
	<b>STANDARD OPERATING PROCEDURE</b>	No.	SOP-1000-GM-002
	<b>Water Audits</b>	Effective Date	2023-2-16
		Final Approver	 Miguel C. Bordallo, P.E. General Manager
		Revision Letter	A

## 1.0 Purpose

This Standard Operating Procedures (SOP) establishes the guidelines and procedures for the timely submission of data by Guam Waterworks Authority's (GWA) divisions' heads, which data are to be used for GWA's water audit handled by Asset Management. This SOP also provides guidance on how to use the American Water Works Authority's (AWWA) Free Water Audit Software (AWWA FWAS) in conducting GWA's water audit based on AWWA M36 Manual.

## 2.0 Scope

This SOP applies to the Utility Services Administrator for Operations (USA-Ops) and designated Management Analyst (the User) and all GWA divisions/sections' heads who are required to submit data (monthly and annually) to the former.

## 3.0 Policy

GWA adopts the AWWA M36 manual as a standard in conducting its water audits, and shall use the AWWA FWAS as a tool for conducting its water audits. The USA-Ops shall ensure that water audits are conducted in accordance with AWWA M36 and all stakeholders must submit the required data identified herein on or before its designated due date.

## 4.0 Definitions

- 4.1. **American Water Works Association (AWWA):** An international, nonprofit, scientific, and educational society dedicated to providing total water solutions assuring the effective management of water.<sup>1</sup>
- 4.2. **User:** GWA employee who is designated by the –USA-Ops to conduct a water audit using AWWA FWAS.
- 4.3. **AWWA Free Water Audit Software (FWAS):** A spreadsheet-based water audit tool 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.<sup>2</sup>
- 4.4. **Water Audit:** A review of records and data that traces the flow of water from its source and treatment, through the water distribution system, and through the customers' water meter. It is usually in the form of a worksheet or spreadsheet that details the sources and uses for water produced in the GWA water system.<sup>3</sup>

<sup>1</sup> <https://www.awwa.org/About-Us>

<sup>2</sup> <https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control>

<sup>3</sup> M36 Water Audit and Loss Control Program, Manual of Water Supply Practices, 4<sup>th</sup> Edition

- 4.5. **Water Balance:** Summarizes the components and provides accountability, as all of the water placed into a distribution system should - in theory - equal all of the water taken out of the distribution system.<sup>4</sup>

## 5.0 Roles and Responsibilities

5.1.	General Manager (GM)	<p>Approves this SOP and all its subsequent changes.</p> <p>Oversees the development, revision, and implementation of this SOP as the Policy Owner.</p> <p>Endorses to SOP Committee any amendment(s) needed to this SOP.</p> <p>Review and approves water audit report.</p> <p>Submits periodic reports (to include water audit results) to the CCU and PUC.</p>
5.2.	Assistant General Manager – Operations	Provides guidance and resources to the water loss program, and helps communicate its success.
5.3.	Utility Services Administrator for Operations (USA-Ops)	<p>Designates and oversees the GWA employee (Management Analyst) who will conduct the water audit.</p> <p>Monitors compliance to this SOP.</p> <p>Provides training on the use of FWAS, when needed.</p>
5.4.	<p>O&amp;M Manager - Water Production (WP)</p> <p>O&amp;M Manager - Water Distribution (WD)</p> <p>Administrator, Utility Service Division (USD)</p> <p>Controller</p> <p>Manager - Geographic Information System (GIS) Engineering</p> <p>Supervisor - Permits and Planning</p>	Comply with the requirements of this SOP.
5.5.	User (Management Analyst)	Use the latest version of AWWA FWAS in performing the GWA water audit.

<sup>4</sup> M36 Water Audit and Loss Control Program, Manual of Water Supply Practices, 4th Edition

		<p>Submits quarterly water audit reports to the GM, AGM-O, AGM-AS, CFO, and Chief Engineer.</p> <p>Comply with the provisions of this SOP. When confronted by a situation not covered by this or requiring clarification, clarify with the respective Administrator.</p>
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### 6.0 Procedure Description

6.1. **Monthly Submission of Report:** The following persons must submit to the User the monthly data below no later than the 10<sup>th</sup> of the following month:

DIVISION/SECTION	PERSON TO SUBMIT DATA	FWAS TERM	REPORT
WP	Manager	Volume from Own Sources	Water Production Report
Finance	Controller	Water Imported	Navy Water Purchases (unaudited)
		Authorized Billed Metered Consumption	Monthly Water Consumption (unaudited)
		Authorized Unbilled Metered Consumption	
		Authorized Billed Unmetered Consumption	
		Unauthorized Unbilled Metered Consumption	
		Total Annual Operating Cost	GWA Monthly expense by BU, Object, and Subsidiary (unaudited)
		Customer Retail Unit Charge	GWA Tariff Sheet
		Customer Retail Unit Cost	W & WW Demand by Account Type (unaudited)
		Variable Production Cost	GWA Monthly expense by BU <sup>5</sup> , Object, and Subsidiary (unaudited)
WD	Manager	Authorized Consumption, Unbilled Unmetered	Fire Hydrant Flushing;

<sup>5</sup> BU - Business Unit

DIVISION/SECTION	PERSON TO SUBMIT DATA	FWAS TERM	REPORT
			GFD Usage Report, Water Quality Testing
USD	Administrator	Unauthorized Consumption	Illegal, Theft, ISC Meters
Operations	USA-Ops	Customer Metering Inaccuracies	Meter Maintenance Program Report
		Active and Inactive Service Connections	Active and Inactive Service Points
Engineering - GIS	Manager	Length of Mains	Length of Mains
Engineering - Permits & Planning	Supervisor	Average Operating Pressure	Average Operating Pressure

6.2. **Annual Report:** The following reports must be submitted by the Controller to the User annually:

PERIOD TO SUBMIT	FWAS TERM	REPORT
Upon Approval by the PUC	Customer Retail Unit Charge	GWA Tariff Sheet
30 days after the year-end closing	Variable Production Cost	GWA Monthly expense by BU, Object, and Subsidiary (unaudited)

6.3. **Use of AWWA FWAS:** GWA uses the AWWA FWAS in conducting its water audit. This worksheet is downloadable from [www.awwa.org](http://www.awwa.org) and GWA intranet.

The User, after receiving all the data from its sources identified in the previous section, should enter said data into the worksheet to generate a water audit report.

Below, in general, are the contents of the spreadsheet:

- 6.3.1. Definition, guides user on how to determine the data be entered in the worksheet;
- 6.3.2. Start Page, guides on how to use the worksheet for water audit (referred to in §6.3.3) and interactive data gathering. Click the acronym button at the lower right corner and answer (input the data) in the order they are presented, grade will populate when all visible questions are complete for an input. See **Attachment 1**;
- 6.3.3. Users enters the required data on this worksheet to calculate the water balance and data grading. See **Attachment 2**;
- 6.3.4. Interactive Data Grading, *answer the questions about operational practices for each audit input, and the data validity grades will automatically populate.* See **Attachment 3**;
- 6.3.5. Dashboard, review NRW components, performance indicators, and graphical outputs to evaluate the results of the audit. See **Attachment 4**;

- 6.3.6. Notes, enter notes to explain how values were calculated, document data sources, and related information about data management practices. See **Attachment 5**;
- 6.3.7. Water Balance, the values entered in the worksheet automatically populate the Water Balance. See **Attachment 6**; and
- 6.3.8. Loss Control Planning, use this sheet to interpret the results of the audit validity score and performance indicators. See **Attachment 7**.
- 6.4. **Quarterly Meeting on the Water Audit Report:** Before the end of the quarter and before the due date of submission of the water audit report to the GM, the User should hold a meeting with the following persons for purposes of discussing and confirming the submitted data for the water audit:
  - 6.4.1. Administrator - USD;
  - 6.4.2. USA-Ops;
  - 6.4.3. Controller;
  - 6.4.4. Manager - WP;
  - 6.4.5. Manager - WD;
  - 6.4.6. Manager - GIS Engineering; and
  - 6.4.7. Supervisor - Permits and Planning
- 6.5. **Quarterly Submission of Water Audit Report/Water Balance:** The User must submit the water audit report/water balance to the following persons:
  - 6.5.1. GM;
  - 6.5.2. AGM-AS;
  - 6.5.3. AGM-C&S;
  - 6.5.4. AGM-O;
  - 6.5.5. CFO; and
  - 6.5.6. Chief Engineer.
- 6.6. **Periodic Submission of Water Loss Control / Water Audit Reports to CCU and PUC:** The USA-Ops shall coordinate with the GM on incorporation of completed water audits into periodic reporting as may be required by PUC Orders or CCU request.
- 6.7. **Training:** The USA-Ops should conduct training on the use of FWAS (worksheet), when needed.

- 6.8. **Availability of the Approved Quarterly Water Audit Report:** The Approved quarterly water audit report will be available for download in the GWA intranet. The USA-Ops shall post the approved quarterly audit report to the intranet.

## 7.0 Document Approvals

Role	Position	Name of Approver	Approval Signature	Date Approved
Authors	Management Analyst IV USA-Ops	Karen O. Grape Ma. Teogenesa Q. Salayon	Approval on File	On File
Policy Owner	General Manager	Miguel C. Bordallo, P.E.	Approval on File	On File
Final Approver	General Manager	Miguel C. Bordallo, P.E.	Page 1	Page 1

By existing Guam and Federal laws, the contents of this SOP were reviewed thoroughly by its policy owner and were found to be:

- appropriate for publication on the GWA website without compromising the security of GWA's system or the public's health and safety.
- not appropriate for publication on the GWA website because it might jeopardize the security of GWA's system or the public's health and safety.

## 8.0 Records of Revisions

All suggestions for improvement shall be directed to the Policy Owner indicated below. The Policy Owner will consider input received, develop recommendations on how to address the suggestions, and obtain authorization to make the recommended changes. Updates, revisions, corrections, and waivers to this SOP shall be made in writing and approved by the GM.

8.1. Policy Owner: General Manager

8.2. Authorization: General Manager

Effective Date	Revision Letter	Document Author	Description of Change
Page 1	A	Karen O. Grape Ma. Teogenesa Q. Salayon	Initial Release of Policy/Procedure

## 9.0 References

- 9.1. CCU Resolution 21-FY2011, August 23, 2011
- 9.2. M36 Water Audit and Loss Control Program, Manual of Water Supply Practices, 4th Edition
- 9.3. Example Water Audit v6.0 from AWWA website
- 9.4. [www.awwa.org](http://www.awwa.org)
- 9.5. Draft "GWA Water Audit (AWWA M36, Top-Down Approach)" prepared by Karen O. Grape

**Attachment 1: Illustration of Start Page**

## AWWA Free Water Audit Software v6.0

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FWAS v6.0

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.

### Table of Contents (TOC)

- Start Page** The current sheet. Enter contact information and basic audit details.
- Worksheet** Enter the required data on this worksheet to calculate the water balance and data grading.
- Interactive Data Grading** Answer questions about operational practices for each audit input, and the data validity grades will automatically populate.
- Dashboard** Review NRW components, performance indicators and graphical outputs to evaluate the results of the audit.
- Notes** Enter notes to explain how values were calculated, document data sources, and related information about data management practices.
- Blank Sheet** By popular demand! A blank sheet. The world is your canvas.
- Water Balance** The values entered in the Worksheet automatically populate the Water Balance.
- Loss Control Planning** Use this sheet to interpret the results of the audit validity score and performance indicators.
- Definitions** Use this sheet to understand the terms used in the audit process.
- Service Connection Diagram** Diagrams depicting possible customer service connection line configurations.
- Acknowledgements** Acknowledgements for development of the AWWA Free Water Audit Software v6.0.

**AWWA Web Resources for Water Loss Control**  
<https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control>  
 Items referenced in the Free Water Audit Software v6.0 on the web:  
 Data Grading Matrix v6.0  
 Example Water Audit v6.0  
 Water Audit Compiler v6.0  
 AWWA Reports on Performance Indicators  
 M36 Manual

If you have questions or comments regarding this software please contact us at: [wlc@awwa.org](mailto:wlc@awwa.org)

### Enter Basic Information

Name of Utility:	City of Asheville
Name of Contact Person:	Brandon Buckner
Email:	
Telephone   Ext.:	
City/Town/Municipality:	Asheville
State / Province:	North Carolina (NC)
Country:	USA
Audit Preparation Date:	Nov 01 2020
Audit Year:	2020
Audit Year Label:	Fiscal (Fiscal, Calendar, etc)
Audit Period Start Date:	Jul 01 2019
Audit Period End Date:	Jun 30 2020
Volume Reporting Units:	Million gallons (US)
Water System Structure:	Retail
Water Type:	Potable Water
System ID Number:	01-11-010
Validator Name/ID:	Will Jernigan, P.E.
Validator Email:	<a href="mailto:will.jernigan@cavanaughssolutions.com">will.jernigan@cavanaughssolutions.com</a>
Estimated Total Population Served by Water Utility:	200,000

### Key of Input Acronyms In order of appearance in the Worksheet

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

**Color Key**    User input     Calculated     Optional default

### Guidance for the Worksheet

Choosing to enter unit of **percent** or **volume** (applies to VOSEA, WIEA, WEEA, CMI)  
 choose entry option:  

1.00%	percent	or	
	volume		25.000

Choosing to enter **default** or **custom input** (applies to UUAC, SDHE, UC)  
 choose entry option:  

0.25%	default	or	
	custom		75.000

### 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	WIEA	WE	WEEA	BMAC	BUAC	UMAC	UUAC
SDHE	CMI	UC	Lm	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

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 v6.0 (see web resources) Limiting

**Attachment 2: Illustration of Worksheet**

**AWWA Free Water Audit Software:**  
**Worksheet**

FWAS v6.0  
American Water Works Association  
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Water Audit Report for: **City of Asheville**

Audit Year: **2020**    **Jul 01 2019 - Jun 30 2020**    **Fiscal**

Click 'W' to add notes    Click 'g' to determine data validity grade    To edit water system [go to start page](#)

To access definitions, click the [input](#)    All volumes to be entered as: MILLION GALLONS (US) PER YEAR

**WATER SUPPLIED**    Water Supplied Error Adjustments

choose entry option:

VOS	Volume from Own Sources: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="9"/>	7,439.150	MG/Yr	<input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="4"/>	volume	315.215	MG/Yr	<input type="text" value="under-registration"/>	VOSEA WIEA WEEA
WI	Water Imported: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="n/a"/>	0.000	MG/Yr						
WE	Water Exported: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="n/a"/>	0.000	MG/Yr						
<b>WATER SUPPLIED:</b>		<b>7,754.365</b>	MG/Yr						

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**AUTHORIZED CONSUMPTION**

BMAC	Billed Metered: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="8"/>	5,409.823	MG/Yr						
BUAC	Billed Unmetered: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="n/a"/>	0.000	MG/Yr						
UMAC	Unbilled Metered: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="9"/>	4.260	MG/Yr						
UUAC	Unbilled Unmetered: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="10"/>	90.120	MG/Yr						
<b>AUTHORIZED CONSUMPTION:</b>		<b>5,504.203</b>	MG/Yr						

choose entry option:   MG/Yr

---

**WATER LOSSES**    Apparent Losses

choose entry option:

SDHE	Systematic Data Handling Errors: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="3"/>	13.525	MG/Yr	<input type="text" value="0.25%"/>	<input type="text" value="default"/>					
CM	Customer Metering Inaccuracies: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="8"/>	115.005	MG/Yr	<input type="text" value="2.08%"/>	<input type="text" value="percent"/>	<input type="text" value="under-registration"/>				
UC	Unauthorized Consumption: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="3"/>	13.525	MG/Yr	<input type="text" value="0.25%"/>	<input type="text" value="default"/>					
<b>Apparent Losses:</b>		<b>142.054</b>	MG/Yr							

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

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**Real Losses**

Real Losses: **2,108.108** MG/Yr

WATER LOSSES: **2,250.162** MG/Yr

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**NON-REVENUE WATER**

NON-REVENUE WATER: **2,344.542** MG/Yr

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**SYSTEM DATA**

Lm	Length of mains: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="10"/>	1,280.0	miles	(including fire hydrant lead lengths)					
Nc	Number of service connections: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="8"/>	61,840		(active and inactive)					
	Service connection density: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="10"/>	48	conn./mile main						

Are customer meters typically located at the curbstops/property line?

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:     psi

---

**COST DATA**

CRUC	Customer Retail Unit Charge: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="10"/>	\$3.70	\$/100 cubic feet (ccf)	<b>Total Annual Operating Cost</b>					
VPC	Variable Production Cost: <input type="text" value="n"/> <input type="text" value="g"/> <input type="text" value="10"/>	\$301.75	\$/Million gallons	<input type="text" value="\$40,687,242"/> \$/yr (optional input)					

---

**WATER AUDIT DATA VALIDITY TIER:**

\*\*\* The Water Audit Data Validity Score is in Tier IV (71-90). See Dashboard tab for additional outputs. \*\*\*
[go to dashboard](#)

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

**PRIORITY AREAS FOR ATTENTION TO IMPROVE DATA VALIDITY:**

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

1: Billed Metered (BMAC)
2: Volume from Own Sources (VOS)
3: Unauthorized Consumption (UC)

**KEY PERFORMANCE INDICATOR TARGETS:**

OPTIONAL: If targets exist for the operational performance indicators, they can be input below:

Unit Total Losses:	<input type="text"/>	gal/conn/day
Unit Apparent Losses:	<input type="text"/>	gal/conn/day
Unit Real Losses <sup>A</sup> :	55.0	gal/conn/day
Unit Real Losses <sup>B</sup> :	<input type="text"/>	gal/mile/day

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



**Attachment 3: Illustration of Interactive Data Grading**

Interactive Data Grading Responses

<b>2020</b>	<b>VOS</b>	<b>VOSE</b>	<b>WI</b>	<b>WIEA</b>	<b>WE</b>	<b>WEEA</b>	<b>BMAC</b>	<b>BUAC</b>	<b>UMAC</b>	<b>UUAC</b>	Limiting criteria (see Start Page for details) ↓
White = incomplete Orange = complete	<b>SDHE</b>	<b>CMI</b>	<b>UC</b>	<b>Lm</b>	<b>Nc</b>	<b>Lp</b>	<b>AOP</b>	<b>CRUC</b>	<b>VPC</b>		
Use acronyms for navigation	FWAS v6.0 American Water Works Association. Copyright © 2020. All Rights Reserved.										

**Volume from Own Sources (VOS) - Data Grading Criteria**

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> = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.</p> <p><b>Electronic calibration</b> = 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 conversion to mA, meter transmitter 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	Limiting
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?	Annually	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)?	Between ±3% to ±6%	Limiting
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	
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>9</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#) **Volume from Own Sources Error Adjustment (VOSEA) - Data Grading Criteria** [go to notes](#)

vosea	Criteria Question	Select Best-Fit Answers to All Visible Questions	
vosea.1	Are tank levels monitored automatically & recorded daily?	No	Limiting
vosea.2			
vosea.3	Is the annual net distribution storage change included in either the VOS input or the VOSEA input?	No	
vosea.4	Are the flow accuracy test and/or electronic calibration results included in the VOSEA input in the water audit?	Yes, results are analyzed and incorporated	
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>4</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

	Water Imported (WI) - Data Grading Criteria	
wi	<b>Criteria Question</b>	<b>Select Best-Fit Answers to All Visible Questions</b>
wi.0	Did the water utility import any water during the audit year?	No
wi.1		
<p style="color: red; margin: 0;"><b>For questions 2-10 below: Choose the answer that applies for those meters that measure &gt;90% of the water imported volume.</b></p> <p><b>In-situ flow accuracy testing</b> = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.</p> <p><b>Electronic calibration</b> = 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 conversion to mA, meter transmitter or similar instrumentation.</p> <p><b>Tertiary device</b> can include SCADA, historian or other computerized archival system.</p>		
wi.2		
wi.3		
wi.4		
wi.5		
wi.6		
wi.7		
wi.8		
wi.9		
wi.10		
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		n/a

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

	<a href="#">go to input</a>	<b>Water Imported Error Adjustment (WIEA) - Data Grading Criteria</b>	<a href="#">go to notes</a>
<b>wiea</b>	<b>Criteria Question</b>	<b>Select Best-Fit Answers to All Visible Questions</b>	
wiea.1			
wiea.2			
wiea.3			
wiea.4			
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>n/a</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#) **Water Exported (WE) - Data Grading Criteria** [go to notes](#)

we	Criteria Question	Select Best-Fit Answers to All Visible Questions
we.0	Did the water utility export any water during the audit year?	No
we.1		
<p><b>For questions 2-10 below: Choose the answer that applies for those meters that measure &gt;90% of the water exported volume.</b>  <b>In-situ flow accuracy testing</b> = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.  <b>Electronic calibration</b> = a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).  <b>Secondary device</b> can include conversion to mA, meter transmitter or similar instrumentation.  <b>Tertiary device</b> can include SCADA, historian or other computerized archival system.</p>		
we.2		
we.3		
we.4		
we.5		
we.6		
we.7		
we.8		
we.9		
we.10		
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		n/a

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

<a href="#">go to input</a>	Water Exported Error Adjustment (WEEA) - Data Grading Criteria		<a href="#">go to notes</a>
weea	Criteria Question	Select Best-Fit Answers to All Visible Questions	
weea.1			
weea.2			
weea.3			
weea.4			
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		n/a	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

	<a href="#">go to input</a>	<b>Billed Metered Authorized Consumption (BMAC) - Data Grading Criteria</b>	<a href="#">go to notes</a>
<b>bmac</b>	<b>Criteria Question</b>	<b>Select Best-Fit Answers to All Visible Questions</b>	
bmac.0	Were any customers metered in the audit year?	Yes	
bmac.1	For billed metered accounts, what % of bills are estimated in a typical billing cycle?	5% or less	
bmac.2	How often does the utility read its customer meters? For systems with multiple read frequencies, select the reading frequency that describes the majority of your customers.	Bi-Monthly	Limiting
bmac.3	Is the BMAC volume pro-rated to represent consumption occurring exactly during the audit period?	No	Limiting
bmac.4	How frequently does internal review by utility staff of the BMAC volumes occur?	Every billing cycle	
bmac.5	What level of detail is examined in the internal review of BMAC volumes?	Totals grouped by use type or customer class and specific accounts flagged for anomalous consumption	
bmac.6	When was the most recent billing data review by someone who is independent of the utility billing process?	Within last 3 years	
bmac.7	What level of detail was examined in the review by someone who is independent of the utility billing process?	Full billing database query and analysis of raw data to verify the summary consumption volumes	
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>8</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#) **Billed Unmetered Authorized Consumption (BUAC) - Data Grading Criteria** [go to notes](#)

buac	Criteria Question	Select Best-Fit Answers to All Visible Questions
buac.0	Was there any billed consumption on unmetered accounts in the audit year?	No
buac.1		
buac.2		
buac.3		
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		n/a



**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

<a href="#">go to input</a>	Unbilled Metered Authorized Consumption (UMAC) - Data Grading Criteria		<a href="#">go to notes</a>
umac	Criteria Question	Select Best-Fit Answers to All Visible Questions	
umac.0	Did the water utility have any unbilled-metered consumption in the audit year?	Yes	
umac.1	Does the water utility policy articulate which accounts are exempt from billing?	Policy includes specific exemptions	
umac.2	How many unbilled metered accounts exist?	Monitored, count available	
umac.3	How often is each unbilled customer meter read? For systems with multiple read frequencies, select the reading frequency that describes the majority of your customers.	Bi-Monthly	Limiting
umac.4	How often are unbilled metered volumes reviewed for error?	Each billing cycle	
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>9</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

Unbilled Unmetered Authorized Consumption (UUAC) - Data Grading Criteria	
<a href="#">go to input</a>	<a href="#">go to notes</a>
uuac	Criteria Question
Select Best-Fit Answers to All Visible Questions	
uuac.0	On the Worksheet, the status of the default option is:
uuac.1	How well-understood is the extent of unbilled unmetered use?
uuac.2	Which best describes the records that are kept for events of unbilled unmetered use?
uuac.3	How is the majority of unbilled unmetered use estimated?
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>	
<b>10</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

---

[go to input](#) **Systematic Data Handling Error (SDHE) - Data Grading Criteria** [go to notes](#)

This Data Grading Criteria is hidden when the 'default' input is used on the Worksheet

FINAL DATA GRADE FOR THIS AUDIT INPUT: 3

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#)

**Customer Metering Inaccuracies (CMI) - Data Grading Criteria**

[go to notes](#)

cmi	Criteria Question	Select Best-Fit Answers to All Visible Questions
cmi.0	Was there any metered customer usage during the audit period?	Yes
cmi.1	Do you test meters reactively (when triggered by customer complaint or billing/consumption flag)?	Reactive testing conducted
cmi.2	For small size customer meters, which best describes the frequency of proactive testing (effort beyond when triggered by customer complaint or billing/consumption flags)?	Not recurring, but conducted within 5 years prior to audit period
cmi.3	Which best describes what meters are included in the proactive small size customer meter testing activities?	Testing targeted to subsets of meters ie oldest meters
cmi.4	For mid and large size customer meters, which best describes the frequency of the proactive testing program?	Ongoing, conducted annually
cmi.5	Which best describes what meters are included in the proactive mid- and large customer meter testing activities?	Testing targeted to subsets of meters (ie most revenue generating or customer types)
cmi.6	Which best describes how the input was derived?	Calculated based on most recent meter accuracy tests, but not comprehensive of all meter performance
cmi.7	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	Yes
cmi.8	To what extent does meter replacement occur and for which meters?	Replacement upon complete failure or special circumstance (as needed)
cmi.9	Which best describes the reliability of meter installation records?	Records are kept for meter installations, and they include data on installation date, type, size, and manufacturer
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>6</b>

Limiting

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

---

[go to input](#) **Unauthorized Consumption (UC) - Data Grading Criteria** [go to notes](#)

This Data Grading Criteria is hidden when the 'default' input is used on the Worksheet

FINAL DATA GRADE FOR THIS AUDIT INPUT: 3

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#)

**Length of Mains (Lm) - Data Grading Criteria**

[go to notes](#)

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

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#)

**Number of Service Connections (Nc) - Data Grading Criteria**

[go to notes](#)

Nc	Criteria Question	Select Best-Fit Answers to All Visible Questions	
Nc.1	How was the input derived?	Extracted from Services inventory (GIS, billing system, etc)	
Nc.2	What is the count of services based on?	Premise based, i.e. service connection count, location ID count	
Nc.3	Are inactive (but still pressurized) service lines included in the input? These may be metered or unmetered.	Yes	
Nc.4	Which best describes how the inventory of service connections (GIS, billing system, etc) is kept up to date?	Additions or subtractions are updated in the service line inventory (GIS, billing system, etc), at least annually	
Nc.5	Which best describes how the inventory of service connections (GIS, billing system, etc) is field validated to confirm field conditions match the inventory?	Field validation is accomplished for a portion of the system (i.e. in daily operations or specific validation projects)	Limiting
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>8</b>	

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

Average Length of (Private) Customer Service Line (Lp) - Data Grading Criteria		
go to input	go to notes	
Lp	Criteria Question	Select Best-Fit Answers to All Visible Questions
Lp.0	Are customer meters typically located at the curbstop or property line?	Yes
Lp.1		
Lp.2		
Lp.3		
Lp.4		
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>10</b>



**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#)

**Average Operating Pressure (AOP) - Data Grading Criteria**

[go to notes](#)

aop	Criteria Question	Select Best-Fit Answers to All Visible Questions
aop.1	Which best describes checks on the boundary integrity for the system's pressure zone(s)?	Normally-closed boundary valves between zones have been confirmed to be fully closed more than 3 years ago
aop.2	Which best describes how one-time pressure readings (i.e. from hydrants) are collected?	Collected annually during routine system flushing and/or hydrant testing
aop.3	Which best describes where continuous pressure data (via temporary data loggers or permanent telemetry) is collected?	At zone boundary conditions, plus some locations inside the zone(s) but not representing the full pressure profile
aop.4	Which best describes how continuous pressure data is collected?	Temporary data logger(s) deployed, adequately capturing seasonal variation during the year
aop.5	How was the input derived?	Calculated from field data as a simple average
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>7</b>

Limiting

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

[go to input](#)

**Customer Retail Unit Charge (CRUC) - Data Grading Criteria**

[go to notes](#)

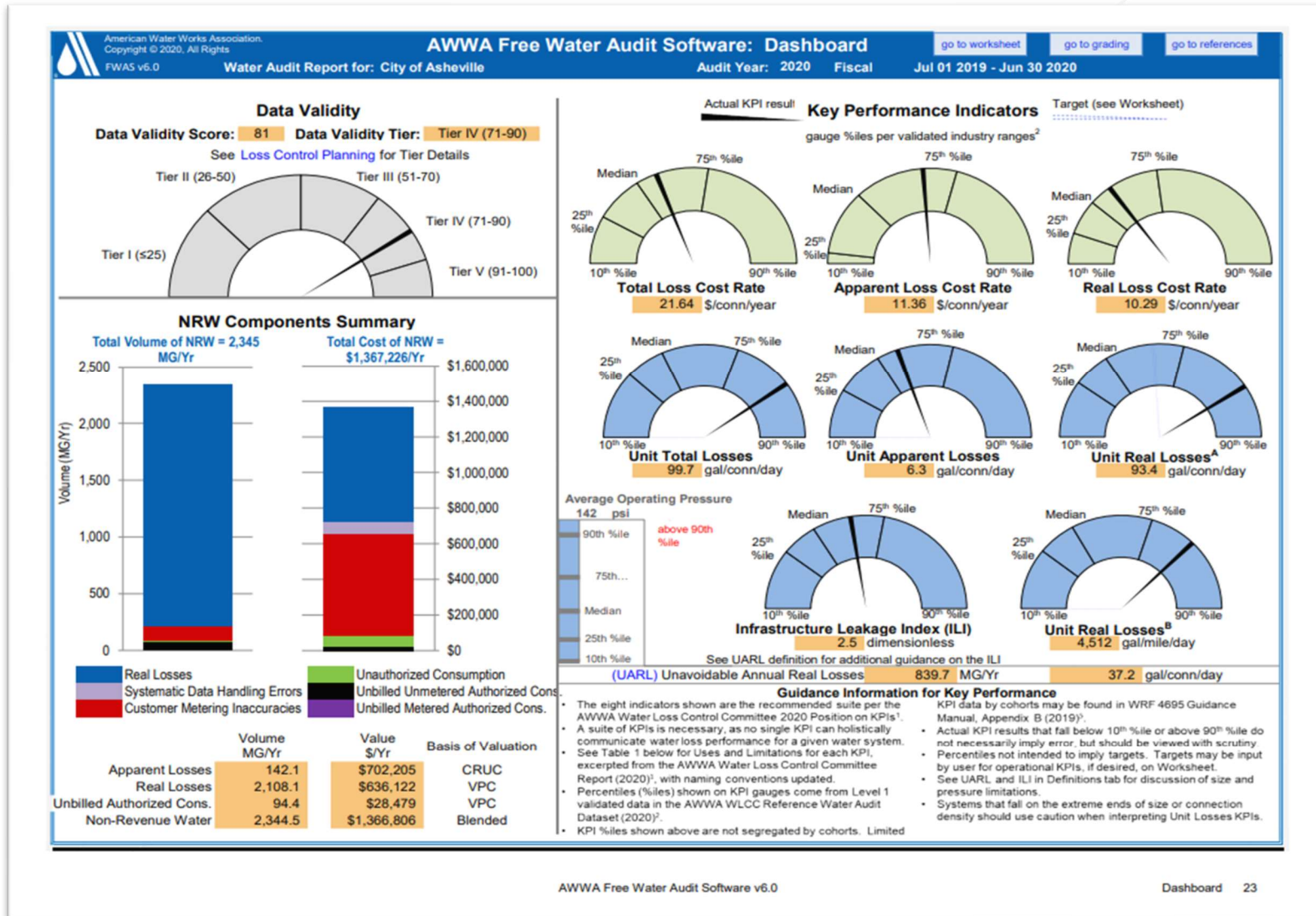
cruc	Criteria Question	Select Best-Fit Answers to All Visible Questions
cruc.0	Was any metered consumption billed on a volumetric basis in the audit period?	Yes
cruc.1	Which best describes the use and reliability of the current rate structure?	Customer bill calculations have been checked to confirm the rate structure is correctly implemented
cruc.2	Choose the option that best describes how the input was derived	A volume-weighted average of all rates was calculated
cruc.3	Is there any additional volumetric revenue the utility receives that depends on water meter readings, such as sewer?	Yes, and this has been incorporated into the volume-weighted average calculation
cruc.4	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	Yes
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>10</b>

**Attachment 3: Illustration of Interactive Data Grading (Cont.)**

Interactive Data Grading Responses

go to input		Variable Production Cost (VPC) - Data Grading Criteria	go to notes
vpc	Criteria Question	Select Best-Fit Answers to All Visible Questions	
vpc.1	Choose the option that best describes how the input was derived	Multiple sources of water exist, and a volume-weighted average was calculated for all sources	
vpc.2	<p>Choose the option that best describes which short-run marginal costs have been included in the input, using the definitions below for reference. Short-run marginal costs can include the following:</p> <ul style="list-style-type: none"> <li>- chemicals + power for treatment, typically applicable if the utility is producing/treating water</li> <li>- power for distribution, typically applicable if pumps exist in the distribution network</li> <li>- water acquisition costs, typically applicable if the utility is purchasing water or incurs any extraction costs for withdrawing from a source</li> </ul> <p>Some short-run marginal costs may not be applicable. The auditor should analyze the system characteristics to determine which costs are applicable for inclusion in the VPC input derivation. See also the latest AWWA M36 Manual for further guidance.</p>	All applicable short-run marginal costs are included	
vpc.3	<p>Choose the option that best describes which long-run marginal costs have been included in the input, using the definitions below for reference. Long-run marginal costs can include the following:</p> <ul style="list-style-type: none"> <li>- water treatment residuals management, typically applicable if solids are produced from water treatment process</li> <li>- accelerated wear &amp; tear on dynamic equipment, typically applicable if pumps exist for treatment and/or distribution, or any other equipment exists that wears out as a function of use instead of time (i.e. filter media, chemical dosing pumps, uv disinfection bulbs, etc)</li> <li>- payouts for damage claims from main and service line breaks, typically applicable if damage claims are paid by the utility</li> <li>- accelerated expansion of supply capacity, typically applicable if the utility is at or nearing supply capacity, or scarcity costs in water scarce areas</li> <li>- full cost pricing that includes all lifecycle costs and externalities (internalized or not)</li> </ul> <p>Some long-run marginal costs may not be applicable. The auditor should analyze the system characteristics to determine which costs are applicable for inclusion in the VPC input derivation. See also the latest AWWA M36 Manual for further guidance.</p>	Long-run marginal costs have been evaluated for applicability, and all applicable costs are included	
vpc.4	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	Yes	
<b>FINAL DATA GRADE FOR THIS AUDIT INPUT:</b>		<b>10</b>	

**Attachment 4: Illustration of Dashboard**



**Attachment 5: Notes**

<span style="float: right; font-size: small;">AWWA Free Water Audit Software: User Notes</span> <span style="float: right; font-size: x-small;">FWAS v6.0 American Water Works Association. Copyright © 2020, All Rights Reserved.</span>	
Water Audit Report for: << Please enter system details on the Start Page >> Audit Year:	
<b>General Notes:</b>	
<b>Audit Item</b>	<b>Notes on Input Derivation</b>
<b>Volume from Own Sources (VOS)</b>	<b>Notes on Data Validity Grading</b>
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	
<a href="#">go to worksheet</a> <a href="#">go to grading</a>	

**Attachment 5: Notes (Cont.)**

Audit Item	Notes on Input Derivation	Notes on Data Validity Grading
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Unauthorized Consumption (UC)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Length of Mains (Lm)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Number of Service Connections (Nc)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Average Length of (private) Customer Service Line (Lp)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Average Operating Pressure (AOP)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Customer Retail Unit Charge (CRUC)</b>		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> <b>Variable Production Cost (VPC)</b>		

**Attachment 5: Notes (Cont.)**

Audit Item	Notes on Input Derivation	Notes on Data Validity Grading
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Water Exported Error Adjustment (WEIA)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Billed Metered Authorized Consumption (BMAC)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Billed Unmetered Authorized Consumption (BUAC)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Unbilled Metered Authorized Consumption (UMAC)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Unbilled Unmetered Authorized Consumption (UUAC)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Systematic Data Handling Errors (SDHE)		
<a href="#">go to worksheet</a> <a href="#">go to grading</a> Customer Metering Inaccuracies (CMI)		


**Attachment 6: Illustration of Water Balance**

AWWA Free Water Audit Software		Water Audit Report for:		FWAS v6.0		
Water Balance		Audit Year:		American Water Works Association, Copyright © 2020, All Rights Reserved.		
		Data Validity Tier:		Jul 01 2019 - Jun 30 2020		
Volume from Own Sources (VOS) (corrected for known errors)  7,754.365	System Input Volume 7,754.365	Water Exported (WE) (corrected for known errors) 0.000	Billed Water Exported			Revenue Water (Exported) 0.000
		Water Supplied 7,754.365	Authorized Consumption 5,504.203	Billed Authorized Consumption 5,409.823	Billed Metered Consumption (BMAC) (water exported is removed) 5,409.823	Revenue Water 5,409.823
Water Losses 2,250.162	Apparent Losses 142.054			Unbilled Authorized Consumption 94.380	Billed Unmetered Consumption (BUAC) 0.000	Non-Revenue Water (NRW) 2,344.542
		Real Losses 2,108.108	Unbilled Metered Consumption (UMAC) 4.260	Unbilled Unmetered Consumption (UUAC) 90.120	Systematic Data Handling Errors (SDHE) 13.525	
Leakage on Transmission and/or Distribution Mains Not broken down	Customer Metering Inaccuracies (CMI) 115.005					
	Leakage on Service Connections Not broken down					

\*\*\*Water Balance Worksheet, breaks down the authorized consumption and water losses into individual components.



**Attachment 7: Illustration of Loss Control Planning**



**AWWA Free Water Audit Software:  
Determining Water Loss Standing**

FWAS v6.0  
American Water Works Association,  
Copyright © 2020. All Rights Reserved.

Water Audit Report for:  
Audit Year:  
Data Validity Tier:

<b>Water Loss Control Planning Guide</b>					
<b>Water Audit Data Validity Tier (Score Range)</b>					
<b>Functional Focus Area</b>	<b>Tier I (1-25)</b>	<b>Tier II (26-50)</b>	<b>Tier III (51-70)</b>	<b>Tier IV (71-90)</b>	<b>Tier V (91-100)</b>
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.*