPARENT LOSSES                 | CUSTOMER METER INACCURACIES    |                  |
|                |                        |                                 | UNAUTHORIZED CONSUMPTION       |                  |
|                |                        |                                 | DATA HANDLING ERRORS           |                  |
|                |                        | REAL LOSSES                     |                                |                  |

- *Mass balance – process of elimination*
- *Account for all water*
- *Accuracy matters!*



# Water Losses

## 1. ...Estimate volumes of Water Loss!

Apparent Losses



Real Losses







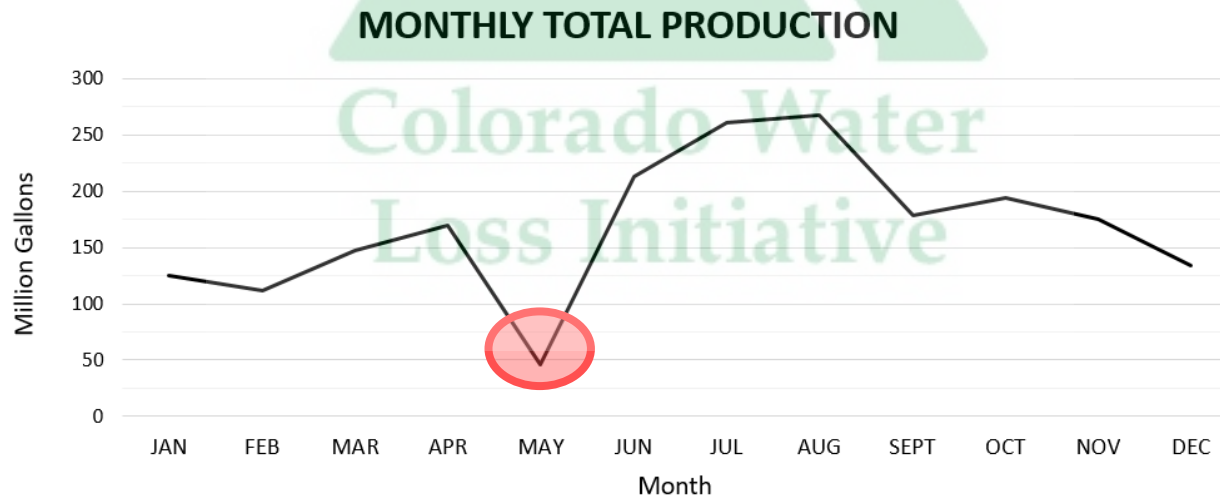
# Water Audit

## 2. Evaluate data reliability

Complete?

Consistent?

Accurate?



*Does the data story make sense?*



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# Water Audit

## 3. Communicate water distribution efficiency

customized performance indicators

**financial value** of Water Losses

\$ \$ \$



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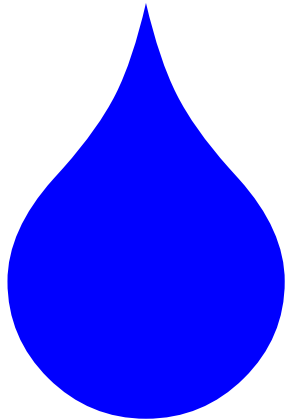
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# Water Audit

volumes



values



validity





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# Water Audit Volumes

The big volumes...

Water Supplied

Authorized Consumption

Water Losses

*each volume is composed of sub-volumes*



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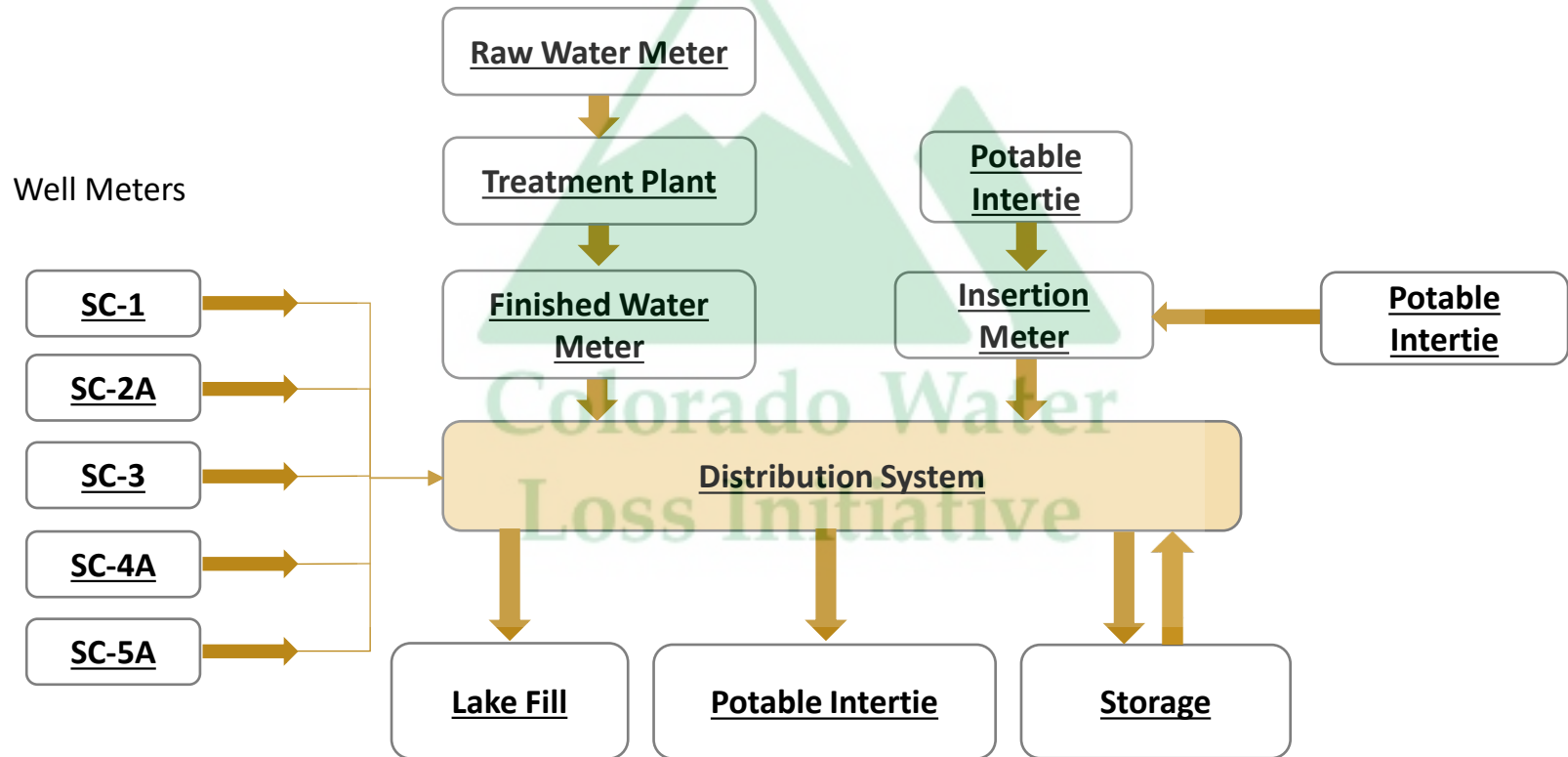
# Water Supplied

|                |                        |                                 |                                |                  |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                        |                                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | WATER LOSSES           |                                 |                                |                  |
|                |                        | UNAUTHORIZED CONSUMPTION        |                                |                  |
|                |                        | DATA HANDLING ERRORS            |                                |                  |
|                |                        | REAL LOSSES                     |                                |                  |





# Water Supplied – Audit Boundaries





# Knowledge Check

Water Audit Boundary

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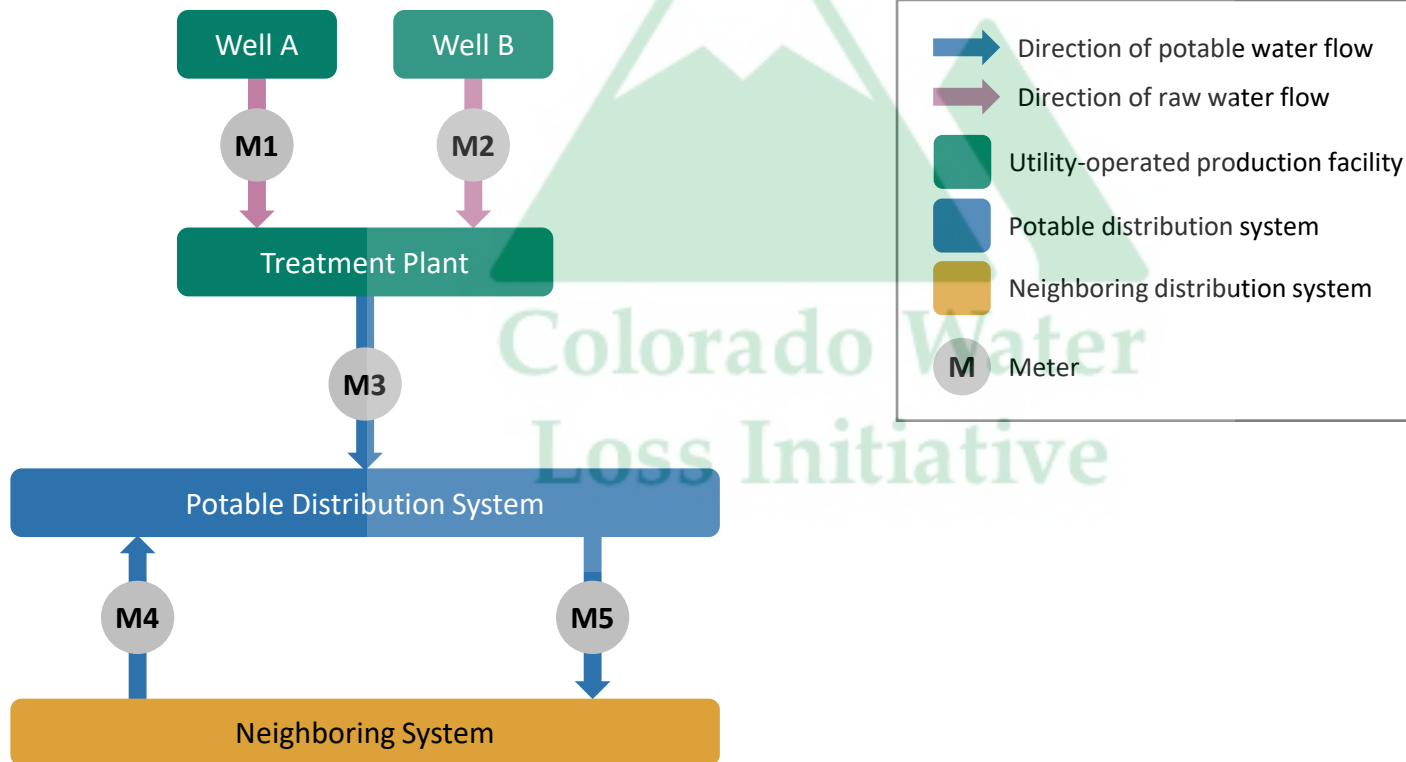
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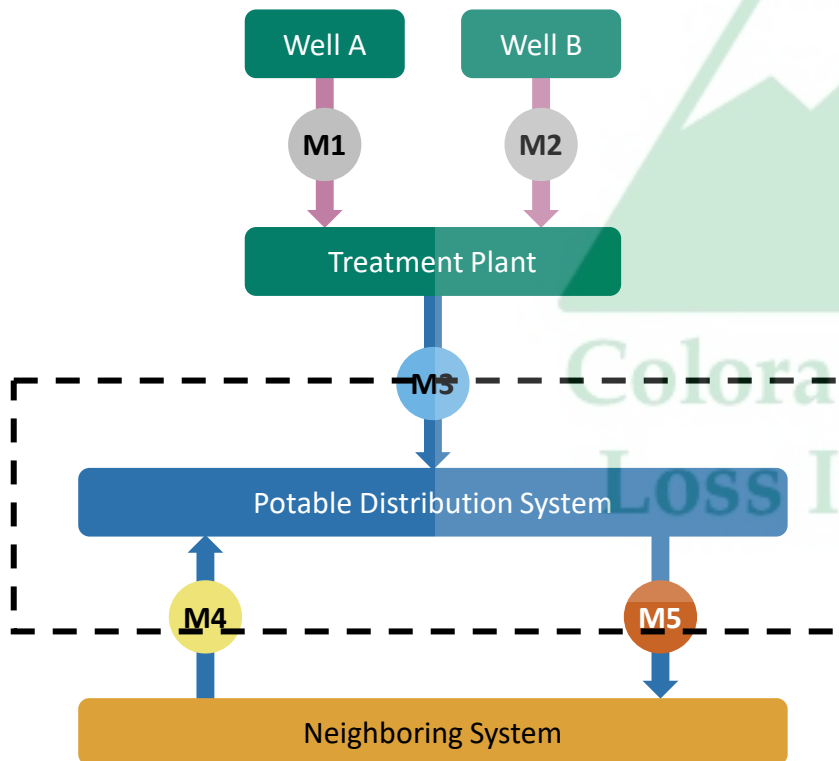


# Water Audit Boundary Exercise





# Water Audit Boundary



➡ Direction of potable water flow

➡ Direction of raw water flow

Utility-operated production facility

Potable distribution system

Neighboring distribution system

Meters that form example water audit boundary

Meter used to determine volume from own sources (VOS)

Meter used to determine water imported (WI)

Meter used to determine water exported (WE)

Meters that are not part of example water audit boundary

Meter not used to determine VOS, WI, or WE



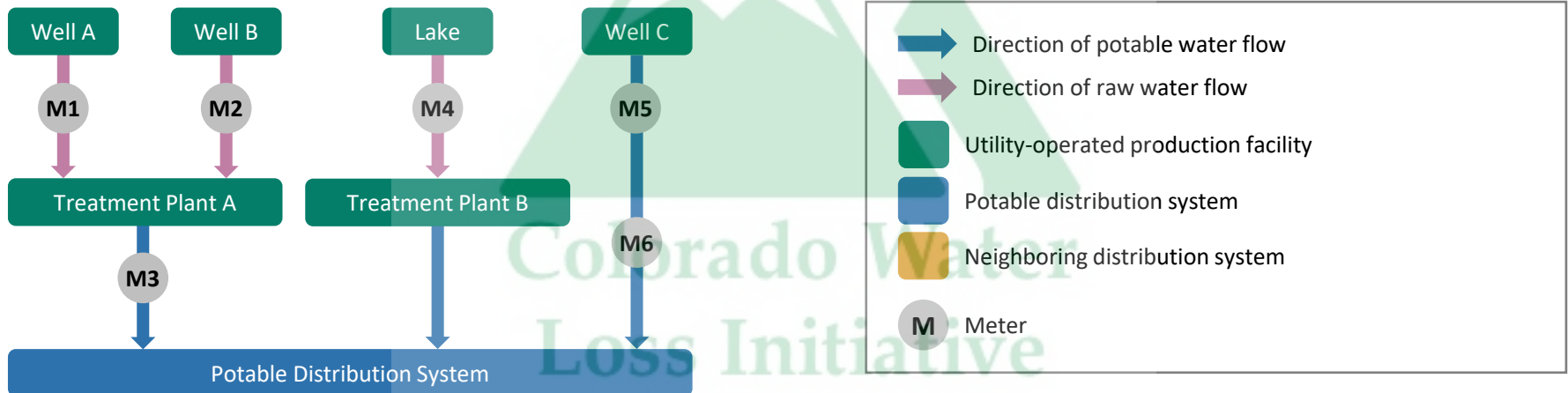
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# Water Audit Boundary Exercise







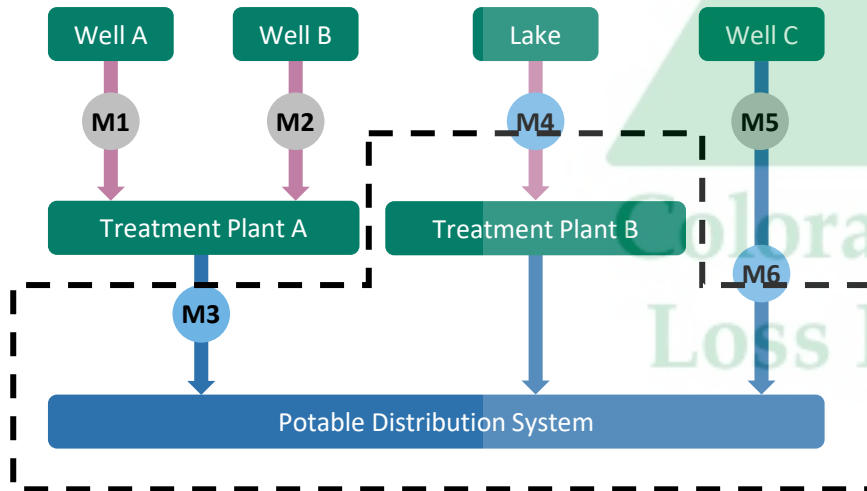
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# Water Audit Boundary



- Direction of potable water flow
- Direction of raw water flow
- Utility-operated production facility
- Potable Distribution System
- Meter determines volume from own sources (VOS).
- Meter not used to determine VOS.  
This meter is not part of an example water audit boundary.



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# Water Supplied

[ inputs ]

Volume from  
Own Sources

Water  
Imported



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[ exports ]

Water  
Exported

*captures all the potable water input to the distribution  
system to serve your customers*



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# Water Supplied

## *Volume from Own Sources*



*groundwater*  
*surface water*

Which meters?

Where are the meters?



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# Water Supplied

*Water Imported*



Which meters?

How is Water Imported  
tracked?





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# Water Supplied

## *Water Exported*



*bulk water sales  
supplements to  
raw/reclaimed systems*

Which meters?

How is Water Exported tracked?





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# Water Supplied

## *Master Meter Error Adjustment*

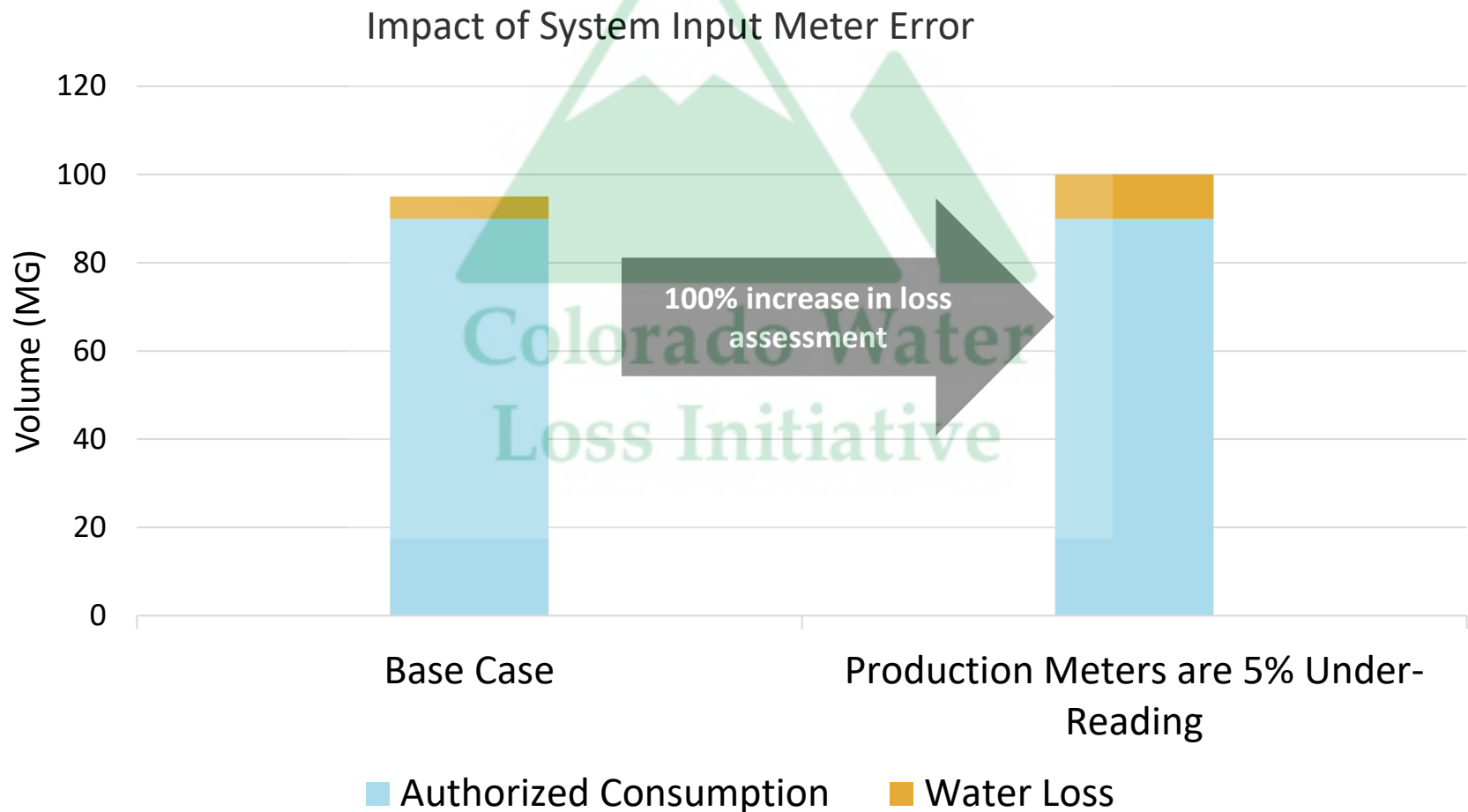
How accurate are Water  
Supplied meters?

*electronic calibration*  
*volumetric accuracy testing*





# Source Meter Testing





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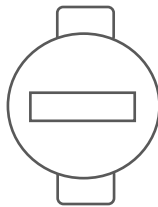
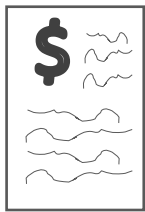


# Authorized Consumption

|                |                        |                                 |                                |                  |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                        |                                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | WATER LOSSES           | APPARENT LOSSES                 | CUSTOMER METER INACCURACIES    |                  |
|                |                        |                                 | UNAUTHORIZED CONSUMPTION       |                  |
|                |                        |                                 | DATA HANDLING ERRORS           |                  |
|                |                        | REAL LOSSES                     |                                |                  |



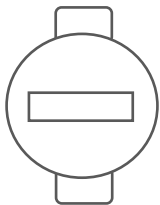
# Authorized Consumption



**Billed Metered  
Consumption**



**Billed Unmetered  
Consumption**



**Unbilled Metered  
Consumption**



**Unbilled Unmetered  
Consumption**

How much **water is used** for all intended purposes?

**How accurate** are tracking mechanisms?



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# Billed Metered Authorized Consumption

|                |                                |                                 |                              |                  |                             |
|----------------|--------------------------------|---------------------------------|------------------------------|------------------|-----------------------------|
| WATER SUPPLIED | AUTHORIZED CONSUMPTION         | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION   | REVENUE WATER    |                             |
|                |                                |                                 | BILLED UNMETERED CONSUMPTION |                  |                             |
|                |                                | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION | NONREVENUE WATER |                             |
|                | UNBILLED UNMETERED CONSUMPTION |                                 |                              |                  |                             |
|                | WATER LOSSES                   |                                 | APPARENT LOSSES              |                  | CUSTOMER METER INACCURACIES |
|                |                                |                                 |                              |                  | UNAUTHORIZED CONSUMPTION    |
|                |                                | DATA HANDLING ERRORS            |                              |                  |                             |
|                |                                | REAL LOSSES                     |                              |                  |                             |





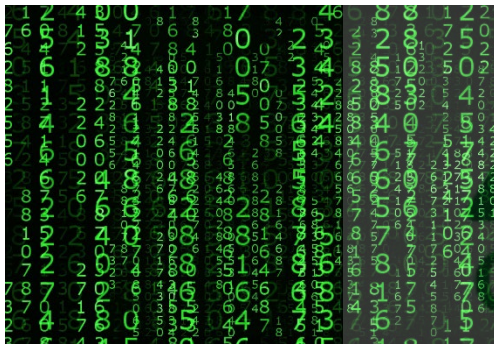
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# Billed Metered Authorized Consumption



**A lot of data**

Duplicates  
Missing Data  
Adjustments  
Negative Reads  
Zero Reads  
Outliers

**One summary  
number**



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# Other Authorized Consumption

|                        |                           |                                       |                                    |                                      |                     |
|------------------------|---------------------------|---------------------------------------|------------------------------------|--------------------------------------|---------------------|
| SYSTEM INPUT<br>VOLUME | AUTHORIZED<br>CONSUMPTION | BILLED AUTHORIZED<br>CONSUMPTION      | BILLED<br>METERED<br>CONSUMPTION   | REVENUE WATER                        |                     |
|                        |                           |                                       | BILLED<br>UNMETERED<br>CONSUMPTION |                                      |                     |
|                        |                           | UNBILLED<br>AUTHORIZED<br>CONSUMPTION |                                    | UNBILLED<br>METERED<br>CONSUMPTION   | NONREVENUE<br>WATER |
|                        |                           |                                       |                                    | UNBILLED<br>UNMETERED<br>CONSUMPTION |                     |
|                        | WATER LOSSES              |                                       | APPARENT LOSSES                    | CUSTOMER METER<br>INACCURACIES       |                     |
|                        |                           | UNAUTHORIZED<br>CONSUMPTION           |                                    |                                      |                     |
|                        |                           | DATA HANDLING<br>ERRORS               |                                    |                                      |                     |
|                        |                           | REAL LOSSES                           |                                    |                                      |                     |



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# Other Authorized Consumption

Billed Unmetered

Unbilled Metered

Unbilled Unmetered

District use?

City use?

Special customers?

Exemptions?





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# Now we know Water Losses!

|                |                        |                                 |                                |                  |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                        |                                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | WATER LOSSES           | APPARENT LOSSES                 | CUSTOMER METER INACCURACIES    |                  |
|                |                        |                                 | UNAUTHORIZED CONSUMPTION       |                  |
|                |                        |                                 | DATA HANDLING ERRORS           |                  |
|                | REAL LOSSES            |                                 |                                |                  |



# Water Losses

$$[ \text{Water Supplied} ] - [ \text{Authorized Consumption} ] =$$

**Water Losses**



Real Losses

Apparent Losses





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# Apparent Losses

|                |                             |                               |                                 |                                |                  |
|----------------|-----------------------------|-------------------------------|---------------------------------|--------------------------------|------------------|
| WATER SUPPLIED | AUTHORIZED CONSUMPTION      | BILLED AUTHORIZED CONSUMPTION | BILLED METERED CONSUMPTION      | REVENUE WATER                  |                  |
|                |                             |                               | BILLED UNMETERED CONSUMPTION    |                                |                  |
|                |                             | WATER LOSSES                  | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                             |                               | APPARENT LOSSES                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | CUSTOMER METER INACCURACIES |                               |                                 |                                |                  |
|                |                             | UNAUTHORIZED CONSUMPTION      |                                 |                                |                  |
|                |                             | DATA HANDLING ERRORS          |                                 |                                |                  |
|                | REAL LOSSES                 |                               |                                 |                                |                  |



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# Apparent Losses

water volume that reaches an end user

***but is not registered or properly tracked***

(and so you're not paid)





# Apparent Losses

often referred to as “paper losses”

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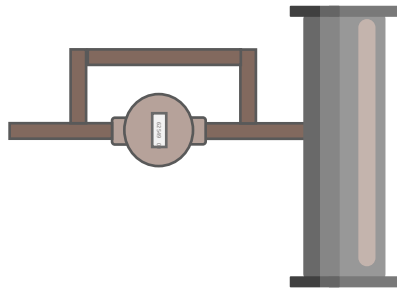
reducing Apparent Losses *increases revenue*  
but creates *no new water*

\$ \$ \$



# Apparent Loss – Categories

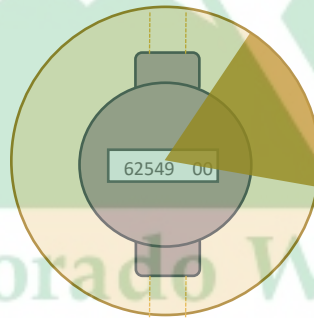
*How much water is delivered but not registered (or paid for)?*



Unauthorized Consumption



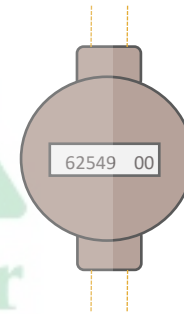
Theft!



Metering Inaccuracy



Customer meter under registration



| read.p | read.r |
|--------|--------|
| 62549  | 62549  |
| 62549  | 62549  |
| 62549  | 62549  |

Data Handling Errors



Reporting or other clerical errors during the handling of meter reading data



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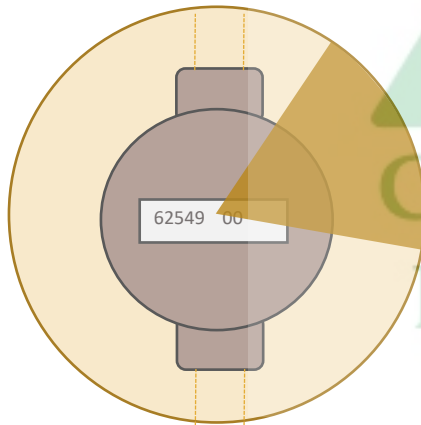
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# Apparent Loss – Value

**90% Customer Meter Accuracy**

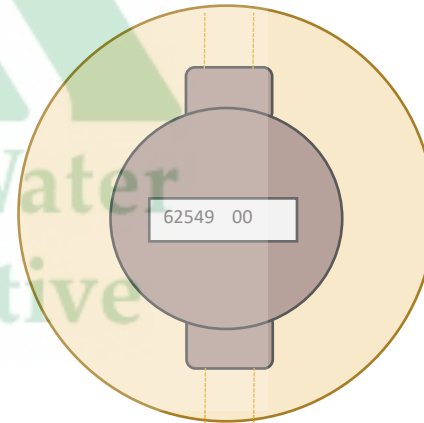


Service Charge: \$20

Volume of Use: 9 CCF

Variable Charge:  $\$3.00 \times 9 = \$27.00$

**100% Customer Meter Accuracy**



Service Charge: \$20

Volume of Use: 10 CCF

Variable Charge:  $\$3.00 \times 10 = \$30.00$





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# Real Losses

| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
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|                |                        |                                 | UNAUTHORIZED CONSUMPTION       |                  |
|                |                        |                                 | DATA HANDLING ERRORS           |                  |
|                |                        |                                 | REAL LOSSES                    |                  |



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Conservation Board

Department of Natural Resources



# Real Losses

often referred to as “physical losses”

leaks

seeps

breaks

Colorado Water  
Loss Initiative





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Department of Natural Resources



# Real Losses



reducing Real Losses *creates an additional resource*

can reduce operating costs

can defer capital expenditure



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# System Data

## Infrastructure information

- Length of Mains (includes hydrants laterals)
- Count of service connections (active and inactive)

## Operating Pressure

*used to calculate a technical minimum volume of leakage*



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# Cost Data

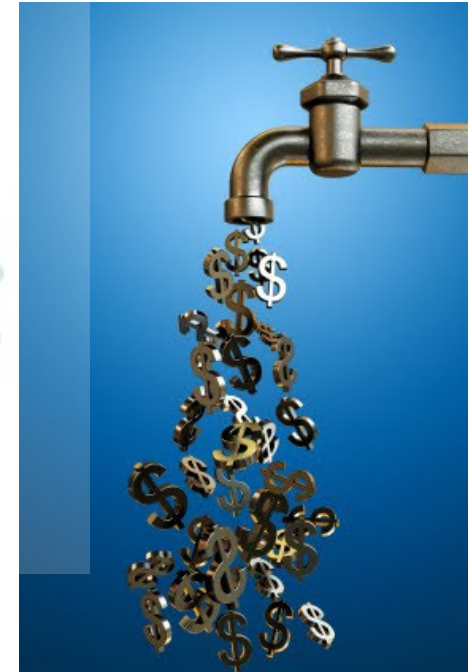
## Total Annual Operating Cost

*How much are Apparent Losses worth?*

## Customer Retail Unit Cost

*How much are Real Losses worth?*

## Variable Production Cost





# Let's review...

|                   |                           |                                       |                                 |                          |
|-------------------|---------------------------|---------------------------------------|---------------------------------|--------------------------|
| Water<br>Supplied | Authorized<br>Consumption | Billed<br>Authorized<br>Consumption   | Billed Metered Consumption      | Revenue<br>Water         |
|                   |                           |                                       | Billed Unmetered Consumption    |                          |
|                   |                           | Unbilled<br>Authorized<br>Consumption | Unbilled Metered Consumption    | Non-<br>Revenue<br>Water |
|                   |                           |                                       | Unbilled Unmetered Consumption  |                          |
|                   | Water<br>Losses           | Apparent<br>Losses                    | Unauthorized Consumption        |                          |
|                   |                           |                                       | Customer Metering Inaccuracies  |                          |
|                   |                           |                                       | Systematic Data Handling Errors |                          |
|                   |                           | Real<br>Losses                        | Leakage on Mains                |                          |
|                   |                           |                                       | Leakage on Service Lines        |                          |
|                   |                           |                                       | Leakage & Overflows at Storage  |                          |

# Knowledge Check

Another term for physical leaks in a system is

\_\_\_\_\_?

- A. Water theft
- B. Billed Metered Authorized Consumption
- C. Real Loss
- D. Flushing
- E. Water Loss

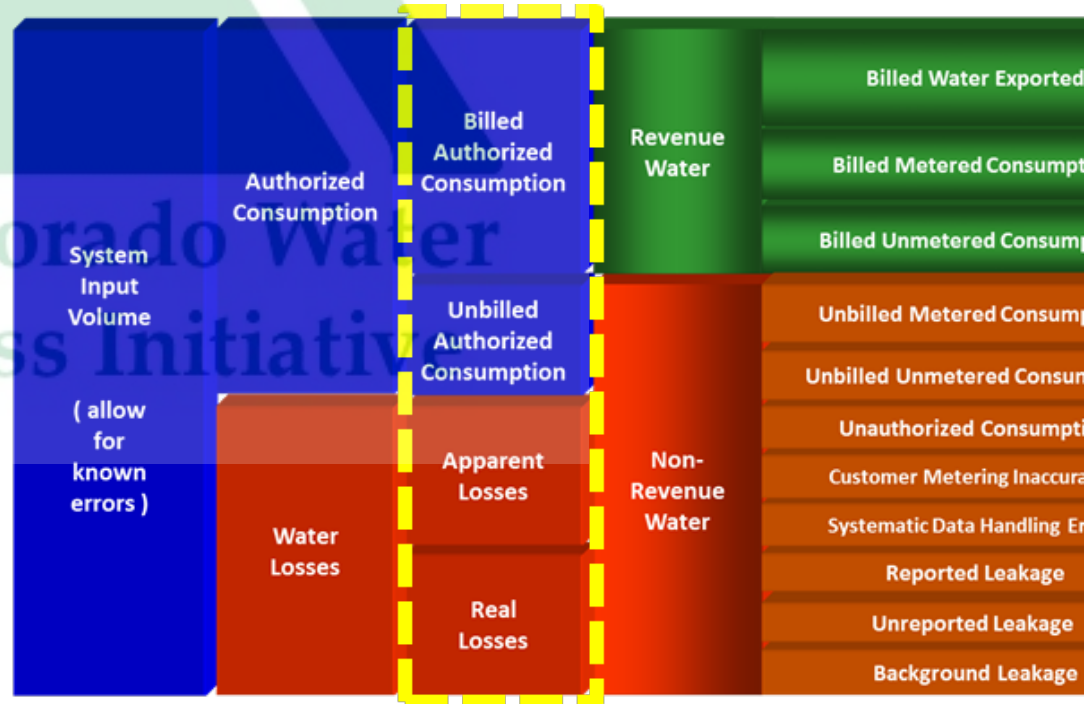


District facility use  
 Tank overflow  
 AMR Device transmission failure  
 Well water lubrication  
 Firefighting  
 Main breaks  
 Flat-rate condominiums  
 Parks department irrigation  
 Single-family indoor use  
 Under-registered customer meters

# Knowledge Check



## Colorado Water Loss Initiative



# Break



Colorado Water  
Loss Initiative

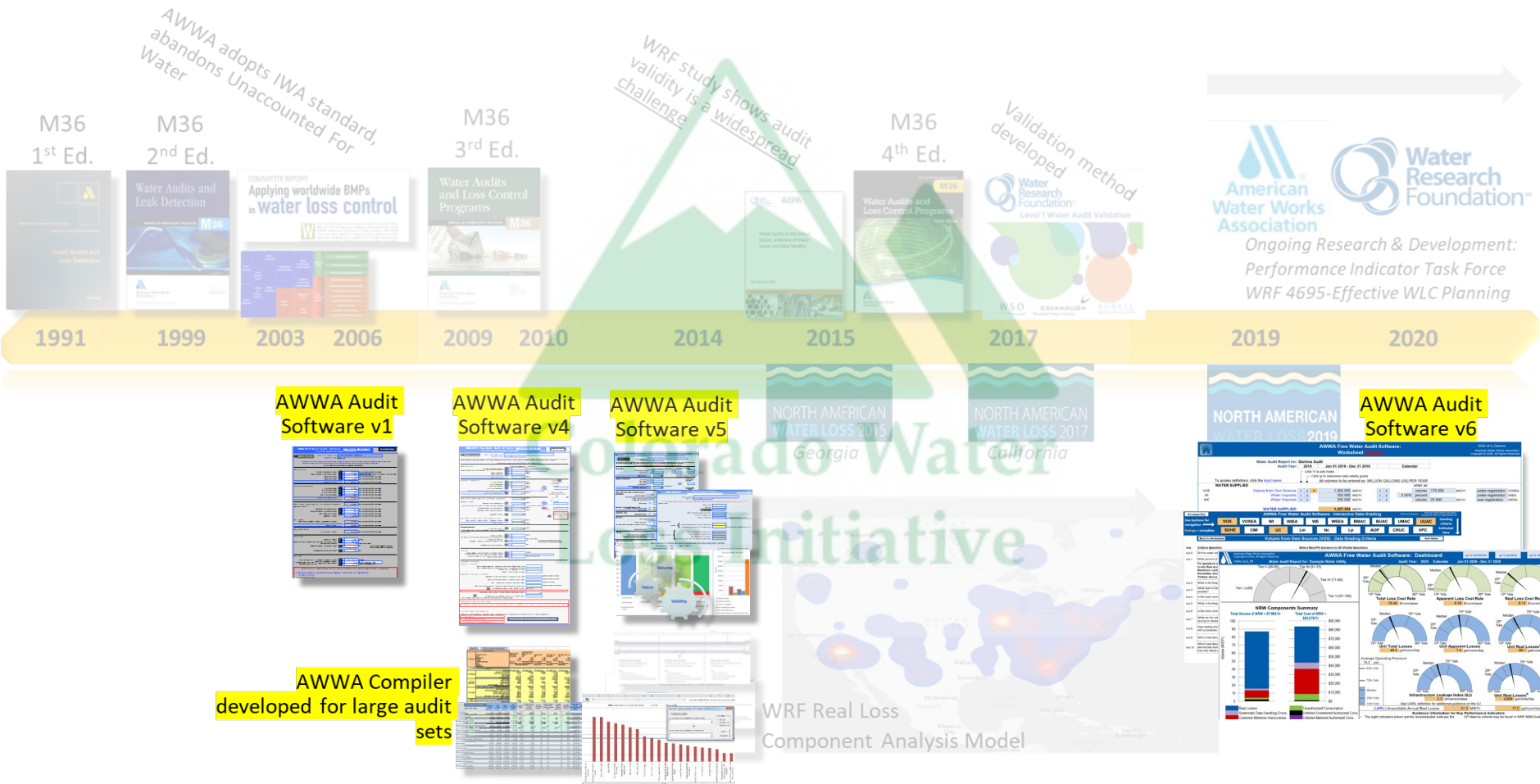
# AWWA Free Water Audit Software

Colorado Water  
Loss Initiative

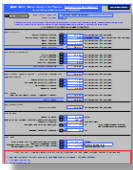
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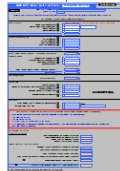
# AWWA M36 Methodology – Evolution of the Water Audit Software



## FWAS v1 (200)



FWAS v2 – v3



MG volumes only  
Data grading:  
either 'measured'  
or 'estimated'

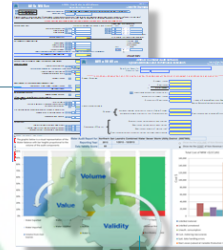
Megaliters added  
Two financial performance indicators  
added (cost of real and apparent losses)  
Acre-ft added  
Example audits included  
Two default values  
Data checks / instant feedback added

## FWAS v4 (2,000)



Data grading matrix (1-10)  
Service connection diagram  
French language version  
available

## FWAS v5 (13,000)

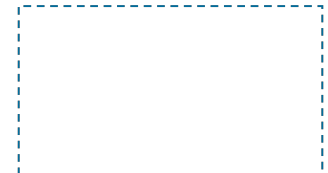
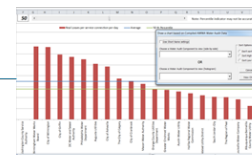
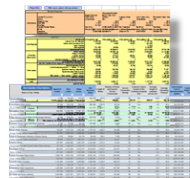


Separate data input/output tabs  
Dashboard  
Volume weighted data grading  
Comments page  
Meter error adjustment for all  
water supplied components

## FWAS v6

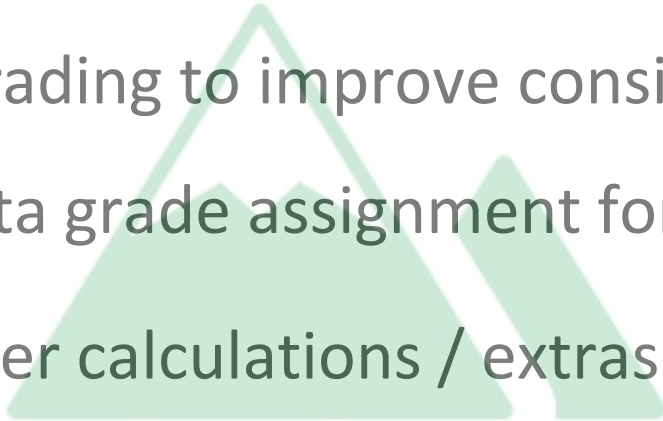


AWWA Compiler developed for  
large audit sets



# SUMMARY OF MAJOR V6 IMPROVEMENTS

- Interactive Data Grading to improve consistency, objectivity, transparency in data grade assignment for each input
- Blank sheet for user calculations / extras
- Fighterjet Dashboard
- KPIs updated per AWWA 2020 Position
- KPIs shown on gauge against industry ranges

The logo features a stylized green mountain range with three peaks. The text "Colorado Water Loss Initiative" is written in a green, sans-serif font, centered below the mountain range.

Colorado Water  
Loss Initiative

# AWWA Free Water Audit Software – Instructions Worksheet

| AWWA Free Water Audit Software v6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | FWAS v6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|---------|------|--------|------|--------|------|------|-------|---------|------|--------|----|--------|----|----|-----|------|-----|--|
| American Water Works Association Copyright © 2020, All Rights Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p>This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format and is not meant to take the place of a full-scale, comprehensive water audit format. Auditors are strongly encouraged to refer to the most current edition of AWWA M36 Manual for Water Audits for detailed guidance on the water auditing process and targeting loss reduction levels. This tool contains several separate worksheets. Sheets can be accessed using the tabs at the bottom of the screen, or by clicking the TOC links below.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <b>Table of Contents (TOC)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Enter Basic Information</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p><b>Start Page</b> The current sheet. Enter contact information and basic audit details.</p> <p><b>Worksheet</b> Enter the required data on this worksheet to calculate the water balance and data grading.</p> <p><b>Interactive Data Grading</b> Answer questions about operational practices for each audit input, and the data validity grades will automatically populate.</p> <p><b>Dashboard</b> Review NRW components, performance indicators and graphical outputs to evaluate the results of the audit.</p> <p><b>Notes</b> Enter notes to explain how values were calculated, document data sources, and related information about data management practices.</p> <p><b>Blank Sheet</b> By popular demand! A blank sheet. The world is your canvas.</p> <p><b>Water Balance</b> The values entered in the Worksheet automatically populate the Water Balance.</p> <p><b>Loss Control Planning</b> Use this sheet to interpret the results of the audit validity score and performance indicators.</p> <p><b>Definitions</b> Use this sheet to understand the terms used in the audit process.</p> <p><b>Service Connection Diagram</b> Diagrams depicting possible customer service connection line configurations.</p> <p><b>Acknowledgements</b> Acknowledgements for development of the AWWA Free Water Audit Software v6.0.</p> <p><b>AWWA Web Resources for Water Loss Control</b><br/> <a href="https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control/">https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control/</a><br/>           Items referenced in the Free Water Audit Software v6.0 on the web:<br/>           Data Grading Matrix v6.0<br/>           Example Water Audit v6.0<br/>           Water Audit Compiler v6.0<br/>           AWWA Reports on Performance Indicators<br/>           M36 Manual</p> | <p>Name of Utility: County Water Utility</p> <p>Name of Contact Person: John Smith, Manager</p> <p>Email:</p> <p>Telephone   Ext:</p> <p>City/Town/Municipality: Anytown</p> <p>State / Province:</p> <p>Country: USA</p> <p>Audit Preparation Date: Nov 02 2022</p> <p>Audit Year: 2021</p> <p>Audit Year Label: Calendar (Fiscal, Calendar, etc)</p> <p>Audit Period Start Date: Jan 01 2021</p> <p>Audit Period End Date: Dec 31 2021</p> <p>Volume Reporting Units: Million gallons (US)</p> <p>Water System Structure: Retail</p> <p>Water Type: Potable Water</p> <p>System ID Number:</p> <p>Validator Name/ID:</p> <p>Validator Email:</p> <p>Estimated Total Population Served by Water Utility:</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Key of Input Acronyms</b> <i>In order of appearance in the Worksheet</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>VOS Volume from Own Sources</p> <p>VOSEA VOS Error Adjustment</p> <p>WI Water Imported</p> <p>WIEA WI Error Adjustment</p> <p>WE Water Exported</p> <p>WEEA WE Error Adjustment</p> <p>BMAC Billed Metered Authorized Consumption</p> <p>BUAC Billed Unmetered Authorized Consumption</p> <p>UMAC Unbilled Metered Authorized Consumption</p> <p>UUAC Unbilled Unmetered Authorized Consumption</p> <p>SDHE Systematic Data Handling Errors</p> <p>CMI Customer Metering Inaccuracies</p> <p>UC Unauthorized Consumption</p> <p>Lm Length of mains</p> <p>Nc Number of service connections</p> <p>Lp Average length of (private) customer service line</p> <p>AOP Average Operating Pressure</p> <p>CRUC Customer Retail Unit Charge</p> <p>VPC Variable Production Cost</p> |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Color Key</b> User input <span style="background-color: #d9e1f2; border: 1px solid black; padding: 2px;"> </span> Calculated <span style="background-color: #fce4d6; border: 1px solid black; padding: 2px;"> </span> Optional default <span style="border: 1px dashed black; padding: 2px;"> </span>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Guidance for the Worksheet</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>Choosing to enter unit of <b>percent</b> or <b>volume</b> (applies to VOSEA, WIEA, WEEA, CMI)</p> <p>choose entry option:</p> <table border="1"> <tr> <td>1.00%</td> <td>percent</td> <td>or</td> <td>25.000</td> </tr> <tr> <td></td> <td>volume</td> <td></td> <td></td> </tr> </table> <p>Choosing to enter <b>default</b> or <b>custom</b> input (applies to UUAC, SDHE, UC)</p> <p>choose entry option:</p> <table border="1"> <tr> <td>0.25%</td> <td>default</td> <td>or</td> <td>75.000</td> </tr> <tr> <td></td> <td>custom</td> <td></td> <td></td> </tr> </table>                                                                                                                                                                                                 |        | 1.00% | percent | or   | 25.000 |      | volume |      |      | 0.25% | default | or   | 75.000 |    | custom |    |    |     |      |     |  |
| 1.00%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | percent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 25.000 |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
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| 0.25%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | default                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 75.000 |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>Use acronym buttons in IDG header to navigate among inputs. Acronym Key above. White = needs answers, orange = complete, clear = not required. Example below.</p> <table border="1"> <tr> <td>VOS</td> <td>VOSEA</td> <td>WI</td> <td>WIEA</td> <td>WE</td> <td>WEEA</td> <td>BMAC</td> <td>BUAC</td> <td>UMAC</td> <td>UUAC</td> </tr> <tr> <td>SDHE</td> <td>CMI</td> <td>UC</td> <td>Lm</td> <td>Nc</td> <td>Lp</td> <td>AOP</td> <td>CRUC</td> <td>VPC</td> <td></td> </tr> </table> <p>After clicking an acronym button, answer all visible questions in the order they're presented, choosing best-fit answer</p> <p>Grade will populate when all visible questions are complete for an input</p> <p>Limiting</p>                                                      |        | VOS   | VOSEA   | WI   | WIEA   | WE   | WEEA   | BMAC | BUAC | UMAC  | UUAC    | SDHE | CMI    | UC | Lm     | Nc | Lp | AOP | CRUC | VPC |  |
| VOS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | VOSEA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | WI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | WIEA   | WE    | WEEA    | BMAC | BUAC   | UMAC | UUAC   |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| SDHE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CMI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | UC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Lm     | Nc    | Lp      | AOP  | CRUC   | VPC  |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>The limiting criteria will be labeled along the right. If only 1 limiting criterion is shown, improving on that criterion will achieve a higher data grade. If multiple limiting criteria are shown, improving on <i>each</i> limiting criterion is necessary to achieve a higher data grade. A complete inventory of data grading criteria is available in the Data Grading Matrix v6.0 (see web resources)</p>                                                                                                                                                                                                                                                                                                                                                             |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p>If you have questions or comments regarding this software please contact us at: <a href="mailto:wlc@awwa.org">wlc@awwa.org</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |

# AWWA Free Water Audit Software

## Worksheet

Water Audit Report for: **Pre-Release Example Audit - Review Only**  
Audit Year: **2019** Jan 01 2019 - Dec 31 2019 Calendar

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: MILLION GALLONS (US) PER YEAR

Water Supplied Error Adjustments  
choose entry option:

**WATER SUPPLIED**

VOS Volume from Own Sources:    1,000,000 MG/Yr  
WI Water Imported:   MG/Yr  
WE Water Exported:   MG/Yr

choose entry option:    1.00% percent  VOSEA  
WIEA  
WEEA

**WATER SUPPLIED:** 990,099 MG/Yr

**AUTHORIZED CONSUMPTION**

BMAC Billed Metered:    850,000 MG/Yr  
BUAC Billed Unmetered:   MG/Yr  
UMAC Unbilled Metered:   MG/Yr  
UIAC Unbilled Unmetered:    15,000 MG/Yr

choose entry option:    15,000 MG/Yr  15,000 MG/Yr

**AUTHORIZED CONSUMPTION:** 865,000 MG/Yr

**WATER LOSSES** 125,099 MG/Yr

**Apparent Losses**

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

SDHE Systematic Data Handling Errors:    2,125 MG/Yr  
CMI Customer Metering Inaccuracies:    8,586 MG/Yr  
UC Unauthorized Consumption:    2,125 MG/Yr

choose entry option:    2,125 MG/Yr  0.25% default  
 1.00% percent  
 0.25% default

Default option selected for Unauthorized Consumption, with automatic data grading of 3

**Apparent Losses:** 12,836 MG/Yr

**Real Losses**

**Real Losses:** 112,263 MG/Yr

**WATER LOSSES:** 125,099 MG/Yr

**NON-REVENUE WATER**

**NON-REVENUE WATER:** 140,099 MG/Yr

**SYSTEM DATA**

Lm Length of mains:    200.0 miles (including fire hydrant lead lengths)  
Nc Number of service connections:    5,000 (active and inactive)  
Service connection density:    25 conn./mile main

Are customer meters typically located at the curbstops/property    Yes

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

AOP Average Operating Pressure:    50.0 psi

**COST DATA**

CRUC Customer Retail Unit Charge:    \$2.00 /1000 gallons (US)  
VPC Variable Production Cost:    \$500.00 /\$Million gallons

**Total Annual Operating Cost**  
\$2,500,000 \$/yr (optional input)



# AWWA Free Water Audit Software - Data Grading

- Components are assigned a Grading from 1-10 based upon the validity of the source data and operational practices
- Interactive Data Grading Matrix worksheet gives criteria for grading components according to utility operations and practices
- Grading criteria is a ***process-based*** approach

Test Utility  
2019

VOS

VOSEA

WI

WIEA

WE

WEEA

BMAC

BUAC

UMAC

UUAC

SDHE

CMI

UC

Lm

Nc

Lp

AOP

CRUC

VPC

White = incomplete  
Orange = complete  
Use acronyms for navigation

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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%                                                                                   |
|        | <p><b>For questions 2-10 below: Choose the answer that applies for those meters that measure &gt;90% of the finished water volume.</b></p> <p><b>In-situ flow accuracy testing</b> refers to a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location.</p> <p><b>Electronic calibration</b> refers to a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).</p> <p><b>Secondary device</b> can include meter transmitter, DP cell, chart recorder or similar instrumentation.</p> <p><b>Tertiary device</b> can include SCADA, historian or other computerized archival system.</p> |                                                                                        |
| 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)?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <div>At ±6% or greater</div> <div>Between ±3% to ±6%</div> <div>At or within ±3%</div> |
| 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                        |

FINAL DATA GRADE FOR THIS AUDIT INPUT:

# AWWA Free Water Audit Software

## Interactive Data Grading

Test Utility 2019

AWWA Free Water Audit Software: Interactive Data Grading

acronym key

Limiting criteria (see Start Page for details)

White = incomplete  
Orange = complete

Use acronyms for navigation

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

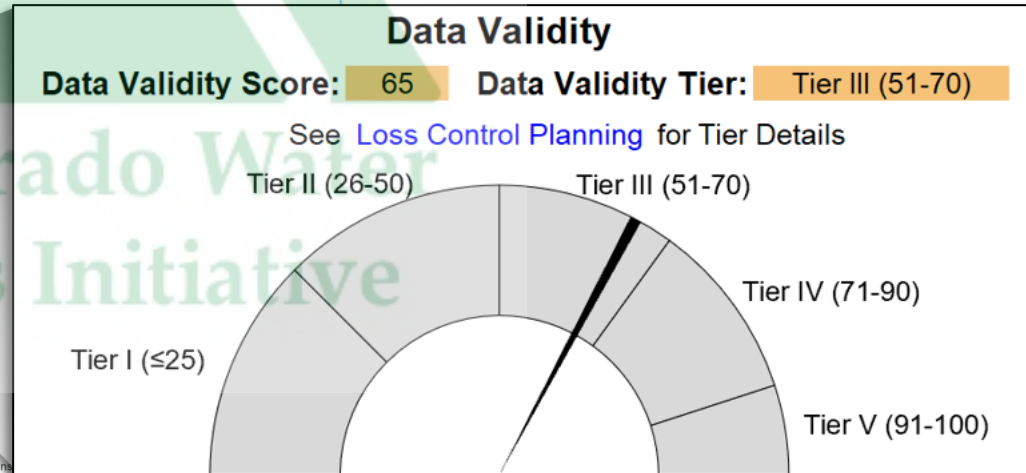
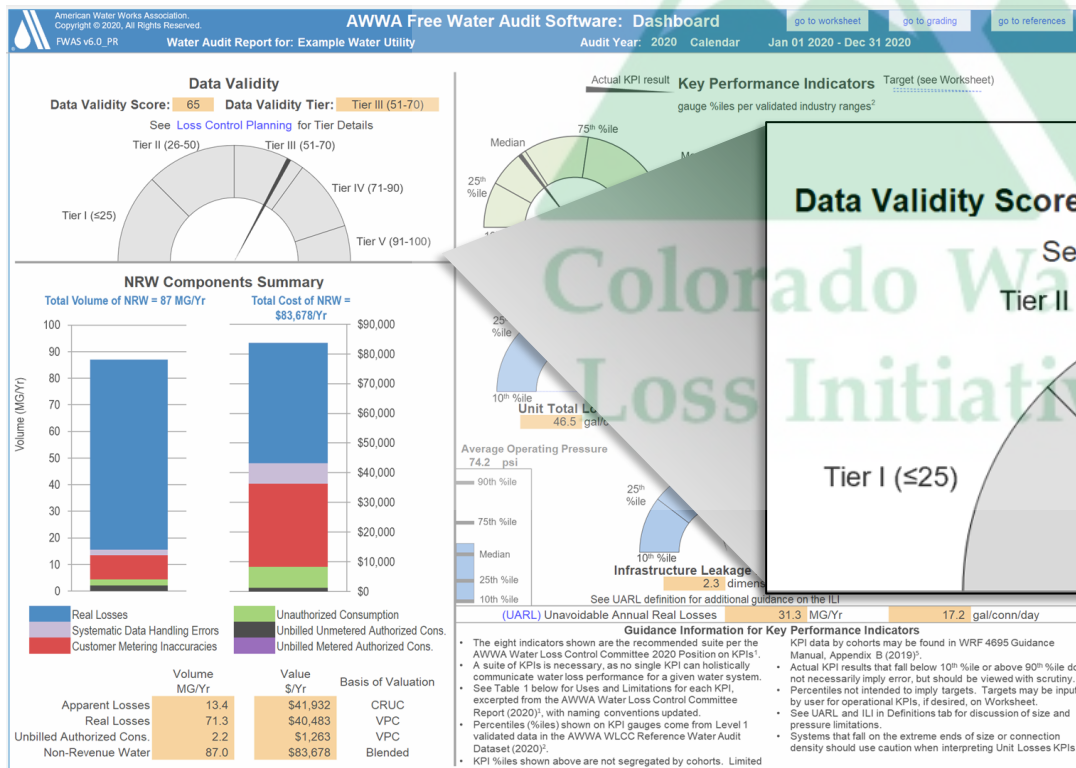
- Includes questions regarding practices, policies, and grading criteria selections
- Automated Data Grade selections
- Includes guidance for improvement to the next grade shown as 'Limiting' criteria

# AWWA Free Water Audit Software

## Quantifying Data Validity

### Data Validity Score (DVS)

- A composite calculation based upon the gradings of the individual water audit components
- Represents the overall validity, or trustworthiness, of the data and is an indirect assessment of the utility's processes to supply and deliver water



# AWWA Free Water Audit Software

## *What does the DVS mean for my water utility?*

- **Water Loss Control Planning Guide**
- Gives guidance on interpretation of the Data Validity Tier (DVT)
- Represents a continuum of process-based assessments
- Higher validity = more reliable assessment of water loss standing and greater loss control opportunities

| Water Loss Control Planning Guide |                                                                                                         |                                                                                                                                                                        |                                                                                                                                          |                                                                                                                                  |                                                                                                                             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Functional Focus Area             | Water Audit Data Validity Tier (Score Range)                                                            |                                                                                                                                                                        |                                                                                                                                          |                                                                                                                                  |                                                                                                                             |
|                                   | Tier I (1-25)                                                                                           | Tier II (26-50)                                                                                                                                                        | Tier III (51-70)                                                                                                                         | Tier IV (71-90)                                                                                                                  | Tier V (91-100)                                                                                                             |
| Audit Data Collection             | Launch auditing and loss control team; address supply metering deficiencies                             | Analyze business process for customer metering and billing functions and water supply operations; identify data gaps; improve supply metering                          | Establish/revise policies and procedures for data collection                                                                             | Refine data collection practices and establish as routine business process                                                       | Annual water audit is a reliable gauge of year-to-year water efficiency standing                                            |
| Short-term loss control           | Research information on leak detection programs; Begin flowcharting analysis of customer billing system | Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc                           | Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring                   | Refine, enhance or expand ongoing programs based upon economic justification                                                     | Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation      |
| Long-term loss control            |                                                                                                         | Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or AMR/AMI system | Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process | Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management | Continue incremental improvements in short-term and long-term loss control interventions                                    |
| Target-setting                    |                                                                                                         |                                                                                                                                                                        | Establish long-term apparent and real loss reduction goals (+10 year horizon)                                                            | Establish mid-range (5 year horizon) apparent and real loss reduction goals                                                      | Evaluate and refine loss control goals on a yearly basis                                                                    |
| Benchmarking                      |                                                                                                         |                                                                                                                                                                        | Preliminary Comparisons - can begin to rely upon with Pls for performance comparisons for real losses                                    | Performance Benchmarking with Pls is meaningful in comparing real loss standing                                                  | Identify Best Practices/ Best in class; Pls are very reliable as real loss performance indicators for best in class service |

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*

# Accuracy in the Water Balance

Where does error sneak in?

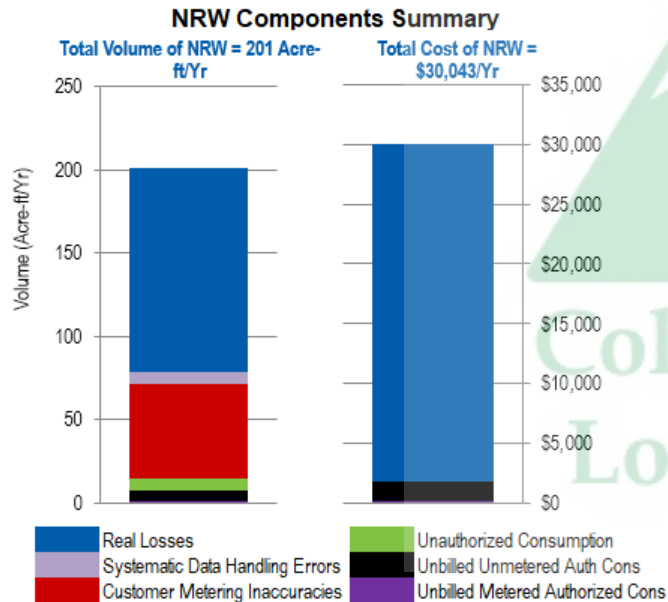
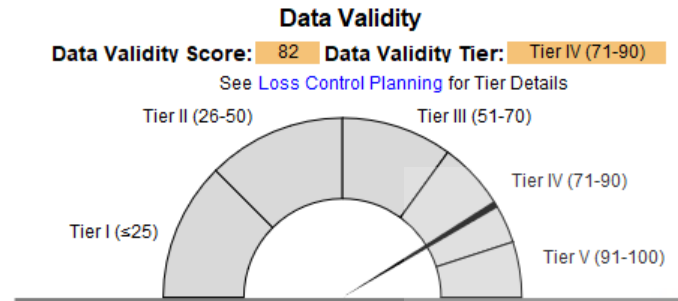
|                                                               |                     |                                                     |                                 |                               |                                                                     |                          |
|---------------------------------------------------------------|---------------------|-----------------------------------------------------|---------------------------------|-------------------------------|---------------------------------------------------------------------|--------------------------|
| Volume from Own Sources (VOS)<br>(corrected for known errors) | System Input Volume | Water Exported (WE)<br>(corrected for known errors) | Billed Water Exported           |                               |                                                                     | Revenue Water (Exported) |
|                                                               |                     | Water Supplied                                      | Authorized Consumption          | Billed Authorized Consumption | Billed Metered Consumption (BMAC)<br>(water exported is removed)    | Revenue Water            |
|                                                               |                     |                                                     |                                 |                               | Billed Unmetered Consumption (BUAC)                                 |                          |
|                                                               |                     |                                                     | Unbilled Authorized Consumption |                               | Unbilled Metered Consumption (UMAC)                                 | Non-Revenue Water (NRW)  |
|                                                               |                     |                                                     |                                 |                               | Unbilled Unmetered Consumption (UUAC)                               |                          |
|                                                               |                     |                                                     | Apparent Losses                 |                               | Systematic Data Handling Errors (SDHE)                              |                          |
|                                                               |                     |                                                     |                                 |                               | Customer Metering Inaccuracies (CMI)                                |                          |
|                                                               |                     |                                                     |                                 |                               | Unauthorized Consumption (UC)                                       |                          |
|                                                               |                     |                                                     | Real Losses                     |                               | Leakage on Transmission and/or Distribution Mains                   |                          |
|                                                               |                     |                                                     |                                 |                               | Not broken down<br>Leakage and Overflows at Utility's Storage Tanks |                          |
|                                                               |                     |                                                     |                                 |                               | Not broken down<br>Leakage on Service Connections                   |                          |
|                                                               |                     |                                                     |                                 |                               | Not broken down                                                     |                          |
| Water Imported (WI)<br>(corrected for known errors)           |                     |                                                     |                                 |                               |                                                                     |                          |

- Primary instrumentation
- Secondary data management, archival, and summary
- Interaction with data and methodology; estimation



# Impacts of Data Validation for a Particular Water Utility – DVS Decreased!

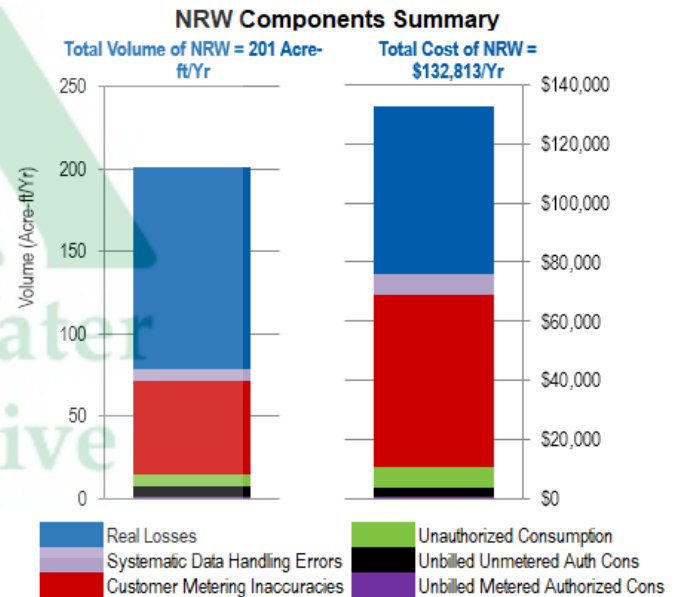
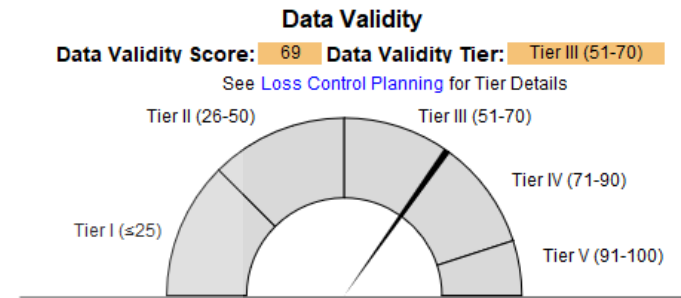
## Pre-Level 1 Validation



**Infrastructure Leakage Index (ILI)**

**1.3** dimensionless

## Post-Level 1 Validation



**Infrastructure Leakage Index (ILI)**

**1.3** dimensionless

# Filling out the Software

**1. Gather** data and supporting documents

data for each input:

complete? consistent? accurate?

**3. Enter** the input.

**4. Comment** on source of data, quality of data, etc.

**5. Select** a data validity grade for each input

# Step 1 – Assemble the Supporting Documents



## The Colorado Water Loss Initiative

### Level 1 Water Audit Validation Session:

#### How to Prepare

The Level 1 Water Audit Validation will be a ~2-hour teleconference with shared screen during which your Water Audit Team and a member of the CWLI team discuss your water audit and the data that supports it.

To prepare for the session, you will need to gather and provide to us the following documents and data. Do the best you can! If you can't provide every item requested, please do what you are able and note any gaps in the data for us to discuss. You also have the option to schedule a pre-conference meeting with your assigned Water Audit Validator to go over any questions to ensure readiness for the validation session.

#### Documents to send to the CWLI Team:

- Required documentation for Level 1 Validation:
- ☐ Completed AWWA Free Water Audit Software (Excel Spreadsheet)
  - ☐ Volume from Own Sources broken down by month and finished water supply meter
  - ☐ Water Imported broken down by month by meter
  - ☐ Water Exported broken down by month by meter
  - ☐ Supply meter testing and/or calibration documentation
  - ☐ Authorized Consumption broken down by month and use type (e.g. charge status, water type, customer)



Example of Supporting Documentation for all Water Supplied Volumes

| Volume from Own Sources, Water Imported, Water Exported |            |        |        |        |            |                             |
|---------------------------------------------------------|------------|--------|--------|--------|------------|-----------------------------|
| UNITS = MG                                              |            |        |        |        |            |                             |
| Month                                                   | Import M-1 | Well 1 | Well 2 | Well 3 | Export E-1 | Monthly Distribution Totals |
| May 2017                                                | 125.48     | 15.33  | 11.19  | 45.61  | -          | 197.60                      |
| June 2017                                               | 170.61     | -      | 55.48  | 30.59  | -          | 256.68                      |
| July 2017                                               | 202.11     | 5.75   | 60.58  | 36.22  | -          | 304.67                      |
| August 2017                                             | 185.45     | 2.03   | 37.67  | 32.58  | -          | 257.74                      |
| September 2017                                          | 178.74     | 1.49   | 34.31  | 32.04  | -          | 246.59                      |
| October 2017                                            | 171.39     | -      | 25.15  | -      | 5.18       | 191.36                      |
| November 2017                                           | 123.00     | 2.31   | 39.35  | 32.85  | 45.79      | 151.72                      |
| December 2017                                           | 49.11      | 5.43   | 58.60  | 35.91  | 22.46      | 126.58                      |
| January 2018                                            | 31.56      | 34.60  | 23.82  | 64.49  | -          | 154.46                      |
| February 2018                                           | 7.29       | 31.94  | 22.20  | 61.89  | -          | 123.32                      |
| March 2018                                              | 6.06       | 31.22  | 21.70  | 61.18  | -          | 120.17                      |
| April 2018                                              | 58.44      | 35.56  | 24.43  | 65.44  | -          | 183.87                      |

Example of Supporting Documentation for Billed Metered Authorized Consumption

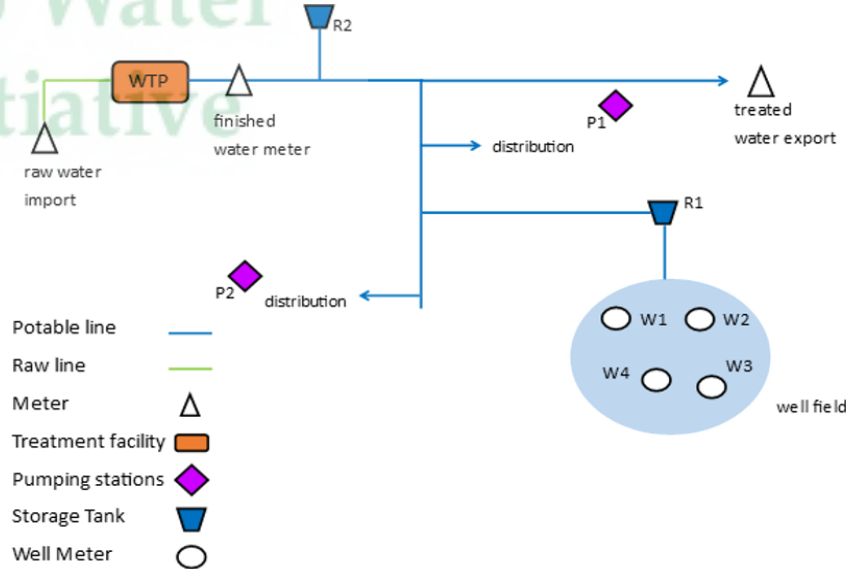
| Water Sold, UNITS = MG    |          |           |           |             |                |              |               |               |
|---------------------------|----------|-----------|-----------|-------------|----------------|--------------|---------------|---------------|
| Month                     | May 2017 | June 2017 | July 2017 | August 2017 | September 2017 | October 2017 | November 2017 | December 2017 |
| Single Family Residential | 31.15    | 32.81     | 38.42     | 28.18       | 42.15          | 47.77        | 48.99         | 51.23         |
| Multi Family Residential  | 16.07    | 15.55     | 18.54     | 17.84       | 18.49          | 17.65        | 19.29         | 21.01         |
| Commercial/Institutional  | 12.67    | 14.23     | 8.78      | 8.96        | 10.84          | 13.01        | 12.91         | 11.01         |
| Industrial                | 1.20     | 1.40      | 1.40      | 1.50        | 1.20           | 1.10         | 1.60          | 1.20          |
| Landscape Irrigation      | 10.02    | 7.56      | 2.54      | 4.82        | 8.42           | 10.48        | 11.94         | 11.01         |
| Municipal                 | 3.45     | 2.88      | 2.22      | 2.25        | 2.56           | 2.93         | 2.91          | 2.91          |
| Water Department          | 1.42     | 1.10      | 1.50      | 1.55        | 1.05           | 1.66         | 1.20          | 1.20          |
| Recycled                  | 8.53     | 9.11      | 10.08     | 8.04        | 10.83          | 11.95        | 12.20         | 11.01         |

#### WATER AUDIT TOTALS

excludes recycled water accounts

|                                            |          |    |
|--------------------------------------------|----------|----|
| Billed Metered Authorized Consumption:     | 1,051.33 | MG |
| Billed Unmetered Authorized Consumption:   | N/A      |    |
| Unbilled Metered Authorized Consumption:   | 17.27    | MG |
| Unbilled Unmetered Authorized Consumption: |          |    |

includes SF Residential, MF Re:  
all billed customers have a me  
this includes our own facility u  
this includes minimal flushing,



# Supporting Documentation

*provides more detail on key values*

| REQUIRED                                                                                                | SUPPLEMENTAL                                                                                      |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> Volume from Own Sources<br><i>broken down by month and meter</i>               | <input type="checkbox"/> Customer Meter Inaccuracy derivation                                     |
| <input type="checkbox"/> Water Imported<br><i>broken down by month and meter</i>                        | <input type="checkbox"/> Average Operating Pressure derivation                                    |
| <input type="checkbox"/> Water Exported<br><i>broken down by month and meter</i>                        | <input type="checkbox"/> Customer Retail Unit Cost derivation                                     |
| <input type="checkbox"/> Supply Meter Test Records<br><i>for all supply meters, if conducted</i>        | <input type="checkbox"/> Variable Production Cost derivation                                      |
| <input type="checkbox"/> Volume of Metered Consumption<br><i>broken down by month and use type/code</i> | <input type="checkbox"/> System Schematic<br><i>showing locations of Supply and Export Meters</i> |

# Developing the Inputs

1. Assemble supporting documents

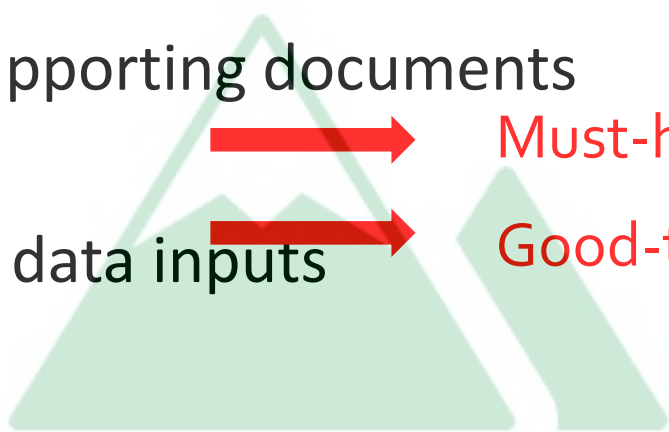


Must-have docs

2. Develop the data inputs



Good-to-have docs

A large, light green logo in the background featuring a stylized mountain range. Below the mountains, the text 'Colorado Water Loss Initiative' is written in a serif font.

Colorado Water  
Loss Initiative



# Developing the Inputs

1. Assemble supporting documents

→ Must-have docs

2. Develop the data inputs

→ Good-to-have docs

→ Build it from supporting docs

→ Look for errors. Does the data make sense?

Colorado Water  
Loss Initiative

## Step 2 – Develop the Inputs

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

Audit Year: **2019**    **Jan 01 2019 - Dec 31 2019**    **Calendar**

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: **MILLION GALLONS (US) PER YEAR**

**WATER SUPPLIED**

Volume from Own Sources:     MG/Yr

Water Imported:    MG/Yr

Water Exported:    MG/Yr

Water Supplied Error Adjustments  
choose entry option:

VOSEA  
WIEA  
WEEA

**WATER SUPPLIED:**  MG/Yr

- **Develop the Input**

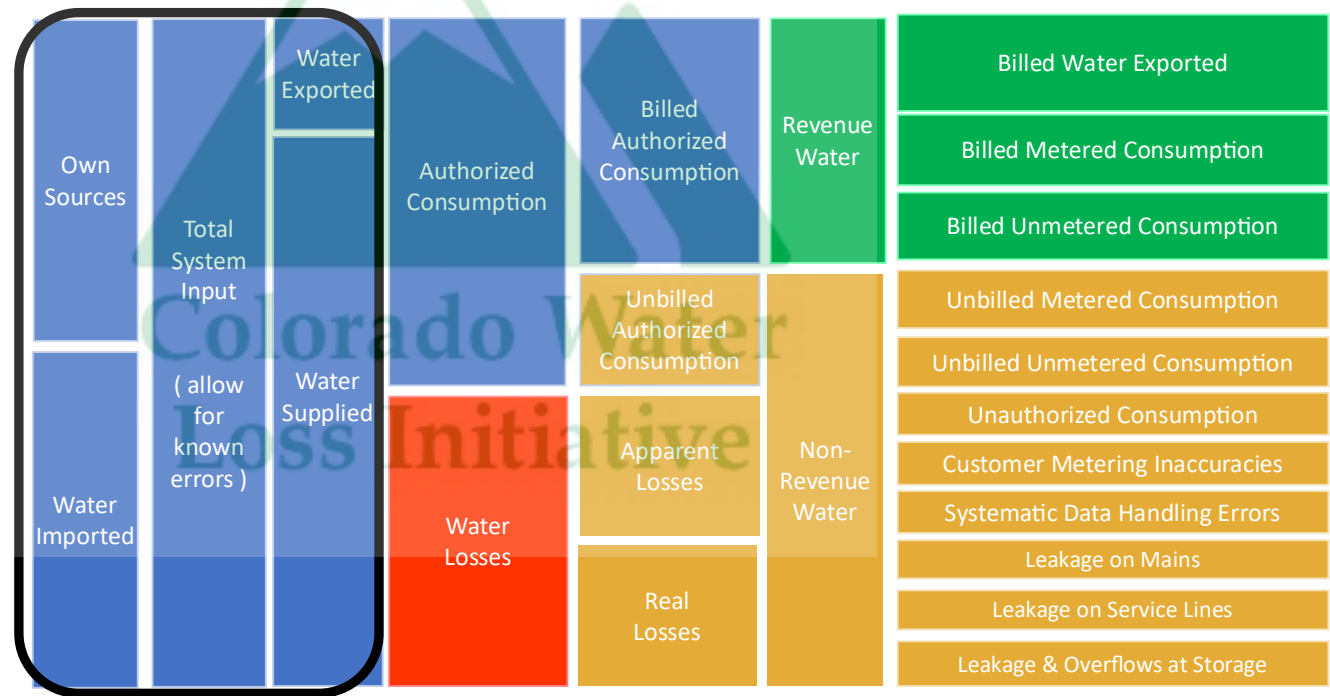
- Trace from production reports
- Trace from testing reports

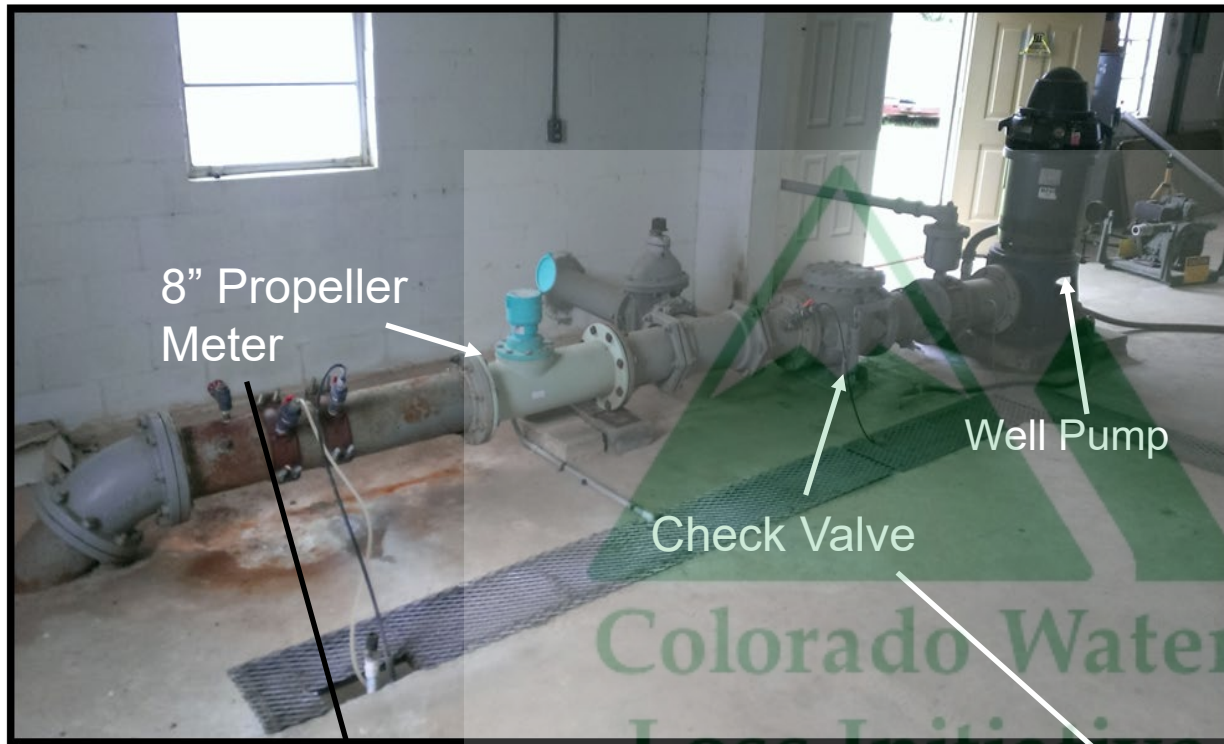
- **Look for Potential Errors**

- Missing or extra volumes
- Mismatched timeframe
- Error adjustment should be a weighted average of test results (if available)
- Wrong + or – on error adjustment

# Potential Errors in Water Supplied

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





8" Propeller  
Meter

Well Pump

Check Valve

Accuracy results from MFR  
test bench: 99.5%

Accuracy results from in-  
situ test: 142.2%

Colorado Water  
Loss Initiative



# Flow Data Archiving

- Production flow data should be reviewed every business day for data gaps
- Gaps occur due to:
  - Unplanned interruption: lightning strike, power failure
  - Planned interruption: instrumentation calibration
- Gaps in water flow data should be quantified and added back to the daily total

| Example of Water Pumping Data Gaps and |                                                  |                                                        |
|----------------------------------------|--------------------------------------------------|--------------------------------------------------------|
| 8/15/2012,<br>hrs                      | High Service<br>Pumping Rate, mgd<br>actual flow | High Service<br>Pumping Rate, mgd<br>raw recorded data |
| 0:00                                   | 8.69                                             | 8.69                                                   |
| 1:00                                   | 8.65                                             | 8.65                                                   |
| 2:00                                   | 8.32                                             | 8.32                                                   |
| 3:00                                   | 8.11                                             | 8.11                                                   |
| 4:00                                   | 7.94                                             | 0                                                      |
| 5:00                                   | 8.02                                             | 0                                                      |
| 6:00                                   | 8.44                                             | 0                                                      |
| 7:00                                   | 8.98                                             | 0                                                      |
| 8:00                                   | 9.34                                             | 0                                                      |
| 9:00                                   | 9.25                                             | 0                                                      |
| 10:00                                  | 9.17                                             | 0                                                      |
| 11:00                                  | 9.12                                             | 9.12                                                   |
| 12:00                                  | 9.27                                             | 9.27                                                   |
| 13:00                                  | 9.22                                             | 9.22                                                   |
| 14:00                                  | 9.08                                             | 9.08                                                   |
| 15:00                                  | 8.99                                             | 8.99                                                   |
| 16:00                                  | 9.14                                             | 9.14                                                   |
| 17:00                                  | 9.18                                             | 9.18                                                   |
| 18:00                                  | 9.25                                             | 9.25                                                   |
| 19:00                                  | 9.22                                             | 9.22                                                   |
| 20:00                                  | 8.82                                             | 8.82                                                   |
| 21:00                                  | 8.78                                             | 8.78                                                   |
| 22:00                                  | 8.75                                             | 8.75                                                   |
| 23:00                                  | 8.71                                             | 8.71                                                   |
| 0:00                                   | 8.68                                             | 8.68                                                   |
|                                        |                                                  |                                                        |
| Total                                  | <b>212.43</b>                                    | <b>151.29</b>                                          |
| Average                                | <b>8.85</b>                                      | <b>6.30</b>                                            |
| Difference                             |                                                  | <b>2.55</b>                                            |
|                                        |                                                  |                                                        |

(Source: AWWA M36 Publication, 4<sup>th</sup> Ed.)



# Step 2 – Develop the Inputs

**AUTHORIZED CONSUMPTION**

|      |                     |   |   |   |         |       |
|------|---------------------|---|---|---|---------|-------|
| BMAC | Billed Metered:     | n | g | 9 | 850.000 | MG/Yr |
| BUAC | Billed Unmetered:   | n | g |   |         | MG/Yr |
| UMAC | Unbilled Metered:   | n | g |   |         | MG/Yr |
| UUAC | Unbilled Unmetered: | n | g | 4 | 15.000  | MG/Yr |

choose entry option:  
  MG/Yr

**AUTHORIZED CONSUMPTION:**  MG/Yr

---

**WATER LOSSES**  MG/Yr

**Apparent Losses**

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

|      |                                  |   |   |   |       |       |
|------|----------------------------------|---|---|---|-------|-------|
| SDHE | Systematic Data Handling Errors: | n | g | 3 | 2.125 | MG/Yr |
| CMI  | Customer Metering Inaccuracies:  | n | g | 1 | 8.586 | MG/Yr |
| UC   | Unauthorized Consumption:        | n | g | 3 | 2.125 | MG/Yr |

choose entry option:

Default option selected for Unauthorized Consumption, with automatic data grading of 3

**Apparent Losses:**  MG/Yr

## Develop the Input

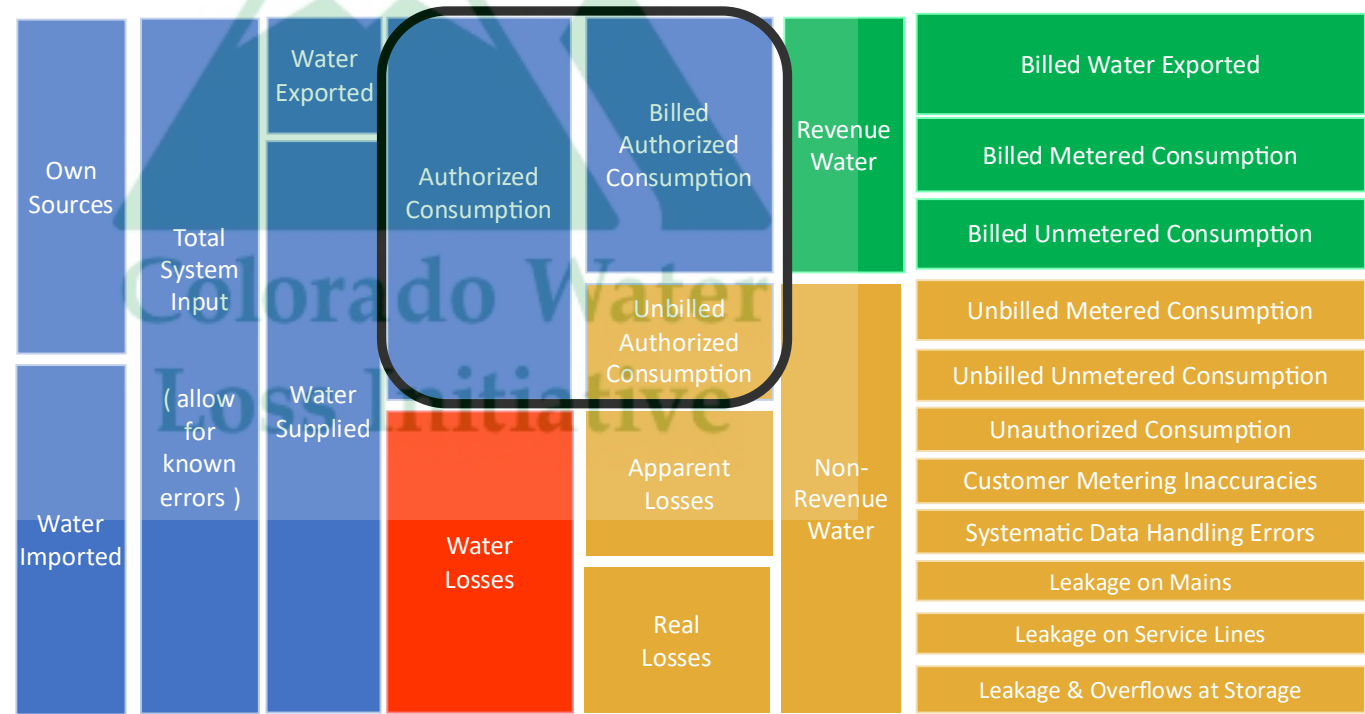
- Trace from billing reports
- Trace from flushing (etc) tracker

## Look for potential errors

- Billing report
- Double counting Water Exported in Billed Metered
- Double counting Unbilled Metered in Billed Metered
- Including leaks / breaks in Unbilled Unmetered

# Potential Errors in Authorized Consumption

- Duplicate volumes
- Non-potable volumes
- Missing volumes
- Mismatched timeframes



# Developing the Inputs

1. Assemble supporting documents



Must-have docs

2. Develop the data inputs



Good-to-get docs



Build it from supporting docs



Look for errors. Does the data make sense?

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Loss Initiative

# Knowledge Check

The AWWA Free Water Audit Software...

- A. reports water losses as a percentage of supply input.
- B. calculates Unaccounted-For Water.
- C. is the industry standard tool for quantifying water losses.
- D. is expensive.
- E. None of the above



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Loss Initiative

The logo features a stylized mountain range with three peaks. The central peak is the tallest and is outlined in a light green color. The two flanking peaks are smaller and filled with a solid light green color. Below the mountains, the text "Colorado Water Loss Initiative" is written in a light green, sans-serif font.

# Data Validity Grading

---

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Loss Initiative





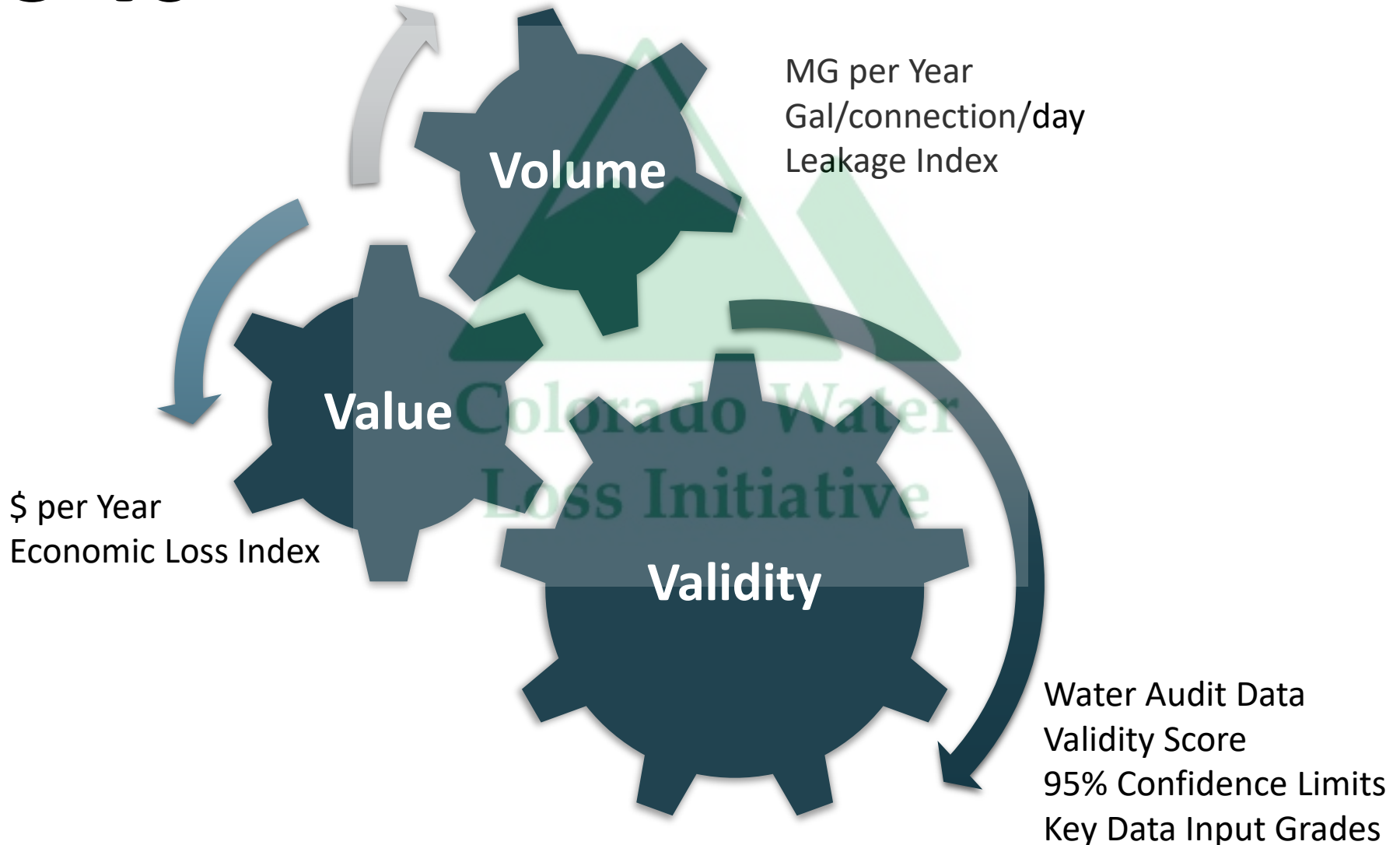
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Conservation Board

Department of Natural Resources



# 3-Vs





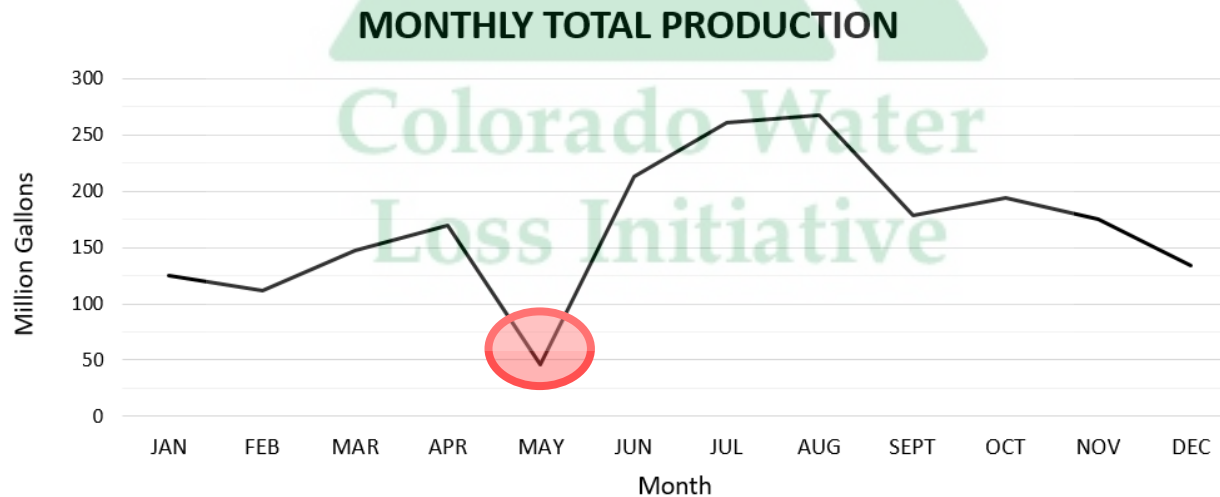
# Water Audit

## 2. Evaluate data reliability

Complete?

Consistent?

Accurate?



*Does the data story make sense?*



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# Data quality matters!

inaccuracy &  
uncertainty in  
inputs → inaccuracy &  
uncertainty in  
results

## Sources of error:

- Instruments
- Databases
- People
- Missing information



# Data Validity Grades

Data validity grades (DVGs) document utility practices of:

- Data collection
- Data review
- Instrument maintenance

Each audit input is automatically assigned a DVG between 1 and 10 based on answers to IDG criteria questions

DVG criteria are predominantly qualitative

DVGs are NOT a measure of accuracy!

**Pre-Release Example Audit - Review Only**

| 2019 | Jan 01 2019 - Dec 31 2019 | Calendar |
|------|---------------------------|----------|
|------|---------------------------|----------|

Click 'n' to add notes  
Click 'g' to determine data validity grade  
All volumes to be entered as: MILLION GALLONS (US) PER YEAR

| n         | g | 7 | 1,000.000 | MG/Yr |
|-----------|---|---|-----------|-------|
| n         | g |   |           | MG/Yr |
| n         | g |   |           | MG/Yr |
| SUPPLIED: |   |   | 990.099   | MG/Yr |
| n         | g | 9 | 850.000   | MG/Yr |
| n         | g |   |           | MG/Yr |
| n         | g |   |           | MG/Yr |
| n         | g | 4 | 15.000    | MG/Yr |
| SUMPTION: |   |   | 865.000   | MG/Yr |
|           |   |   | 125.099   | MG/Yr |

choose en  
1.00% perc  
cust



# Data Validity Grading

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: | <input type="text" value="n"/> | <input type="text" value="g"/> | 1,000.000 | MG/Yr |
| Water Imported:          | <input type="text" value="n"/> | <input type="text" value="g"/> |           | MG/Yr |
| Water Exported:          | <input type="text" value="n"/> | <input type="text" value="g"/> |           | MG/Yr |

WATER SUPPLIED: **990.099** MG/Yr





# Data Validity Grading

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

**Audit Year:** 2019 Jan 01 2019 - Dec 31 2019

To access definitions, click the [input name](#)

Click 'n' to add notes

Click 'g' to determine data validity grade

All volumes to be entered as: MILLION GALLONS

**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





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# Data Validity Grading

Test Utility  
2019

VOS

VOSEA

WI

WIEA

WE

WEEA

BMAC

BUAC

UMAC

UUAC

SDHE

CMI

UC

Lm

Nc

Lp

AOP

CRUC

VPC

White = incomplete  
Orange = complete  
Use acronyms for navigation

AWWA Free Water Audit Software: Interactive Data Grading

acronym key  
Limiting criteria  
(see Start Page for details)

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Colorado Water  
Loss Initiative



# Data Validity Grading

Test Utility 2019

AWWA Free Water Audit Software: Interactive Data Grading

White = incomplete  
Orange = complete  
Use acronyms for navigation

VOS VOSEA WI WIEA WE WEEA BMAC BUAC UMAC UUAC

SDHE CMI UC Lm Nc Lp AOP CRUC VPC

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acronym key

Limiting criteria (Start page for details)

## Key of Input Acronyms

*In order of appearance in the Worksheet*

|       |                                                   |
|-------|---------------------------------------------------|
| VOS   | Volume from Own Sources                           |
| VOSEA | VOS Error Adjustment                              |
| WI    | Water Imported                                    |
| WIEA  | WI Error Adjustment                               |
| WE    | Water Exported                                    |
| WEEA  | WE Error Adjustment                               |
| BMAC  | Billed Metered Authorized Consumption             |
| BUAC  | Billed Unmetered Authorized Consumption           |
| UMAC  | Unbilled Metered Authorized Consumption           |
| UUAC  | Unbilled Unmetered Authorized Consumption         |
| SDHE  | Systematic Data Handling Errors                   |
| CMI   | Customer Metering Inaccuracies                    |
| UC    | Unauthorized Consumption                          |
| Lm    | Length of mains                                   |
| Nc    | Number of service connections                     |
| Lp    | Average length of (private) customer service line |
| AOP   | Average Operating Pressure                        |
| CRUC  | Customer Retail Unit Charge                       |
| VPC   | Variable Production Cost                          |



# Data Validity Grading

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)

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Use acronym buttons in IDG header to navigate among inputs. Acronym Key above.  
White = needs answers, orange = complete, clear = not required.

After clicking an acronym button, answer all visible questions in  
the order they're presented, choosing best-fit answer

Grade will populate when all visible questions  
are complete for an input

The limiting criteria will be labeled along the right. If only 1 limiting criterion is shown, improving on that criterion will achieve a higher data grade. If multiple limiting criteria are shown, improving on each limiting criteria is necessary to achieve a higher data grade. A complete inventory of data grading criteria is available in the Data Grading Matrix v6.0 (see web resources)

Limiting



# Interactive Data Grading

v6

Test Utility  
2019

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

White = incomplete  
Orange = complete  
Use acronyms for navigation

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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%                                                                                   |
|        | <p><b>For questions 2-10 below: Choose the answer that applies for those meters that measure &gt;90% of the finished water volume.</b></p> <p><b>In-situ flow accuracy testing</b> refers to a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location.</p> <p><b>Electronic calibration</b> refers to a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).</p> <p><b>Secondary device</b> can include meter transmitter, DP cell, chart recorder or similar instrumentation.</p> <p><b>Tertiary device</b> can include SCADA, historian or other computerized archival system.</p> |                                                                                        |
| 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)?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <div>At ±6% or greater</div> <div>Between ±3% to ±6%</div> <div>At or within ±3%</div> |
| 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                        |

FINAL DATA GRADE FOR THIS AUDIT INPUT:





# Interactive Data Grading

Test Utility  
2019

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)

AWWA Free Water Audit Software: Interactive Data Grading

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White = incomplete  
Orange = complete  
Use acronyms for navigation

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



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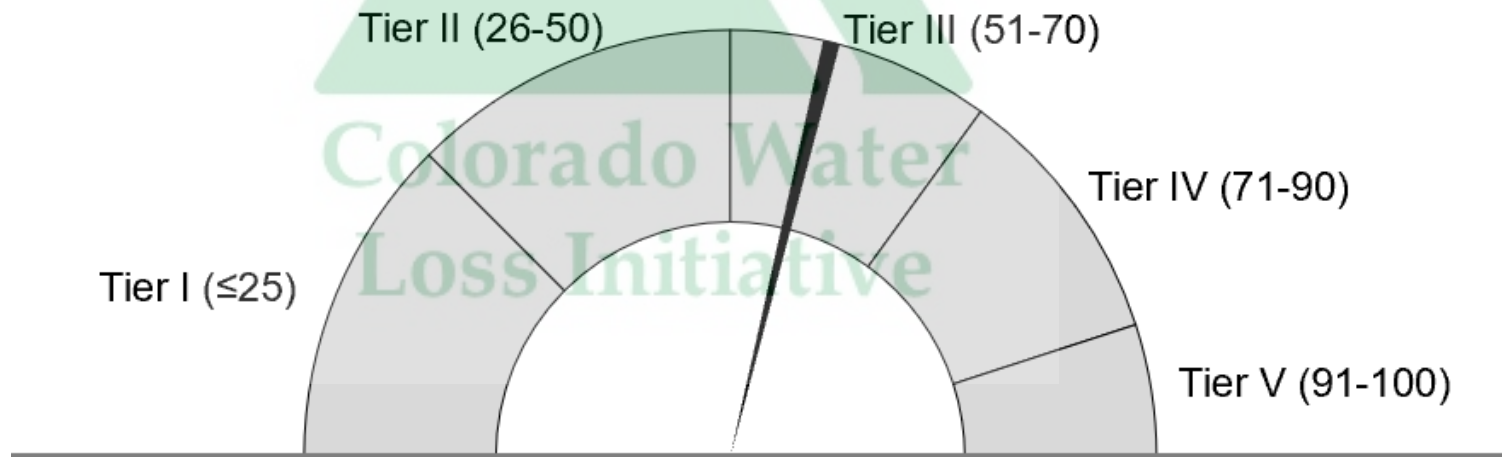


# Dashboard

## Data Validity

**Data Validity Score:** 57 **Data Validity Tier:** Tier III (51-70)

See [Loss Control Planning](#) for Tier Details







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## Water Loss Control Planning Guide

### Water Audit Data Validity Tier (Score Range)

| Functional Focus Area                                                                                                   | Tier I (1-25)                                                                                           | Tier II (26-50)                                                                                                                                                        | Tier III (51-70)                                                                                                                         | Tier IV (71-90)                                                                                                                  | Tier V (91-100)                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Audit Data Collection                                                                                                   | Launch auditing and loss control team; address supply metering deficiencies                             | Analyze business process for customer metering and billing functions and water supply operations; Identify data gaps; improve supply metering                          | Establish/revise policies and procedures for data collection                                                                             | Refine data collection practices and establish as routine business process                                                       | Annual water audit is a reliable gauge of year-to-year water efficiency standing                                            |
| Short-term loss control                                                                                                 | Research information on leak detection programs; Begin flowcharting analysis of customer billing system | Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc                           | Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring                   | Refine, enhance or expand ongoing programs based upon economic justification                                                     | Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation      |
| Long-term loss control                                                                                                  |                                                                                                         | Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or AMR/AMI system | Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process | Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management | Continue incremental improvements in short-term and long-term loss control interventions                                    |
| Target-setting                                                                                                          |                                                                                                         |                                                                                                                                                                        | Establish long-term apparent and real loss reduction goals (+10 year horizon)                                                            | Establish mid-range (5 year horizon) apparent and real loss reduction goals                                                      | Evaluate and refine loss control goals on a yearly basis                                                                    |
| Benchmarking                                                                                                            |                                                                                                         |                                                                                                                                                                        | Preliminary Comparisons - can begin to rely upon with PIs for performance comparisons for real losses                                    | Performance Benchmarking with PIs is meaningful in comparing real loss standing                                                  | Identify Best Practices/ Best in class; PIs are very reliable as real loss performance indicators for best in class service |
| For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved. |                                                                                                         |                                                                                                                                                                        |                                                                                                                                          |                                                                                                                                  |                                                                                                                             |



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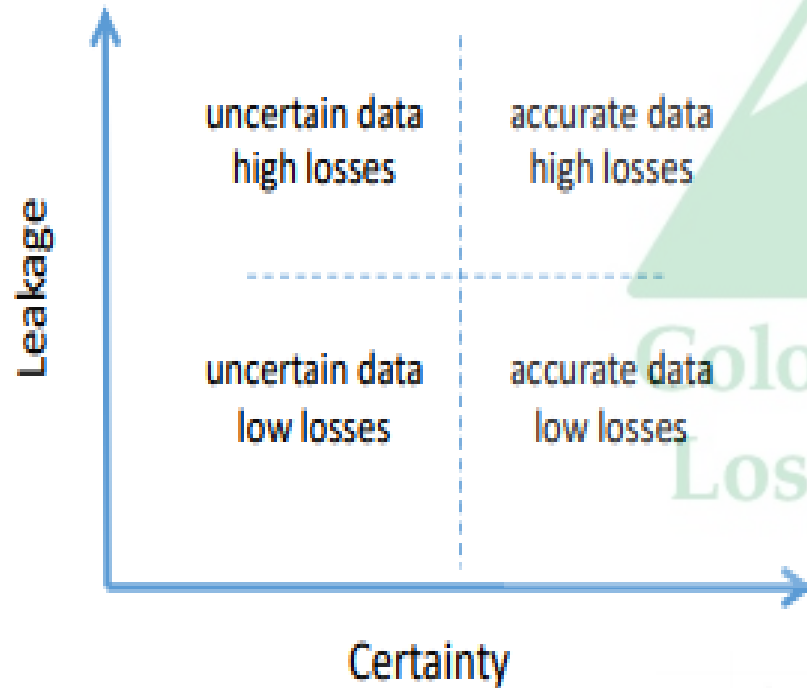
# The BEST(?) Number

# 100

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# The BEST(?) Number



VS.



# Demonstration: AWWA Free Water Audit Software

AWWA Free Water Audit Software v5.0  
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This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" primary water audit format and is not meant to take the place of a full-scale, comprehensive water audit format. Auditors are strongly encouraged to refer to the most current edition of AWWA M36 Manual for Water Audits for detailed guidance on the water auditing process and targeting loss reduction levels. This tool contains several separate worksheets. Sheets can be accessed using the tabs at the bottom of the screen, or by clicking the TOC links below.

| Table of Contents (TOC)         |                                                                                                                                    |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>Start Page</b>               | The current sheet. Enter contact information and basic audit details.                                                              |
| <b>Worksheet</b>                | Enter the required data on this worksheet to calculate the water balance and data grading.                                         |
| <b>Interactive Data Grading</b> | Answer questions about operational practices for each audit input, and the data validity grades will automatically populate.       |
| <b>Dashboard</b>                | Review NRW components, performance indicators and graphical outputs to evaluate the results of the audit.                          |
| <b>Notes</b>                    | Enter notes to explain how values were calculated, document data sources, and related information about data management practices. |
| <b>Blank Sheet</b>              | By popular demand! A blank sheet. The world is your canvas.                                                                        |

The values entered in the Worksheet automatically populate the Water Balance.

Use this sheet to interpret the results of the audit validity and performance indicators.

Use this sheet to understand the terms used in the audit process.

Diagrams depicting possible customer service connection line configurations.

Acknowledgments for development of the AWWA Free Water Audit Software v5.0.

Resources for Water Loss Control  
[www.awwa.org/Resources-Tools/Resource-Tools](https://www.awwa.org/Resources-Tools/Resource-Tools)  
referenced in the Free Water Audit Software v5.0  
Data Grading Matrix v5.0  
Example Water Audit v5.0  
Water Audit Compiler v5.0  
AWWA Reports on Performance Indicators  
M36 Manual

AWWA.org

### Enter Basic Information

|                                                     |                          |
|-----------------------------------------------------|--------------------------|
| Name of Utility:                                    | City Water Utility       |
| Name of Contact Person:                             | Joanna Smith, Manager    |
| Email:                                              |                          |
| Telephone (Ext.:                                    |                          |
| City/Town/Municipality:                             | Anytown                  |
| State / Province:                                   |                          |
| Country:                                            | USA                      |
| Audit Preparation Date:                             |                          |
| Audit Year:                                         | 2021                     |
| Audit Year Label:                                   | (Fiscal, Calendar, etc.) |
| Audit Period Start Date:                            | Jan 01 2021              |
| Audit Period End Date:                              | Dec 30 2021              |
| Volume Reporting Units:                             | Million gallons (US)     |
| Water System Structure:                             | Retail                   |
| Water Type:                                         | Potable Water            |
| System ID Number:                                   |                          |
| Validator Name/ID:                                  |                          |
| Validator Email:                                    |                          |
| Estimated Total Population Served by Water Utility: |                          |

Color Key: User input (blue), Calculated (orange), Optional default (white)

### Key of Input Acronyms

In order of appearance in the Worksheet

|       |                                                   |
|-------|---------------------------------------------------|
| VOS   | Volume from Own Sources                           |
| VOSEA | VOS Error Adjustment                              |
| WI    | Water Imported                                    |
| WIFA  | WI Error Adjustment                               |
| WE    | Water Exported                                    |
| WEEA  | WE Error Adjustment                               |
| BMAC  | Billed Metered Authorized Consumption             |
| BUAC  | Billed Unmetered Authorized Consumption           |
| UMAC  | Unbilled Metered Authorized Consumption           |
| UUAC  | Unbilled Unmetered Authorized Consumption         |
| SDHE  | Systematic Data Handling Errors                   |
| CMi   | Customer Metering Inaccuracies                    |
| UC    | Unauthorized Consumption                          |
| Ln    | Length of mains                                   |
| Nc    | Number of service connections                     |
| Lp    | Average length of (private) customer service line |
| AOP   | Average Operating Pressure                        |
| CRUC  | Customer Retail Unit Charge                       |
| VPC   | Variable Production Cost                          |

### Guidance for the Interactive Data Grading

Use acronym buttons in IDG header to navigate among inputs. Acronym Key above. White = needs answers, orange = complete, clear = not required. Example below.

|      |       |    |      |    |      |      |      |      |      |
|------|-------|----|------|----|------|------|------|------|------|
| VOS  | VOSEA | WI | WIFA | WE | WEEA | BMAC | BUAC | UMAC | UUAC |
| SDHE | CMi   | UC | Ln   | Nc | Lp   | AOP  | CRUC | VPC  |      |

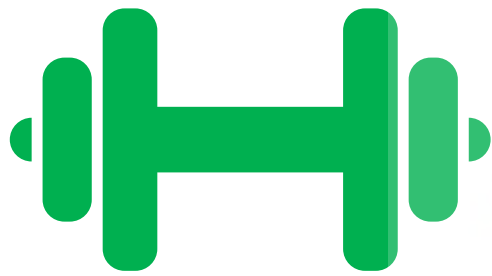
After clicking an acronym button, answer all visible questions in the order they're presented, choosing best-fit answer

Grade will populate when all visible questions are complete for an input

7

Limiting

The limiting criteria will be labeled along the right. If only 1 limiting criterion is shown, improving on that criterion will achieve a higher data grade. If multiple limiting criteria are shown, improving on each limiting criterion is necessary to achieve a higher data grade. A complete inventory of data grading criteria is available in the Data Grading Matrix v5.0 (see web resources)



# Group Exercise:

Developing Inputs &  
Determining Data Grades

---

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Loss Initiative

Volume from Own Sources (VOS)

Water Exported (WE)

Billed Metered Authorized Consumption (BMAC)



# Level 1 Validation

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# Purpose of Level 1 Validation

- 1) review of audit methodology and volume determination
- 2) review of Data Validity Grade selection

*goals: quality and consistency*



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# Purpose of Level 1 Validation

- 1) review of audit methodology and volume determination
- 2) review of Data Validity Grade selection

## Level 1 Validation Tools:

- Discussion with Validator
- Supporting Documentation



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# Data quality matters!

inaccuracy &  
uncertainty in  
inputs → inaccuracy &  
uncertainty in  
results

## Sources of error:

- Instruments
- Databases
- People
- Missing information

# Levels of Validation

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Water audit validation aims to:

- Identify and correct errors
- Evaluate and communicate uncertainty

Level 1 – interview & summary records

Level 2 – deep data review

Level 3 – new data from the field





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WRF #4372B:

# WATER AUDITS IN THE UNITED STATES: A REVIEW OF DATA VALIDITY AND RESULTS

**Data quality** – the validity, or trustworthiness, of the data

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- *Water Research Foundation 4372B*
- many audits are unrealistic
  - *more training (ie GA, TN) produces fewer unrealistic audits*
  - *even level 1 validation doesn't fully eliminate unrealistic audits*

|                         | CA  | DRBC | GA  | TN  | TX    |
|-------------------------|-----|------|-----|-----|-------|
| total audits            | 300 | 517  | 452 | 629 | 2,646 |
| # of unrealistic audits | 100 | 130  | 74  | 122 | 1,065 |
| % of unrealistic audits | 33% | 25%  | 16% | 19% | 40%   |

## sources of uncertainty:

- data source quality (primary measurement or secondary data management)
- methodology (use of the software, selection of data)



**If a Water Audit is self-reported in the forest, is it valid?**





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# WRF #4639:

## ESTABLISHING WATER UTILITY GUIDANCE AND METHODOLOGY FOR WATER AUDIT VALIDATION

**Data validation** – a quality control process conducted to verify, and improve as needed, the data inputs and gradings of the water audits submitted by water utilities.

**Water Loss Audit validation** – does not make data inputs or gradings “right” or “wrong”, but merely aligns them with the actual conditions that occurred in the operation of the utility for the audit year

Level 1 -- Top down Data Review

Level 2 -- Top down Data Mining Review

Level 3 -- Bottom up Field Investigation



# Submitted Data - Unfiltered



|            |                            | 2016<br>n = 292 | 2016<br>n = 292 | 2016<br>n = 292 |                            |
|------------|----------------------------|-----------------|-----------------|-----------------|----------------------------|
| STATISTIC  |                            | <i>min</i>      | <i>median</i>   | <i>max</i>      | UNIT                       |
| financial  | Customer Retail Unit Cost  | \$0.00          | \$3.93          | \$180,097.61    | \$ / 1,000 gal             |
|            | Variable Production Cost   | \$0.00          | \$1,315.45      | \$25,007,000.00 | \$ / million gal           |
|            | NRW as % of Operating Cost | 0.00%           | 3.54%           | 242305%         | % of operating cost        |
| volumetric | Apparent Losses            | -4.34           | 6.36            | 122.3           | gal/ serv conn / day       |
|            | Real Losses (serv conns)   | -35             | 19.46           | 334.54          | gal/ serv conn / day       |
|            | Real Losses (pressure)     | -0.66           | 0.371           | 5.31            | gal/ serv conn / day / psi |
|            | ILI                        | -3.03           | 1.18            | 17.84           | CARL / UARL                |
|            | Data Validity Score        | 2.35            | 75.33           | 98.27           | points out of 100          |



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WRF #4372B:

WATER AUDITS IN THE UNITED STATES:  
A REVIEW OF DATA VALIDITY AND RESULTS

WRF #4639:

ESTABLISHING WATER UTILITY GUIDANCE AND  
METHODOLOGY FOR WATER AUDIT VALIDATION



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# What does Level 1 water audit validation do?

The Level 1 water audit validation aims to:

- Confirm the accurate application of AWWA M36 water audit methodology and terminology to the utility-specific situation
- Identify/adjust any evident inaccuracies
- Validation of best-fit IDG answers, and understanding the answers in full context of the utility operations

In meeting these goals, the Level 1 validation process results in:

- Data validity grades that reflect utility practices
- Identification of macro-level inaccuracies
- Recommendations for advanced validation activities





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# What does Level 1 water audit validation *NOT* do?

Level 1 water audit validation is the least rigorous level of validation. The effort and time required to complete Level 1 validation are relatively small. Level 1 water audit validation does not:

- Correct inaccuracies in raw data that may affect summary data and audit inputs
- Investigate data processing and handling to identify and correct inaccuracies
- Study instrument accuracy through field tests to improve the certainty of the water audit
- Corroborate the volume of Real Losses with bottom-up or field investigations of leakage



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# WRF #5057:

## UPDATE TO LEVEL 1 VALIDATION GUIDANCE MANUAL



- **New chapter on AWWA Software v6** that describes the major changes from v5 and how they affect the validation process. This manual assumes that the user is validating a water audit completed using the AWWA Software v6.
- **New content related to audit input validation** that emphasizes key points of consideration when reviewing the methodology used to determine specific input values.
- **Real world examples of supporting documentation** for each audit input, as well as idealized versions to make best practices clear.
- **Updated language** throughout the manual to match AWWA Software v6 and to clarify confusing or ambiguous terminology.
- **Summary of research** related to certification programs and the effect of validation in North America.
- **Revisions based on industry feedback** that was collected from a dedicated advisory group of water loss professionals familiar with the first edition of the manual.



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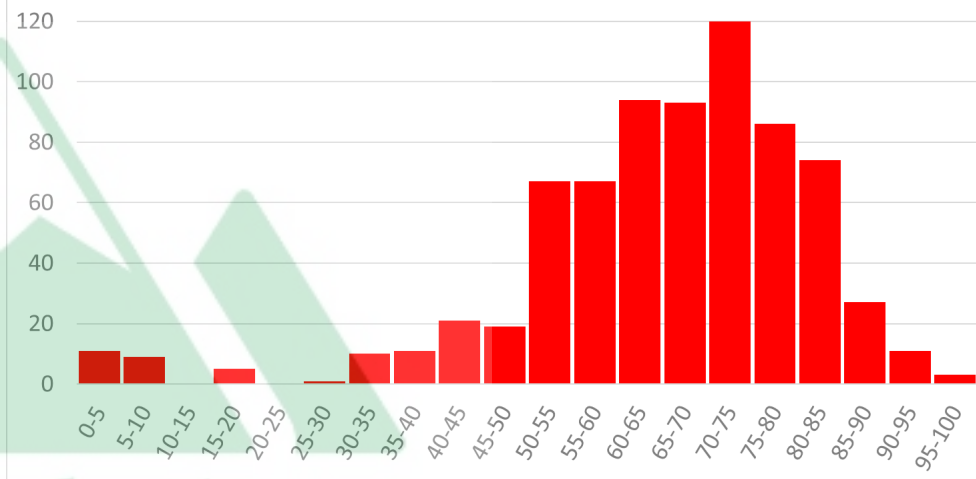
Department of Natural Resources



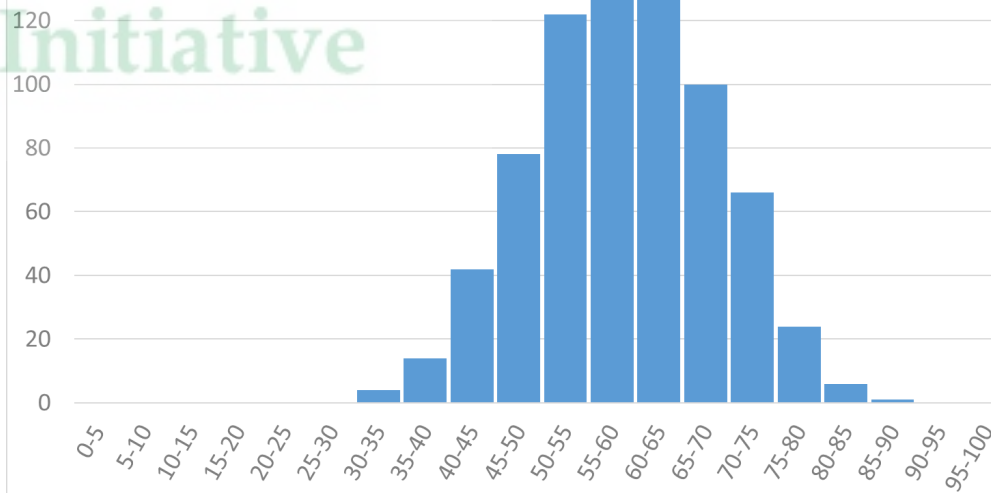
# Pre- Validated vs. Post- Validated Audits

## Data Validity Distribution

Pre-Level 1 Validation (Self-Reported)



Post-Level 1 Validation



# Review



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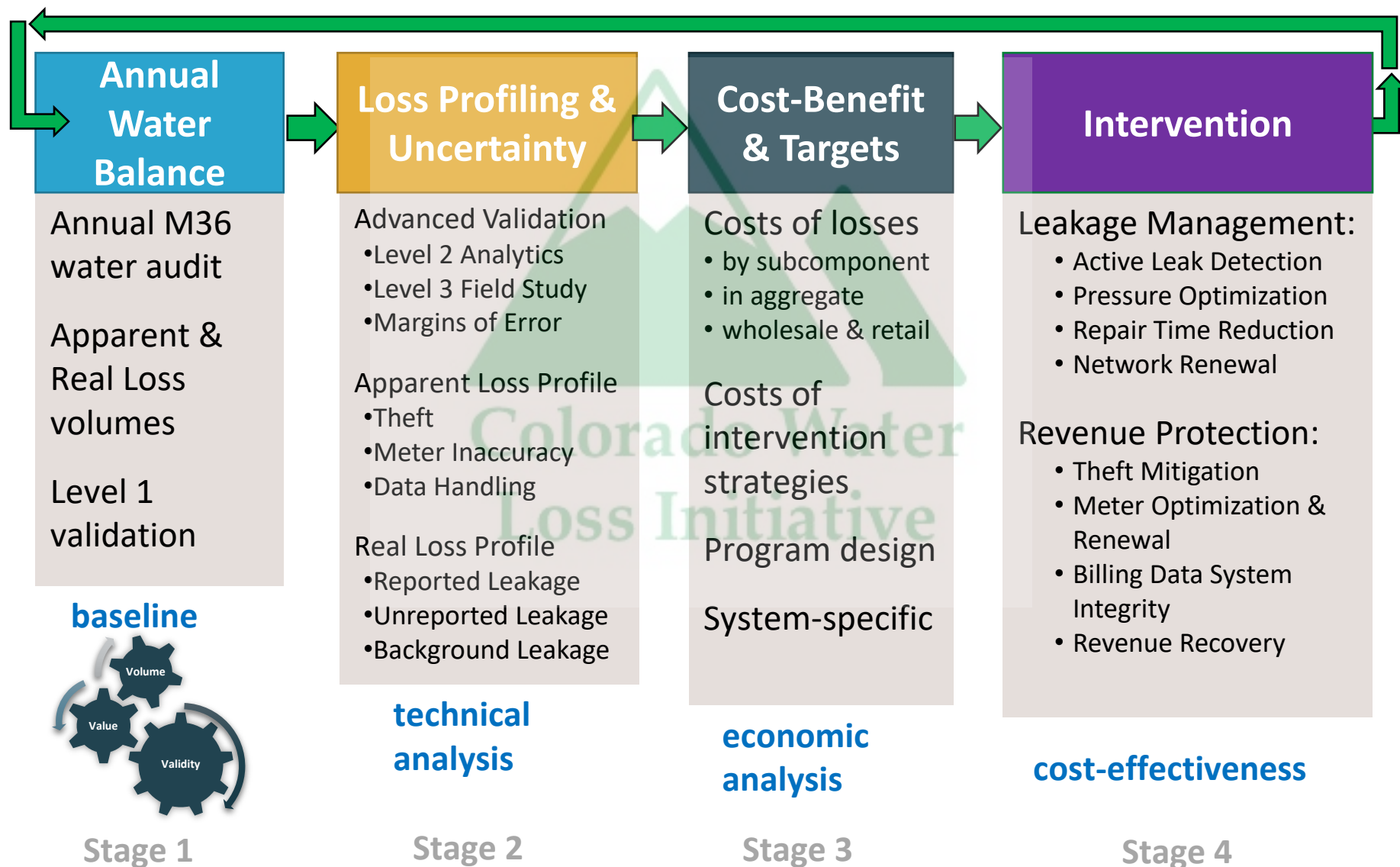
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# Your Water Loss Team

Who should participate from your utility?

Supply &  
Operations

Customer  
Metering

Billing &  
Finance

Management

who is responsible for

*supplying audit data?*

*submitting the audit?*

*coordinating schedules?*



# The Water Balance

## 1. Account for volumes...

| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION   | BILLED METERED CONSUMPTION     | REVENUE WATER    |
|----------------|------------------------|---------------------------------|--------------------------------|------------------|
|                |                        |                                 | BILLED UNMETERED CONSUMPTION   |                  |
|                |                        | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION   | NONREVENUE WATER |
|                |                        |                                 | UNBILLED UNMETERED CONSUMPTION |                  |
|                | WATER LOSSES           | APPARENT LOSSES                 | CUSTOMER METER INACCURACIES    |                  |
|                |                        |                                 | UNAUTHORIZED CONSUMPTION       |                  |
|                |                        |                                 | DATA HANDLING ERRORS           |                  |
|                |                        | REAL LOSSES                     |                                |                  |

- *Mass balance – process of elimination*
- *Account for all water*
- *Accuracy matters!*

# AWWA Free Water Audit Software – Instructions Worksheet

| AWWA Free Water Audit Software v6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | FWAS v6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
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| American Water Works Association Copyright © 2020, All Rights Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p>This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format and is not meant to take the place of a full-scale, comprehensive water audit format. Auditors are strongly encouraged to refer to the most current edition of AWWA M36 Manual for Water Audits for detailed guidance on the water auditing process and targeting loss reduction levels. This tool contains several separate worksheets. Sheets can be accessed using the tabs at the bottom of the screen, or by clicking the TOC links below.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <b>Table of Contents (TOC)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Enter Basic Information</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p><b>Start Page</b> The current sheet. Enter contact information and basic audit details.</p> <p><b>Worksheet</b> Enter the required data on this worksheet to calculate the water balance and data grading.</p> <p><b>Interactive Data Grading</b> Answer questions about operational practices for each audit input, and the data validity grades will automatically populate.</p> <p><b>Dashboard</b> Review NRW components, performance indicators and graphical outputs to evaluate the results of the audit.</p> <p><b>Notes</b> Enter notes to explain how values were calculated, document data sources, and related information about data management practices.</p> <p><b>Blank Sheet</b> By popular demand! A blank sheet. The world is your canvas.</p> <p><b>Water Balance</b> The values entered in the Worksheet automatically populate the Water Balance.</p> <p><b>Loss Control Planning</b> Use this sheet to interpret the results of the audit validity score and performance indicators.</p> <p><b>Definitions</b> Use this sheet to understand the terms used in the audit process.</p> <p><b>Service Connection Diagram</b> Diagrams depicting possible customer service connection line configurations.</p> <p><b>Acknowledgements</b> Acknowledgements for development of the AWWA Free Water Audit Software v6.0.</p> <p><b>AWWA Web Resources for Water Loss Control</b><br/> <a href="https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control/">https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control/</a><br/>           Items referenced in the Free Water Audit Software v6.0 on the web:<br/>           Data Grading Matrix v6.0<br/>           Example Water Audit v6.0<br/>           Water Audit Compiler v6.0<br/>           AWWA Reports on Performance Indicators<br/>           M36 Manual</p> | <p>Name of Utility: County Water Utility</p> <p>Name of Contact Person: John Smith, Manager</p> <p>Email:</p> <p>Telephone   Ext:</p> <p>City/Town/Municipality: Anytown</p> <p>State / Province:</p> <p>Country: USA</p> <p>Audit Preparation Date: Nov 02 2022</p> <p>Audit Year: 2021</p> <p>Audit Year Label: Calendar (Fiscal, Calendar, etc)</p> <p>Audit Period Start Date: Jan 01 2021</p> <p>Audit Period End Date: Dec 31 2021</p> <p>Volume Reporting Units: Million gallons (US)</p> <p>Water System Structure: Retail</p> <p>Water Type: Potable Water</p> <p>System ID Number:</p> <p>Validator Name/ID:</p> <p>Validator Email:</p> <p>Estimated Total Population Served by Water Utility:</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Color Key</b> User input <span style="background-color: #d9e1f2; border: 1px solid black; padding: 2px;"> </span> Calculated <span style="background-color: #fce4d6; border: 1px solid black; padding: 2px;"> </span> Optional default <span style="border: 1px dashed black; padding: 2px;"> </span>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
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| VOS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | VOSEA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | WI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | WIEA   | WE    | WEEA    | BMAC | BUAC   | UMAC | UUAC   |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| SDHE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CMI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | UC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Lm     | Nc    | Lp      | AOP  | CRUC   | VPC  |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>The limiting criteria will be labeled along the right. If only 1 limiting criterion is shown, improving on that criterion will achieve a higher data grade. If multiple limiting criteria are shown, improving on <i>each</i> limiting criterion is necessary to achieve a higher data grade. A complete inventory of data grading criteria is available in the Data Grading Matrix v6.0 (see web resources)</p>                                                                                                                                                                                                                                                                                                                                                             |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |
| <p>If you have questions or comments regarding this software please contact us at: <a href="mailto:wlc@awwa.org">wlc@awwa.org</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |       |         |      |        |      |        |      |      |       |         |      |        |    |        |    |    |     |      |     |  |



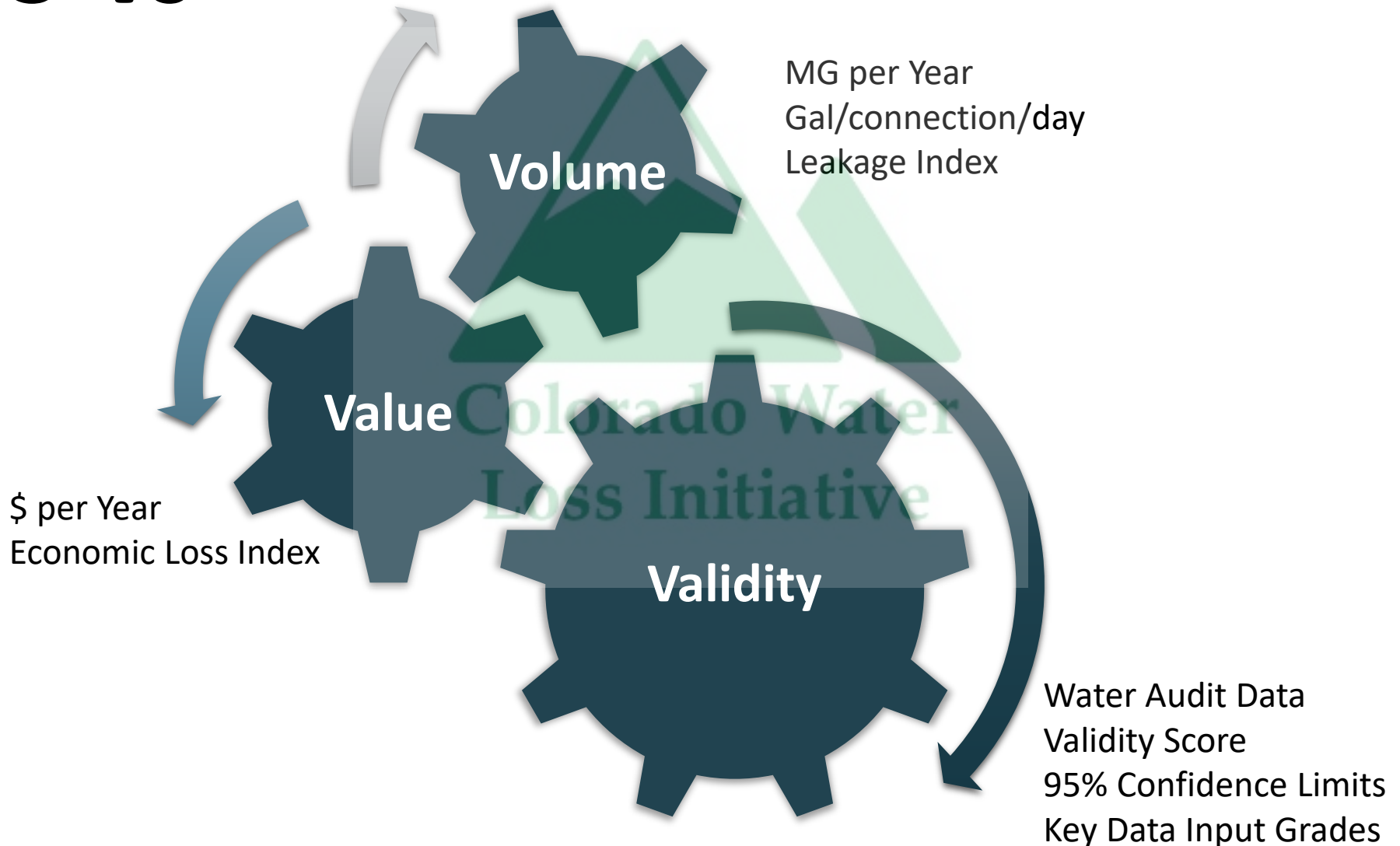
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# 3-Vs





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# What does Level 1 water audit validation do?

The Level 1 water audit validation aims to:

- Confirm the accurate application of AWWA M36 water audit methodology and terminology to the utility-specific situation
- Identify/adjust any evident inaccuracies
- Validation of best-fit IDG answers, and understanding the answers in full context of the utility operations

In meeting these goals, the Level 1 validation process results in:

- Data validity grades that reflect utility practices
- Identification of macro-level inaccuracies
- Recommendations for advanced validation activities



# Next Steps



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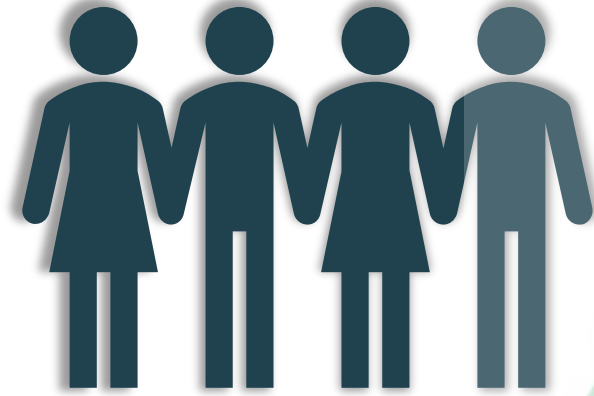
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# Establish Your Team

## Colorado Water Loss Initiative

- Supply Metering
- Customer Metering
- Billing/Finance
- Management



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Supply metering/Customer Metering/Billing/Management



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# Scheduling Your Session

The screenshot shows the Calendly scheduling interface for an event titled 'CWLI: Level 1 Validation'. The event duration is set to 2 hours. The event description states: 'This event is scheduled to perform the Level 1 Validation through the Colorado Water Loss Initiative.' The interface includes a calendar for November 2024, with the date Tuesday, November 12, selected. The time zone is set to Eastern Time - US & Canada (9:48am). A list of available time slots is shown on the right, ranging from 9:00am to 1:00pm. The Cavanaugh logo is visible in the top left corner of the interface.

**CAVANAUGH**

**CWLI: Level 1 Validation**

🕒 2 hr

This event is scheduled to perform the Level 1 Validation through the Colorado Water Loss Initiative.

**Select a Date & Time**

November 2024

Tuesday, November 12

| SUN | MON | TUE | WED | THU | FRI | SAT |
|-----|-----|-----|-----|-----|-----|-----|
|     |     |     |     |     |     | 1 2 |
| 3   | 4   | 5   | 6   | 7   | 8   | 9   |
| 10  | 11  | 12  | 13  | 14  | 15  | 16  |
| 17  | 18  | 19  | 20  | 21  | 22  | 23  |
| 24  | 25  | 26  | 27  | 28  | 29  | 30  |

**Time zone**

🕒 Eastern Time - US & Canada (9:48am)

9:00am

9:30am

10:00am

10:30am

11:00am

11:30am

12:00pm

12:30pm

1:00pm

[Cookie settings](#) [Report abuse](#) [Troubleshoot](#)

<https://calendly.com/d/2hx-6pb-mbp/cwli-level-1-validation>

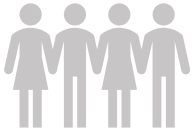




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# Gather Data & Compile Water Audit

- **2023 Data**
- Data Request Sheet/Supporting Documentation
- Water Audit: Inputs & Data Validity Grades





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# Supporting Documentation

## Required

- ☐ Completed **AWWA Free Water Audit Software** (Excel Spreadsheet)
- ☐ **Volume from Own Sources** broken down by month and finished water supply meter
- ☐ **Water Imported** broken down by month by meter
- ☐ **Water Exported** broken down by month by meter
- ☐ **Supply meter testing** and/or calibration documentation
- ☐ **Authorized Consumption** broken down by month and use type (e.g. charge status, water type, customer class)



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# Supporting Documentation

## Supplemental

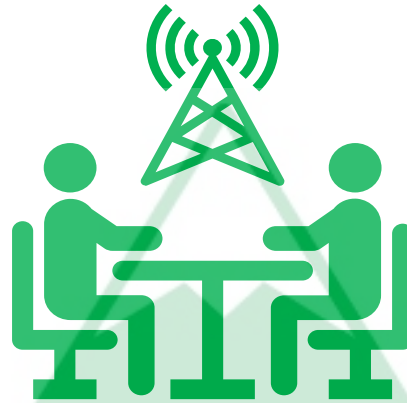
- ☐ **System schematic** showing at least locations of Own Source, Import, and Export meters
- ☐ **Customer Meter Inaccuracy** derivation
- ☐ **Average Operating Pressure** derivation
- ☐ **Customer Retail Unit Cost** derivation
- ☐ **Variable Production Cost** derivation



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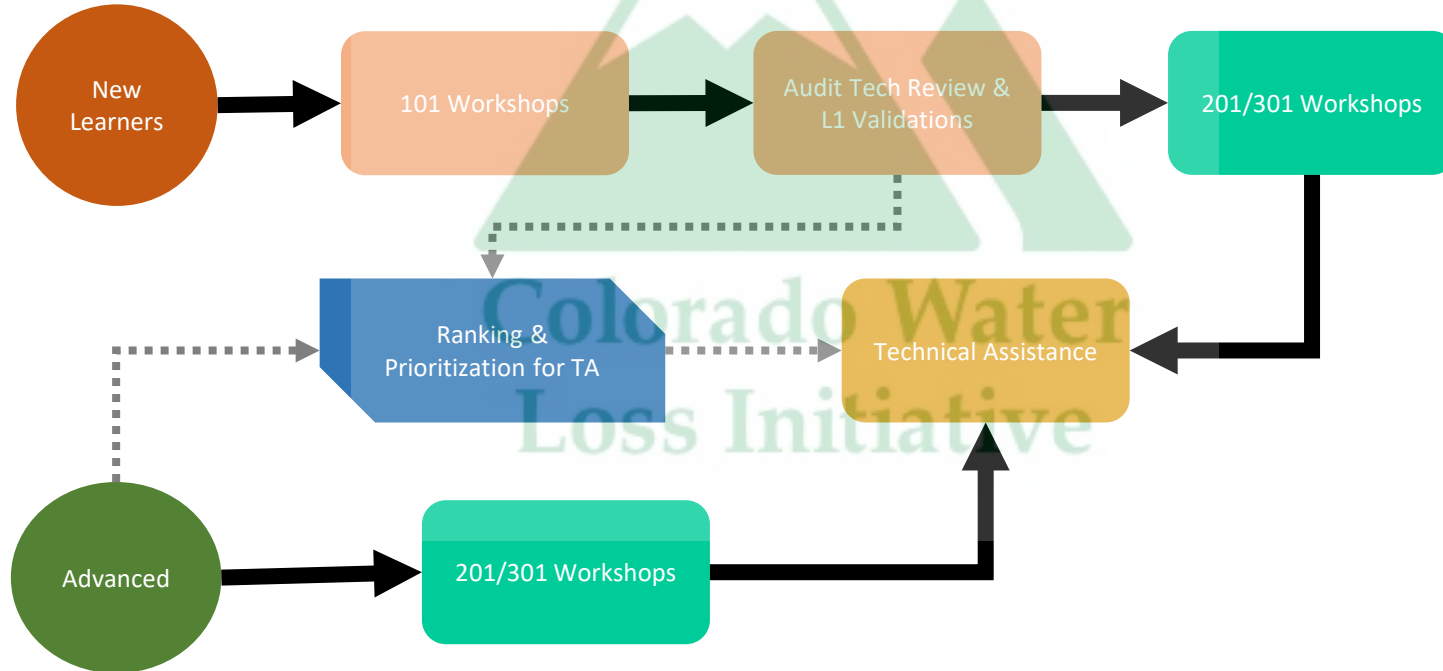


## Level 1 Validation Session

- One-on-One validation session with your water audit validator



## Phase 2 Design



# Question & Answer

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[team@coloradowaterloss.org](mailto:team@coloradowaterloss.org)







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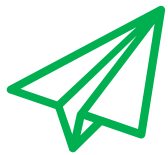
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# Thank you!



[www.coloradowaterloss.org](http://www.coloradowaterloss.org)



[team@coloradowaterloss.org](mailto:team@coloradowaterloss.org)