Redesigning Water Loss Standards in California Using the New IWA Methodology

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Summary

This paper will discuss the issues involved in changing a 1991 best practice standard requiring that water utilities have less than 10% unaccounted for water to instead reflect the new IWA methodology and terminology, and will describe the process and pitfalls of adopting a more meaningful new requirement not based on the antiquated unaccounted for water percentages. The new standard will be based on several different metrics, not just an Infrastructure Leakage Index (ILI) value. It is hoped that California's work on this issue will generate some discussion in the international water loss community as to additional appropriate benchmarks for measuring utility performance in this area.

Introduction

It is no secret that system water auditing and water loss reduction in general are given short shrift by most utilities. This is the case even in California, where most other demand management programs are at the leading edge and generally change the world of water efficiency. No, the same issues that plague utilities all over the world in water loss management are active in California as well: political infeasibility of admitting system leakage; falsifying water accounting records; lack of recognition that recapturing non-revenue water with an upfront investment is a still great business case with fast payback; and inherent mistrust of anyone outside the utility examining their system.

Best Management Practice standards were developed in 1991 in California based on the unaccounted-for-water percentage of 10%. Although in force for nearly fifteen years, these standards have been weak and ineffective at achieving any real progress toward utility system leakage reduction, despite universal claims by the individual utilities that their systems are 10% or less.

The Existing Water Loss Standard

California developed the first consensus-driven statewide water efficiency program in 1991. Based on a Memorandum of Understanding (MOU) signed by water utilities and environmental groups, the negotiated program required that water efficiency "Best Management Practices" be implemented by the signing water utilities in order to avoid regulatory cutbacks of their water supply or lawsuits on excessive water waste from disgruntled environmental advocates. Born during the 1988-91 drought in California which devastated ecosystems and lowered levels of available water supplies, the MOU is a continually-updated negotiated agreement between the water utility and environmental community. It defines "water efficiency" and how it might best be done statewide. Originally ratified on December 11, 1991, the current MOU forged by this historic consensus process has been signed by 337 signatories as of June, 2005. These signatories represent about 80% of the urban water use in California.

The California Urban Water Conservation Council was created by a section of the ratified Memorandum. The Council was charged with the responsibility to monitor and evaluate the progress of water agencies and utilities in implementing the Best Management Practices, to provide technical assistance in the form of publications and reports on specific research topics, and to report the results of the collective actions to the State of California Water Resources Control Board, the regulatory body for water supply in California.

The current MOU contains fourteen Best Management Practices. Water utilities are required to implement any Best Management Practice (BMP) that is cost-effective for their system. If the cost of any BMP is below the expected incremental cost of adding new water supplies, then the measure is considered cost-effective and must be implemented. New supply costs vary widely across the state, depending upon the region, but because of the unavailability of new water supply options, particularly in the more arid regions, the costs for new water are such that all the Best Management Practices are cost-effective, even those requiring plumbing and appliance retrofits in customer homes.

One of the Best Management Practices concerns water loss. It was drafted in 1991 based on a 10% unaccounted-for water standard of allowable water loss, and it references the AWWA M36 Manual as the guidance for completing full system water audits. While a noble concept, the BMP ultimately has failed in its intended implementation. The language of the BMP created a process of annual “pre-screening system audits” to determine if a full-scale water audit was warranted; this created an opportunity for evasion. If a simple calculation of dividing the metered sales plus other verifiable uses by the total supply into the system yielded a calculation equal to or more than 0.9, then nothing further from the utility was required. Hence, water utilities quickly figured out that simple manipulation of data could yield the desired answer and thus avoid the expense of a full audit and other leakage activity, despite the potential paybacks of doing so. The text of the original BMP appears below (see next page).

Reporting of BMP 3 Data

The MOU requires water utilities to report their progress on implementing Best Management Practices to the Council every two years. The data are directly entered into a web-enabled database, and the results are rolled up into aggregate totals for reporting to the State Water Resources Control Board. In the 2003-2004 year, 188 utilities reported. The average number of retail customer connections was 28,000, with a median of 14,000 and a maximum number of 677,000. Thus, the systems are of varying sizes and show a high variability of loss among utilities. Unfortunately, the reporting process does not require any data validation or copies of detailed audit reports, even if those audits were conducted by the water utility.

The CURRENT BMP 3:

SYSTEM WATER AUDITS, LEAK DETECTION AND REPAIR

A. Implementation

Implementation shall consist of at least the following actions:

a) Annually complete a prescreening system audit to determine the need for a fullscale system audit. The prescreening system audit shall calculated as follows:
   i) Determine metered sales;
   i) Determine other system verifiable uses;
   ii) Determine total supply into the system;
   iii) Divide metered sales plus other verifiable uses by total supply into the system. If this quantity is less than 0.9, a fullscale system audit is indicated.

b) When indicated, agencies shall complete water audits of their distribution systems using methodology consistent with that described in AWWA's *Water Audit and Leak Detection Guidebook.*

c) Agencies shall advise customers whenever it appears possible that leaks exist on the customer's side of the meter; perform distribution system leak detection when warranted and cost-effective; and repair leaks when found.

B. Implementation Schedule

a) Agencies signing the MOU prior to December 31, 1997, implementation shall commence no later than July 1, 1998.

b) Agencies signing the MOU or becoming subject to the MOU after December 31, 1997, implementation shall commence no later than July 1 of the year following the year the agency signed or became subject to the MOU.

C. Coverage Requirements

a) Agency shall maintain an active distribution system auditing program.

b) Agency shall repair identified leaks whenever cost-effective.

D. Requirements for Documenting BMP Implementation

a) Prescreening audit results and supporting documentation;

b) Maintain in-house records of audit results or the completed AWWA Audit Worksheets for each completed audit period.

E. Criteria to Determine BMP Implementation Status

a) Agency has annually completed a pre-screening distribution system audit.

b) Agency has conducted a full system audit consistent with methods described by AWWA's *Manual of Water Supply Practices, Water Audits and Leak Detection* whenever indicated by a pre-screening audit.

F. Water Savings Assumptions

Unaccounted water losses assumed to be no more than 10% of total water into the water supplier's system.

The BMP reports that are filed with the Council are shared with the State Water Resources Control Board. This Board, in addition to setting the legal water rights of water utilities, also issues grants and loans. Compliance with BMPs in general are already a factor in awarding of these grants and loans. Thus, the poor reporting of the current BMP 3 is a disadvantage, as it does not tell the State Board which systems are "water tight" and well managed. The goal is therefore to change the process such that the following are eventually accomplished for BMP 3

- State grant funding should based on a performance indicator analysis
- Bond ratings should be based on a performance indicator analysis
- Water Rights should be renewed based on a performance indicator analysis

Steps Toward Changing BMP 3

Dissatisfaction with the lack of compliance with the current BMP 3 had already been expressed as California began to learn of international discussions concerning a new method of calculating system losses. IWA's new methodology for "performance indicators" seemed to be a good solution to getting California into the 21st century. A committee of the Council, the Utilities Operation Committee, began to look at BMP 3 compliance issues in 2004, and began studying the new IWA methodology to determine its appropriateness for California. This now familiar methodology for identifying all components of water loss appears below.

<table>
<tr><td rowspan="10">Water from Own Sources
(corrected for known errors)</td><td rowspan="11">System Input Volume</td><td rowspan="2">Water Exported</td><td rowspan="10">Authorized Consumption</td><td rowspan="3">Billed Authorized Consumption</td><td>Billed Water Exported</td><td rowspan="3">Revenue Water</td></tr>
<tr><td rowspan="9">Water Supplied</td><td>Billed Metered Consumption</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="6">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 Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Water Imported</td><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

In examining the IWA method, it became clear that the current antiquated BMP 3 needed to be revised to accomplish the following:

- Encompass all components of water loss;
- Establish the business case for water loss control;
- Compare performance in a standard manner using approved performance indicators;
- Set meaningful targets for reduction of water loss throughout California; and
- Incorporate data validation into the reporting process.

Since the MOU is a negotiated document, any changes or revisions to Best Management Practices need to approved in a consensus process and demonstrated to the membership that the changes have value. Thus, in order to officially change the BMP 3 standard, the following steps would be necessary:

1. Conduct case study water audits to assess the feasibility of the IWA methodology for California utilities and what further issues need to be examined.
2. Review the 52 existing detailed AWWA M36 audits which have reported to have been done by utilities over the last 24 months under the existing BMP 3 standard and map these audits to the new AWWA water balance format, with confidence limits calculated and baselines set.
3. Rewrite the current BMP 3 requirements for documentation.
4. Devise reporting parameters in addition to the Infrastructure Leakage Index (ILI) and Economic Leakage Index (ELI) that could help describe a utility's progress in water loss management.
5. Collect current data from California water utilities using the new reporting parameters.
6. Determine appropriate benchmarks of a combination of metrics to set a statewide compliance standard using volumes as opposed to percentages.
7. Draft new BMP language.
8. Submit the new language to the MOU signatories for adoption, hopefully in 2006.
9. Revise the MOU when adopted and begin implementation of the new protocol.

Progress Toward Revising BMP 3

At this point in time, Step 1 is fully underway. Two case studies have been conducted in California using the new methodology and a third will be underway soon. It is already clear that the performance-indicator-based approach will work satisfactorily. In the first case study, the Los Angeles Department of Water and Power has conducted a screening audit using the new methods. In the second case study, the El Dorado Irrigation District has undertaken a full comprehensive audit with ELL analysis and some pilot implementation. For the final case study, the San Francisco Public Utilities Commission (the wholesale supplier for the San Francisco region) will soon be undertaking a full comprehensive audit with ELL analysis along with some pilot implementation. All the case study results will be considered in the BMP 3 revision process.

Step 2 involves examining the existing detailed M36 audits that have been completed by the water utilities. This analysis should yield further understanding about the level of confidence in the current audit methods and how these results can be reinterpreted into the IWA methodology. Work on Step 2 will begin shortly.

Step 3 is underway. New reporting parameters have been discussed by the Council's Utility Operations Committee, and even before BMP 3 language will be adopted in 2006 or 2007 the new reporting criteria could be implemented. Parameters being discussed for inclusion in the BMP 3 report include parameters for volumes, infrastructure and hydraulics, and maintenance activities, and will include a check box for each to inquire of the utility if the reported value is calculated or estimated. The proposed new reporting parameters are as follows:

For Volumes:

- Water supplied to the system
- Water exported from the system
- Billed authorized metered consumption
- Billed authorized un-metered consumption
- Unbilled authorized metered consumption
- Unbilled authorized un-metered consumption

For Infrastructure and hydraulics:

- System input (source or master meter) volumes
- Miles of mains
- % of rigid pipe
- Number of service connections (accounts)
- % of service connections in rigid pipes
- Number and % of residential unmetered service connections
- Estimate of customer meter under registration
- Estimate of average distance from curb-stop to customer meter (or first point of consumption)
- Average pressure and range of pressures
- % of the system fed from gravity feed
- % of the system fed by pumping and re pumping

For Maintenance:

- What frequencies are used for testing, repair and replacement for different meter sizes or customer categories
- Proactive search for leaks using leak survey techniques or reactive repair of leaks only?

It is hoped that changes to the BMP reporting parameters can be web-enabled for reporting beginning with the July 1, 2006 reporting period. Clearly, training will need to be given to water utilities who will be surprised by the new detailed questions and likely unable to produce the values without assistance. This process should therefore provide a good training opportunity for introducing the performance indicators and the IWA water loss evaluation process.

Eventual Target Adoption for Revising BMP 3

The most complicated step will be Step 6: Determining the appropriate benchmarks of a combination of metrics to set a statewide compliance standard using volumes as opposed to percentages. It would be desirable to also have a target range of desirable Infrastructure Leakage Index (ILI) values for compliance, in addition to other volumetric indicators.

Interesting are the international developments in respect of using the ILI as intervention indicator and for target setting purposed.

While it was recognized that several performance indicators are required when assessing water losses from a supply system, various new recommendations were recently (Australia, February 2005) proposed involving the use of the ILI as a key indicator for excessive leakage in a system. The first set of values (Figure 5) was suggested in the "Managing and Reducing Losses from Water Distribution Systems, Manual 10 - Executive Summary", published by the Queensland Environment Protection Agency.

Proposed Minimum Leakage Activities Based on ILI Classification

		ILI<1.5	1.5<ILI<2.0	2.0<ILI<2.5	2.5<ILI<3.0	3.0<ILI<3.5	ILI>3.5
	Management Action	*Excellent*	*Good*	*Reasonable*	*Fair*	*Poor*	*Unacceptable*
DO	Economic Pressure Management	Yes	Yes	Yes	Yes	Yes	Yes
YOU	Repair Policy Statement	Yes	Yes	Yes	Yes	Yes	Yes
NEED	Single Detection Intervention			Yes	Yes	Yes	Yes
THIS	Regular leak Detection Intervention				Yes	Yes	Yes
ACTION?	Peer Review of Leak Management Activities				Yes	Yes	Yes
	Formulate and Implement Action Plan						Yes

Notes:

1. Determine your ILI classification (eg) "Reasonable" 2.0<ILI<2.5
2. Look down chart to identify the management actions required for "reasonable" (ie) Economic Pressure Management, Repair Policy Statement, Single Direction Intervention
3. Wherever the word "yes" appears you must, as a minimum, implement these management actions

Figure 13: Proposed ILI classification for Australia (Waldron and Lambert, 2005)

As can be seen from Figure 5, the ILI is being used as an indicator to highlight when specific remedial measures should be implemented. The higher the ILI value, the greater need for more comprehensive leakage reduction activities. An important issue that should be appreciated from Figure 5 is the relatively low ILI values used in the assessment. Due to the relatively low levels of leakage experienced in Australian water supply systems, the ILI bands used in the analysis are very narrow and the overall ILI values relatively low. In many other countries with greater levels of leakage, it is necessary to look into a more comprehensive and flexible process where a greater range of ILI values can be accommodated.

To address water supply systems in countries with high(er) levels of leakage and correspondingly high ILI values, a revised proposal was suggested by Liemberger (Liemberger, 2005) and has now been included in the new water loss reduction training modules of the World Bank Institute (WBI, the capacity building arm of World Bank Group). The proposed approach is shown in Figure 6 and was first presented to the IWA Water Loss Task Force in February 2005. The approach was well received and was considered appropriate for use in both developed as well as developing countries.

Technical Performance Category		ILI	Litres/connection/day (when the system is pressurised) at an average pressure of:				
			10 m	20 m	30 m	40 m	50 m
Developed Countries	A	1 - 2		< 50	< 75	< 100	< 125
	B	2 - 4		50-100	75-150	100-200	125-250
	C	4 - 8		100-200	150-300	200-400	250-500
	D	> 8		> 200	> 300	> 400	> 500
Developing Countries	A	1 – 4	< 50	< 100	< 150	< 200	< 250
	B	4 – 8	50-100	100-200	150-300	200-400	250-500
	C	8 - 16	100-200	200-400	300-600	400-800	500-1000
	D	> 16	> 200	> 400	> 600	> 800	> 1000

Figure 14: Proposed use of ILI as PI in developed and developing countries (Liemberger, 2005)

As can be seen from Figure 6, different ILI ranges have been provided for developing and developed countries which was not necessary in the earlier Australian proposal. The proposal by Liemberger also attempts to classify the leakage levels within the Water Utilities into four categories based on the ILI value as follows:

Category A: Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost effective improvement

Category B: Potential for marked improvements; consider pressure management; better active leakage control practices, and better network maintenance

Category C: Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts

Category D: Horrendously inefficient use of resources; leakage reduction programs imperative and high priority

It should also be noted, that unlike the Australian recommendations, Liemberger does not attempt to define the water loss reduction interventions required. It is assumed that the leakage management specialist will first identify the key problem areas after which the most appropriate interventions will be established to provide the greatest returns for the available budget.

This simple A, B, C, D rating may be a model for how we might set compliance categories in California. Rather than being solely based on the ILI metric, the California rating may be a combination of factors. Until all the steps are completed in our revision process, it is too soon to predict the outcome.

Training Issues for the New BMP 3

Luckily, the American Water Works Association is in the process of revising its M36 Manual for Water Loss Management to reflect the new IWA methods. Thus, the necessary training that the Council will need to undertake will be assisted by the tools being prepared for the M36 manual, which include at this time a guidance manual as well as a calculation spreadsheet tool. In adopting a new BMP 3 standard, the Council will need to make sure that the following tools will be available to the water utility community:

- Detailed reporting assistance from staff at the council and trained water loss management consultants. This assistance will be provided free of charge or on a nominal fee basis.
- A Web-based Model or spreadsheet for inputting the audit results. Hopefully the M36 manual spreadsheet will be suitable for this purpose.
- "Cost effectiveness" business case tools, which will enable the water utility to value its water supply correctly. The Council publication on overall BMP Costs and Savings will need to be revised, and a spreadsheet for correctly calculating the cost-effectiveness of water loss management strategies will need to be built.
- A detailed California Guidance Manual may need to be written over and above the M36 Manual if BMP 3 standards are different.
- Training Programs for water utilities will need to be conducted.
- Tiered recognition levels will need to be set, which will indicate basic compliance as well as "Gold" or "Platinum" level compliance. This incentive structure has been specifically requested by Council water utility members.

Conclusion

California is making progress toward adopting a statewide benchmark standard for water loss management that will use the latest most advanced methods for calculating optimal system management. In embracing the new International Water Association Performance Indicator Methods, the California Urban Water Conservation Council will promote a more thorough assessment of water loss among its signatory water utilities, which represent approximately 80% of the water deliveries in California. There is considerable research and negotiation in this process, but a logical progression of steps that are currently being undertaken should insure that the new set of standards will be adopted no later than 2006-2007.

References

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