Appendix B

PowerPoint Presentations
Agenda

- Introductions
- Participating Agency Contact Information
- Review Project Scope and Budget
- Review Project Schedule
- AWWA M36 Revision 3 Draft
- Water Balance Spreadsheet Software
- Consultant Data Request: Available Information/Schedule for Delivery
- References
- Open Discussion
- Next Meeting Date
Contact Information

- Richard Bell, MWDOC, Principal Engineer/Project Manager
  - (714) 593-5003
  - rbell@mwdoc.com

- Steve Davis, Malcolm Pirnie, Inc., Project Manager
  - (949) 450-7948
  - sdavis@pirnie.com

- Andree Hunt, Malcolm Pirnie, Inc., Project Scientist
  - (949) 450-7939
  - ahunt@pirnie.com
Participating Agency Contact Information
Project Background

What are the benefits of conducting a water audit?
Growing Pressure to Manage Water More Efficiently

U.S. Drought Monitor

July 25, 2006
Valid 8 a.m. EDT

Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, July 27, 2006
Author: C. Tankersley/L. Love-Brotak, NOAA/NESDIS/NCDC
“A better system of accounting is needed to instill better accountability in drinking water utilities”
No consistent definitions for the various components of use or loss have been employed

Worldwide, no standard definition has been found to exist for the term “unaccounted-for” water

Percentage indicators have been found to be suspect in measuring technical performance

Percentage indicators translate nothing about water volumes and costs

Many water utilities have no active functions to assess or control losses
Better Understanding Real Losses

- Most leakage losses by volume over the course of the year occur on customer service connection piping – not water mains

- Policies that place the burden on customers to repair leaks on their service connections are often inefficient

- New policies/programs to address service line leakage are needed to economically reduce this leakage
Water Loss Control Improvements: Controlling Apparent Losses

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

0. Administration and Management
1. Collect and Review Data
2. Kick-off Meeting with MWDOC
3. Kick-off Meeting with Participating Systems
4. Complete Data Analysis and Formatting for IWA/AWWA Water Audit Software
Project Scope

5. Conduct Leakage Management Program and Systems Operation Review
6. Perform Field Measurement Activities
7. Prepare Retail System Water Audit Reports
8. Recommend Follow-Up Activities for Improved Water Loss Management
9. Complete Project Report
## Project Schedule - 2008

<table>
<thead>
<tr>
<th>Task</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration and Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect and Review Relevant Audit Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Data Analysis and Formatting for IWA/AWWA Water Audit Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct &quot;Unbilled Authorized Water Consumption&quot; Review and Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Leakage Management Program and Systems Operation Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform Relevant Field Measurement Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Project Schedule - 2009

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Administration and Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Conduct Leakage Management Program and Systems Operation Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Perform Relevant Field Measurement Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Prepare Retail Water System Audit Reports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Provide Recommendations for Follow-Up Activities for Improved Water Loss Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Complete Project Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AWWA M36 Revision 3 Draft

- Draft dated October 2007

- Explains the IWA/AWWA water audit methodology

- Provided an overview of the best loss control techniques
Contents Include:

- Conducting the Water Audit
- Identifying & Controlling Apparent Losses
- Understanding & Controlling Real Losses
- Planning & Sustaining the Water Loss Control Program
- Considerations for Small Systems
Standard Water Balance Format
Water Balance Spreadsheet Software

- Launched April 2006
- Available for FREE download at: http://www.awwa.org/WaterWiser/waterloss/Docs/WaterAuditSoftware.cfm
- Simple, user friendly: good for top-down audit
- “Beta tested” by 21 water utilities during 2005
- AWWA Water Loss Control Committee provides user support for the software and plans future upgrades
Consultant Data Request

- Date needed to populate the Water Balance Spreadsheet Software and to make recommendations for water loss management activities.

- Date needed by: June 4th

- Please send to Richard Bell (rbell@mwdoc.com) or Steve Davis (sdavis@pirnie.com).
Consultant Data Request

- Is the utility a party to the CUWCC MOU?

- Does the utility conduct an annual audit? If so, what method or format?

- Does the utility have a meter testing/repair shop? If not, is this contracted?
Consultant Data Request

- Water Supply Sources
  - Water supply sources, locations, and meter designations
  - Capacity and type/size/age/manufacturer of supply meter
  - Calibration frequency and by whom
  - Calibration reports
Consultant Data Request

- Water Supply Costs
  - Production cost per unit ($/mil gal) for water produced by the system.
  - Cost to purchase each unit ($/mil gal) of MWDOC water.
Consultant Data Request

- Water Supply/Production Data
  - Monthly metered supply data by each source for the past 3 fiscal years
  - Table showing values in cubic feet per second (cfs)
  - Table showing values in acre-feet
  - Table showing values in million gallons
  - Monthly metered supply data by each source for July thru December 2007
Consultant Data Request

- **Water Billing Data**
  - Volume of billed consumption for past 3 fiscal years
    - Monthly by customer class
    - Monthly by meter size
  - Volume of billed consumption for July thru December 2007

- **Unbilled Authorized Water Consumption**
  - Fire fighting, fire training, fire hydrant flow tests, main flushing, hydrant flushing, street cleaning, public irrigation, public buildings, etc.
Water Loss Management Program Assessment

Potable Water System Audits

December 17, 2008
Agenda

• Introductions/Project Status

• Authorized Unmetered Consumption
  a. Types
  b. Utility procedures, methods, and sources of data
  c. Discuss options that can improve estimates

• Water Meters
  I. Meter inventories
  II. Accuracy test data and methods
  III. Demand characterization
  IV. Meter replacement criteria
    – Age
    – Cumulative Volume

• Next Meeting Date
Contact Information

• Richard Bell, MWDOC, Principal Engineer/Project Manager
  – (714) 593-5003
  – rbell@mwdoc.com

• Steve Davis, Malcolm Pirnie, Inc., Project Manager
  – (949) 450-7948
  – sdavis@pirnie.com

• Andree Hunt, Malcolm Pirnie, Inc., Project Scientist
  – (949) 450-7939
  – ahunt@pirnie.com
## Overview of Future Consultant/Agency/MWDOC Responsibilities

<table>
<thead>
<tr>
<th>Task</th>
<th>Malcolm Pirnie</th>
<th>Agencies</th>
<th>MWDOC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 1-3: Complete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Task 4: Conduct Leakage Management Program and Systems Operation Review | • Review leak history and management information gathered from each system.  
• Perform component analysis to model leakage volumes.  
• Recommend improvements to each leak management program. | • Provide requested information regarding leakage detection and management. | |
| Task 5: Perform Relevant Field Measurement and Activities | • Recommend field measurement activities.  
• Perform statistical analyses on data collected.  
• Contract with field services firm to perform field measurement activities. | • Recommend locations for field measurements. | • Obtain testing equipment.  
• Approve subcontractor to perform field measurement activities. |
<table>
<thead>
<tr>
<th>Task</th>
<th>Malcolm Pirnie</th>
<th>Agencies</th>
<th>MWDOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 6: Prepare Retail System Water Audit Reports</td>
<td>• Document water audit results and findings for each utility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 7: Provide Recommendations for Follow-Up Activities for Improved Water Loss Management</td>
<td>• Recommend activities to reduce apparent and real water losses and to assess the economic feasibility of water loss reduction activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 8: Complete Project Report</td>
<td>• Prepare a draft report documenting data collected, audit results, leakage management program assessments, and field data collection results and analysis.</td>
<td>• Provide comments on draft report</td>
<td>• Provide comments on draft report</td>
</tr>
</tbody>
</table>
# Water Audit Results

## System Data

<table>
<thead>
<tr>
<th></th>
<th>Moulton</th>
<th>Laguna</th>
<th>Tustin</th>
<th>Brea</th>
<th>Huntington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of mains:</td>
<td>740</td>
<td>134</td>
<td>172</td>
<td>162</td>
<td>590</td>
</tr>
<tr>
<td>Number of active AND inactive service connections:</td>
<td>53,533</td>
<td>7979</td>
<td>14,124</td>
<td>11745</td>
<td>52,300</td>
</tr>
<tr>
<td>Connection density:</td>
<td>72</td>
<td>60</td>
<td>82</td>
<td>72.5</td>
<td>89</td>
</tr>
<tr>
<td>Average length of customer service line:</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Average operating pressure:</td>
<td>?</td>
<td>?</td>
<td>50.0</td>
<td>?</td>
<td>63.00</td>
</tr>
</tbody>
</table>

## Cost Data

<table>
<thead>
<tr>
<th></th>
<th>Moulton</th>
<th>Laguna</th>
<th>Tustin</th>
<th>Brea</th>
<th>Huntington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total annual cost of operating water system:</td>
<td>?</td>
<td>8,824,547</td>
<td>11,649,391</td>
<td>11,118,011</td>
<td>29,000,000</td>
</tr>
<tr>
<td>Customer retail unit cost (applied to Apparent Losses):</td>
<td>?</td>
<td>?</td>
<td>1.99</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Variable production cost (applied to Real Losses):</td>
<td>?</td>
<td>?</td>
<td>379.64</td>
<td>?</td>
<td>358.00</td>
</tr>
</tbody>
</table>
C. Unbilled Unmetered Authorized Consumption

The most common occurrences include:

• Firefighting, hydrant testing, and training
• Flushing water mains, storm inlets, and sewers
• Street cleaning
• Landscaping/irrigation
• Decorative water facilities
• Construction sites
• Water consumption at public buildings not included in the customer billing system.
Quantifying Unmetered Water Usage

Methodologies

I. Portable Meters

II. Estimation Methods
  – General estimation techniques
  – Practical assessments
I. Portable Meters

If no meters exist at a water source, a portable meter can be used to estimate flow.

- Portable meters can be brought to the site and installed on source piping just downstream of the water source.

- A minimum of 24 hours of continuous metering is recommended.
I. Portable Meters

One such meter is a portable, non-invasive, ultrasonic water meter:

• Clamps onto outside of the pipe

• Uses ultrasound to measure water flow in the pipe

• Requires a pipe diameter of at least 1.5 inches

• Does not perform well on some PVC piping
II. Estimation Methods

If a portable meter is not feasible, estimation and practical assessments should be made.

• Use a default value of 1.25% of water supplied for the entire authorized unmetered category.

• The California Department of Water Resources used 1-2% of the average total metered use for the previous 5 years to estimate their unmetered water usage for fire and line flushing.
II. Estimation Methods

If consumption is significantly greater than the default value, obtain detailed estimates through:

i. Batch Procedure

ii. Discharge Procedure

iii. Comparison Procedure
i) Batch Procedure

Used when water is transported by tank truck or container.

• Multiply the volume of the tank/container by the number of times it is filled from the distribution system.

• Careful record keeping is necessary for accurate estimates:
  – What is the number of trucks in operation?
  – What is the volume of water a truck transports?
  – The street cleaning and sewer flushing departments should be able to provide the necessary data.
ii) Discharge Procedure

When water is applied directly from a pipe, sprinkler system, fire hydrant, etc.

- Multiply the rate of water discharge by the total time it flows.
- Example: fire flows = # of events x flow rate x duration.
- Multiply the flow rate of a garden hose in gallons per minute times the number of minutes of use.
- When water pump performance characteristics are known, a volume estimate can be derived by multiplying the number of hours that the pump was operated during the year by the average pumping rate.
iii) Comparison Procedure

For some facilities and areas, such as schools, swimming pools, and construction sites, consumption figures may be adapted from similar facilities elsewhere.

• By comparing facilities, an estimate can be developed.

• Better estimates result if the facility has similar:
  – Size
  – Hours of operation
  – Type of use
  – Landscaping
  – Most other details
Authorized Unmetered Consumption Recommendations

According to the AWWA WLCC water audit guidelines, authorized unmetered consumption in most water utilities is a small component, which is very often substantially overestimated.

- This component has many sub-components of water use which are often tedious to identify and quantify.
- Because of this and the fact that it is usually a small portion of the water supplied, it is recommended that the auditor apply the default value of 1.25% of the volume from own sources.
- If the water utility already has well-validated data that gives a value substantially higher/lower than the default volume, this value can be entered.
Customer Water Meters

I. Meter inventories
   I. Size
   II. Manufacturer
   III. Age (years in service)
   IV. Cumulative volume by meter

II. Accuracy test data and methods
   I. Existing meter accuracy testing procedures and results

III. Replacement Criteria
   I. Age, cumulative volume, or accuracy level at which a meter is replaced
   II. Cost for meter replacement
DEMAND CHARACTERIZATION
Meter-Master 100EL
METER-MASTER CHARACTERISTICS

FEATURES
- Quick/Easy Setup
- Portable
- Rugged
- High Resolution
- Securable
- Submersible
- Accuracy Verification
- RF Communications
- Standard Pulse Input
- Dual Memory Options
- Universal Compatibility

APPLICATIONS
- Customer Service
- Billing Disputes
- Meter Sizing
- Meter Maintenance
- Conservation
- Hydraulic Modeling
- Demand Monitoring
- Cost of Service Studies
- Water Audits
Flow Report

Location Information
ID: 11075
Name: Watertown MUA
Address: Cooper Road
City: Evanston
State/Prov: Pennsylvania
Postal Code: 19002
Phone: 388-388-3569
Notes: Meter Size Check

Meter Information
Make: Sensus
Model: Turbo
Size: W-2000
Unit: Gallons

Flow Range  | Percentage | Volume
-------------|------------|--------
0 - 7.5      | 16.46      | 8,480.84
7.5 - 15     | 37.79      | 19,467.85
15 - 30      | 44.91      | 23,134.25
30 - 920     | 0.83       | 429.63
920+         | 0.00       | 0.00

% and Volume In each Flow Range
Figure 4.1: 5/8-Inch Meters Cumulative Flow vs. Accuracy

- High Flow
- Medium Flow
- Low Flow
- Ultra Low Flow

The graph shows the cumulative flow in gallons on the x-axis and the percent (%) accuracy on the y-axis. The data points are color-coded to represent different flow rates and are connected by lines indicating the trend for each flow rate category. The equation $y = -0.0001x + 100$ is also shown, where $x$ is the gallons and $y$ is the percent accuracy.
Figure 4.2: 3/4-Inch Meters Cumulative Flow vs. Accuracy

- High Flow
- Medium Flow
- Low Flow
- Ultra Low Flow

- New Accuracy Warranty
- Repaired Accuracy Warranty

Gallons vs. Percent (%)
Figure 4.3: 1-Inch Meters Cumulative Flow vs. Accuracy

- High Flow
- Medium Flow
- Low Flow
- Ultra Low Flow

Percent (%)

Gallons

New Accuracy Warranty
Repaired Accuracy Warranty
Figure 4.4: 1 1/2-Inch Meters Cumulative Flow vs. Accuracy

Graph showing cumulative flow in gallons and percent accuracy for different tests: Hi test, Med test, Low test, Extra low test.
Next Meeting Date

January 2009?
Questions/Discussion
MWDOC Water Loss Control: CUWCC BMP 1.2 Workshop

Stephen E. Davis, P.E., BCEE
Vice President
Malcolm Pirnie, Inc
Irvine, CA

October 13, 2009
Meeting Contents

- Project Tasks
  - Consultant To-Do List
  - Agency To-Do List

- Changes to Water Audit Methodology
  - AWWA Water Audit Software Version 4.0
  - Data Validation Scoring

- BMP 1.2 Water Loss Control- Status and Overview

- Field Work Recommendations
Contact Information

• Richard Bell, MWDOC, Principal Engineer/Project Manager
  – (714) 593-5003
  – rbell@mwdoc.com

• Steve Davis, Malcolm Pirnie, Inc., Project Manager
  – (949) 450-7948
  – sdavis@pirnie.com

• Andree Hunt, Malcolm Pirnie, Inc., Project Scientist
  – (949) 450-7939
  – ahunt@pirnie.com
## Overview of Future Consultant/Agency/MWDOC Responsibilities

<table>
<thead>
<tr>
<th>Task</th>
<th>Malcolm Pirnie</th>
<th>Agencies</th>
<th>MWDOC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 1–3: Complete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Task 4:** Conduct Leakage Management Program and Systems Operation Review | • Review leak history and management information gathered from each system.  
• Perform component analysis to model leakage volumes.  
• Recommend improvements to each leak management program. | • Provide requested information regarding leakage detection and management. | |
| **Task 5:** Perform Relevant Field Measurement and Activities | • Recommend field measurement activities.  
• Perform statistical analyses on data collected.  
• Contract with field services firm to perform field measurement activities. | • Recommend locations for field measurements. | • Obtain testing equipment.  
• Approve subcontractor to perform field measurement activities. |
<table>
<thead>
<tr>
<th>Task</th>
<th>Malcolm Pirnie</th>
<th>Agencies</th>
<th>MWDOC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 6: Prepare Retail System Water Audit Reports</strong></td>
<td>• Document water audit results and findings for each utility.</td>
<td>• Reformat in new AWWA software with data validation</td>
<td></td>
</tr>
<tr>
<td><strong>Task 7: Provide Recommendations for Follow-Up Activities for Improved Water Loss Management</strong></td>
<td>• Recommend activities to reduce apparent and real water losses and to assess the economic feasibility of water loss reduction activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 8: Complete Project Report</strong></td>
<td>• Prepare a draft report documenting data collected, audit results, leakage management program assessments, and field data collection results and analysis.</td>
<td>• Provide comments on draft report</td>
<td>• Provide comments on draft report</td>
</tr>
</tbody>
</table>
Agency To Do List

- Complete/review spreadsheet audit
- Complete Water Audit Data Validity Score
- Confirm field work needs
  - Report/document existing activities
Validation of Data

- Top-down audit is considered preliminary
- Grading system assists in data validation
- Validation questions or confirms preliminary water audit data
- Assessment of results determines areas of focus

Successful water loss management requires valid data!
Spreadsheet-Based Water Loss Audit Tool

• The Old ----

• The New!
AWWA Free Water Audit Software

- April 2006 First commercial version of software 2.0
- August 2007 Second version of software 3.0
- April 2009, M36 Third Edition published
- May 2009, Software Version 4.0 published
Water Audit Data Validity Score

- Provides a label for the “quality” of the data
- Data grading capability is a significant enhancement from previous versions
Grades assigned to each data component to describe auditor confidence and accuracy of input data with explicit defined criteria

Audit accuracy improved most by improving the confidence in the following audit inputs:

- Volume from own sources (metering)
- Water imported (metering)
- Billed metered consumption (metering)
Customer Service Line Diagram: Meter at Curb Stop

Figure 1

Typical house connection: Meter at curb stop
Not to scale
Customer Service Line Diagram: Meter Inside Property

Connection to Water Main

Curb stop

Property boundary

Connection

Lp

(underground pipe from curb stop to meter)

Typical house connection: Meter inside property
Not to scale

Figure 2
Water Supplied Data Confidence

For optimum confidence and accuracy:

- Meter 100% of production and imported sources
- Conduct semi-annual accuracy testing and calibration
- Less than 10% of source meters outside of +/-3% accuracy
Consumption Data Confidence

For optimum confidence and accuracy:

- Maintain 95% meter reading success rate, or launch AMR trials
- Implement large scale customer meter testing and replacement program
- Use computerized billing with routine auditing
- Conduct annual third party audit verification
Customer Metering Inaccuracies

- No longer a default value in Version 4.0- Need to determine based on meter data
- Consider cumulative volume, meter size, and meter type
- Longevity specific to utility water quality
Water Audit Data Validity Level/Score

- Level I (0-25)
- Level II (26-50)
- Level III (51-70)
- Level IV (71-90)
- Level V (91-100)
What Do We Do With The Audit Data?

- Don’t predetermine a solution to an undefined problem.
- The audit defines the problem.
- Focus on high value losses and supply losses as determined by the audit.
- Separate apparent loss problems from real loss problems.
CUWCC BMP 1.2 Water Loss Control

- Revision to the CUWCC’s water audits BMP, formerly known as BMP 3 System Water Audits, Leak Detection and Repair

- Presented at the June 11 CUWCC Plenary Meeting

- Revised by the Steering Committee on August 13th to address MOU signatory comments

- Voting ended September 15th – Mods Passed
A. Implementation Sequence

1. Standard Water Audit & Water Balance
2. Validation
3. Economic Values
4. Component Analysis
5. Interventions
6. Customer Leaks
B. Implementation Schedule

1. For Agencies signing the MOU after Dec. 31, 2008, implementation shall commence no later than July 1 of the year following the year the agency signed the MOU
   a. Agencies shall provide a full BMP 1.2 report for the first reporting period after implementation and for each reporting year thereafter.

2. A benchmark for the performance indicator in terms of water loss standard will be determined after the first 4 years data collected based upon the data reported by agencies. The performance indicator and benchmark will be voted upon by the Council by year 6 of this revision. Ongoing data collection and data reporting requirements will be decided upon as part of this process.
C. Coverage Requirements

1. Agencies to compile the standard water audit and balance annually using the AWWA Software. Beginning in the 2nd year of implementation, agencies to test source, import, and production meters annually.
2. Agencies shall improve the data accuracy and data completeness of the standard water balance during the first four years of implementation. Agencies shall achieve a Water Audit Data Validity score of 66 or higher using the AWWA software no later than the end of the first four-year period and shall achieve a Data Validity Level IV no later than the end of the end of the 5th year of implementation. Estimations for data that are not directly measured should be improved using the methods outlined by the AWWA.
3. Agencies shall seek training in the AWWA water audit method and component analysis process (offered by CUWCC or AWWA) during the first four years of BMP implementation. They shall complete a component analysis of real losses by the end of the fourth year and update this analysis no less frequently than every four years.
C. Coverage Requirements (Cont.)

4. Beginning in the fifth year of implementation, through the tenth year of implementation, agencies shall demonstrate progress in water loss control performance as measured by the AWWA software real loss performance indicator “gallons per service connection per day” (or “gallons per mile of mains per day” if system density is less than 32 service connections per mile) by one of the following:

   a. Achieving a performance indicator score less than the agency’s score the previous year (gallons per day per connection);
   b. Achieving a performance indicator score less than the average of the agency’s scores for the previous three years; or
   c. In year 6 and beyond, reducing real losses to or below the benchmark value determined in the Council’s process referenced in section B2.
5. Agencies shall repair all reported leaks and breaks to the extent cost effective. By the end of the second year, agencies shall establish and maintain a record-keeping system for the repair of reported leaks, including time of report, leak location, type of leaking pipe segment or fitting, and leak running time from report to repair. By the end of the fourth year, agencies shall include estimated leakage volume from report to repair and cost of repair (including pavement restoration costs and paid-out damage claims, if any).

6. Agencies shall locate and repair unreported leaks to the extent cost effective.
1. Agency shall submit the completed AWWA Standard Water Audit and Water Balance worksheets in the BMP 1.2 report form every reporting period.

2. For each reporting period, agency shall keep and make available validation for any data reported.

3. Agency shall maintain in-house records of audit results and methodologies and shall incorporate results into future annual standard water balances.

4. Agency:
   a. keeps records of intervention(s) performed, including standardized reports on leak repairs, the economic value assigned to apparent losses and to real losses, miles of system surveyed for leaks, pressure reduction undertaken for loss reduction, volumes of water saved, and costs of intervention(s); and
   b. prepares a yearly summary of this information for submission to the Council.
<table>
<thead>
<tr>
<th>Year</th>
<th>Coverage Requirements</th>
</tr>
</thead>
</table>
| 1+   | • Provide Full BMP 1.2 Report  
      • Complete audit using AWWA software  
      • Repair all cost-effective 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 AWWA Level IV  
      • Demonstrate progress in water loss control performance as measured by “gallons per service connection per day” |
Field Work- Recommendations

- **BMP 1.2 is focused on real losses (real water conservation by the utility)**

- **Field work should focus on meeting BMP 1.2 coverage requirements.**
  - Leak detection
  - Component analysis
  - Improving data validity score
Proposed Service Contractor:

- Large water meter testing, evaluation, and maintenance
- **Water Distribution System Leak Surveys and Pin-Pointing**
- Valve Locating, Exercising and Computerized Mapping
- Fire Hydrant Testing
- Water Main Flushing
- Water Main Locating
- 24-hour Flow Testing, C-Factor Testing, Pump Curves and Head Loss
M36 Goals of Water Audits:

1. Improve water resources management
2. Optimize revenue recovery
3. Minimize operational disruptions
4. Increase water system integrity
AWWA M36 Background

- First edition in 1991
- Second edition in 1999
  - Minor updates
- Third edition in 2009
  - Advances in audit methodology
  - Incorporates IWA method
  - Incorporates AWWA software
Non-Revenue Water

Unaccounted-for-Water = Non-Revenue Water (NRW) =

Real Losses

Unbilled Authorized Consumption

Apparent Losses

Source

Inaccuracy

Transmission Main

Customer Meter

Residence

Distribution Network

WTP

Source Meter

Reservoir

Theft
Conducting a Water Audit

1. Top-Down Approach
2. Component Analysis
3. Bottom-up Approach
Top Down Audit

- Basic “desk top” exercise
- Use of current data
- Very little field work
- Preliminary/rough draft
- Water Balance
- Typically annual
How Can the Top-Down Audit Help the Utility?

- Shows deficient areas within the utility
- Shows the need to implement the use of benchmarks or performance indicators
- Asks the question “Where in the system are we losing water?”
- Asks “How can we prevent the losses?”
- Determines value of lost water
- Can increase utility financial standing
Water Loss = Non Revenue Water

- **Real losses**
  - Reported leaks
  - Unreported leaks

- **Apparent losses**
  - Customer meter under-registering
  - Unauthorized consumption (theft)
  - Billing adjustments and waivers
IWA/AWWA Water Balance

- **Own Sources**
  - Total System Input
  - Water Exported (allow for known errors)

- **Water Supplied**
  - Authorized Consumption
  - Water Losses
  - Apparent Losses
  - Real Losses

- **Billed Authorized Consumption**
  - Unbilled Authorized Consumption

- **Revenue Water**
  - Billed Water Exported
  - Billed Metered Consumption
  - Billed Unmetered Consumption

- **Non-Revenue Water**
  - Unbilled Metered Consumption
  - Unbilled Unmetered Consumption
  - Unauthorized Consumption
  - Customer Metering Inaccuracies
  - Systematic Data Handling Error
  - Leakage on Mains
  - Leakage on Service Lines
  - Leakage & Overflows at Storage
Apparent Losses

- Unauthorized Consumption
  - Fire hydrant theft
  - Unauthorized connections
- Meter Inaccuracies
  - Under registering
  - Improper installation
- Accounting discrepancies
  - Non-billed accounts
  - Billing software inaccuracies
  - Waivers
Apparent Losses

- Typically are the most costly losses, since they are valued at the retail water rate.
- Reducing apparent losses increases revenue but does not create new water.
- Reducing apparent losses may generate sufficient new revenue to fund other necessary forms of loss control.
Real Losses

- Physical losses from leaks, breaks, and overflows, up to the point of customer metering
- Calculated in top-down audit as:
  Water Losses – Apparent Losses = Real Losses
- Verified by component analysis and field measurements
- Reducing real losses creates a new resource (e.g. water conservation)
Definition of Real Losses

- The physical escape of water from the system, including:
  - Pipe breaks and leaks
  - Leakage from pipe joints and fittings
  - Reservoir and tank leakage
  - Reservoir and tank over flows

- Real losses occur prior to the point of end delivery
Visual Main Leaks - Reported
Hidden Main Leaks - Non Reported
Hidden Meter Set Leaks - Non Reported
Reasons for Distribution System Leakage

1. Poor installation and workmanship
2. Poor materials (pipeline, bedding, and backfill)
3. Mishandling of materials prior to installation
4. Incorrect backfill
5. Pressure transients
6. Pressure fluctuations
7. Excessive pressure
8. Corrosion (internal and external)
9. Vibration and traffic loading
10. Environmental conditions (hot and cold)
11. Lack of proper scheduled maintenance
12. Lack of leakage monitoring
13. Disturbance by other utilities (sewer rehabilitation)
System Storage Leaks
Reservoir and Tank Leakage
Leaks Occur at System Weak Spots
Fixing leaks has its own challenges.
Validates top down results with field measurements, including:
- Leakage losses from integrated zonal or District Metered Area (DMA) nightflows
- Physical inspection of customer sites and meters
- Process flowcharting of billing systems
Component Analysis Model - There are Existing Tools for the Job

- **Background leakage**: Un-reported and un-detectable using traditional acoustic equipment.
- **Un-reported leakage**: Often does not surface but is detectable using traditional acoustic equipment.
- **Reported leakage**: Often surfaces and is reported by the public or utility workers.

**Tools**
- Pressure stabilization
- Pressure reduction
- Main and service replacement
- Reduction in the number of joints and fittings
- Proactive leak detection
- Pressure stabilization
- Pressure reduction
- Main and service replacement
- Reduction in the number of joints and fittings
- Optimized repair time
Real Loss Management Tool Box

- Pressure Management
- Improved Leak Repair Time
- Economic Level Real Loss
- Proactive Leak Detection
- Current Annual Real Loss Volume
- Unavoidable Real Loss
- Infrastructure Management
Operational Performance Indicators

Level 1 Operational PI =
Real Distribution Losses in Gallons Per Service Line Per Day Per PSI of Operating Pressure

Level 3 Operational PI =
\[
\frac{\text{Annual Real Losses}}{\text{Unavoidable Annual Real Losses (UARL)}}
\]

= Infrastructure Leakage Index (ILI)
IWA Definition of Pressure Management:

- The practice of managing system pressures to the optimum levels of service - ensuring sufficient and efficient supply to legitimate uses while:
  - Reducing unwanted demands or theft
  - Eliminating transients and faulty level controls
  - Eliminating variations due to changing head loss
  - Reducing unnecessary or excess pressures
Pressure Management Tools

- Introduction of pressure-controlled areas (pressure zones)
- Fixed outlet pressure control
- Advanced flow-modulated pressure control
- Altitude and level control
- Transient control
Benefits of Pressure Management

- Reduction of Real Losses
- Reduction of new leaks/breaks = extended infrastructure life
- Possible water conservation tool
- Increased energy efficiency
- Ensures minimum standards are met
Real Loss Control - District Control & Pressure Management

Source: Canadian Infrastructure Guide
Pressure Reduction
Well Pump Control
Booster Pump Control
Bottom Up Measurements
Before Detection and Repair

Verifies the annual data and shows immediate results for pilot interventions.
Effect of Time on Leakage Losses - ALR Concept

Numerous small, hidden leaks account for the greatest overall volume of leakage losses.
Leakage Losses Affected by Run Time

- **Reported Main Break**
  - 22,000 gal

- **Reported Customer-Side Service Break**
  - 299,000 gal

Gallons/day

- 20,000 gallons/day for 1.1 days
- 6,500 gallons/day for 46 days
Leak Detection Process

**Localize**
- Noise logging
- Measure intensity and speed

**Locate**
- Noise correlation
- Two or three sensors
- Measure noise arrival time

**Confirm**
- Human acoustic field confirmation
Leak Pinpointing & Repair

Principle of correlation: \( L = \frac{1}{2} (D - (V \times T_d)) \)
Real Loss Control: Infrastructure Management
Start with the Fastest Payback Options

- Set upset limit for annual operating expenses
- When hit, look to longer term capital investment
- Sometimes it’s better to have surgery than take an aspirin
- Look at your component analysis and statistics
- Optimize value of water saved with expenses
- Make informed economic decisions
Target methods that minimize cost of leakage control and lost water

Background Leakage and Reported Bursts

Economic Leakage Level

Cost of Water Lost

Cost of Leakage Control

COST OF LEAKAGE CONTROL AND WATER LOST

LOSSES (Ml/d)
You still need to conduct fieldwork...
..and Maintain Water Loss Reduction Strategies
Questions?

Email: sdavis@pirnie.com

Irvine Office: 949-450-7948