Municipal Water District of Orange County

Water Loss Management Program Assessment

Potable Water System Audits

RECLAMATION
Managing Water in the West

December 2010

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Acknowledgements

The Project Team appreciates the opportunity afforded it through funding of this project by the United States Bureau of Reclamation Southern California Area Office under its Water Conservation Field Services Program and California Department of Water Resources under State Proposition 50. The project representative from the Municipal Water District of Orange County was Mr. Richard Bell, P.E., Senior Program Manager. Primary representatives from the five participating retail water utilities included Ron Krause from the City of Brea, Ken Dills and Bill Crisp from the City of Huntington Beach, Rich Mathis from the Laguna Beach County Water District, Greg Hooper and Charles Roy from the Moulton Niguel Water District, and Fred Adjarian and Vicky Kim from the City of Tustin.

The Project Team appreciates the efforts of MWDOC and the five participating utilities in workshop corroboration, discussion and debate of water loss issues, and data collection and formatting to allow for critical evaluation and comparison. The ME Simpson Company provided field leak detection services for each of the five utilities as part of the study.

The Malcolm Pirnie Consultant Project Team consisted of Megan Norman, Andree Hunt, and Steve Davis (Project Manager).

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Acronyms Used in the Report

AB	Assembly Bill
ACT	Urban Water Management Planning Act of 1983
AF	Acre-Feet (325,851 gallons)
AFY	Acre-Feet per Year
AWWA	American Water Works Association
AwwaRF	AWWA Research Foundation
BMP	Best Management Practice of the CUWCC
CARL	Current Annual Real Losses
CCF	Hundred Cubic Feet (748 gallons)
CIP	Capital Improvement Program
CUWCC	California Urban Water Conservation Council
DMA	District Metered Area
DMM	Demand Management Measure
DWR	Department of Water Resources
EPA	Environmental Protection Agency
Ft	Feet
GPCD	Gallons Per Capita Per Day
GPM	Gallons Per Minute
In	Inches
ILI	Infrastructure Leakage Index
IWA	International Water Association
M36	AWWA Manual on Water Audits and Loss Control Programs
MAF	Million Acre-Feet
MGD	Million Gallons per Day
MNWD	Moulton Niguel Water District
MOU	Memorandum Of Understanding
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NRW	Non-Revenue Water
OC	Orange County
SB	Senate Bill
UARL	Unavoidable Annual Real Losses
USBR	U.S. Bureau of Reclamation (Reclamation)
UWMP	Urban Water Management Plan
WLCC	AWWA Water Loss Control Committee

Executive Summary

This report has been prepared to document results of an assessment jointly funded by the U.S. Bureau of Reclamation Southern California Area Office (USBR) and the State of California Department of Water Resources (DWR) under State Proposition 50. The focus of this assessment is a follow-up to the Municipal Water District of Orange County (MWDOC) Water Loss Management Program Assessment dated March 2007. The recommendations from that study were as follows:

1. MWDOC should enhance the accuracy of audit work for the City of Tustin by conducting additional field investigations on calibration and validity testing of water supply meters and on leak detection surveys.

2. Water audits in the AWWA spreadsheet software format should be prepared for additional MWDOC retail member agencies to characterize water loss issues throughout its service area.

3. Additional grant applications to the USBR and the DWR should be prepared and submitted in pursuit of follow-up funding of water audit work.

4. Results of this study should be shared with the CUWCC to advocate the extended application of the IWA/AWWA Water Audit Methodology to other signatories to the MOU.

5. MWDOC retail member agencies and other California conservation–conscious water utilities should begin collecting and organizing the necessary water supply and customer demand information to conduct a standard annual water audit using IWA/AWWA methodology and to perform periodic updates.

6. Upon collection of multiple utility audits, a database should be developed to compare audit results, utility standard performance indicators, and water loss reduction methodologies and successes.

The current study documented in this report was performed under a professional services contract agreement between MWDOC and Malcolm Pirnie, Inc. This study was performed between May 2008 and May 2010, with a discontinuity in contract accomplishment due to an approximate six-month interruption in DWR funding for the project.

The purposes of this Project were to:

- Educate the Participating retail water agencies on the most recent international water loss control methods and technologies
- Perform retail system water audits for each Participant to determine current water losses and areas for improvement
- Review each Participant's leakage management program and recommend improvements
- Assist the Participants in achieving the California Urban Water Conservation Council (CUWCC) Best Management Practice (BMP) 1.2 compliance

There were five MWDOC retail water utilities which participated in the study. These retail agencies were:

- the City of Brea
- the City of Huntington Beach
- the Laguna Beach County Water District
- the Moulton Niguel Water District
- the City of Tustin

Each agency sent representatives to multiple project meetings and workshops, participated in group dialogue to understand and question the IWA/AWWA water audit methodology, prepared multiple annual water audits using version 3.0 and 4.0 of the Free AWWA Water Audit Spreadsheet software, prepared a data validation of their individual annual water audit data, participated in a field leak detection survey, and was educated about their compliance with existing and future requirements with the CUWCC BMP 1.2.

The following represent major study findings of the MWDOC Water Loss Management Program Assessment – Potable Water System Audits Study:

- There was a significant disparity between level of participation and information provided among the participants, which limited the extent to which the Consultant could compare and extrapolate finding of the study for the whole group of five utility participants.
- Those Participants who provided sufficient data for a full audit and analysis demonstrated excellent water loss control practices. These Participants should meet

the requirements of the CUWCC BMP 1.2 with only minimal adjustments to their existing practices.

- Although the portion of each system on which leak surveys were performed was not a significant enough percentage to extrapolate the results to each of the entire distribution systems, the results from these surveys were promising. Participants typically selected portions of their system for the leak surveys with older pipes or suspected issues, yet leaks were detected in only 2 of the 5 systems.

- Individual audits for different selected audit years are provided for the five retail agency participants. Based on an assessment of audit information, data validation scores, and audit results, recommended water loss accounting follow-up activities have been provided for each participant. All participating agencies have room to improve their real water loss and apparent water loss data collection, monitoring, and control practices.

- Non-Revenue Water ranged from 3 to 10 percent of volume of water supplied, which is very good and well within the range of efficient water utilities concerned about conservation and water loss management practices.

- Due to the increasingly stringent requirements for BMP 1.2 compliance in the future, participants will need to become proficient at component analysis for bottom up data collection and analysis to achieve better understanding of individual audit elements.

- The collaborative workshop approach with multiple concurrent participation and collaboration between consultant, wholesale water agency (MWDOC), and the participating retail agencies was excellent for group presentation, dialogue confirmation of understanding of audit elements in preparation for achieving water conservation requirements of the state. This project successfully prepared agency participants for California's water loss management element of its conservation program.

1. Introduction

1.1. Description of the Project

This report has been prepared to document results of an assessment jointly funded by the U.S. Bureau of Reclamation Southern California Area Office (USBR) and the State of California Department of Water Resources (DWR) under State Proposition 50. The focus of this assessment is a follow-up to the Municipal Water District of Orange County (MWDOC) Water Loss Management Program Assessment dated March 2007.

There has been a growing focus in California on municipal and other water conservation to address drought and regulatory water supply shortages. One form of water conservation which has recently drawn attention is the accountable management of water supplies, performed through water utility supply and demand auditing and the implementation of appropriate and cost-effective water loss control techniques. The current study documented in this report was performed under a professional services contract agreement between MWDOC and Malcolm Pirnie, Inc. This study was performed between May 2008 and May 2010, with a discontinuity in contract accomplishment due to an approximate six-month interruption in DWR funding for the project.

The purposes of the Project are to:

- Educate the Participants on most recent water loss control methods and technologies
- Perform retail system water audits for each Participant to determine current water losses and areas for improvement
- Review each Participant's leakage management program and recommend improvements
- Assist the Participants in achieving the California Urban Water Conservation Council (CUWCC) Best Management Practice (BMP) 1.2 compliance

The project was accomplished through nine scope of work tasks, as indicated below:

1. Perform Project Administration and Management
2. Collect and Review Relevant Audit Data
3. Complete Data Analysis and Formatting for AWWA Water Audit Software

4. Conduct "Unbilled Authorized Water Consumption" Review and Analysis

5. Conduct Leakage Management Program and Systems Operation Review

6. Perform Relevant Field Measurement Activities

7. Prepare Retail System Water Audit Reports

8. Provide Recommendations for Follow-Up Activities for Improved Water Loss Management

9. Complete Project Report

The full scope of work is indicated in Appendix A found at the end of this report.

1.2. Project Retail Utility Participants

There are five MWDOC retail water utilities which participated in the study. These retail agencies are:

- the City of Brea
- the City of Huntington Beach
- the Laguna Beach County Water District
- the Moulton Niguel Water District
- the City of Tustin

The City of Tustin was the primary participant in the 2007 MWDOC initial water loss assessment study. The locations of the participating agencies are shown on the map in Figure 1-1 below.

Per the purposes of the project stated above, the implementation of the study involved a highly collaborative workshop approach with targeted, subject-specific powerpoint presentations, data collection and formatting by the consultant team and agency participants, and roundtable discussions by the consultant team, MWDOC staff, and MWDOC agency participants.

Source: MWDOC

Figure 1-1: Map of MWDOC Indication Locations of Five Participating Agencies

Five major workshop meetings were held at offices of MWDOC:

- May 21, 2008
- August 7, 2008
- October 9, 2008
- December 17, 2008
- October 13, 2009

Copies of PowerPoint presentation images are included in Appendix B.

Due to the project funding support received from the U.S. Bureau of Reclamation, Southern California Area Office, semi-annual progress reports for the project were prepared and submitted.

2. Background of Water Auditing and Loss Control Programs

2.1. IWA/AWWA Water Audit Methodology

The American Water Works Association (AWWA) and International Water Association (IWA) have collaborated to assemble an international best management practice methodology for utility water auditing and water loss control. The AWWA Manual M36 Third Edition presents the IWA/AWWA water audit methodology and provides an overview of the best water loss control techniques that can currently be implemented for a sustainable and cost-effective water loss control program.

As a companion to AWWA M36, the AWWA Water Loss Control Committee has developed the Free Water Audit Software (AWWA Software), which can be used for a top down water audit and preliminary investigation of water losses and their associated costs.

Some key components of IWA/AWWA Water Audit Methodology include:

- Water balance- a summary of the key water audit data that shows the annual water supplies and demands from source to customer, with the sum of quantities in all columns equal. The standard water balance is shown in Figure 2-1.

- Apparent losses- Losses in customer consumption due to customer metering inaccuracies, data handling error, and unauthorized consumption. Apparent losses represent paper losses that result in uncaptured revenue for the water utility and the distortion of customer data.

- Real losses- physical water losses from the pressurized system and the utility's storage tanks, up to the point of the customer's meter. Real losses include leakage on transmission and distribution mains, storage tank overflows, and leakage on service connections. This category does not include water loss after the customer's water meter, since this usage is metered and billed.

- Component analysis- a means to analyze specific components of the occurrence of leakage in water distribution systems and apparent water losses. For real water loss, this analysis typically assesses leakage events in their three component phases- the awareness period, the location period, and the repair period- and is conducted to determine background leakage, unreported leakage, and reported leakage.

<table>
<tr><td rowspan="10">Water From Own Sources</td><td>Water Exported</td><td colspan="4">Billed Water Exported</td></tr>
<tr><td rowspan="9">Water Supplied to the retail customers</td><td rowspan="2">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and or Distribution Mains</td></tr>
<tr><td>Leakage and overflow at Utility`s Storage Tanks</td></tr>
<tr><td>Leaks on Service Connections</td></tr>
<tr><td>Water Imported</td></tr>
</table>

Source: AWWA M36 page 9.

Figure 2-1: The IWA/AWWA "Best Practice" Standard Water Balance

2.2. AWWA Spreadsheet Water Audit Software

Microsoft Excel spreadsheet software has been developed by the AWWA Water Loss Control Committee and adopted by the AWWA for performing a top down water utility audit. The major objective behind the development of this software is to bring the best practice water audit methodology developed by the International Water Association and the AWWA to all utilities, to make the water audit terms and definitions standardized throughout the industry to assess water supply efficiency in a standard reliable manner, and to give utilities a user-friendly way to compile and compare their water audit data with other utilities. This spreadsheet-based software helps to quantify, as well as track, the water losses which may occur in water distribution systems. It also helps in identifying areas where efficiency can be improved and costs associated with water loss can be recovered. Since the IW/AWWA water audit methodology gives consistent definitions for the major forms of water consumption and water losses encountered in drinking water utilities, it is considered universally applicable. In order for water utilities to make a meaningful assessment of their water loss, this software consists of a set of performance indicators (financial and operational) that evaluate utilities on system-specific features, such as average pressure in the distribution system and total length of water mains. The term "unaccounted-for water" is no longer used in the international water community and has been replaced by the term "non-revenue water".

The AWWA Water Audit Software Version 4.0 is a Microsoft Excel spreadsheet workbook consisting of seven worksheets. The seven worksheets contain the following:

- The First worksheet provides instructions on the use of the software and allows the user to input the general information about the water audit being performed.

- The Second worksheet is the reporting worksheet, which acts as an input data screen prompting the user to enter all of the required information about the water supply, such as the volume of water supplied, customer consumption, and various quantities of losses in the distribution system in order to perform the water-balancing calculations. It also prompts for the utility-specific information, such as average distribution system pressure, length of mains, etc. for calculating the performance indicators.

- The Third worksheet is a water balance worksheet, which shows summarized totals of each component of the water audit in columns. The water balance is in the same format as Figure 2-1. The table format balances all of the water entering the system (supplies) with all of the water leaving the system (metered and unmetered demands) by performing a top down water audit to determine real water losses. All of the values entered by the user on the Reporting Worksheet are utilized for calculating the components of the water balance sheet.

- The Fourth worksheet is a 2009 addition to the software consisting of a data validity grading matrix. The premise of this feature is that the accuracy of an audit is dependent of the quality of the data used to complete it. The new data validation feature uses a process-based approach to assign a validity score from 1 to 10 for each data component and for the audit as a whole. Recommended actions for improving these scores are also included in the software. The individual data validity scores are weighted and summed on the reporting spreadsheet. The top score is 100. The higher the score, the higher is the utility's confidence in the reliability and accuracy of the input data in the audit. Table 2-1 indicates the various levels assigned to specific ranges of data validity scores. A utility's goal should be to improve the data validity score by implementing recommendations in the grading matrix spreadsheet. Some water conservation guidelines require utilities to achieve a specific level to assure confidence in water audit results.

Table 2-1: Water Audit Validity Levels

Level	Score
Level I	0-25
Level II	26-50
Level III	51-70
Level IV	71-90
Level V	91-100

Source: AWWA M36, p. 235

- The Fifth worksheet provides customer service diagrams to define and compute average length of customer service line entered on the reporting worksheet.

- The Sixth worksheet consists of definitions and guidelines for use of all the terms established in the IWA/AWWA methodology. It is extremely easy to switch between the reporting worksheet to the definitions worksheet to have access to the meaning of each term for entering the appropriate data into the reporting worksheet.

- The Seventh worksheet provides a water loss control planning guide which indicates recommendations for water loss control in functional areas based on the water audit data validity score. The worksheet also provides guidelines for setting a target ILI (Infrastructure Leakage Index) and its use as an approximate leakage reduction tool. The ILI is calculated by dividing the Calculated Average Real Leakage by the Unavoidable Annual Real Losses (UARL). The value of ILI acts as a good operational benchmark for real water loss control. A table showing the general guidelines for establishing a target ILI range has been provided in this sheet. The availability of water resources to the utility is a determinant to setting a target ILI range. A utility should seek to minimize its ILI within its economic optimum for leak mitigation.

- Also included for reference at the end of the workbook are two example water audits for the City of Philadelphia Water Department and the Regional Municipality of Peel. Units of water supply are million gallons and megaliters per year, respectively.

The seven worksheets have been completed for a specific audit year by the five MWDOC retail utility participants in this study and are included in Appendix E to this Report. Retail audit results are presented and discussed in Section 7 of this report.

2.3. Water Loss Management

Water losses in a distribution system may be divided into two categories - namely, real losses and apparent losses. Apparent losses are the paper losses that occur in utility operations due to customer meter inaccuracies, data errors in the billing process, and unauthorized consumption or water theft. This water is consumed, but it is improperly measured, or un-paid. These losses reduce utility revenue and lead to distortion of data on customer consumption patterns. Real losses are the physical losses of water from the distribution system, including leakage and storage overflows. These losses inflate the water utility's production costs and put a stress on water resources, since they represent water that is extracted and treated but never reaches customers for a beneficial use. In order to make the water distribution system more efficient, utmost importance must be placed on water loss management. Independent of the type of method being used for performing a water audit, there will always be an uncertainty while calculating non-revenue water, apparent losses, and real losses.

The relationship shared by real losses from the IWA/AWWA water balance and UARL (Unavoidable Annual Real Losses) is clearly shown in Figure 2-2. The UARL calculation is based on length of mains, number of services, customer meter location, and average pressure in the distribution system. There are four methods of managing real losses, which are indicated by the four arrows in Figure 2-2. Putting a focus on these four management methods can reduce real losses, but, at a given average system operating pressure, the total real losses cannot be economically reduced any further than the value of UARL.

Figure 2-3 shows the four basic methods for managing apparent losses. Dependent upon the amount of attention given to each component related to apparent losses in the diagram, the losses will increase or decrease. A primary objective of the water-conserving, revenue efficient utility is to keep real and apparent losses at a minimum to minimize use of water resources and maximize revenue.

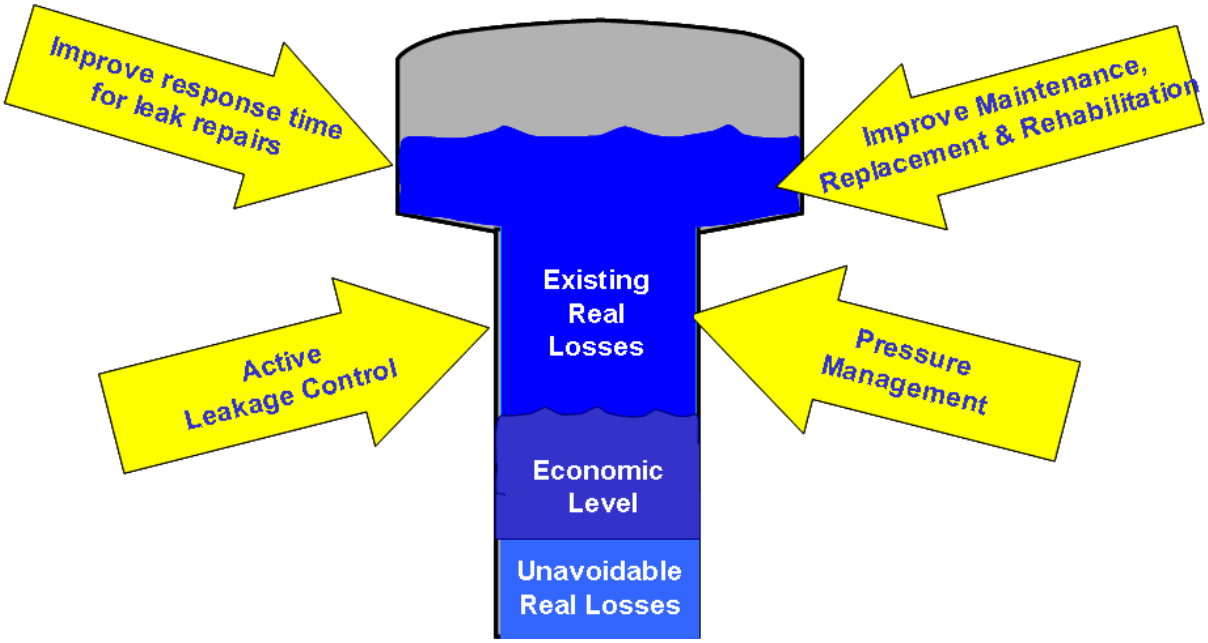


Figure 2-2: the four basic methods of managing Real Losses

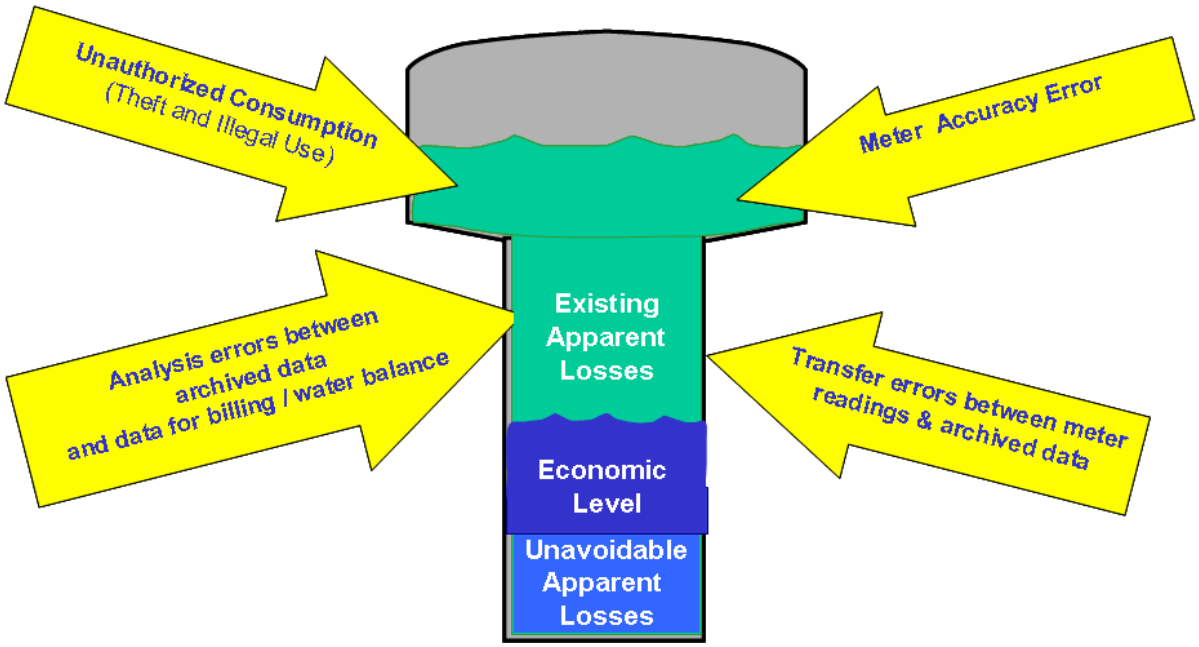


Figure 2-3: The four basic methods of managing Apparent Losses

2.4. California Regulatory Environment

The State of California has been subjected to loss of water resources through perfection of water rights of neighboring states, protection of endangered fish species in the Bay-Delta region of the State, and long-term drought. These conditions have prompted more stringent requirements for urban water conservation resulting in the formation of the California Urban Water Conservation Council (CUWCC), requirements for signing a Memorandum of Understanding (MOU) with the CUWCC to maintain qualification for State grant funding, and the recent passage of the Water Conservation Act of 2009 (SBX7-7). This new law is the water conservation component of the Bay-Delta legislative package with a goal of achieving a statewide reduction in urban per capita water use of twenty percent by December 31, 2020. Successful achievement of this conservation requirement will achieve a statewide water savings of about 380,000 acre-feet per year by 2020. Understanding and applying IWA/AWWA water audit methodologies will assist retail agencies in making their water delivery systems more efficient and achieving these stringent regulatory water reduction requirements.

2.4.1. CUWCC BMP 1.2

The California Urban Water Conservation Council recently revised BMP 1.2, the water loss control best management practice formerly known as BMP 3. BMP 1.2 is part of the CUWCC Foundational Utility Operations Program and incorporates the new water loss management procedures documented in AWWA M36 and applies them to water utilities in California. Retail water utilities are expected to use the free AWWA Audit Software to complete their standard water audit and water balance. The full text of BMP 1.2 is provided in Appendix C.

2.4.2. AB 1420 and BMP 1.2 Compliance

Effective January 1, 2009, AB 1420 amended the Urban Water Management Planning Act to require that water management grants or loans made to water suppliers and awarded or administered by DWR be conditioned on implementation of the water Demand Management Measures (DMMs). These DMMs correspond to the 14 CUWCC BMPs.

Of the retail utility Participants in this study, Huntington Beach and MNWD are currently signatories to the CUWCC Memorandum of Understanding (MOU) and are required to meet BMPs to retain grant eligibility.

2.4.3. Implementation Requirements

To be in compliance with BMP 1.2, water utilities need to complete at least the following actions:

- Complete the standard water audit and balance using the AWWA Audit Software at least annually.

- Test source, import, and production meters annually.
- Develop a validated data set from all entries of their water audit and water balance within four years, following AWWA Software methodology. Agencies should achieve a Water Audit Data Validity score of 66 or higher no later than the end of the first four- year period and should achieve a score Level IV no later than the end of the fifth year of implementation.
- Perform component analysis at least once every four years to analyze the causes of real and apparent losses.
- Reduce real losses to the extent cost-effective via economic analysis.
- Advise customers whenever it appears possible that leaks exist on the customer's side of the water meter.

2.4.4. Implementation Schedule

Table 2-2 below shows the implementation schedule for BMP 1.2 from the commencement of implementation. For agencies that signed the CUWCC MOU prior to December 31, 2008, implementation should commence no later than July 1, 2009, with agencies providing the first full BMP 1.2 report by December 1, 2010 for years 2008-09 and 2009-10. Agencies signing the MOU after December 21, 2008 should begin implementation no later than July 1 of the year following the year the agency signed the MOU.

Table 2-2: BMP 1.2 Implementation Schedule

Year	Coverage Requirements
1+	• Provide Full BMP 1.2 Report • Complete audit using AWWA software • Repair all reported leaks and breaks • Locate and repair unreported leaks when cost-effective
2+	• Test source, import, and production meters annually • Establish/maintain a record-keeping system for the repair of reported leaks
4+	• Record estimated leakage volume from report to repair and cost of repair • Achieve Data Validity Score of 66 or higher
5-10	• Achieve Data Validity Score Level IV • Demonstrate progress in water loss control performance as measured by gallons per service connection per day"

2.5. Retail Agency Top-Down Water Audits

The top down water audit is completed by gathering available records and entering data into the AWWA Audit Software. Participating retail water agencies were asked to enter their data into the AWWA Software themselves to enable them to learn the software for future BMP 1.2 reporting. Completion of the top down audit using the AWWA Software is a key component of BMP 1.2 compliance. Agencies are required to complete the standard water audit and balance at least annually. The annual audit worksheets are to be submitted in the BMP 1.2 report form every reporting period. Agencies are also required to develop a validated data set for all data used in the water audit within 4 years of implementation, and the validation for reported data must be kept and made available.

The CUWCC has not yet identified a benchmark for a statewide utility comparative performance indicator in terms of water loss standards. The standard will be determined after the first 4 years of data has been collected and reviewed and will be voted on by the Council by Year 6. The current BMP 1.2 language identifies "gallons per service connection per day" and "gallons per mile of mains per day" as performance indicators that can be used to measure progress. Other financial and operational performance indicators used in the AWWA audit method are identified in Table 2-3.

Table 2-3: IWA/AWWA Water Audit Performance Indicators

Function	Performance Indicator	Comments
Financial: Nonrevenue water by volume	Volume of nonrevenue water as a percentage of system input	Easily calculated from the water balance. Should be used in high level financial terms only and not as a measure of operational efficiency.
Financial: Nonrevenue water by cost	Value of non-revenue water as a percentage of the annual cost of running the system	Good financial indicator that incorporates different unit costs for nonrevenue components.
Operational: Apparent Losses	[gal/service connection/d]	Basic and useful performance indicator for apparent losses; easy to calculate.
Operational: Real Losses	[gal/service connection/d] (if service connection density is greater than 32/mi)	Best traditional performance indicator. Useful for target setting but not for comparison between systems.
Operational: Unavoidable Annual Real Losses	UARL (gal) = (5.41Lm + 0.15Nc + 7.5Lc) x P Where: Lm =length of water mains, mi Nc = number of service connections Lc = total length of private service connection pipe, mi = Nc x average distance from curb stop to customer meter , Lp P = average operation pressure, psi	Theoretical reference value representing the technical low limit of leakage that could be achieved if the best technology were successfully applied. Key variable in ILI calculation. Not valid for systems with <3,000 connections.
Operational: Real Losses	ILI (dimensionless) = CARL/UARL	Ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL); considered by AWWA to be the best indicator for comparisons between systems.

Source: AWWA M36: Water Audits and Loss Control Programs, p. 53

3. Participant Profiles

This section describes relevant water system physical and financial information used in the AWWA Water Audit Software. The source of the information is the 2008 Orange County Water Agencies Water Rates Report for calendar year 2008. More recent information for the five agencies has become available through the draft version of the 2009 Water Rates Report included in Appendix D at the end of this report.

3.1. City of Brea

The City of Brea is a retail water supplier which serves its customers both local groundwater and imported water purchased from the Metropolitan Water District of Southern California (MWD) through MWDOC. Brea's water supplies consisted of 60% local groundwater and 40% imported water in FY 2008. General water system data is summarized below in Table 3-1.

Table 3-1: City of Brea General Water System Data

Population	39,584
Miles of Mains (8" and larger)	162 miles
Annual Water Produced and Purchased	11,453 AF
Less Annual Water Sales	10,689 AF
Less Internal Uses (flushing, cleaning, irrigation, etc.)	100 AF
Equals Non-Revenue Water	961 AF (9%)
Peak Month Use Last Fiscal Year	1,365 AF in September 2004
Average Single Family Residential Use (monthly)	16 ccf

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

Brea's meter maintenance program includes testing and calibrating all water meters 1 ½-inch and larger every two years. These meters are repaired or replaced in house. All residential water meters are replaced every 15-20 years regardless of cumulative volume through the meter.

Financial information for the City of Brea is provided in Table 3-2.

Table 3-2: City of Brea Financial Information

Source of Funds 2007-08		
	Amount	**Percent**
Collected from Rate Payers (monthly or bi-monthly water bills)	$10,456,506	87%
Other Operating Revenues	192,963	2%
Investment Income	370,358	3%
Property Taxes	0	0%
Capital Reserve Fund	1,044,083	9%
Total Source of Funds	**$12,063,910**	**100%**
Use of Funds 2007-08		
	Amount	**Percent**
Source of Supply	$5,355,076	44%
Pumping	249,973	2%
Treatment	0	0%
Transmission & Distribution	368,555	3%
Customer Accounts	0	0%
Administrative	1,584,484	13%
Principal & Interest (all obligations)	1,582,107	13%
Capital Improvements funded by non-debt	2,573,715	21%
Other	0	0%
Transfers to City General Fund	350,000	3%
Total Use of Funds	**$12,063,910**	**100%**
Net Source and Use of Funds	**$ 0**	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

3.2. City of Huntington Beach

The City of Huntington Beach has 52,300 service connections and 614 miles of water mains. Huntington Beach is a member of the CUWCC. The City's water sources included 19.7% imported water and 80.3% local groundwater in FY 2008. General water system data for Huntington Beach, as documented in Orange County Water Agencies Water Rates, Water System Operations and Financial Information 2008, is summarized in Table 3-3 below.

Table 3-3: City of Huntington Beach General Water System Data

General Water System Data		
Population	203,490	
Miles of Mains (8"& larger)	376	Miles
Annual Water Produced & Purchased	31,857	AF
Less Annual Water Sales	30,697	AF
Less Internal Uses (flushing, cleaning, irrigation, etc.)	40	AF
Equals Unaccounted for Water	1,120	AF 3.5 % UAW
Peak Month Use Last Fiscal Year	3,421	AF in July 2007
Average Single-family Residential Use (monthly)	12 ccf	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

Huntington Beach has an in-house meter test bench which is used to test some meters removed for replacement to gather data on apparent losses due to meter inaccuracies. Huntington Beach replaces ¾-inch and 1-inch residential meters every 15 years, with the exception of high consumption meters. 1 ½ and 2-inch positive displacement meters are replaced by consumption and age of meter. 2 through 10-inch compound and Class II meters are overhauled on a maintenance program using a factor of consumption at last overhaul data. Huntington Beach reads its own customer meters and maintains statistics on missed meter reads and meter reader performance.

Financial information for the City of Huntington Beach is summarized in Table 3-4 below.

Table 3-4: City of Huntington Beach Financial Information

Source of Funds 2007-08		
	Amount	**Percent**
Collected from Rate Payers (monthly or bi-monthly water bills)	$31,952,860	92.05%
Other Operating Revenues	0	0%
Investment Income	1,668,747	4.81%
Property Taxes		0%
Other	1,092,292	3.15%
Total Source of Funds	**$34,713,899**	**100%**
Use of Funds 2007-08		
	Amount	**Percent**
Source of Supply	$10,570,413	30.45%
Pumping	3,098,614	8.93%
Treatment	703,256	2.03%
Transmission & Distribution	2,901,192	8.36%
Customer Accounts	1,327,415	3.82
Administrative	5,387,078	15.52%
Principal & Interest (all obligations)	-0-	0%
Capital Improvements funded by non-debt	1,786,423	5.15%
Other	1,507,582	4.34%
Transfers to City General Fund	4,224,069	12.17%
Reserves (set aside)	3,207,857	9.24%
Total Use of Funds	**$34,713,899**	**100%**
Net Source and Use of Funds	**$ 0**	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

3.3. Laguna Beach County Water District

Laguna Beach County Water District (LBCWD) is a retail water district with 8,513 service connections. LBCWD currently purchases 100 percent of its water supplies from Metropolitan Water District through MWDOC. General water system data for LBCWD is summarized in Table 3-5 below.

Table 3-5: LBCWD General Water System Data

General Water System Data	
Population	20,530
Miles of Mains (8"& larger)	132 Miles
Annual Water Produced & Purchased	3,874 AF
Less Annual Water Sales	3,956 AF
Less Internal Uses (flushing, cleaning, irrigation, etc.)	18 AF
Equals Unaccounted for Water	64 AF 0 % UAW
Peak Month Use Last Fiscal Year	473 AF in Sept. 07
Average Single-family Residential Use (monthly)	15ccf

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

LBCWD replaces meters every 20 years and maintains meter boxes every 3 years. Financial information for LBCWD is summarized in Table 3-6 below.

Table 3-6: LBCWD Financial Information

Source of Funds 2007-08		
	Amount	**Percent**
Collected from Rate Payers (monthly or bi-monthly water bills)	$6,738,228	66%
Other Operating Revenues	142,877	1%
Investment Income	1,193,716	12%
Property Taxes	1,957,706	19%
Other	152,088	2%
Total Source of Funds	**$10,184,615**	**100%**

Use of Funds 2007-08		
	Amount	**Percent**
Source of Supply	$2,424,267	28%
Pumping	433,482	5%
Treatment		0%
Transmission & Distribution	1,897,028	22%
Customer Accounts	229,814	3%
Administrative	2,024,828	23%
Principal & Interest (all obligations)	-0-	0%
Capital Improvements funded by non-debt	1,584,070	18%
Other	132,929	1%
Transfers to City General Fund		0%
Total Use of Funds	**$8,726,418**	**100%**
Net Source and Use of Funds	**$1,458,197**	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

3.4. Moulton Niguel Water District

Moulton Niguel Water District (MNWD) is a retail water district serving about 167,000 people through 53,810 service connections. MNWD currently purchases 100 percent of its potable water supplies (81 percent of total water supplies) from Metropolitan Water District through MWDOC. No groundwater pumping occurs. Recycled water is used for non-potable purposes, providing about 19 percent of total water supplies. Annual water use is reported at about 43,000 acre-feet. General water system data for MNWD is summarized in Table 3-7 below. The table reports an "unaccounted for water" (UAW) amount of 5.4 percent of total water supplied.

Table 3-7: Moulton Niguel Water District General Water System Data

General Water System Data			
Population	166,677		
Miles of Mains (8"& larger)	740	Miles	
Annual Water Produced & Purchased	42,887	AF	
Less Annual Water Sales	39,758	AF	
Less Internal Uses (flushing, cleaning, irrigation, etc.)	1,163	AF	
Equals Unaccounted for Water	1,965	AF	5.4 % UAW
Peak Month Use Last Fiscal Year	3,596	AF in July 2008	
Average Single-family Residential Use (monthly)	16 ccf		

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

Moulton Niguel reports that small residential water meters are tested every 3-5 years with replacement targeted on a 15-20 year cycle. Commercial meters are tested every year for accuracy. Residential meters are read monthly, and commercial meters are read bi-monthly.

Financial information for the Moulton Niguel Water District for Fiscal Year 2007-08 is presented in Table 3-8.

Table 3-8: Moulton Niguel Water District Financial Information

Source of Funds 2007-08		
	Amount	**Percent**
Collected from Rate Payers (monthly or bi-monthly water bills)	$24,843,950	52%
Other Operating Revenues	229,493	0%
Investment Income	3,936,098	8%
Property Taxes	18,193,555	38%
Other	698,889	1%
Total Source of Funds	**$47,901,985**	**100%**

Use of Funds 2007-08		
	Amount	**Percent**
Source of Supply	18,400,709	36%
Pumping	242,222	0%
Treatment		
Transmission & Distribution	2,958,395	6%
Customer Accounts	214,764	0%
Administrative	7,871,315	15%
Principal & Interest (all obligations)	8,273,386	16%
Capital Improvements funded by non-debt	13,111,847	26%
Other	0	0%
		0%
Total Use of Funds	**$51,072,638**	**100%**
Net Source and Use of Funds	**($3,170,653)**	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

3.5. City of Tustin

The City of Tustin recently used 30 percent imported water and 70 percent local groundwater in FY 2007-08. General water system data for Tustin is summarized in Table 3-9 below.

Table 3-9: City of Tustin General Water System Data

General Water System Data	
Population	67,706
Miles of Mains (8"& larger)	69 Miles
Annual Water Produced & Purchased	13,659 AF
Less Annual Water Sales	11,933 AF
Less Internal Uses (flushing, cleaning, irrigation, etc.)	415 AF
Equals Unaccounted for Water	790 AF 5.5 % UAW
Peak Month Use Last Fiscal Year	1,490 AF in Sept. 2007
Average Single-family Residential Use (monthly)	24 ccf

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

Tustin maintains small residential water meters on a regular program designed to replace every residential meter within 15 years. Broken and inaccurate meters are replaced on an as-needed basis as determined by City staff.

Financial information for the City of Tustin for Fiscal Year 2007-08 is presented in Table 3-10.

Table 3-10: City of Tustin Financial Information

Source of Funds 2007-08		
	Amount	**Percent**
Collected from Rate Payers (monthly or bi-monthly water bills)	10,923,061	97%
Other Operating Revenues	23,338	.2%
Investment Income	291,039	2.6%
Property Taxes	-0-	0%
Other	3,315	.1%
Total Source of Funds	**$11,240,753**	**100%**
Use of Funds 2007-08		
	Amount	**Percent**
Source of Supply: RA, Met	2,255,437	19%
Pumping: Wells & booster pump stas.	1,604,806	14%
Treatment	3,777,497	32%
Transmission & Distribution	675,435	5.7%
Customer Accounts	90,212	.8%
Administrative	504,332	4%
Principal & Interest (all obligations)	560,184	4.7%
Capital Improvements funded by non-debt	1,202,104	10%
Other	14,710	0%
Transfers to City General Fund	1,131,278	10%
Total Use of Funds	**$11,815,995**	**100%**
Net Source and Use of Funds	**($575,242)**	

Source: OC Water Agencies Water Rates, Water System Operations and Financial Information 2008 (FY 2007-08)

4. Leakage Management Program and System Operations Assessment

The primary focus of CUWCC BMP 1.2 is the reduction of real losses due to leaks and breaks from water mains and customer service connections, pipes, joints, and fittings; from leaking reservoir walls; and from reservoir or tank overflows. Leakage is typically the greatest portion of real water losses as defined by the IWA/AWWA water audit method.

BMP 1.2 requires the following leakage management activities:

- Agencies must repair all reported leaks and breaks to the extent cost-effective.
- Agencies must maintain records for the repair of reported leaks, including (by the end of Year 2 of implementation):
    - Time of report
    - Leak location
    - Type of leaking pipe segment or fitting
    - Leak running time from report to report
    - Estimated leakage volume from report to repair (by end of Year 4)
    - Cost of repair, including pavement restoration and paid-out damage claims (by end of Year 4)
- Agencies must locate and repair unreported leaks to the extent cost-effective
- Agencies must perform component analysis at least once every four years, with the goal of identifying causes, volumes, and value of water loss for each component to support economic analysis and selection of intervention tools.

One caveat of the AWWA Software is that it calculates real losses by subtracting apparent losses from total water losses and provides no mechanism to account for measured real losses through field activities. Some utilities, not including those participating in this study, maintain multiple field leak detection crews with in-office administrative and technical support to maintain an extensive program for monitoring, reporting, and repairing water distribution system leaks. One such utility is the Miami-

Dade County Water and Sewer Department (WASD), which targets a complete system leakage survey every 9-10 months. The survey incorporates field noise loggers, noise correlators, computer software for pinpointing, and human acoustic validation. WASD staff has developed customized, utility-specific formulas for estimating leaks from various pipeline materials and various leak configurations and sizes. They apply these empirical results to develop a monthly estimation of leakage volume assuming a leak run time of one-half of their leak detection cycle. WASD staff has more faith in their volumetric leakage losses than their top-down calculated apparent losses. In this case, the Miami-Dade water audit uses total production minus real losses to estimate apparent losses, atypical of the AWWA audit approach.

The following are reported leak detection programs for the five participating retail agencies in this study.

4.1. City of Brea

The City of Brea did not provide information on their leakage detection or management programs. Brea now maintains records on pipe inventories, but has not historically.

4.2. City of Huntington Beach

Huntington Beach is currently updating its pipe inventories in its GIS database.

4.3. Laguna Beach County Water District

LBCWD repairs all reported main breaks and leaks. LBCWD has a database of repaired leaks and can pull up information on leaks by street. LBCWD also maintains a monthly operations report which details water losses due to main breaks, overflows, and other causes as well as water used for hydrant flushing. These reports contain the following information:

- Description and location of event
- Date
- Run time from report to repair (minutes)
- Estimated flow (gpm)
- Estimated leakage volume (gallons)

Water losses documented in LBCWD operations reports are presented in Table 4-1 below.

Table 4-1: LBCWD Documented Water Losses (FY 2006-08)

	Documented Water Losses by Type (AF)			
Year	Main and Service Line Breaks	Overflows	Other Water Loss	Total
2007-08	0.09	-	-	0.09
2006-07	0.36	-	-	0.36
2005-06	0.13	-	0.07	0.20

Laguna Beach's method for tracking reported leaks is mostly consistent with the requirements of BMP 1.2 and would require only minimal modifications to achieve full compliance. In order to be in full compliance and to improve leakage management procedures, Laguna Beach should consider the following minor modifications to its documentation procedures:

1. Add time of leak report to the reporting spreadsheet.

2. Include documentation of repair cost, including materials, labor, pavement restoration, and damage cost.

3. Consider including a separate column for type of leaking pipe segment or fitting. While LBCWD typically records this information under the event description, it may be useful to have it identified separately in order to ensure it is recorded and analyze data.

LBCWD's documented water losses for FY 2006-2007 represent only a fraction of a percent of total water losses calculated using the AWWA Software.

4.4. Moulton Niguel Water District

Moulton Niguel did not report any in-house or outside contracted periodic leak detection program or leakage management procedures.

4.5. City of Tustin

The City of Tustin did not report any in-house or outside contracted periodic leak detection program or leakage management procedures.

5. Leak Detection Field Measurement Results

Malcolm Pirnie retained the ME Simpson Co., Inc. as a sub-consultant to perform leak detection services for the five retail water utilities participating in the project. The individual utilities selected lengths of distribution system pipeline that were suspected of having potential leaks due to leakage history, pipeline material, or pipeline age. Utility staff were invited to accompany ME Simpson staff to witness and assist in the leak detection process. Since leak detection and mitigation is the focus of BMP 1.2, the field observation of leak detection and noise correlation are important elements of training to meet these requirements in the future. The following are results for each agency. The entire leak detection methodology and results reports for the five utilities are included as Appendix F. Results were provided to each utility.

5.1. City of Brea

A survey of approximately 16.8 miles (88,704 lineal feet) of water main was performed for the City of Brea. The survey included all fire hydrants, accessible mainline valves, and selected services within the area selected by Brea. The survey was conducted using an electronically enhanced listening device which measures the time it takes the sound of a leak to travel from the leak to the leak correlator connection point. The leak correlator is connected to the water line at two locations in order to compute the exact leak location. Hydrants and accessible valves were used as acoustic listening points to identify leaks.

The survey for Brea identified one main line leak on a 10-inch main at Beechwood Drive and Parkcrest Way, with a estimated rate of leakage potential of 79,200 GPD. Based on a production price of $2.17 per thousand gallons, this leak was costing Brea $171.86 per day or $62,730 annually. Based on this analysis, the cost of the leak survey will be recovered through leak repair and value of water saved within 1 month.

5.2. City of Huntington Beach

A survey of approximately 12 miles (63,360 lineal feet) of water main was performed for the City of Huntington Beach. The survey included all fire hydrants, accessible mainline valves, and selected services within the area selected by Huntington Beach. The survey was conducted using an electronically enhanced listening device which measures the time it takes the sound of a leak to travel from the leak to the leak correlator connection point. The leak correlator is connected to the water line at two locations in order to compute the exact leak location. Hydrants and accessible valves were used as listening points to identify leaks.

The survey did not locate any discernable leaks in the Huntington Beach water distribution system, which is consistent with Huntington Beach's top-down audit results.

5.3. Laguna Beach County Water District

A survey of approximately 6.5 miles (34,320 lineal feet) of water main was performed for LBCWD. The survey included all fire hydrants, accessible mainline valves, and selected services within the area selected by LBCWD. The survey was conducted using an electronically enhanced listening device which measures the time it takes the sound of a leak to travel from the leak to the leak correlator connection point. The leak correlator is connected to the water line at two locations in order to compute the exact leak location. Hydrants and accessible valves were used as listening points to identify leaks.

The survey identified 1 hydrant leak at 49 La Costa Court, with an estimated leakage potential of 1,440 GPD. Based on a production price of $4.40 per thousand gallons, this leak was costing Brea $3.34 per day or $2,312.64 annually. Based on this analysis, repair of the leak, and value of water saved, the cost of the leak survey will be recovered within 20 months.

5.4. Moulton Niguel Water District

A survey of approximately 16.5 miles (87,120 lineal feet) of water main was performed for MNWD. The survey included all fire hydrants, accessible mainline valves, and selected services within the area selected by MNWD. The survey was conducted using an electronically enhanced listening device which measures the time it takes the sound of a leak to travel from the leak to the leak correlator connection point. The leak correlator is connected to the water line at two locations in order to compute the exact leak location. Each hydrant and accessible valve was used as a listening point to identify leaks. Water pipelines constructed of PVC were investigated via correlation, and correlation distances for PVC did not exceed 500 feet unless listening points were unavailable.

The survey did not locate any discernable leaks on the MNWD water distribution system.

5.5. City of Tustin

A survey of approximately 5.3 miles (27,984 lineal feet) of water main was performed for the City of Tustin. The survey included all fire hydrants, accessible mainline valves, and selected services within the area selected by Tustin. The survey was conducted using an electronically enhanced listening device which measures the time it takes the sound of a leak to travel from the leak to the leak correlator connection point. The leak correlator is connected to the water line at two locations in order to compute the exact leak location. Each hydrant and accessible valve was used as a listening point to identify leaks. The survey did not locate any discernable leaks on the Tustin water distribution system.

6. Apparent Loss Review and Assessment

Apparent losses per definition in the IWA/AWWA water audit methodology are the nonphysical water losses that occur when water is successfully delivered to the customer but is not measured or recorded accurately. When such errors occur systematically, the aggregate measure of water consumption can be underreported. The result can be a significant loss in revenue to the utility as well as a difference in reported production and reported metered consumption.

The three primary components of apparent losses are:

1. Meter inaccuracies, such as meters under-registering flow from mechanical wear, tampering, and improper installation. Meters become less accurate with cumulative volume through the meter, particularly at the low-flow range of the meter.

2. Accounting discrepancies, including non-billed accounts, billing software inaccuracies, billing adjustments and waivers.

3. Unauthorized consumption, such as fire hydrant theft, system theft, and unauthorized connections.

Reduction of apparent losses, unlike reduction of real losses, does not create a new source of water for the utility and, as a result, has not been the focus of water conservation best management practices such as the CUWCC BMP 1.2. However, the reduction of apparent losses creates new revenue for the utility, which may be used to fund other forms of water loss control and other water conservation activities. Since apparent losses result in lost revenue to the utility, they are valued at the retail rate and are, therefore, typically the most costly losses.

Table 6.1 identifies apparent losses by type for each Participating Agency. These results are taken from the most recent agency annual water audits included in Appendix E.

Table 6-1: Apparent Losses for Participating Agencies

Agency	Calculated Apparent Losses (AFY)				Percentage of Total Water Supplied
	Unauthorized Consumption	Customer Metering Inaccuracies	Data Handling Errors	Total	
City of Brea	31.000	58.000	1.000	90.000	0.7%
City of Huntington Beach	10.000	500.000	1.000	511.000	1.6%
Laguna Beach County Water District	11.0	Unknown	Unknown	N/A	Unknown
Moulton Niguel Water District	91.000	Unknown	Unknown	N/A	Unknown
City of Tustin	5.000	425.814	-	430.814	3.0%

6.1. City of Brea

The City of Brea reports that residential water meters are replaced every 15 to 20 years regardless of cumulative volume through the meter. All water meters sized 1 1/2 – inches and larger are tested and calibrated every two years regardless of cumulative volume through the meter. The length of time between residential meter replacements is predictably resulting in apparent water loss due to under-registration of the water meter at low flow rates. Brea reports a low customer metering inaccuracy relative to the other participating agencies, but without testing, this estimate is questionable.

6.2. City of Huntington Beach

The City of Huntington Beach has an existing meter accuracy test program, including an in-house test bench. Huntington Beach currently performs accuracy testing on selected meters that have been pulled from the system for replacement.

Huntington Beach's meter replacement program utilizes monthly audits comparing monthly consumption to the previous three month's consumption and the previous year's consumption. This generates replacement of small water meters and repairs of 3-inch to 10-inch meters. Huntington Beach has a 15-year replacement program for 2-inch and smaller meters. All 3-inch to 10-inch meters are field tested based on consumption and are repaired and calibrated as needed.

Cost of meter replacement for Huntington Beach, as provided by the City, is listed in Table 6-2 below. These costs do not take into account labor.

Table 6-2: Huntington Beach Meter Replacement Costs

Meter Size	Meter Cost
¾-inch	$58.19
1-inch	$92.13
1 ½-inch	$183.18
2-inch	$268.30

Huntington Beach reads its own customer meters and maintains statistics on missed meter reads and meter reader performance. Huntington Beach also has an AMR pilot program in place.

6.3. Laguna Beach County Water District

LBCWD is currently implementing a meter replacement program, based upon meter age. LBCWD has calculated that its meters have a useful life of 17.5 years, and 25 percent of the meters in its system are over 20 years old. Meter replacement cost is $110 to $120 per meter, including labor. LBCWD also has a significant number of fire sprinklered structures and is changing out these meters per fire sprinkler standards.

LBCWD does not have an in-house meter test shop and uses a contractor to calibrate source meters. For customer meters, LBCWD reads its own meters and maintains statistics on missed meter reads and meter reader performance.

6.4. Moulton Niguel Water District

MNWD has an in-house meter test shop and has data from meter accuracy testing on the volume lost due to meter inaccuracies. MNWD also performs portable water meter testing. Residential meters are replaced every 15-20 years. Zero or low usage meters are checked at the time of reading for proper function. Commercial meters are tested every year, and residential meters are tested every 3-5 years.

6.5. City of Tustin

Tustin maintains a meter replacement program which is based on meter cumulative flow rather than age. Cumulative flow at which each meter is replaced and meter replacement costs are shown in Table 6.3 below. Tustin does not have an in-house meter test bench, but contracts with Measurement Control for its meter accuracy testing. Meter accuracy testing is performed regularly at varying meter lifespans to determine optimum replacement time for each meter type. While apparent losses due to meter inaccuracy still represent the most significant loss in the Tustin water system, these losses are still relatively low, as is Tustin's water loss overall.

Table 6-3: Tustin Meter Replacement Costs

Meter Size	Usage Units (CCF) at Replacement	Meter Cost	Labor Cost
5/8-inch	2,000	$41.50	$30.75
1-inch	3,500	$92.00	$30.75
1 ½-inch	>10,000	$178.50	61.50
2-inch	>10,000	$268.00	$61.50
3-inch	As needed	Market price	$500.00
4-inch	As needed	$2,165.14	$500.00
6-inch	As needed	Market price	$500.00

7. Retail System Water Audit Reports

As previously stated, a major objective of this study was to educate participating utilities through workshops and collaborative discussion about the IWA/AWWA water audit methodology, individual components of water usage, and application of the free AWWA water audit software. Knowledge and methodology gleaned from the study provide utilities with tools to meet the regulatory requirements of CUWCC BMP 1.2, maintain eligibility for California grant funding, and better achieve utility water conservation and efficiency goals. Major workshop topics of discussion included:

- Context of Water Loss in the U.S.
- AWWA M36 "Water Audits and Loss Control Programs"
- IWA/AWWA Standard Water Balance
- Differentiating Real and Apparent Water Losses
- Production and Demand Data Requested of Participating Utilities
- Authorized Unmetered Consumption
- Water Meters
- AWWA Water Audit Software Version 4.0 with Data Validation
- CUWCC BMP 1.2 – Water Loss Control – Requirements
- Recommended Field Leak Surveys

The above topics have been documented in copies of PowerPoint presentations included in Appendix B. Participating Utilities collected information and filled out annual audits using Versions 3.0 and 4.0 of the AWWA Audit Software. This section presents the results of the participating agency audits and provides recommendations for further enhancement to achieve compliance with CUWCC BMP 1.2. For each agency, the reporting spreadsheet is presented for the selected year of audit followed by the water balance spreadsheet. A discussion of results of each agency audit follows.

7.1. City of Brea

7.1.1. Summary of Audit Results

The City of Brea staff participated in the collaborative workshops and completed multiple drafts of the AWWA Water Audit Software, including Version 4.0 with the data validation and scoring features. The reporting spreadsheet for the most recent audit for Brea fiscal year 2006-07 is included in Figure 7-1. The corresponding water balance for the reporting year is presented as Figure 7-2.

AWWA WLCC Free Water Audit Software: Reporting Worksheet

WAS v4.0

Back to Instructions

? Click to access definition

Water Audit Report for: City of Brea
Reporting Year: 2007 7/2006 - 6/2007

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

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED		<< Enter grading in column 'E'		
Volume from own sources:	10	7,356.000	acre-ft/yr	
Master meter error adjustment (enter positive value):	6	110.000	under-registered	acre-ft/yr
Water imported:	10	4,904.000	acre-ft/yr	
Water exported:	10		acre-ft/yr	
WATER SUPPLIED:		12,370.000	acre-ft/yr	
AUTHORIZED CONSUMPTION				Click here: ? for help using option buttons below
Billed metered:	10	11,174.000	acre-ft/yr	
Billed unmetered:	10		acre-ft/yr	
Unbilled metered:	10	281.760	acre-ft/yr	Pcnt: 1.25% Value:
Unbilled unmetered:		154.625	acre-ft/yr	
Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed				Use buttons to select percentage of water supplied OR value
AUTHORIZED CONSUMPTION:		11,610.385	acre-ft/yr	
WATER LOSSES (Water Supplied - Authorized Consumption)		759.615	acre-ft/yr	
Apparent Losses				Pcnt: Value:
Unauthorized consumption:		30.925	acre-ft/yr	0.25%
Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed				
Customer metering inaccuracies:	10	57.567	acre-ft/yr	0.50%
Systematic data handling errors:	10	1.000	acre-ft/yr	
Apparent Losses:		89.492		Choose this option to enter a percentage of billed metered consumption. This is NOT a default value
Real Losses				
Real Losses = Water Losses - Apparent Losses:		670.123	acre-ft/yr	
WATER LOSSES:		759.615	acre-ft/yr	
NON-REVENUE WATER				
NON-REVENUE WATER:		1,196.000	acre-ft/yr	
= Total Water Loss + Unbilled Metered + Unbilled Unmetered				
SYSTEM DATA				
Length of mains:	10	162.0	miles	
Number of active AND inactive service connections:	10	11,753		
Connection density:		73	conn./mile main	
Average length of customer service line:	10	0.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	10	63.0	psi	
COST DATA				
Total annual cost of operating water system:	10	$3,330,096	$/Year	
Customer retail unit cost (applied to Apparent Losses):	10	$1.78	$/100 cubic feet (ccf)	
Variable production cost (applied to Real Losses):	10	$478.50	$/acre-ft/yr	

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	9.7%
Non-revenue water as percent by cost of operating system:	18.0%
Annual cost of Apparent Losses:	$69,389
Annual cost of Real Losses:	$320,654

Operational Efficiency Indicators

Apparent Losses per service connection per day:	6.80	gallons/connection/day
Real Losses per service connection per day*:	50.90	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.81	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	60.69	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	3.60	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 93 out of 100 ***

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

PRIORITY AREAS FOR ATTENTION:

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

1: Master meter error adjustment
2: Unauthorized consumption
3: Unbilled unmetered

For more information, click here to see the Grading Matrix worksheet

Figure 7-1: City of Brea Reporting Worksheet

Figure 7-2: City of Brea Water Balance

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.0

Water Audit Report For:	Report Yr:
City of Brea	2007

Own Sources (Adjusted for known errors) 7,356.000	Water Exported 0.000	Billed Water Exported			
	Water Supplied 12,260.000	Authorized Consumption 11,327.250	Billed Authorized Consumption 11,174.000	Billed Metered Consumption (inc. water exported) 11,174.000	Revenue Water 11,174.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 153.250	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 1,086.000
				Unbilled Unmetered Consumption 153.250	
		Water Losses 932.750	Apparent Losses 30.650	Unauthorized Consumption 30.650	
				Customer Metering Inaccuracies 0.000	
				Systematic Data Handling Errors 0.000	
Water Imported 4,904.000			Real Losses 902.100	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Table 7-1: Brea Performance Indicator Assessment

Performance Indicator	Result
Non-revenue water as percent by volume of Water Supplied	9.7%
Non-revenue water as percent by cost of operating system	18.0%
Apparent Losses per service connection per day	6.80 gallons/connection/day
Real Losses per service connection per day	50.90 gallons/connection/day
Unavoidable Annual Real Losses (UARL)	60.69 million gallons/year
Infrastructure Leakage Index (ILI)	3.60

7.1.2. Data Gaps

The City of Brea provided all necessary data to complete the water audit and analyze financial and operational performance for the audit period. Additionally, Brea has completed its data validity scoring and demonstrates excellent record-keeping practices overall. Given Brea's audit and data validity scoring results, the City is well on track to achieving CUWCC BMP 1.2 compliance and requires only minimal adjustments to its practices to meet all requirements of the BMP within the specified time frames.

Table 7-2 shows the activities required for Brea to be in compliance with BMP 1.2 and the completion status of each.

Table 7-2: Status of Brea BMP 1.2 Compliance

Requirement for Compliance	Year Completion Required	Status	Notes
Compile standard water audit and balance	Annual	Completed	Brea needs to prepare audits for most recent years 2008 and 2009
Test source, import, and production meters annually	Year 2	Completed	Accuracy testing and calibration conducted semi-annually
Achieve a Water Audit Data Validity Score of 66 or higher	Year 4	Completed	Data Validity Score of 93 for FY 2006-07 audit
Achieve a Water Audit Data Validity Score of Level IV (71-90) or higher	Year 5	Completed	Data Validity Score of 93 for FY 2006-07 audit
Seek training in the AWWA water audit method and component analysis process	Year 4		
Complete a component analysis of real losses	Year 4	-	
Demonstrate progress in water loss control performance as measured by gallons per service connection per day	Year 5 through Year 10		
Repair all reported leaks and break to the extent cost-effective	Ongoing		
Maintain a record-keeping system for the repair of reported leaks	Year 2		
Include estimated leakage volume from report to repair and cost of repair in leak records	Year 4		
Locate and repair unreported leaks to the extent cost effective	Ongoing		

7.1.3. Recommended Follow-Up Activities

The Consultant recommends that Brea consider the following activities to improve their water loss management practices and ensure compliance with BMP 1.2

- Formalize a regular review of permitting and billing practices and a regular auditing process to reveal scope of systematic data handling errors. When refinements to the computerized billing system are undertaken, enhance reporting capabilities.

- Revise record-keeping system for the repair of reported leaks to include all information required by BMP 1.2, if not already included. Consider a GIS database to track locations of reported leaks, as well as pipe materials and age, to facilitate early identification of problem areas. While Brea does not currently have a major leakage problem per results of the field survey, leakage increases with system age, and simple, affordable steps for tracking leakage can prevent a problem from developing.

- Consider a more intense meter accuracy testing program, including maintaining records on cumulative flow for each meter and pulling meters from the system at random for testing to develop a database tracking meter accuracy versus cumulative flow through the meter. The current system for meter replacement in Brea based on 15 to 20 years in service does not allow for early identification of meters which have stopped working entirely, and does not account for meters which have decreased in accuracy gradually. Mechanical, positive displacement-type residential meters generally have an economic life of about ten years based on cumulative volume through the meter. Additionally, Brea should consider tracking time-of-day water use for a sample of selected residential meters to characterize customer demand at low, normal, and high flow rates in order to confirm economic optimum for meter replacement, confirm appropriate meter sizing, and to refine apparent loss estimates.

- Consider implementing a regular leak survey program to detect unreported leaks and background leakage. While Brea's current real losses do not warrant annual surveys of its full system, partial surveys of problem areas or of samples of the system may assist the City in completing the component analysis required under BMP 1.2 and in early detection of background leakage.

7.2. City of Huntington Beach

7.2.1. Summary of Audit Results

The City of Huntington Beach participated avidly in all workshops and collaborative meetings, often sending multiple persons. Staff provided requested data and prepared multiple drafts of various water audits for multiple years. Their most recent full audit results for fiscal year 2008-2009 is included in Appendix F. The reporting spreadsheet for the audit is provided in Figure 7.3 below. The water balance for 2008-09 is shown in Figure 7.4.

AWWA WLCC Free Water Audit Software: Reporting Worksheet

 WAS v4.0

Back to Instructions

? Click to access definition

Water Audit Report for: City of Huntington Beach
Reporting Year: 2009 7/2008 - 6/2009

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

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED			<< Enter grading in column 'E'		
Volume from own sources:	?	10	21,857.000	acre-ft/yr	
Master meter error adjustment (enter positive value):	?	4	1.000	under-registered	acre-ft/yr
Water imported:	?	10	9,773.000	acre-ft/yr	
Water exported:	?	n/a		acre-ft/yr	
WATER SUPPLIED:			31,631.000	acre-ft/yr	
AUTHORIZED CONSUMPTION					
Billed metered:	?	10	29,937.000	acre-ft/yr	
Billed unmetered:	?	n/a		acre-ft/yr	
Unbilled metered:	?	n/a	0.000	acre-ft/yr	
Unbilled unmetered:	?	8	39.000	acre-ft/yr	
AUTHORIZED CONSUMPTION:	?		29,976.000	acre-ft/yr	
WATER LOSSES (Water Supplied - Authorized Consumption)			1,655.000	acre-ft/yr	
Apparent Losses					
Unauthorized consumption:	?	8	10.000	acre-ft/yr	
Customer metering inaccuracies:	?	10	500.000	acre-ft/yr	
Systematic data handling errors:	?	6	1.000	acre-ft/yr	
Apparent Losses:	?		511.000		
Real Losses					
Real Losses = Water Losses - Apparent Losses:	?		1,144.000	acre-ft/yr	
WATER LOSSES:			1,655.000	acre-ft/yr	
NON-REVENUE WATER					
NON-REVENUE WATER:	?		1,694.000	acre-ft/yr	
= Total Water Loss + Unbilled Metered + Unbilled Unmetered					
SYSTEM DATA					
Length of mains:	?	10	614.0	miles	
Number of active AND inactive service connections:	?	10	52,300		
Connection density:			85	conn./mile main	
Average length of customer service line:	?	9	30.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	?	10	63.0	psi	
COST DATA					
Total annual cost of operating water system:	?	10	$25,800,000	$/Year	
Customer retail unit cost (applied to Apparent Losses):	?	8	$1.56	$/100 cubic feet (ccf)	
Variable production cost (applied to Real Losses):	?	8	$358.00	$/acre-ft/yr	

Click here: ? for help using option buttons below

Pcnt: Value:
39.000
Use buttons to select percentage of water supplied OR value
Pcnt: Value:
10.000
500.000
Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	5.4%
Non-revenue water as percent by cost of operating system:	3.0%
Annual cost of Apparent Losses:	$347,243
Annual cost of Real Losses:	$409,552

Operational Efficiency Indicators

Apparent Losses per service connection per day:	8.72	gallons/connection/day
Real Losses per service connection per day*:	19.53	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.31	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	308.03	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	1.21	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 88 out of 100 ***

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

PRIORITY AREAS FOR ATTENTION:

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

1: Master meter error adjustment
2: Systematic data handling errors
3: Customer retail unit cost (applied to Apparent Losses)

For more information, click here to see the Grading Matrix worksheet

Figure 7-3: City of Huntington Beach Reporting Worksheet

Figure 7-4: City of Huntington Beach Water Balance

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.0

Water Audit Report For:	Report Yr:
City of Huntington Beach	2009

	Water Exported 0.000	Billed Water Exported			
Own Sources (Adjusted for known errors) 21,858.000	Water Supplied 31,631.000	Authorized Consumption 29,976.000	Billed Authorized Consumption 29,937.000	Billed Metered Consumption (inc. water exported) 29,937.000	Revenue Water 29,937.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 39.000	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 1,694.000
				Unbilled Unmetered Consumption 39.000	
		Water Losses 1,655.000	Apparent Losses 511.000	Unauthorized Consumption 10.000	
				Customer Metering Inaccuracies 500.000	
				Systematic Data Handling Errors 1.000	
Water Imported 9,773.000			Real Losses 1,144.000	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Table 7-3: Huntington Beach Performance Indicator Assessment

Performance Indicator	Result
Non-revenue water as percent by volume of Water Supplied	5.4%
Non-revenue water as percent by cost of operating system	3.0%
Apparent Losses per service connection per day	8.72 gallons/connection/day
Real Losses per service connection per day	19.53 gallons/connection/day
Unavoidable Annual Real Losses (UARL)	308.03 million gallons/year
Infrastructure Leakage Index (ILI)	1.21

7.2.2 Data Gaps

Huntington Beach provided all necessary data to complete the water audit and analyze financial and operational performance for the audit period. Additionally, Huntington Beach has completed its data validity scoring and demonstrates excellent record-keeping practices overall. Given Huntington Beach's audit and data validity scoring results, the City is well on track to achieving BMP 1.2 compliance and requires only minimal adjustments to its practices to meet all requirements of the BMP within the specified time frames.

Table 7-4 shows the activities required for Huntington Beach to be in compliance with BMP 1.2 and the current completion status of each.

Table 7-4: Status of Huntington Beach BMP 1.2 Compliance

Requirement for Compliance	Year Completion Required	Status	Notes
Compile standard water audit and balance	Annual	Completed	
Test source, import, and production meters annually	Year 2	Completed	Accuracy testing and calibration conducted semi-annually
Achieve a Water Audit Data Validity Score of 66 or higher	Year 4	Completed	Data Validity Score of 88 for FY 2008-09 audit
Achieve a Water Audit Data Validity Score of Level IV (71-90) or higher	Year 5	Completed	Data Validity Score of 88 for FY 2008-09 audit
Seek training in the AWWA water audit method and component analysis process	Year 4		
Complete a component analysis of real losses	Year 4	-	
Demonstrate progress in water loss control performance as measured by gallons per service connection per day	Year 5 through Year 10	-	
Repair all reported leaks and break to the extent cost-effective	Ongoing	Ongoing	
Maintain a record-keeping system for the repair of reported leaks	Year 2	Partially Completed	
Include estimated leakage volume from report to repair and cost of repair in leak records	Year 4		
Locate and repair unreported leaks to the extent cost effective	Ongoing		

7.2.3. Recommended Follow-Up Activities

The Consultant recommends that Huntington Beach consider the following activities to improve their water loss management practices and ensure compliance with BMP 1.2

- Formalize a regular review of permitting and billing practices and a regular auditing process to reveal scope of systematic data handling errors. When refinements to the computerized billing system are undertaken, enhance reporting capabilities.

- Revise record-keeping system for the repair of reported leaks to include all information required by BMP 1.2, if not already included. Consider a GIS database to track locations of reported leaks, as well as pipe materials and age, to facilitate early identification of problem areas. While Huntington Beach does not currently have a leakage problem, leakage increases with system age and simple, affordable steps for tracking leakage can prevent a problem from developing.

- Consider a more intense meter accuracy testing program, including maintaining records on cumulative flow for each meter and pulling meters from the system at random for testing to develop a database tracking meter accuracy vs. cumulative flow. The current system for meter replacement in Huntington Beach allows for early identification of meters which have stopped working entirely, but may overlook meters which have decreased in accuracy gradually. Additionally, Huntington Beach should consider tracking time-of-day water use, perhaps in conjunction with its AMR pilot program, in order to confirm appropriate meter sizing and to refine apparent loss estimates.

- Consider implementing a regular leak survey program to detect unreported leaks and background leakage. While Huntington Beach's current real losses do not warrant annual surveys of its full system, partial surveys of problem areas or of samples of the system may assist Huntington Beach in completing the component analysis required under BMP 1.2 and in early detection of background leakage.

7.3. Laguna Beach County Water District

7.3.1. Summary of Results

Laguna Beach County Water District staff participated in all project meetings and workshops and provided all data required for the multiple preparations of annual water system audits for their utility. The lack of an in-house meter testing facility precluded reporting of estimated customer metering inaccuracy. They also did not have a basis to estimate billing system and customer data handling inaccuracies. Laguna Beach did not feel it had sufficient information to rate enough audit data input categories to compute a data validity score. Figure 7.5 indicates the LBCWD water audit reporting spreadsheet for FY 2007. Figure 7.6 provides the annual water balance.

Figure 7-5: Laguna Beach County Water District Reporting Worksheet

AWWA WLCC Free Water Audit Software: Reporting Worksheet

 WAS v4.0

Back to

? Click to access definition

Water Audit Report for: Laguna Beach County Water District
Reporting Year: 2007 7/2006 - 6/2007

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

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED << Enter grading in column 'E'

Volume from own sources:	0.000	acre-ft/yr	
Master meter error adjustment (enter positive value):		acre-ft/yr	
Water imported:	4,569.480	acre-ft/yr	
Water exported:	0.000	acre-ft/yr	
WATER SUPPLIED:	4,569.480	acre-ft/yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

Billed metered:	4,457.450	acre-ft/yr	
Billed unmetered:		acre-ft/yr	
Unbilled metered:		acre-ft/yr	
Unbilled unmetered:	8.770	acre-ft/yr	Pcnt: Value: 8.770
AUTHORIZED CONSUMPTION:	4,466.220	acre-ft/yr	

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption) 103.260 acre-ft/yr

Apparent Losses

Unauthorized consumption:	11.424	acre-ft/yr	Pcnt: 0.25% Value:
Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed			
Customer metering inaccuracies:	0.000	acre-ft/yr	
Systematic data handling errors:		acre-ft/yr	
Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5			
Apparent Losses:	11.424		

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

Real Losses

Real Losses = Water Losses - Apparent Losses:	91.836	acre-ft/yr
WATER LOSSES:	103.260	acre-ft/yr

NON-REVENUE WATER

NON-REVENUE WATER:	112.030	acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	135.0	miles	
Number of active AND inactive service connections:	8,513		
Connection density:	63	conn./mile main	
Average length of customer service line:	30.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	65.0	psi	

COST DATA

Total annual cost of operating water system:	$6,900,000	$/Year
Customer retail unit cost (applied to Apparent Losses):	$3.20	$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	$519.00	$/acre-ft/yr

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	2.5%
Non-revenue water as percent by cost of operating system:	1.0%
Annual cost of Apparent Losses:	$15,924
Annual cost of Real Losses:	$47,663

Operational Efficiency Indicators

Apparent Losses per service connection per day:	1.20	gallons/connection/day
Real Losses per service connection per day*:	9.63	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.15	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	56.23	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	0.53	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

Add a grading value for 11 parameter(s) to enable an audit score to be calculated

PRIORITY AREAS FOR ATTENTION:

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

1: Water imported
2: Billed metered
3: Customer metering inaccuracies

For more information, click here to see the Grading Matrix worksheet

Figure 7-6: Laguna Beach County Water District Water Balance

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.0

Water Audit Report For:	Report Yr:
District	2007

Own Sources (Adjusted for known errors) 0.000	Water Exported 0.000		Billed Water Exported		
		Authorized Consumption 4,466.220	Billed Authorized Consumption 4,457.450	Billed Metered Consumption (inc. water exported) 4,457.450	Revenue Water 4,457.450
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 8.770	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 112.030
				Unbilled Unmetered Consumption 8.770	
	Water Supplied 4,569.480	Water Losses 103.260	Apparent Losses 11.424	Unauthorized Consumption 11.424	
				Customer Metering Inaccuracies 0.000	
				Systematic Data Handling Errors 0.000	
Water Imported 4,569.480			Real Losses 91.836	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Table 7-5: LBCWD Performance Indicator Assessment

Performance Indicator	Result
Non-revenue water as percent by volume of Water Supplied	2.5%
Non-revenue water as percent by cost of operating system	1.0%
Apparent Losses per service connection per day	1.20 gallons/connection/day
Real Losses per service connection per day	9.63 gallons/connection/day
Unavoidable Annual Real Losses (UARL)	56.23 million gallons/year
Infrastructure Leakage Index (ILI)	0.53

7.3.2. Data Gaps

The following information would improve the accuracy of the LBCWD audit:

- LBCWD is missing data on customer metering inaccuracies and systematic data handling errors. Exclusion of this data will cause apparent losses to appear artificially low and, consequently, will cause real losses to appear artificially high.
- LBCWD is showing an ILI of less than 1, which may indicate a data flaw. It would be beneficial to confirm the accuracy of production and customer meters and to compare the results from the audit year with data from more recent years, such as FY 2007-08 and FY 2008-09.
- LBCWD has not completed the data validity scoring component of the audit software. This information is required by BMP 1.2 and would prove useful in identifying areas of strength and deficiencies in the audit.

Table 7-6 shows the activities required for LBCWD to be in compliance with BMP 1.2 and the completion status of each.

Table 7-6: Status of LBCWD BMP 1.2 Compliance

Requirement for Compliance	Year Completion Required	Status	Notes
Compile standard water audit and balance	Annual	Completed	
Test source, import, and production meters annually	Year 2	Completed	Accuracy testing and calibration conducted semi-annually
Achieve a Water Audit Data Validity Score of 66 or higher	Year 4	Incomplete	Data Validity Scoring not completed
Achieve a Water Audit Data Validity Score of Level IV (71-90) or higher	Year 5	Incomplete	Data Validity Scoring not completed
Seek training in the AWWA water audit method and component analysis process	Year 4	Complete	
Complete a component analysis of real losses	Year 4	Partially Complete	Performed for reported losses
Demonstrate progress in water loss control performance as measured by gallons per service connection per day	Year 5 through Year 10	-	
Repair all reported leaks and break to the extent cost-effective	Ongoing	Ongoing	
Maintain a record-keeping system for the repair of reported leaks	Year 2	Complete	
Include estimated leakage volume from report to repair and cost of repair in leak records	Year 4	Partially Complete	Estimated volume included

7.3.3. Recommended Follow-Up Activities

- LBCWD should consider a GIS database to record pipe age as well as to track leak locations. While developing pipe inventory would be a long-term project since LBCWD does not maintain age records currently, it would be beneficial to track this information as pipes are replaced. While LBCWD does not currently have a major leakage problem per results of the field survey, leakage increases with system age,

and simple, affordable steps for tracking leakage can prevent a problem from developing.

- To improve its meter replacement program, LBCWD should maintain records of meter cumulative volume and should implement meter accuracy test on randomly pulled residential meters at varying consumption levels. Meter accuracy is typically a function of cumulative volume rather than age; therefore, a meter replacement program based on meter age may not be optimally efficient in reducing apparent losses. The current system for meter replacement in LBCWD based on 15 to 20 years in service does not allow for early identification of meters which have stopped working entirely, and does not account for meters which have decreased in accuracy gradually. Mechanical, positive displacement-type residential meters generally have an economic life of about ten years based on cumulative volume through the meter. Additionally, LBCWD should consider tracking time-of-day water use for a sample of selected residential meters to characterize customer demand at low, normal, and high flow rates in order to confirm economic optimum for meter replacement, confirm appropriate meter sizing, and to refine apparent loss estimates.

- Development of a database which tracks meter accuracy relative to cumulative volume will provide for a more accurate assessment of apparent losses and a more efficient meter replacement program. Improved meter accuracy data will also allow for a more accurate assessment of real losses at a lower cost than leak detection field work.

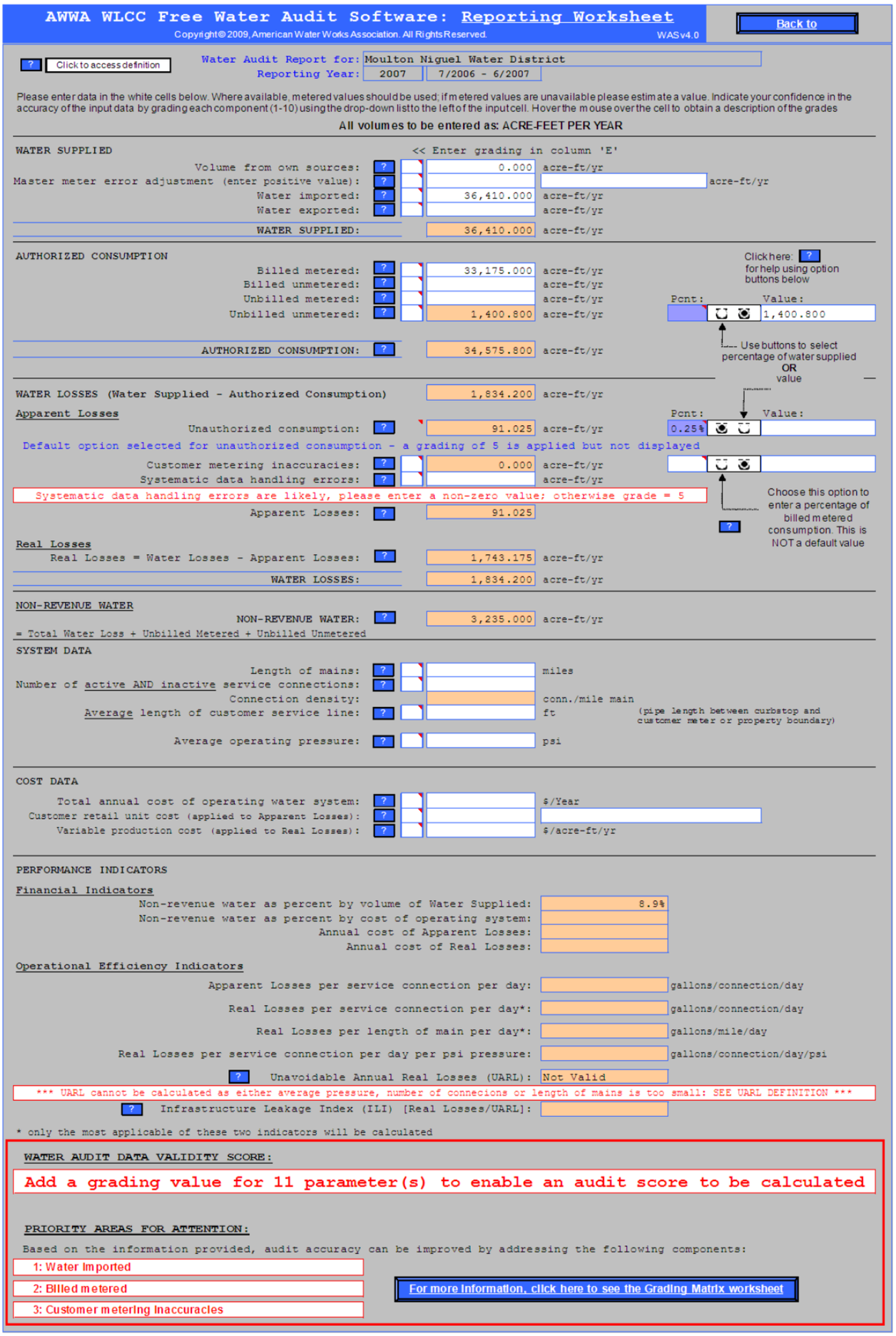
- LBCWD should formalize a regular review of its billing practices and conduct a regular auditing process to reveal scope of systematic data handling errors. When refinements to the computerized billing system are undertaken, LBCWD should consider enhancing reporting capabilities, including exception reports.

7.4. Moulton Niguel Water District

7.4.1. Summary of Results

Moulton Niguel Water District staff participated in the initial and mid-term meetings and workshops, which afforded them the consultant presentation and discussion about IWA/AWWA water audit methodologies and how to prepare an annual audit using the AWWA free audit spreadsheet software. Their audit reporting year is 2006-07. More urgent utility priorities prevented MNWD staff from attending the last BMP 1.2 presentation and workshop. This meeting presented the most recent Version 4.0 of the AWWA software and discussed how to conduct a data validation analysis for scoring the utility's confidence in the accuracy of its audit input data. MNWD staff did not provide sufficient audit information nor source and accuracy information for the consultant to perform a data validity assessment for the FY 2006-07 water audit. Additionally, missing system and cost information for the audit did not allow the audit software to calculate

system performance indicators. Therefore, an assessment with respect to BMP 1.2 compliance was not accomplished. Figure 7.7 provides the water auditing reporting spreadsheet for 2006-07. Figure 7.8 provides MNWD water balance for the same audit year.



AWWA WLCC Free Water Audit Software: Reporting Worksheet

WAS v4.0

Back to

? Click to access definition

Water Audit Report for: Moulton Niguel Water District
Reporting Year: 2007 7/2006 - 6/2007

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

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED << Enter grading in column 'E'

Volume from own sources:	0.000	acre-ft/yr	
Master meter error adjustment (enter positive value):		acre-ft/yr	
Water imported:	36,410.000	acre-ft/yr	
Water exported:		acre-ft/yr	
WATER SUPPLIED:	36,410.000	acre-ft/yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

			Pcnt:	Value:
Billed metered:	33,175.000	acre-ft/yr		
Billed unmetered:		acre-ft/yr		
Unbilled metered:		acre-ft/yr		
Unbilled unmetered:	1,400.800	acre-ft/yr		1,400.800
AUTHORIZED CONSUMPTION:	34,575.800	acre-ft/yr		

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption) 1,834.200 acre-ft/yr

Apparent Losses

			Pcnt:	Value:
Unauthorized consumption:	91.025	acre-ft/yr	0.25%	

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

Customer metering inaccuracies:	0.000	acre-ft/yr		
Systematic data handling errors:		acre-ft/yr		

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses: 91.025

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

Real Losses

Real Losses = Water Losses - Apparent Losses: 1,743.175 acre-ft/yr

WATER LOSSES: 1,834.200 acre-ft/yr

NON-REVENUE WATER

NON-REVENUE WATER: 3,235.000 acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:		miles
Number of active AND inactive service connections:		
Connection density:		conn./mile main
Average length of customer service line:		ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:		psi

COST DATA

Total annual cost of operating water system:		$/Year
Customer retail unit cost (applied to Apparent Losses):		
Variable production cost (applied to Real Losses):		$/acre-ft/yr

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	8.9%
Non-revenue water as percent by cost of operating system:	
Annual cost of Apparent Losses:	
Annual cost of Real Losses:	

Operational Efficiency Indicators

Apparent Losses per service connection per day:		gallons/connection/day
Real Losses per service connection per day*:		gallons/connection/day
Real Losses per length of main per day*:		gallons/mile/day
Real Losses per service connection per day per psi pressure:		gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	Not Valid	

*** UARL cannot be calculated as either average pressure, number of connecions or length of mains is too small: SEE UARL DEFINITION ***

Infrastructure Leakage Index (ILI) [Real Losses/UARL]:

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

Add a grading value for 11 parameter(s) to enable an audit score to be calculated

PRIORITY AREAS FOR ATTENTION:

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

1: Water Imported
2: Billed metered
3: Customer metering inaccuracies

For more information, click here to see the Grading Matrix worksheet

Figure 7-7: Moulton Niguel Water District Reporting Worksheet

Figure 7-8: Moulton Niguel Water District

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.0

Water Audit Report For:	Report Yr:
Moulton Niguel Water District	2007

	Water Exported 0.000	Billed Water Exported			
Own Sources (Adjusted for known errors) 0.000	Water Supplied 36,410.000	Authorized Consumption 34,575.800	Billed Authorized Consumption 33,175.000	Billed Metered Consumption (inc. water exported) 33,175.000	Revenue Water 33,175.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 1,400.800	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 3,235.000
				Unbilled Unmetered Consumption 1,400.800	
		Water Losses 1,834.200	Apparent Losses 91.025	Unauthorized Consumption 91.025	
				Customer Metering Inaccuracies 0.000	
				Systematic Data Handling Errors 0.000	
Water Imported 36,410.000			Real Losses 1,743.175	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

7.4.2. Data Gaps

The Moulton Niguel water audit indicates multiple data gaps which need to be filled prior to an accurate assessment of data validity and accuracy of audit results. No evaluation of compliance with CUWCC BMP 1.2 was performed, since a completed annual audit forms the basis for initial compliance independent of audit results.

7.4.3. Recommended Follow-Up Activities

The Consultant recommends that MNWD consider the following activities to improve their water loss management practices and ensure compliance with BMP 1.2

- Implement an annual water system auditing process to collect, evaluate, and maintain data required to compete annual audits in the IWA/AWWA format as required by CUWCC BMP 1.2. Complete the data validation portion of the annual audit and implement audit suggestions for improving the data validation score, if warranted.

- Formalize a regular review of billing system practices and a conduct a regular customer billing system auditing process to reveal scope of systematic data handling errors. When refinements to the computerized billing system are undertaken, enhance reporting capabilities.

- Revise record-keeping system for the repair of reported leaks to include all information required by BMP 1.2, if not already included. Consider a GIS database to track locations of reported leaks, as well as pipe materials and age, to facilitate early identification of problem areas. While MNWD does not currently have a system leakage problem per results of the field survey, leakage increases with system age, and simple, affordable steps for tracking leakage can prevent a problem from developing.

- Consider a more intense meter accuracy testing program, including maintaining records on cumulative flow for each meter and pulling meters from the system at random for testing to develop a database tracking meter accuracy versus cumulative flow through the meter. The current system for residential meter replacement in MNWD is based on 15 to 20 years in service. The meter reading procedures do allow for early identification of meters which have stopped working entirely. A sample of residential meters is tested every 3-5 years for accuracy. Mechanical, positive displacement-type residential meters generally have an economic life of about ten years based on cumulative volume through the meter. Additionally, MNWD should consider tracking time-of-day water use for a sample of selected residential meters to characterize customer demand at low, normal, and high flow rates in order to confirm economic optimum for meter replacement, confirm appropriate meter sizing, and to refine apparent loss estimates.

7.5. City of Tustin

7.5.1. Summary of Results

The City of Tustin participated avidly in all project meetings and workshops. Tustin staff submitted all data in response to requests for information and completed multiple versions of the IWA/AWWA water audit. Their audit year was calendar year 2007. Tustin demonstrates excellent record-keeping practices necessary to comply with CUWCC BMP1.2. Due to their low calculated ILI, they should perform audits for additional calendar years to validate consistency with their 2007 reported low leakage and system infrastructure leakage index. Their audit reporting spreadsheet is shown below in Figure 7.9. Their water balance is provided in Figure 7.10.

AWWA WLCC Free Water Audit Software: Reporting Worksheet

 WAS v4.0

Back to

? Click to access definition

Water Audit Report for: City of Tustin Water Services Division
Reporting Year: 2007 1/2007 - 12/2007

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

All volumes to be entered as: ACRE-FEET PER YEAR

WATER SUPPLIED		<< Enter grading in column 'E'		
Volume from own sources:	10	11,292.800	acre-ft/yr	
Master meter error adjustment (enter positive value):	4	28.000	under-registered	acre-ft/yr
Water imported:	10	3,014.900	acre-ft/yr	
Water exported:	10	0.000	acre-ft/yr	
WATER SUPPLIED:		14,335.700	acre-ft/yr	

AUTHORIZED CONSUMPTION				
Billed metered:	10	13,360.000	acre-ft/yr	
Billed unmetered:	10		acre-ft/yr	
Unbilled metered:	9	408.000	acre-ft/yr	
Unbilled unmetered:	9	35.000	acre-ft/yr	
AUTHORIZED CONSUMPTION:		13,803.000	acre-ft/yr	

Click here: ? for help using option buttons below

Pcnt: Value: 35.000

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption)		532.700	acre-ft/yr	
Apparent Losses				
Unauthorized consumption:	2	5.000	acre-ft/yr	
Customer metering inaccuracies:	9	425.814	acre-ft/yr	
Systematic data handling errors:	7		acre-ft/yr	
Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5				
Apparent Losses:		430.814		
Real Losses				
Real Losses = Water Losses - Apparent Losses:		101.886	acre-ft/yr	
WATER LOSSES:		532.700	acre-ft/yr	

Pcnt: Value: 5.000

3.00%

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

NON-REVENUE WATER			
NON-REVENUE WATER:		975.700	acre-ft/yr
= Total Water Loss + Unbilled Metered + Unbilled Unmetered			

SYSTEM DATA				
Length of mains:	6	172.0	miles	
Number of active AND inactive service connections:	10	14,124		
Connection density:		82	conn./mile main	
Average length of customer service line:	9	20.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	9	50.0	psi	

COST DATA			
Total annual cost of operating water system:	10	$11,649,391	$/Year
Customer retail unit cost (applied to Apparent Losses):	6	$1.99	$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	9	$379.64	$/acre-ft/yr

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	6.8%	
Non-revenue water as percent by cost of operating system:	5.0%	
Annual cost of Apparent Losses:	$373,449	
Annual cost of Real Losses:	$38,680	

Operational Efficiency Indicators

Apparent Losses per service connection per day:	27.23	gallons/connection/day
Real Losses per service connection per day*:	6.44	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.13	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	62.97	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	0.53	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 83 out of 100 *****

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

PRIORITY AREAS FOR ATTENTION:

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

1: Master meter error adjustment
2: Unauthorized consumption
3: Customer retail unit cost (applied to Apparent Losses)

For more information, click here to see the Grading Matrix worksheet

Figure 7-9: City of Tustin Reporting Worksheet

Figure 7-10: City of Tustin Water Balance

AWWA WLCC Free Water Audit Software: Water Balance

 WAS v4.0

Water Audit Report For:	Report Yr:
Division	2007

Own Sources (Adjusted for known errors) 11,320.800	Water Exported 0.000	Billed Water Exported			
	Water Supplied 14,335.700	Authorized Consumption 13,803.000	Billed Authorized Consumption 13,360.000	Billed Metered Consumption (inc. water exported) 13,360.000	Revenue Water 13,360.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 443.000	Unbilled Metered Consumption 408.000	Non-Revenue Water (NRW) 975.700
				Unbilled Unmetered Consumption 35.000	
		Water Losses 532.700	Apparent Losses 430.814	Unauthorized Consumption 5.000	
				Customer Metering Inaccuracies 425.814	
				Systematic Data Handling Errors 0.000	
Water Imported 3,014.900			Real Losses 101.886	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Table 7-7: Tustin Performance Indicator Assessment

Performance Indicator	Result
Non-revenue water as percent by volume of Water Supplied	6.8%
Non-revenue water as percent by cost of operating system	5.0%
Apparent Losses per service connection per day	27.23 gallons/connection/day
Real Losses per service connection per day	6.44 gallons/connection/day
Unavoidable Annual Real Losses (UARL)	62.97 million gallons/year
Infrastructure Leakage Index (ILI)	0.53

7.5.2. Data Gaps

Tustin provided all necessary data to complete the water audit and analyze financial and operational performance for the audit period. Additionally, Tustin has completed its data validity scoring and demonstrates excellent record-keeping practices overall. Given Tustin's audit and data validity scoring results, the City is well on track to BMP 1.2 compliance and requires only minimal adjustments to its practices to meet all requirements of the BMP within the specified time frames.

In order to verify Tustin's real losses and perform component analysis, it would be beneficial for Tustin to provide detailed records on reported leakage and previous leak detection activities. Additionally, given Tustin's extremely low ILI, review of data from adjacent years would be beneficial to confirm the validity of the data.

Table 7-8 shows the activities required for Tustin to be in compliance with BMP 1.2 and the completion status of each.

Table 7-8: Status of Tustin BMP 1.2 Compliance

Requirement for Compliance	Year Completion Required	Status	Notes
Compile standard water audit and balance	Annual	Completed	
Test source, import, and production meters annually	Year 2	Completed	
Achieve a Water Audit Data Validity Score of 66 or higher using the AWWA	Year 4	Completed	Data Validity Score of 83 for CY 2007 audit
Achieve a Water Audit Data Validity Score of Level IV (71-90) or higher	Year 5	Completed	Data Validity Score of 83 for CY 2007 audit
Seek training in the AWWA water audit method and component analysis process	Year 4	Completed	
Complete a component analysis of real losses	Year 4		
Demonstrate progress in water loss control performance as measured by gallons per service connection per day	Year 5 through Year 10		
Repair all reported leaks and break to the extent cost-effective	Ongoing	Ongoing	
Maintain a record-keeping system for the repair of reported leaks	Year 2		
Include estimated leakage volume from report to repair and cost of repair in leak records	Year 4		
Locate and repair unreported leaks to the extent cost effective	Ongoing		

8. Summary of Findings, Conclusions, and Recommendations

- There was a significant disparity between level of participation and information provided among the participants, which limited the extent to which the Consultant could compare and extrapolate finding of the study for the whole group of five utility Participants. Table 8-1 presents available data provided by individual participating utilities for the audit reporting year indicated. Data for the two utilities for which a data validity score could not be determined should not be considered comparable to the three utilities providing data validity scores. The three Participants providing data validity indicate results above 80. These scores are in Level IV, as indicated in Table 8-2. Level IV achieves the required data validation level to achieve future CUWCC BMP 1.2 goals. Table 8-2 provides guidance from the AWWA Free Water Audit Software to improve water loss standing. The higher data validity score achieved results in a higher water loss standing.

- Those Participants who provided sufficient data for a full audit and analysis demonstrated excellent water loss control practices. These Participants should meet the requirements of the CUWCC BMP 1.2 with only minimal adjustments to their existing practices.

- Although the portion of each system on which leak surveys were performed was not a significant enough percentage to extrapolate the results to the entire distribution systems, the results from these surveys were promising. Participants typically selected portions of their system for the leak surveys with older pipes or suspected issues, yet leaks were detected in only 2 of the 5 systems.

- For water audits providing a data validity score, calculated Infrastructure Leakage Index (ILI) values were excellent. Table 8-3 provides guidance from the AWWA Free Audit Software for establishing a target ILI value for an individual utility based on its specific financial, operational, and water resources considerations. For calculated ILIs in this investigation, the participating utilities appear to have minimal real loss control issues. It is recommended that economics of real water losses be monitored to compare the value of water lost due to leakage to the cost of implementing an effective real loss reduction program.

- Individual audits for different selected audit years are provided for the five retail agency participants, however, not all are complete. Based on an assessment of audit information, data validation scores, and audit results, recommended water loss

accounting follow-up activities have been provided for each participant. All participating agencies have room to improve their real water loss and apparent water loss data collection, monitoring, and control practices.

- Non-Revenue Water ranged from 3 to 10 percent of volume of water supplied, which is very good and well within the range of efficient water utilities concerned about conservation and water loss management practices.

- Due to the increasingly stringent requirements for BMP 1.2 compliance in the future, participants will need to become proficient at component analysis for bottom up data collection and analysis to achieve better understanding of individual audit elements.

The collaborative workshop approach with multiple concurrent participation and collaboration between consultant, wholesale water agency (MWDOC), and the participating retail agencies was excellent for group presentation, dialogue confirmation of understanding of audit elements in preparation for achieving water conservation requirements of the state. This project successfully prepared agency participants for California's water loss management element of its conservation program.

Table 8-1: Comparative Audit Summary

Utility (Reporting Year)	Data Validity	Real Losses (Acre-Feet)	Apparent Losses (Acre-Feet)	UARL (MG per year)	ILI
Brea (FY 2007)	93	670.123	89.492	60.69	3.60
Huntington Beach (FY 2009)	88	1144.000	511.000	308.03	1.21
Laguna Beach County Water District (FY 2007)	NA	91.836	11.424	56.23	0.53
Moulton Niguel Water District (FY 2007)	NA	1743.175	91.025	NA	NA
Tustin (CY 2007)	83	101.866	430.814	62.97	0.53

NA = Non-Available

Table 8-2: AWWA Water Loss Control Planning Guide

AWWA WLCC Free Water Audit Software: Determining Water Loss Standing

WAS v4.0

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Water Loss Control Planning Guide

	Water Audit Data Validity Level / Score				
Functional Focus Area	**Level I** (0-25)	**Level II** (26-50)	**Level III** (51-70)	**Level IV** (71-90)	**Level V** (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	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 Automatic Meter Reading (AMR) 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 the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator 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.

Table 8-3: AWWA Guidelines for Setting a Target ILI

General Guidelines for Setting a Target ILI (without doing a full economic analysis of leakage control options)			
Target ILI Range	**Financial Considerations**	**Operational Considerations**	**Water Resources Considerations**
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		