GOOD MONEY AFTER BAD DATA: THE DEATH OF "UNACCOUNTED FOR WATER"

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Abstract. The AWWA National Water Loss Control Committee has deemed the use of "unaccounted for water" as a measurement of system efficiency as inaccurate. For years water system managers have considered their system in good shape if their "unaccounted for water" was 10% or less. Recent findings prove that this is not the case for most systems. There is no universal benchmark. One size does **not** fit all and now there is proof.

Cavanaugh & Associates, PA has performed 27 water audit and revenue recovery programs in the Carolinas over the past 2 years. Using this data set, we will demonstrate from our findings that an effective revenue recovery program must have data confidence, a culture of efficiency, and benchmarking & data trending as its foundation.

In many cases the data used in preparing water efficiency calculations is not defensible, mainly because systems depend on information that is readily available but inaccurate or information that is pure conjecture. We will show how to improve data confidence in order to quantify and justify water system needs. Armed with this information, water system managers can make financial decisions based on fact, not fiction, and more effectively implement a revenue recovery program instead of throwing good money after bad data.

INTRODUCTION

Water accountability is a growing industry. This is particularly relevant in the municipal arena wherein enterprise fund revenues are the only financial sustenance apart from taxes. Fueled by rising water treatment costs, recurring drought, depletion of available supplies, citizen backlash from increasing rates, the increasing demand for environmentally-sustainable practices, and the increasing overall strain on municipal budgets, water accountability has become a political priority like never before.

Standards and methods for water accountability have been established by the International Water Association (IWA) and the American Water Works Association (AWWA). This paper is not intended to serve as a regurgitation of published standards and methods for water auditing and water loss control. Rather, this paper aims to present the ongoing work in the field of water loss control and revenue recovery that has been undertaken by Cavanaugh & Associates, PA (Cavanaugh) from 2008 to 2010, working with water systems in the Carolinas to implement said published standards and methods with ultimate aims of reduced operational costs and recovery of enterprise fund revenues.

AWWA has disowned the term "unaccounted for water" (UFW), judging it to be an imprecise, inconsistent and unreliable measure of water system performance. In harmony with this, AWWA has provided a means to quantify data confidence, or a measure of how accurate the picture is. However, UFW is still being utilized in the accounting practices of many systems in the Carolinas, often with no consideration for data confidence. This paper will explore the impact that these outdated accounting practices have on making ill-informed decisions for cost-effectiveness of efficiency improvements for water purveyors, and how these systems are beginning to evolve their practices.

Specifically, the objectives of this paper are:

1. Present water audit data for 27 water systems in North and South Carolina.
2. Demonstrate the ingredients and importance of data confidence.
3. Demonstrate the ingredients and importance of a culture of efficiency.
4. Demonstrate the ingredients and importance of benchmarking & data trending.
5. Discuss the essential role of data confidence, culture of efficiency, and benchmarking & data trending in a revenue recovery program.
6. Promote stewardship of water and financial resources.

METHODOLOGY

For 27 water systems in North and South Carolina, beginning in early 2008, a water audit was performed and revenue recovery program implemented by Cavanaugh. These systems included non-profit water associations to water districts to municipally-owned / privately-operated systems to municipally-owned and operated systems. System sizes range from 170 connections to 95,000 connections, and annual system input volumes from 71 million gallons (MG) to 16,600 MG.

Water auditing was performed utilizing the IWA/AWWA Water Audit Method published in the manual *Performance Indicators for Water Supply Services* in 2000 and the *AWWA M36 Manual, Third Edition*. Study periods were determined based upon the most recent completed fiscal year.

Revenue recovery programs were implemented using methodology described in the *AWWA M36 Manual, Third Edition.* Specifically, these programs were implemented via the following steps:

1. Development of strategies for water loss control, improvement in data confidence, and enhancement of utility revenues.
2. Utilization of water audit results for establishment of water efficiency benchmarks.
3. Development of a system performance monthly tracking tool, modeled after the AWWA Water Audit software, for performance data trending on a trailing-twelve month basis.
4. Formation of a multi-departmental Water Loss Control Team and facilitation of on-going monthly team meetings to analyze data trends and proactively manage efficiency improvement efforts.

RESULTS

For 27 water systems in North and South Carolina, beginning in early 2008, a water audit was performed and revenue recovery program implemented by Cavanaugh. These systems included non-profit water associations to water districts to municipally-owned / privately-operated systems to municipally-owned and operated systems. System sizes range from 170 connections to 95,000 connections, and annual system input volumes from 71 million gallons (MG) to 16,600 MG.

Total Water Loss, in terms of percent of System Input Volume, ranged from 7% to 48%. Total Value of Water Loss, in terms of dollars per year, ranged from $13,761 to $921,894. Data Confidence, on a scale of 1 – 100, ranged from 43 to 82, with an average of 58 (Table 1 & 2).

Table 1. Summary Water Audit results from North and South Carolina water systems.

Number of Connections	System Input Vol (MGY)	Total Water Loss (MGY)	Total Value of Water Loss ($/YR)	Data Confidence (of 100)
170	136	12	$ 44,209 *	50
800	71	34	$ 15,274	61
852	117	41	$ 106,173	48
970	234	48	$ 118,377	43
1,100	133	32	$ 85,472 *	66
1,200	112	19	$ 92,898 *	64
1,600	169	14	$ 13,761	50
1,700	161	38	$ 124,567 *	59
1,800	168	65	$ 208,423 *	69
1,800	1,453	168	$ 247,339	52
2,000	916	94	$ 94,437	64
2,100	161	31	$ 59,747	54
2,500	1,325	278	$ 190,811	61
2,600	146	28	$ 34,949	64
3,200	263	93	$ 104,036	50
3,500	317	114	$ 52,774	49
4,500	605	123	$ 252,223	64
6,000	1,210	225	$ 484,417	56
7,000	988	207	$ 386,685	71
7,400	3,530	411	$ 271,871	63
10,400	726	70	$ 288,676 *	50
11,900	3,303	398	$ 640,166	50
12,000	1,630	170	$ 378,451	52
20,500	4,755	352	$ 760,572	49
34,000	3,976	344	$ 604,179	82
66,000	16,596	715	$ 785,987	55
95,000	8,991	1,078	$ 921,894	79

Table 2. Average, Maximum and Minimum Values for Full Data Set.

	System Input Vol (MGY)	Total Water Loss (MGY)	Total Value of Water Loss ($/YR)	Data Confidence (of 100)
Average	1,933	193	272,903	58
Maximum	16,596	1,078	921,894	82
Minimum	71	12	13,761	43

The smallest systems (<5,000 connections) showed a much lower average Total Value of Water Loss as compared to the full group, at $109,000/year. The average Data Confidence for these smallest systems was in line with average Data Confidence for the full group, at a score of 57 (Table 3).

Table 3. Average, Maximum and Minimum Values for Systems with <5,000 connections.

	System Input Vol (MGY)	Total Water Loss (MGY)	Total Value of Water Loss Loss ($/YR)	Data Confidence (of 100)
Average	382	73	108,557	57
Maximum	1,453	278	252,223	69
Minimum	71	12	13,761	43

The mid-range systems (5,000-20,000 connections) showed a higher average Total Value of Water Loss as compared to the full group, at $408,000/year. The average Data Confidence for these mid-range systems was in line with average Data Confidence for the full group, at a score of 57 (Table 4).

Table 4. Average, Maximum and Minimum Values for Systems with 5,000 – 20,000 connections.

	System Input Vol (MGY)	Total Water Loss (MGY)	Total Value of Water Loss Loss ($/YR)	Data Confidence (of 100)
Average	1,898	247	408,378	57
Maximum	3,530	411	640,166	71
Minimum	726	70	271,871	50

The largest systems (>20,000 connections) showed a significantly higher average Total Value of Water Loss as compared to the full group, at $768,000/year. The average Data Confidence for these largest systems was higher than the average Data Confidence for the full group, at a score of 66 (Table 5).

Table 5. Average, Maximum and Minimum Values for Systems with >20,000 connections.

	System Input Vol (MGY)	Total Water Loss (MGY)	Total Value of Water Loss Loss ($/YR)	Data Confidence (of 100)
Average	8,580	622	768,158	66
Maximum	16,596	1,078	921,894	82
Minimum	3,976	344	604,179	49

DISCUSSION

Data Confidence. Why is data confidence (DC) important? DC is a measure of the accuracy of the picture. Accuracy of information promotes informed and effective decisions. In the context of a water system, this directly impacts return-on-investment decisions. Water system managers are continually faced with capital spending decisions. Meter changeout programs, line rehabilitation/replacement programs, and treatment capacity expansions are prime examples. The accuracy of the picture of system efficiency is the foundation for these investment decisions.

The AWWA M36 Manual provides guidance for how to move forward with data collection, short and long-term loss control, target-setting and benchmarking for each of five (5) score ranges. On the whole, DC scores for the systems studied fall into Levels II and III. DC scores range from 43 to 82, with an average of 58. In practice, this means that improvements in DC should be a priority for those systems which fall into Level III or below, because they are presently making capital spending decisions based on a partially inaccurate understanding of system conditions. For those systems which fall into Level IV, opportunities for improvement in DC should be closely evaluated based on economic justification.

For Level III systems or below, DC improvement efforts should be focused on the following areas:

- Periodic Finished Water and Bulk Purchase Meter testing and calibration, annually at a minimum;
- Automatic logging and analysis of daily production values;
- Routine (monthly) estimation of all unmetered consumption;
- Metering of an unmetered consumption if it is significant;
- Quality control reports in billing system to verify integrity of meter readings;
- Routine (monthly) assembly and analysis of water audit data.

Tables 3 and 4 present no significant difference in DC scores for systems with <5,000 connections vs. those with 5-20,000 connections. Table 5 however shows a higher average DC score of 66 for systems with >20,000 connections, versus an average score of 57 for systems with 20,000 connections or less. This may indicate a trend that larger systems on average have a higher DC score than smaller systems, likely due to the prevalence of more sophisticated systems of measurement and quality control. However, as can be seen on Table 1, there are several smaller systems with DC scores higher than some larger systems.

Culture of Efficiency. A culture of efficiency (CE) within the water system fosters quality control at the staff level, thereby elevating the overall organization to improve both DC and system efficiency. Efficiency in this context is the minimization of water and revenue loss. The impact is manifested as supply-side conservation, reduction in operational costs, and increase in water revenues.

Establishment of a CE begins with the formation of the Water Loss Control Team (Water Team). The Water Team must be multi-departmental and cross-functional. It must include all those who can play a part in positively impacting water system efficiency. At a minimum, the Water Team must be comprised of representatives from

Distribution (operation and maintenance), Metering (installation, testing, repair, reading), Billing, Finance, Customer Service, Fire Department, and Executive. Analysis of data trends for water loss and management of efficiency improvement efforts should be the focus of regular Water Team meetings.

Benchmarking and Data Trending. Benchmarking is critical because it allows a system to compare current performance to past performance, as well as to other systems. Where benchmarking reflects the static picture, data trending reveals how conditions are changing over time. Benchmarking & data trending (B&DT) as a tool has three (3) direct benefits:

- Diagnostic – to indicate long-term movements in things like meter accuracy and rate of rise of leakage;
- Evaluation – to indicate effectiveness of improvement efforts;
- Communication – to share proactive efforts with councils, citizens and other stakeholders.

An annual water audit provides system benchmarks. Monthly performance tracking, as shown on Figures 1 and 2 provides data trending of performance indicators for analysis. In the context of water system efficiency, performance indicators should be evaluated in volumetric terms rather than percentages. Percentages can be used for reference, but not as a performance indicator, as percentages can mask or distort actual trends as system input volumes fluctuate. To buffer monthly variations such as lag-time between recordation of production and consumption values, data should be trended on a trailing-12 month average.

Performance indicators should be reported in total volumes as well as normalized volumes (i.e. gallons per number of connections per day). Normalized volumes allow for tracking performance amidst changing system conditions (miles of main, number of connections, operating pressure), and for easy comparison between different systems.

Revenue Recovery Program. The objective of a revenue recovery program (RRP) is minimization of real and apparent water loss to reduce operational costs and increase water and sewer revenues. It may also be referred to as a water loss control program. To be effective, a RRP must focus on steady improvements to data confidence, steady sowing of a culture of efficiency, steady benchmarking and trending of performance indicators, and calculated implementation of efficiency improvements. It is important to capitalize on capturing 'low-hanging fruit' for early success in the RRP to help build momentum. In many of the 27 systems studied, early successes such as large customer meter calibrations or found leakage have elevated the energy level of the Water Team, further sustaining the culture of efficiency and bringing energy to some of the longer-term efficiency efforts. The culture of efficiency can and should be contagious.

Data confidence, culture of efficiency, and benchmarking & data trending have been discussed in the paragraphs above. These elements should be considered foundational to the RRP. However, revenue recovery cannot be achieved by this foundation alone. What sits upon the foundation is a living plan of strategies and tools for physically reducing water loss and increasing revenues. These strategies must be evaluated for return on investment. To perform this calculation, the Water Team must be able to quantify cost of implementation versus expected recovery of revenue.

In analyzing expected recovery of revenue, water loss valuation becomes a function of variable production cost and composite retail rate for a given system. Overwhelmingly for the systems discussed in this paper, variable production costs (VPC) for systems producing water were very low, with an average VPC of $0.58/1,000 gallons. In practice this means that on the whole water is still cheap to make in the Carolinas. The Water Team must revisit this regularly, as costs of chemicals and electricity will continue to rise thereby driving up VPC and water loss valuation. Additionally, real loss must be assessed at composite retail rate during periods of drought or otherwise restricted supply.

Below are examples of water loss control measures that are considered best practices by AWWA, and have been implemented in a RRP by some of the 27 studied systems:

- On-going active leak detection
- District metered areas
- Pressure profiling and management
- Valve inventory/mapping & exercise/flushing program
- Distribution system rehabilitation & replacement
- On-going customer meter testing & replacement
- Theft-control policies and enforcement
- Demand profiling and meter right-sizing
- Long-term rate-setting strategies

CONCLUSIONS

<u>Water</u> is cheap to make in the Carolinas, but rising operational costs and drought will continue to drive the cost of <u>water loss</u> only in the upward direction.

Specific water loss control measures for inclusion in a revenue recovery plan must be selected by the Water Team based on adequacy of data confidence and justification of return on investment. Overall data confidence among the systems studied is low, and measures to improve data confidence must be given priority. Systems with >20,000 connections, tend to score higher on data confidence than those with <20,000 connections.

An effective revenue recovery plan must be supported by sufficient data confidence, a culture of efficiency, and regular benchmarking & data trending. Data confidence promotes effective decision making, a culture of efficiency promotes supply-side conservation and quality control, and benchmarking & data trending promotes long-range understanding of system behavior thereby enhancing effectiveness of long-range capital planning. The outcomes of an effective revenue recovery plan are reduced operational costs and increased revenue.

We are approaching a tipping point of water accountability for systems in North and South Carolina with the implementation of water audit and revenue recovery programs, marking the death of unaccounted for water.

REFERENCES

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