



September 19, 2008

Navassa Town Council  
c/o Hon. Eulis Willis, Mayor  
City Hall  
334 Main Street  
Town of Navassa, NC 28451

Dear Ladies and Gentlemen:

This letter reports on the water audit conducted by the student chapter of Engineers Without Borders at the University of North Carolina at Chapel Hill (EWB-UNC) on Navassa's existing water distribution system. EWB-UNC members Joel Sholtes and Leah Teuber visited Navassa on July 14<sup>th</sup>, 2008 in order to gather documentation and information for this audit and interview Navassa personnel and officials. The audit is composed of billing, consumption, and system infrastructure information gathered during the on-site visit and applied to the American Water Works Association (AWWA) Water Loss Control Committee Water Audit Software v3.0, which generates estimates of water loss. This report outlines the information gathered by EWB-UNC regarding water use and Navassa's water distribution system; it summarizes results from the AWWA water audit software; and it suggests some next steps for Navassa's consideration.

## **Background**

According to records reviewed by EWB-UNC and an interview with the Mayor, Navassa has operated a water distribution system for nearly three decades. The town originally pumped and treated its own well water until service lines from the North Brunswick Sanitation District were extended to sell treated water to this area. Navassa currently purchases bulk water from Brunswick County and distributes it to 370 residential and commercial accounts. Residential consumption comprises an average of 33% and commercial consumption an average of 67% of total annual use according to 2007 and 2008 billing records. The distribution system is primarily composed of six-inch PVC main lines (11.2 miles), PVC lateral lines, and ductile iron valves and hydrants. We were informed that average system operating pressure is 80 psi.

## **Data Sources**

Water consumption and infrastructure data came from documents provided by Navassa including monthly customer billing information (outgoing billed), bulk water provider bills (incoming billed), daily master meter readings of incoming water conducted by Navassa personnel, and water distribution system construction drawings. Navassa personnel and officials were interviewed during the site visit in order to learn about system history, operation and maintenance, unbilled water use, and other pertinent information.

*Billed Water:* Dated monthly bills from North Brunswick Sanitary District (NBSD) and the County of Brunswick, the water suppliers of Navassa (the town switched to the county supply in November 2007), were provided from July 2007 through June 2008. Additionally, daily readings taken at the source master meter were provided for this same time period. These readings are submitted to the NC Department of Environment and Natural Resources, Public Water Supply Section on a monthly basis for supplier permit reporting purposes. Monthly water billing reports from July 2007 to June 2008 from Navassa were also provided. These reports summarize total water sold by Navassa to its customers each month.

The dates of the water bills from the County and NBSD do not correspond exactly with the dates of the meter reading conducted by Navassa of its customers; therefore, some discrepancy exists between these two sources of data, possibly accounting for some error in the water balance. When possible, master meter readings of incoming water corresponding with the dates of customer meter readings were used.

*Accounts:* Account information was obtained from the Navassa customer billing system. Information is accurate as of July 14, 2008:

259 Residential accounts  
11 Commercial accounts  
77 Inactive accounts.

*Meters:* Approximately 150 meters were installed when the system was first built circa 1979. Of these original 150 meters, 120 have been replaced between then and December 2007. The remaining 30 meters have been replaced since December 2007. As the system has been expanded in stages over the past 15 years, additional meters have been installed. The meters associated with expansions range in age from 2 to 25 years and have not been replaced since their original installation.

*Unbilled Metered Water:* Navassa contains several sites of authorized, metered, unbilled water use:

- Town Hall-Police Department complex - approximately 12 full time employees
- Fire Department – a volunteer, minimally occupied facility (approx. 1 full time)
- Public Works Shop – no full time employees, one bathroom, and equipment maintenance activities
- Municipal Park – a standpipe at a baseball field, picnic area, and playground.  
Some manual irrigation occurs seasonally. Unauthorized car washing has been reported from this standpipe.

Information on metered, unbilled use came from meters installed in the spring of 2008 at the above locations. Consumption data were obtained from three weeks of metered use and therefore do not capture the seasonal and random variability in consumption that may occur at some of these sites. The consumption data obtained were extrapolated to obtain estimates of unbilled metered water use for the entire year.

*Unbilled Unmetered Water:* This source of authorized water use includes system flushing for water quality and line installation and water used for fire suppression. No records or estimates are maintained by Navassa for this type of water use and therefore no measured data exist. The AWWA water audit software utilizes a fixed value of 1.25% of incoming water to estimate this volume. This software also applies a fixed value of 0.25% of the incoming water volume to account for unauthorized consumption. The AWWA software was developed for use in water systems larger than Navassa's, and therefore these percentages may not be entirely appropriate in this instance.

## **Water Audit Results**

The following is a discussion of the results provided by the AWWA water audit software. For the water billing period of July 2007 through June 2008, 25.3 million gallons (MG) were purchased by Navassa; this represents the total incoming water to the system.

20.2 MG were billed to Navassa customers, an estimated 0.175 MG was metered and unbilled, an estimated 0.316 MG was unmetered and unbilled (1.25% of total incoming water as estimated by AWWA), and finally, an estimated 0.063 MG was used without authorization (0.25% of total incoming water as estimated by AWWA). Analysis of billing information yields an average daily consumption value of 157 gallons per residential account

and 1,726 gallons per commercial account. According to the 2000 US Census, Navassa average household size is 2.7 people, resulting in 58 gallons of water consumed per person per day. This is below the national average of approximately 70 gallons of water use per day.<sup>1</sup>

Total Water Loss is the difference between the total water purchased by Navassa from the NBSD and the County and the volume of water Navassa billed to its customers plus the estimated amount used for municipal purposes (unbilled metered volume), plus the estimated amount used for unbilled unmetered consumption (system flushing, fire suppression, etc). The Water Loss estimate for Navassa is 4.7 MG per year, or roughly 18 % of water purchased from the County. Water loss, in accordance with the AWWA/IWA standard, includes Apparent Losses such as Unauthorized Consumption (which is also estimated below) and water meter under-registration as well as Real Losses (e.g. leakage). See Table 1 below for the AWWA water audit software output.

Table 1. Water Audit Results

	Volume (MG)	Percentage
Incoming Water	25.316	100.00 %
Billed Water	20.165	79.80 %
Unbilled Metered (estimated)	0.175	0.70 %
Unbilled Unmetered (estimated)	0.316	1.25 %
<b><i>Authorized Consumption</i></b>	<b><i>20.656</i></b>	<b><i>81.59%</i></b>
<b><i>TOTAL Water Loss</i></b>	<b><i>4.660</i></b>	<b><i>18.41 %</i></b>

The above estimates yield a Total Water Loss of 18% of incoming water on an annual basis. At the current purchase price from the County of Brunswick, \$2.397 per 1,000 gallons, the value of these Water Losses is approximately \$11,200 per year. This amount does not include the value added by Navassa to the water via distributions system operation and maintenance costs (especially electrical costs for water pumping) as well as personnel costs. Navassa's billing account information indicates that its total expenditures for water purchases during the study period were \$60,682 (25.316 MG X \$2.397 / kgal, which is the Brunswick County Rate). This value does not include the value added to the water by Navassa including energy costs for pumping, administration, and maintenance of the distribution system. Thus Water Loss is estimated to be 18.46% of Navassa's total annual drinking water expenditures.

An alternative way to consider the impact of unaccounted for water on Navassa is its cost in terms of residential customer bills. At 4.66 MG of annual water loss, approximately 12,800 gallons go unaccounted for a day on average. This yields 50 gallons lost per day per account. At the current cost of water from Brunswick County, this results in a cost of \$3.63 per account per month due to water loss. If the average residential account uses 4,700 gallons per month, their water bill would be \$22.00. In this case, Navassa's Water Loss rate costs approximately 16.5% of the average residential bill.

## Discussion

This report summarizes the findings of a water audit conducted for the Town of Navassa. Information from billing data provided by the town from July 2007 to June 2008 in addition to other metering data, water distribution system plans, and town personnel interviews was used in this audit. It was found that for the 12 month period spanning July 2007 through June 2008, approximately 18% of Navassa's water is lost through

<sup>1</sup> Meyer, P. et al. Residential and Commercial End Use of Water. AWWA Research Foundation Project #241B, Winter 1999/2000.

Apparent Losses (unauthorized use and data handling errors) and Real Loss (leaks). While Navassa does not maintain records of authorized unmetered uses such as system flushing and fire suppression, these sources of water consumption likely account for a small percentage of the unaccounted for water. AWWA estimates these uses at 1.25% of total incoming water.

An additional source of Water Loss may be meter inaccuracy. The ages of customer water meters installed in Navassa range from less than a year old to 15 years old. As meters age, they slowly begin to under-register<sup>2</sup> the volume of water flowing through them. This leads to an under representation of the total volume consumed, leading to a decrease in revenue and an increase in unaccounted for water. A residential water meter generally can be expected to function properly for 5 to 10 years with gradual reduction in accuracy (under registration) throughout that time period. The age of many of Navassa's water meters indicate that under registration may be a significant source of the unaccounted for water documented above.

If meter under-registration does not account for the majority of Water Loss, then there may be significant and ongoing leaks within the system. Given that every water supply system leaks some of its water into the ground, common allowances for leakage are typically below 15%. Navassa personnel have noted water main breaks in the past, with one occurring in the past 12 months. Additional undocumented leaks may account for some of the Water Loss.

The appropriate percentage of total incoming water comprised of unaccounted for water depends in part on the age of the water system, the cost of producing or purchasing drinking water, and the size of the system. Nationwide 10 to 15% of total Water Loss is generally considered in the low to acceptable range. For some utilities, it may or may not make economic sense to lower total Water Loss levels.

*Data Limitations:* Data were not available on water used for system flushing or fire suppressions. This is estimated to be 1.25% of total incoming water by the AWWA. Only three weeks of water consumption data were available for unbilled, metered uses such as water consumed in municipal facilities. Annual water consumption from these sources was extrapolated for the year from the available data and does not capture any seasonal or random variability that may exist with the consumption from these sources.

## **Conclusions**

This water audit has documented an annual Water Loss of 4.66 MG in the Navassa water distribution system based on 12 months of data, which is equivalent to 18% percent of annual volume of water purchased by Navassa. This represents a direct cost of \$11,200 a year to Navassa of water purchased from Brunswick County, but unsold, or \$43.24 per residential account per year. This is an underestimate of costs for Water Loss, however, as they do not account for the value Navassa adds to the water via distribution system construction, operation, and maintenance, and administrative costs.

The Water Loss rate is an important benchmark for water utility operation that is recognized by the AWWA. But in order to understand how significant an 18% Water Loss rate is in Navassa, and if the rate of income versus expenditures is at a level appropriate for the sustainable operation of the water distribution system, additional assessment of the Navassa water utility will be necessary. A more comprehensive audit is recommended for this reason. The additional information would be needed from Navassa includes:

1. Detailed residential demand data by customer account
2. Detailed information on commercial account consumption rates.

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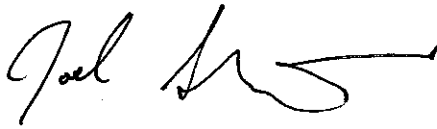
<sup>2</sup> Davis, SE. Residential Water Meter Replacement Economics. Leakage 2005 Conference Proceedings.  
<[www.waterloss2007.com/Leakage2005.com/pdf/Residential%20Water%20Meter%20Replacement%20Economics.pdf](http://www.waterloss2007.com/Leakage2005.com/pdf/Residential%20Water%20Meter%20Replacement%20Economics.pdf)>

3. Information on water and sewer utility operation, maintenance, and administrative costs in addition to information on revenues.
4. Delinquent accounts rate.
5. Capital improvement plans.

UNC-EWB is prepared to assist the Town of Navassa without charge to make a more comprehensive analysis of its water and sanitation system and extend the work that has been done thus far so that the town will have more a complete basis for planning how its citizens can be better served.

On behalf of EWB-UNC and the UNC School of Government, Environmental Finance Center, we would like to thank you for your assistance and cooperation for this effort. We hope that the findings of this report are helpful and look forward to future cooperative efforts among our groups. It is our desire to continue this effort towards a comprehensive assessment of the utility thus far.

Sincerely,

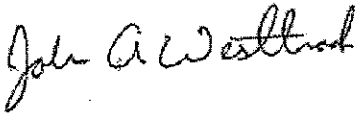


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