2011 Water Audit Technical Memo

Howard, Wisconsin

SEH No. HOWAV 117723

February 2012

SEH

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TECHNICAL MEMORANDUM

TO: Geoff Farr, Village Engineer

FROM: Scott Beduhn

DATE: February 8, 2012

RE: Village of Howard Water Audit
SEH No. HOWAV 117723

This technical memorandum summarizes the findings of the water audit that was performed for the Village of Howard. The purpose of the water audit was to determine the cause(s) of recent trends in increasing unaccounted for water and provide recommendations to decrease the volume of non-revenue and unaccounted for water. Historical operating data and sales data were reviewed and analyzed to help determine the potential cause(s) of the unaccounted for water. Recent leak detection reports were also reviewed.

1.0 INTRODUCTION

The Village of Howard is a community of approximately 17,400 persons located in northeastern Brown County. The Village's Water and Sewer Department provides water to residential, commercial, industrial, and public authority customers. Table 1 summarizes the number of customers for each customer class from 1997 through 2010. Prior to September 2007, the Water and Sewer Department provided water to its customers via three groundwater wells. However, due to water quality issues, the Department became a member of the Central Brown County Water Authority (CBCWA) and continues to provide water to its customers via a 20-inch connection with the CBCWA. The Water and Sewer Department provides water for residential, commercial, industrial, and public authority customers.

The Water and Sewer Department keeps monthly records of non-revenue water (water not sold, i.e. water used for flushing mains, unmetered water, unaccounted for water, etc.) In recent years, the Department has been made aware of an increase in unaccounted for water (non-revenue water that cannot be accounted for). It is the goal of any water utility to keep non-revenue water at a minimum, but when considering the cost of purchased water, the Department is especially interested in keeping non-revenue and unaccounted for water at a minimum.

Prior to performing the water audit, there were several possible explanations for the increase in unaccounted for water, including water theft, unidentified leakage, accounting errors, and/or procedural issues.

2.0 SCOPE

The Village of Howard retained Short Elliott Hendrickson (SEH) to perform a water audit that included the following tasks:

1. Review historical Water and Sewer Department's operating data related to pumpage, sales, water accountability and non-revenue water volumes.

2. Review and trend recent water sales data to Water and Sewer Department's largest customers by volume.
3. Review and comment on recent leak detection activities performed by the Water and Sewer Department.
4. Review reported monthly pumpage and sales data.

3.0 WATER BALANCE

A water balance can be an effective preliminary assessment of water loss. An advantage of completing a water balance is that it can be completed using existing available records; no additional field measurements are required. A simple water balance is illustrated in Figure 1.

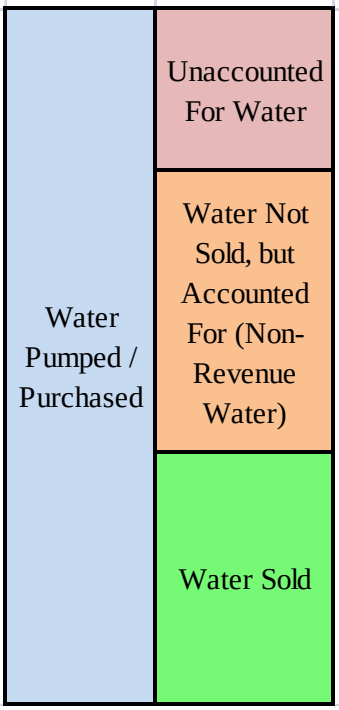

Figure 1: Simple water balance.

The Water and Sewer Department currently keeps records that can be used to complete this water balance and reports the data to the Public Service Commission (PSC) on an annual basis. The water pumped/purchased would include the water pumped from existing wells and the water purchased from CBCWA. The water sold includes all water sales to residential, commercial, industrial and public authority customers. Non-revenue water includes unbilled consumption that is accounted for, including water used for flushing water mains, water tower overflows, firefighting, etc. Unaccounted for water is the volume of water that was pumped into the distribution system, but was not sold and cannot be accounted for. An example water balance for the Village of Howard using data from the 2010 PSC report is shown in Figure 2.

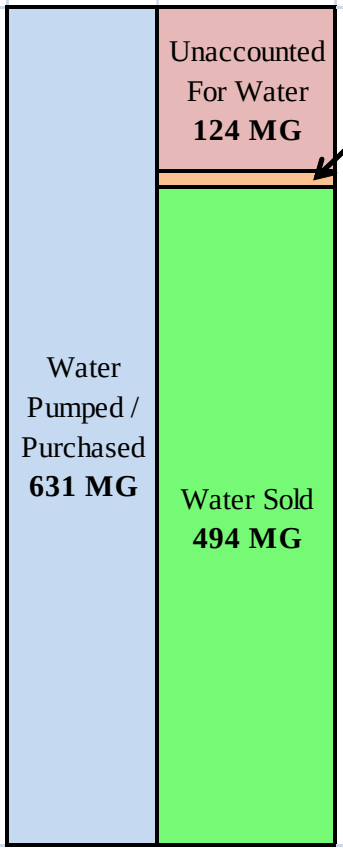

Figure 2: 2010 water balance for Village of Howard.

4.0 UNACCOUNTED FOR WATER

Prior to 2009, water sales revenue was increasing due to community growth as well as water rate adjustments that were implemented for purchasing water from CBCWA. In 2009, a 12 percent decrease in total sales revenue compared with 2008 was realized which may have likely triggered an increased awareness in recent trends in unaccounted for water reported to the PSC. Total sales revenues continued to decline in 2010, as shown in Table 2.

Over the past 10 years, unaccounted for water as reported to the PSC has fluctuated from 0 percent to 20 percent. The Village's unaccounted for water has been comparable with other CBCWA members', as shown in Table 3. The Village's non-revenue water has fluctuated from 1 percent to over 30 percent, and has been similar to other CBCWA members' non-revenue water percentages overall.

Over the years, the Water and Sewer Department has been replacing cast iron water main in the distribution system with PVC water main to help reduce leakage. As a water system expands and older pipe is replaced with newer water main, it is typically expected that the percentage of unaccounted for water would decrease. Therefore, it can be beneficial to look at the volume of unaccounted for water per mile and the volume of unaccounted for water per service lateral to determine if the trend is decreasing. As shown in Table 4, the volume of unaccounted for water per mile of water main and service lateral was decreasing each year until 2009, when the volume of unaccounted for water increased.

5.0 WATER DEMANDS

Historical water demand data was reviewed, including pumpage and sales records, non-revenue water records, and usage by the largest water customers.

5.1 Water Consumption History – PSC Reporting and Billing Records

There are three main sources that can be used to summarize the Water and Sewer Department's sales records: the PSC report, the Water and Sewer Department billing spreadsheet records, and Water and Sewer Department meter records. The Water and Sewer Department installed an automatic meter reading (AMR) system (installation was started in 2004 and completed in 2006) that is used to collect data for billing its customers. The data from the AMR system (water and sewer meter records) is transferred to an Excel spreadsheet (billing spreadsheet) where it can be used to determine how much each customer should be billed.

Table 5 summarizes the water sales by customer class, non-revenue water, total accounted for water, total pumpage, and percentage of accounted for water according to the PSC reports dating back to 1997. As shown in the table, the percentage of accounted for water has ranged from a low of 78.2 percent in 1997 to a high of 99.9 percent in 2007. On average, the Department has been able to account for approximately 89 percent of its total water pumpage over the last 13 years. Since purchasing water from CBCWA, the percentage of accounted for water has been above 90 percent, until recently in 2010.

Table 6 includes the same information shown in Table 5, however, the source of the industrial and public water sales are from the Water and Sewer Department billing spreadsheet records for those customer classes and the total accounted for water and percentage of water accounted for are recalculated. Total pumpage for Table 6 is from the PSC reports through 2008 and is from DNR monthly pumpage records for 2009 and 2010, which differs from what was reported to the PSC for these years. Since the billing spreadsheet records were only available back to 2001, only data from 2001 to present is summarized. Using the data from the billing spreadsheet, the water accountability appears to be consistently around 89 percent over the past several years. The data suggests that a large decrease in accountability occurred from 2008 to 2009, where the percentage of water that was accounted for dropped from 90.5 percent in 2008 to 80.9 percent in 2009 and was calculated as 79.6 percent in 2010.

Table 7 also summarizes water consumption data, this time from 2005 to present. The information for Table 7 is taken from the PSC report for the residential and commercial customers, but data for the industrial and public customers is taken from the AMR meter records to recalculate the total volume and percentage of accounted for water. Similar to Table 6, the total pumpage volume was taken from the PSC report through 2008 and was taken from the DNR monthly pumpage reports for 2009-2010. Utilizing the data from the available AMR meter records, which may not be all-inclusive for customers with multiple accounts, the Water and Sewer Department has been accounting for approximately 86 percent of its water over the last six years. The public sales include the available meter data for the Village of Howard, Brown County, Wisconsin DNR, and the school district.

Table 8 summarizes and compares the historical water sales and percentage accounted for water from the data in Tables 5, 6 and 7. As shown in the table, the data from the PSC report generally shows the highest percentage of accounted for water and the meter records generally show the lowest percentage. The PSC data shows a significant drop in accountability from 2009 to 2010, where the billing spreadsheet data and meter data both show a significant drop in accountability from 2008 to 2009.

Figure 3 is a graphical representation of the historical water sales and pumpage since 1997 (with an estimate for 2011), comparing the three sources of information. The pumpage data in the figure is from the Water and Sewer Department's pumpage records. When the lines representing the total accounted for water run parallel to the line illustrating total pumpage year to year, it means the Department is maintaining accountability of its water year to year. Figure 3 shows that accountability has varied from year to year; however, since 2008, the general trend appears to be going downward.

Comparing the available records, it is difficult to precisely trend the unaccounted for water, especially in recent years. Up until 2006 both the PSC records and billing spreadsheet data unaccounted for water records were in agreement. However, from 2006 to present, there has been variation between the unaccounted for water reported to the PSC and what was recorded in the billing spreadsheet data and meter records. While the billing spreadsheet data and meter record data do not match exactly, the unaccounted for water records between the two sources are very close, with a maximum difference of 1.2 percent. The difference between the PSC records and the billing spreadsheet records and meter records varies up to 9.3 percent; however, the errors in reported data appear to be isolated incidents.

6.0 LARGE WATER USERS

6.1 Historical Water Usage – Top 11 Water Users

If unmetered water usage by customers was accounting for a noticeable percentage of the total unaccounted for water, a significant volume of water would need to be unmetered. Therefore, to determine the possibility of unmetered usage, including water theft, the historical usage patterns of the Department's largest water users were reviewed. Table 9 is a list of the Water and Sewer Department's top 11 water users. Eka Chemicals is by far the Department's largest water user, accounting for almost 10% of the total sales in 2010. Overall, the top users account for approximately 26% of the Department's water sales.

Tables 10-12 illustrate the annual water usage for each of the large users from 2005 to the projected 2011 usage. Table 10 shows the largest industrial users, Eka Chemicals, OMNOVA and Sanimax. After the Village began purchasing water from CBCWA in 2007, Eka Chemicals and OMNOVA's metered water usage has declined. Conversely, Sanimax's water usage increased, and continues to rise. Table 11 shows the largest public and commercial users. The school district's usage has declined since 2008. United Health Group's usage has also declined since the Village began purchasing water from CBCWA in 2007. Bruce Wolf, who owns the Comfort Inn-Rock Garden Suites, has maintained fairly consistent water usage since 2005. Table 12 shows the remainder of the large commercial water users. With the exception of Deer Run Apartments, all of the large commercial customers' water usage has fluctuated less than 0.5 million gallons per year (MGY) since 2005.

6.2 Industrial Water Users – Industrial Surveys

In addition to looking at the water usage data, industrial surveys were also conducted for the Water and Sewer Department's four industrial customers, Eka Chemicals, OMNOVA, Sanimax, and Seaway Foods. The results of the surveys are documented in Appendix A.

6.2.1 Eka Chemicals

Eka Chemicals, the Department's largest water user, uses water to produce silica and non-silica sol products. Silica sol is produced 24 hours per day, seven days per week, 363 days per year, and

attributes to 98% of the plant's water use. It is reported that fluctuations in water use from 2008-2009 were due to the bad economy taking a toll on the plant's production. Since the Village began purchasing water from CBCWA, Eka Chemicals has employed some water conservation/re-use measures. Since the Howard plant is the largest water user in the company, the Howard plant's water usage is closely monitored and is always trying to determine ways to use less water. The plant has an equalization tank that it draws from for its processes, so water drawn from the Department's distribution system is fairly consistent.

The plant does not operate any high capacity wells, although one was considered a few years ago. As of September 2011, Eka Chemicals does not consider a high capacity well to be economically feasible. The plant would consider drilling a high capacity well in the future if water costs went up dramatically. The plant has noticed significant improvement in the water quality since water has been purchased from CBCWA, which is advantageous for silica sol production. Since the process at the Howard plant has been consistent for the last 10 years, Eka Chemicals does not foresee any immediate or long-term expansion that would affect future water consumption. It can be anticipated that the plant will continue to use a maximum of 5 MG per month.

6.2.2 OMNOVA Solutions, Inc.

OMNOVA is the Water and Sewer Department's second largest water user. The majority of OMNOVA's water demand is put into its emulsion polymer product; some is also used for the cooling tower and boiler. The polymer is produced 24 hours per day, seven days per week, 365 days per year. Changes in water usage throughout the years has been a result of an increase or decrease in production, as the methods used for production have remained consistent over the past several years.

OMNOVA is continually looking for ways to reduce water usage. Over the past couple of years, water re-use measures have been implemented and the plant switched to a water purification system that saves approximately 2 MG to 3 MG of water per year. Water use is relatively constant throughout the day and year. There may be a slight increase in water demand in the summer due to greater evaporation from the cooling towers. The plant does not operate any high capacity wells. Since switching to the CBCWA water, OMNOVA has noticed an improvement in water quality, which is beneficial for manufacturing the polymer. The plant does not have any near or long term expansion plans that would impact water consumption in the future.

6.2.3 Sanimax

Sanimax is one of the top 11 water users, but uses considerably less water than either Eka Chemicals or OMNOVA. The reason for this is likely because the majority of the water used for the plant's rendering operations (approximately 95 percent) is from a non-potable high capacity well owned by Sanimax. The water purchased from the Village of Howard is mostly for potable use, such as showers and drinking water, and is not used in the plant's operations. Up until about September 2011, some of the water purchased from the Village was used in two of the scrubbers, but now the scrubbers use the non-potable water from the well. Operations at Sanimax are run 24 hours per day, six days per week. There has been no recent or past growth or expansion that has impacted water consumption from the Village.

No water conservation measures are currently employed or are planned to be employed, but some water conservation measures are being evaluated. Water use from the Village is fairly consistent throughout the day, but if water from the Village was ever utilized in the plant's operations, the usage

would vary quite a bit. Since the plant's operation is variable, water use from the well is not constant, but there is a water tank to help buffer the spikes in water use. Although water use may vary throughout the day, it is fairly consistent throughout the year. There are no known immediate or long-term expansion plans that could affect future water consumption. Since Sanimax uses the majority of its water from its non-potable well, water usage is not expected to decline significantly if water rates increase. Water quality is not a major concern to the plant's operation.

6.3.4 Seaway Foods

While Seaway Foods is one of the four industrial customers the Water and Sewer Department services, it is not one of the top 11 water users by volume. Water is used at Seaway Foods for food processing. For this reason, water quality is very important. Seaway Foods has noticed an improvement in water quality since purchasing water from CBCWA. One of the Department's wells, which has since been abandoned, would produce discolored water in the past, which was not desirable for processing food.

There have been a few water conservation measures that have been implemented to try to conserve water, such as using an air cooled ice machine instead of a water cooled ice machine. Water use is fairly consistent throughout the day and year. Seaway Foods does not operate any high capacity wells, and does not see well water as an option for future water supply. There are no immediate or long-term expansion plans that would impact future water consumption.

7.0 CBCWA METER TESTING

The Water and Sewer Department had the CBCWA meter tested in September 2010 using the pitot rod method. The test results indicated that the meter is 99.4% accurate.

8.0 CUSTOMER METER TESTING

The Water and Sewer Department has been GPS locating and documenting the location of all customer service locations and verifying there is a meter installed. As part of this project, the Department is also doing random meter testing. Recently, the Water and Sewer Department tested the compound meters and a sample of residential meters to determine if customer meters were recording water usage inaccurately. The results of the compound meter testing indicate that the compound meters are reading accurately. The test results on the high side of the meters range from 97.0 percent to 102.9 percent. The test results on the low side of the meters range from 95.4 percent to 102.4 percent. The results of the residential meters tests prove that the residential meters are accurately recording water usage, nearly 100 percent accurate. Documentation of the customer meter and compound meter tests can be found in Appendix B.

9.0 LEAK DETECTION SURVEY

The Water and Sewer Department has been active in identifying lost water due to water system leakage. They have had two leak detection surveys completed in recent years. The first was completed in 2009 and the most recent in 2011. In addition, as part of the service line location and meter verification project, the Department is also testing each service line that is located for leaks and bringing the curb box up to grade.

AECOM performed a leak detection survey throughout the water distribution system during November and December of 2009. The leak detection survey included a review of the existing water distribution

system mapping and reports, a leak detection and location survey with sonic detection, and an inventory of defective system components (valves, hydrants, meters, and curb stops).

The leak detection survey located two water main leaks that accounted for approximately 40,000 gallons per day (gpd) water loss, or about 40 percent of the total leakage identified. In addition, sixteen hydrant leaks were located that accounted for approximately 47,000 gpd water loss, or 54 percent of the total leakage identified.

The 87,000 gpd of leakage that was located was estimated by AECOM to cost the Village approximately $124,000 per year.

Another leak detection survey was performed during November and December of 2011 by M.E. Simpson. Similar to the AECOM leak detection survey, the survey performed by M.E. Simpson also included a review of the existing water distribution system mapping and reports, a leak detection and location survey with a leak correlator, and an inventory of defective system components (valves, hydrants, meters, and curb stops). A major difference between the leak detection survey done by AECOM and the survey that was completed by M.E. Simpson is the M.E. Simpson survey included a more comprehensive leak detection survey of the PVC water main by not only utilizing main valves and fire hydrants, but service valves, also.

The leak detection survey performed by M.E. Simpson located one main line leak that accounted for approximately 36,000 gpd water loss, or about 33 percent of the total leakage identified. Three service line leaks were found, totaling almost 35,000 gpd water loss (approximately 32 percent of the total leakage identified). The two valve leaks that were discovered totaled almost 22,000 gpd water loss, or approximately 20 percent of the total leakage identified. The remaining 15 percent of the identified leakage was hydrant leakage, totaling 17,000 gpd.

The 109,400 gpd of leakage that was located by M.E. Simpson was estimated to cost the Village approximately $166,000 per year.

10.0 PRIVATE HIGH CAPACITY WELLS

Pumpage records for private high capacity wells for the Water and Sewer Department customers were reviewed to determine if purchasing water from CBCWA caused customers to pump more water from their private wells for cost savings. Looking at the pumpage records could also help indicate the possibility of unmetered water use may be occurring if a customer's water usage remained "constant" but there was a decrease in water pumped from their private well.

There are nine high capacity groundwater wells registered with the DNR within the Village limits. Three of those wells belong to the Village of Howard, one of which is abandoned. Of the remaining six wells not owned by the Village, two are abandoned (Peterson), two were not drilled (Eka Chemicals and OMNOVA) and two are active (Sanimax and Moder). Annual pumpage of Moder's private well has varied significantly throughout the years. Since 2007, the volume of water pumped from Moder's well has ranged from 0 MGY to over 3 MGY. The volume of water pumped from Sanimax's well has been more consistent from year to year, varying from 81 MGY to almost 96 MGY since 2007. Table 13 shows a comparison of the water purchased from the Village and the water pumped from the factory's private well. As confirmed in the table, the vast majority of the water used for Sanimax's operations is pumped from the private well.

11.0 AWWA WLCC WATER AUDIT

The American Water Works Association (AWWA) Water Loss Control Committee (WLCC) offers a free water audit software that is available to all users. The software is in Microsoft Excel format. While the free water audit software does not provide a full, detailed water audit, it is useful for compiling a basic audit of water supply and billing operations. The software can be downloaded from the AWWA WaterWiser website at: http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511.

SEH utilized the AWWA WLCC's software to compile a basic water audit for the Village of Howard. The completed Water Audit Spreadsheet is included as Appendix C. The reporting worksheet was completed using PSC data and additional data provided throughout this study.

12.0 FINDINGS

12.1 Water Demands

As mentioned previously, while there have been discrepancies between the percentage of unaccounted for water reported to the PSC and what is calculated from the billing spreadsheets from 2006 to present, these incidences appear to be isolated. The meter records confirm the accuracy of data from the billing spreadsheet. While the billing records do not show a significant increase in unaccounted for water from 2001 to present, they do confirm the increase in unaccounted for water from 2009 to 2010, which was also reported to the PSC. It is therefore believed that the water losses experienced by the Water and Sewer Department are real losses and not just apparent losses as a result of inaccurate accounting and billing procedures of other data handling errors.

12.2 Large Water Users

Looking at the historical usage patterns of the Water and Sewer Department's top 11 water users does not draw a clear conclusion to the likelihood of unmetered usage. Based solely on the historical usage patterns, it seems that significant unmetered water usage is unlikely.

Coupled with the historical usage data, the industrial surveys further indicate that it is unlikely that any of the Water and Sewer Department's industrial users are responsible for water theft. The survey responses regarding historical fluctuations in water usage correlate well with the available historical usage data. Several industrial customers have employed water saving measures to help reduce water use. Fluctuations in water usage over the past few years can also be attributed to the economy.

12.3 Meter Testing

The CBCWA meter test shows that the meter monitoring water use by the Village of Howard Water and Sewer Department is accurate.

The compound meter test results show that the compound meters are accurately recording water usage. The residential meters are also recording water usage accurately.

12.4 Leak Detection Survey

The leak detection survey performed by AECOM in November and December of 2009 did not discover any major leaks in the distribution system. The survey consisted of a preliminary general listening survey

conducted on fire hydrants and system valves throughout the distribution system. Two main leaks and sixteen hydrant leaks were located, estimated to be approximately 87,000 gpd of leakage. The Water and Sewer Department had repaired all of the leaks that were documented in the leak detection survey report as of October 2011.

The leak detection survey performed by M.E. Simpson in November and December of 2011 did not discover any major leaks in the distribution system, either. One main leak, three service leaks, two valve leaks, and twelve hydrant leaks were located, estimated to be approximately 109,440 gpd of leakage.

12.5 Private High Capacity Wells

The pumpage records for the private high capacity wells show that the volume of water pumped from these wells has not changed significantly over the past several years. Therefore, it is unlikely that customers are using these wells to offset the volume of water purchased from CBCWA.

12.6 AWWA WLCC Water Audit

From the data entered into the reporting worksheet, the water balance, grading matrix and loss control planning sheets were automatically compiled. Based on the results of the AWWA WLCC free water audit software, the Village received a water audit data validity score of 84 out of 100. The results of the AWWA WLCC water audit recommend that the Department verify that all customer meters are accurate to help reduce water loss. To help finance the cost of the lost water, the AWWA WLCC water audit suggests that the Department may want to consider increasing customer meter charges to help pay for the water that is lost before it reaches the customers' meters. Detailed results of the AWWA WLCC water audit can be found in Appendix C.

13.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon calculations from the billing spreadsheet records, the unaccounted for water since 2001 has been, on average, 10 percent. However, beginning in 2009, the volume of unaccounted for water increased to almost 20 percent.

The cause of the large increase of unaccounted for water is unclear. However, there are significant discrepancies between the unaccounted for water reported to the PSC and the unaccounted for water volume maintained on record from the billing spreadsheets. This is an issue that needs to be addressed. It is unlikely that meter inaccuracies are to blame for the large volume of unaccounted for water. Neither of the leak detection surveys found any major leaks in the distribution system; however, there is a possibility that not all of the leaks were located.

It is recommended that the Water and Sewer Department take the following actions to try to determine the cause(s) and reduce the amount of unaccounted for water:

- Review the water consumption data on a regular (monthly) basis with the billing/accounting department to ensure that records are matching and are accurate.
- Perform an annual water audit using the AWWA WLCC software to assess where improvements have been made and what actions are still recommended to further improve water accountability.
- Implement temporary district metering to help further locate any leakage and non-revenue water. Appendix D describes a general approach to district metering for the Village of Howard.

- Develop a program to perform routine inspection for customer service meters to verify there is a meter installed and that it is being read and not bypassed. Perform a more detailed investigation for customers with larger or multiple services.
- Continue to calibrate the meters on the CBCWA connection and production wells. The Department should also continue to frequently test and replace customer meters, especially for large water users.
- In areas of high pressure (80 psi and greater), consider installing PRVs or verify that any existing PRVs are functional.
- Perform biannual leak detection surveys to locate newly developed leaks since the previous survey.

rlb
Attachments as noted
c: Patrick Planton, SEH

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TABLES

TABLE 1

HISTORICAL CUSTOMER SUMMARY

HOWARD WATER UTILITY

VILLAGE OF HOWARD, WISCONSIN

Year	Number of Customers					
	Residential	Commercial	Industrial	Public	Other	**Total**
1997	3,290	425	3	18	26	**3,762**
1998	3,420	447	3	20	26	**3,916**
1999	3,516	472	3	20	26	**4,037**
2000	3,627	502	3	22	32	**4,186**
2001	3,834	527	3	23	35	**4,422**
2002	4,108	551	4	23	34	**4,720**
2003	4,299	585	4	24	34	**4,946**
2004	4,515	609	5	28	50	**5,207**
2005	4,737	625	5	28	66	**5,461**
2006	4,842	634	5	28	69	**5,578**
2007	4,950	657	5	29	66	**5,707**
2008	5,048	668	5	28	146	**5,895**
2009	5,048	674	4	28	138	**5,892**
2010	5,163	676	4	29	147	**6,019**

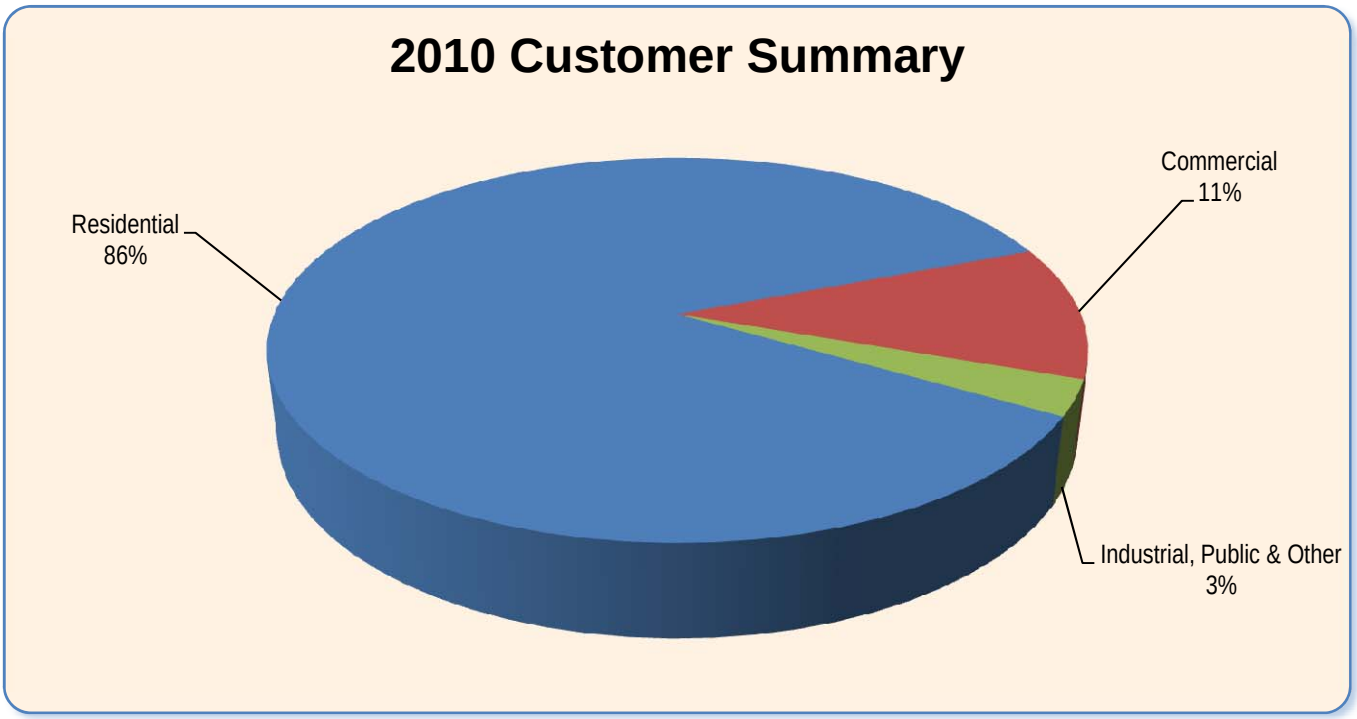

TABLE 2
ANNUAL WATER SALES COMPARISON
HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

Year	Total Sales	% Change	Total Sales Revenue	% Change
1997	368	---	$911.32	---
1998	401	9.0%	$993.62	9.0%
1999	441	10.0%	$1,016.53	2.3%
2000	414	-6.1%	$1,033.92	1.7%
2001	492	18.8%	$1,110.34	7.4%
2002	474	-3.7%	$1,165.75	5.0%
2003	598	26.2%	$1,253.41	7.5%
2004	616	3.0%	$1,250.05	-0.3%
2005	628	1.9%	$1,828.94	46.3%
2006	692	10.2%	$2,376.77	30.0%
2007	725	4.8%	$3,431.42	44.4%
2008	556	-23.4%	$3,579.61	4.3%
2009	514	-7.6%	$3,149.83	-12.0%
2010	494	-3.9%	$3,073.06	-2.4%

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TABLE 3

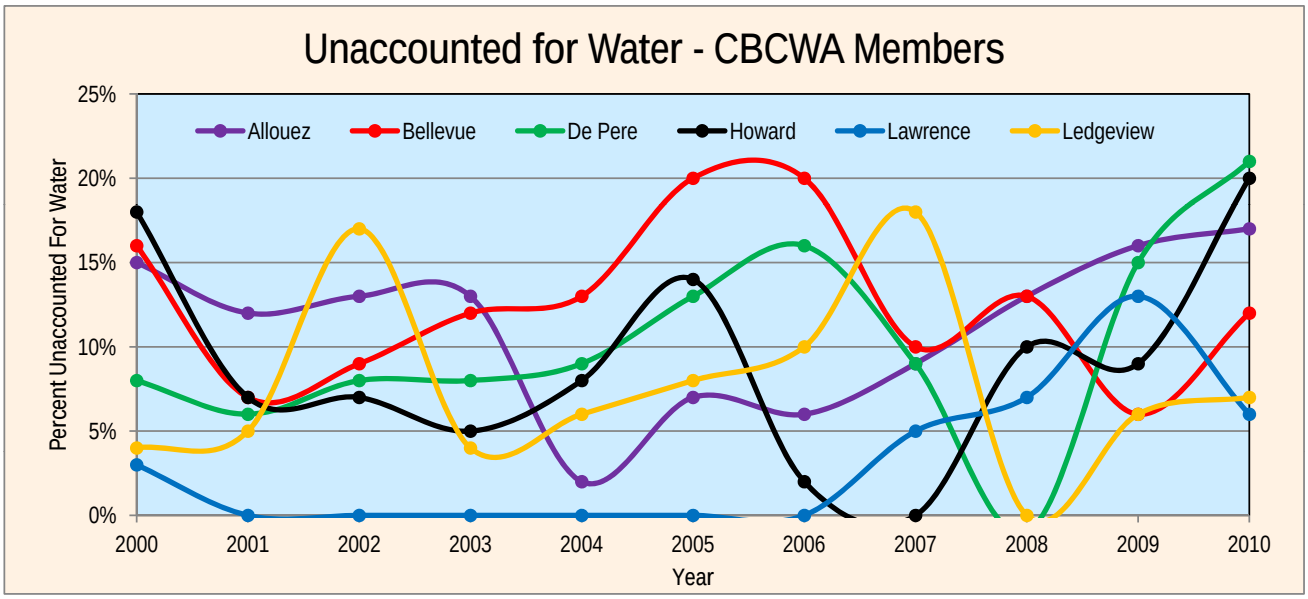
UNACCOUNTED FOR WATER - CBCWA MEMBERS

HOWARD WATER UTILITY

VILLAGE OF HOWARD, WISCONSIN

Year	Allouez		Bellevue		De Pere		Howard		Lawrence		Ledgeview	
	Non-Revenue Water	UFW	Non-Revenue Water	UFW	Non-Revenue Water	UFW	Non-Revenue Water	UFW	Non-Revenue Water	UFW	Non-Revenue Water	UFW
2000	15%	15%	16%	16%	7%	8%	31%	18%	1%	3%	8%	4%
2001	15%	12%	10%	7%	6%	6%	23%	7%	91%	0%	12%	5%
2002	17%	13%	13%	9%	9%	8%	25%	7%	86%	0%	22%	17%
2003	20%	13%	16%	12%	8%	8%	10%	5%	84%	0%	7%	4%
2004	7%	2%	17%	13%	9%	9%	12%	8%	79%	0%	13%	6%
2005	11%	7%	20%	20%	13%	13%	18%	14%	68%	0%	10%	8%
2006	12%	6%	24%	20%	19%	16%	6%	2%	38%	0%	13%	10%
2007	13%	9%	14%	10%	12%	9%	1%	0%	5%	5%	18%	18%
2008	16%	13%	19%	13%	13%	-1%	11%	10%	8%	7%	27%	0%
2009	18%	16%	19%	6%	21%	15%	10%	9%	15%	13%	15%	6%
2010	17%	17%	1%	12%	21%	21%	22%	20%	8%	6%	10%	7%

Note: All UFW data from PSC reports. Data submitted to the PSC does not match the billing spreadsheet data/meter data for the Village of Howard. Lawrence pumpage includes water pumped and sold to Ashwaubenon.



P:\FJ\H\HOWAV\117723\Project\Tables\[UFW Comparison CBCWA Members.xlsx]Sheet2

TABLE 4
UNACCOUNTED FOR WATER BY MILES OF WATER MAIN AND NUMBER OF SERVICE LATERALS

HOWARD WATER UTILITY

VILLAGE OF HOWARD, WISCONSIN

Year	Miles of Water Main	No. of Service Laterals	UFW (1,000 gal/yr)	UFW (1,000 gal/yr) / Mile	UFW (1,000 gal/yr) / Service Lateral
2005	92.8	5,749	108,200	1,165.40	19
2006	92.3	5,751	65,137	705.84	11
2007	93.4	5,820	62,300	667.23	11
2008	94.0	5,862	59,472	632.60	10
2009	93.8	5,793	123,107	1,312.27	21
2010	94.5	5,862	127,891	1,353.17	22

Note: UFW data was calculated based on UFW percentage calculated from billing spreadsheet records.

C:\Users\rblink\Desktop\HOWAV\117723\Project\Tables\[UFW by Miles of Main and No of Services.xlsx]Sheet1

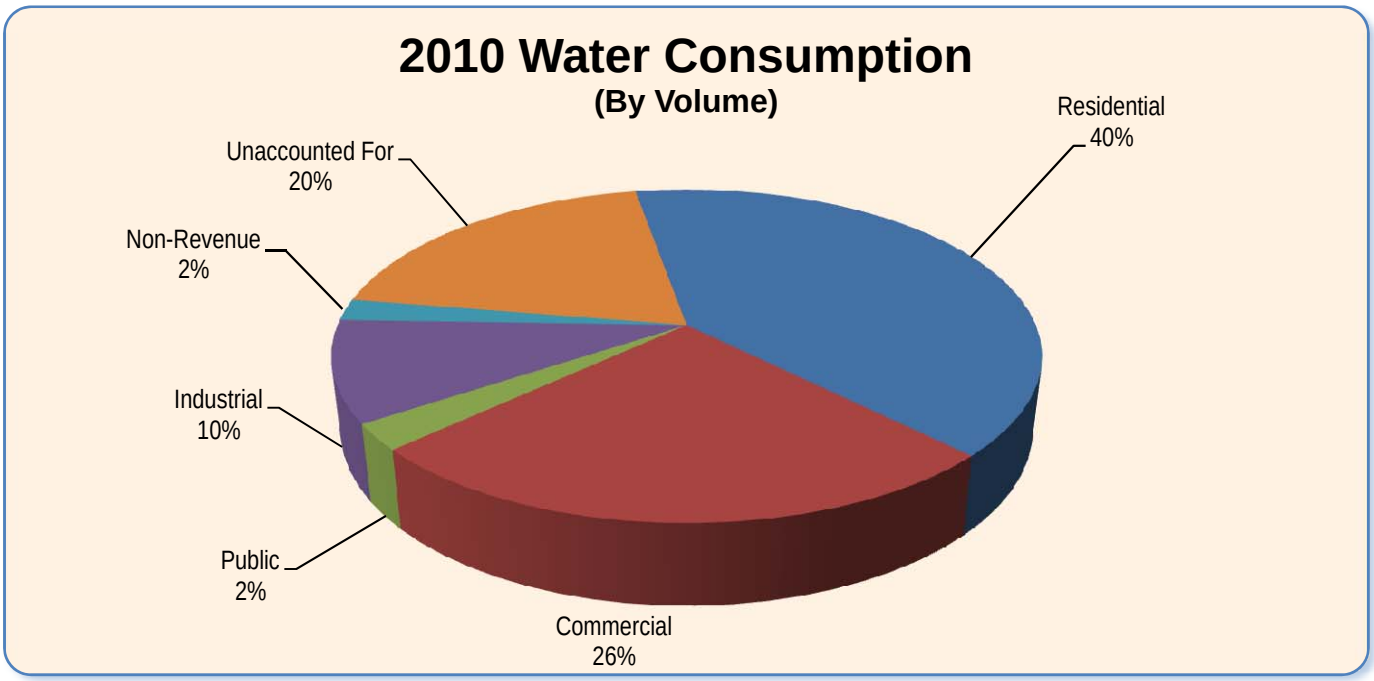
TABLE 5

WATER CONSUMPTION HISTORY - PSC REPORT

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

Year	Accounted for Water (MGY)				Non-Revenue Water (MGY)	Total Accounted For (MGY)	Total Pumpage (MGY)	% Accounted For
	Resi-dential	Com-mercial	Indust-rial	Public				
1997	**211**	**110**	**36**	11	20	**388**	**496**	**78.2%**
1998	222	125	43	11	90	491	591	83.1%
1999	235	151	45	**10**	95	536	617	86.8%
2000	227	127	48	12	96	510	599	85.1%
2001	298	127	50	17	101	593	640	92.7%
2002	284	119	54	17	**112**	586	632	92.7%
2003	339	152	93	14	31	629	663	94.8%
2004	361	150	87	18	28	644	701	91.9%
2005	**369**	154	92	13	30	658	**766**	85.9%
2006	358	163	153	18	23	715	733	97.5%
2007	365	164	**178**	18	**6**	**731**	732	**99.9%**
2008	301	142	94	**19**	7	563	623	90.4%
2009	283	**166**	50	15	7	521	570	91.4%
2010	254	162	62	16	13	507	631	80.4%

Maximum **Minimum**



P:\FJ\H\HOWAV\117723\Project\Report\[Table 4-x for TM.xlsm]Tab 1 PSC

TABLE 6

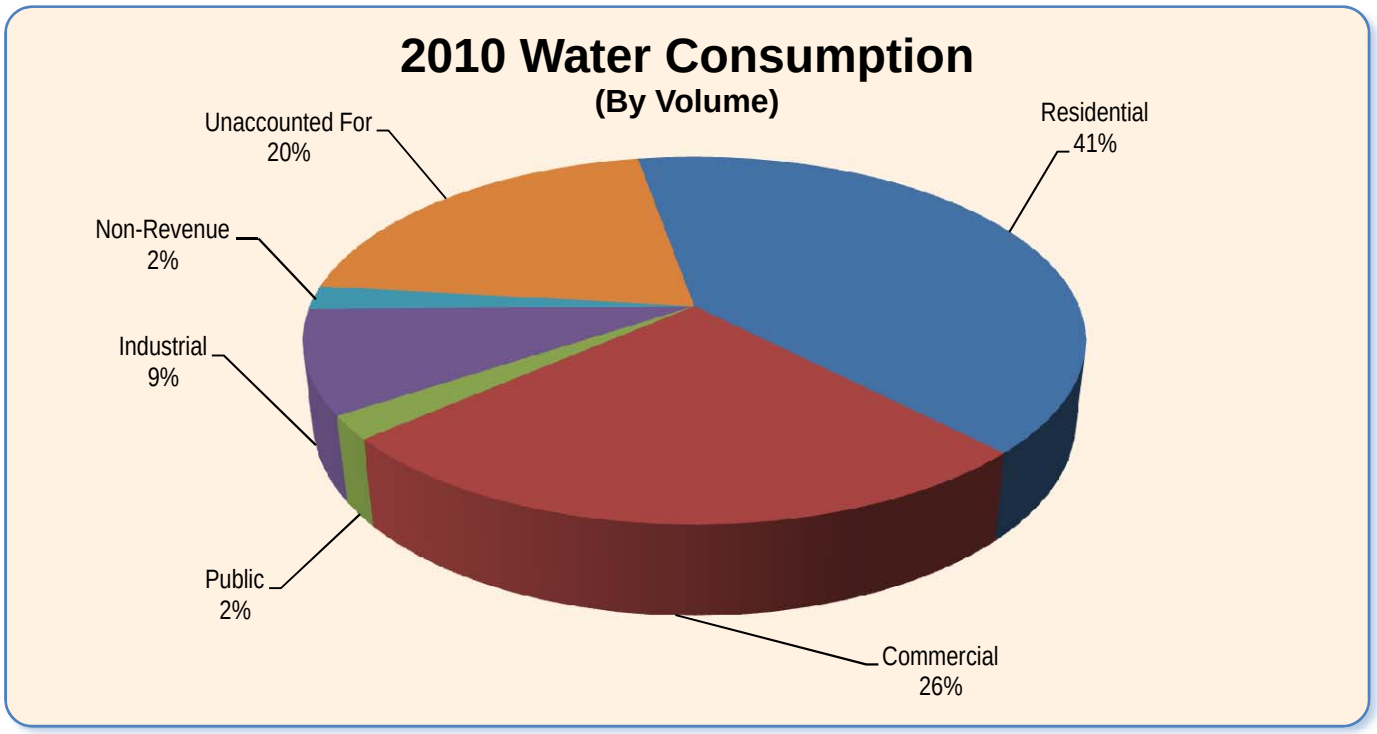
WATER CONSUMPTION HISTORY - BILLING SPREADSHEET DATA (2001-2010)

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

Year	Accounted for Water (MGY)				Non-Revenue Water (MGY)	Total Accounted For (MGY)	Total Pumpage (MGY)	% Accounted For
	Resi-dential	Com-mercial	Indust-rial	Public				
2001	298	127	50	17	101	593	640	92.7%
2002	284	119	54	17	112	586	632	92.7%
2003	339	152	93	14	31	629	663	94.8%
2004	361	150	87	18	28	644	701	91.9%
2005	369	154	92	13	30	658	766	85.9%
2006	358	163	108	16	23	668	733	91.1%
2007	365	164	117	18	6	670	732	91.5%
2008	301	142	94	19	7	564	623	90.5%
2009	283	166	49	15	7	520	643	80.9%
2010	254	162	57	13	13	499	627	79.6%

Note: OMNOVA was not included in industrial sales for 2009-2010 and was instead included in commercial sales for 2009-2010. Public records include available metering data for Village of Howard, Brown County, WDNR, and the school district. Total pumpage for 2009 and 2010 is from the DNR pumpage records, which differ from the PSC records for these years (570 MGY in 2009 and 631 MGY in 2010).

Differs from PSC Report



P:\FJ\H\HOWAV\117723\Project\Report\[Table 4-x for TM.xlsm]Tab 1A Sewer Billing Records

TABLE 7

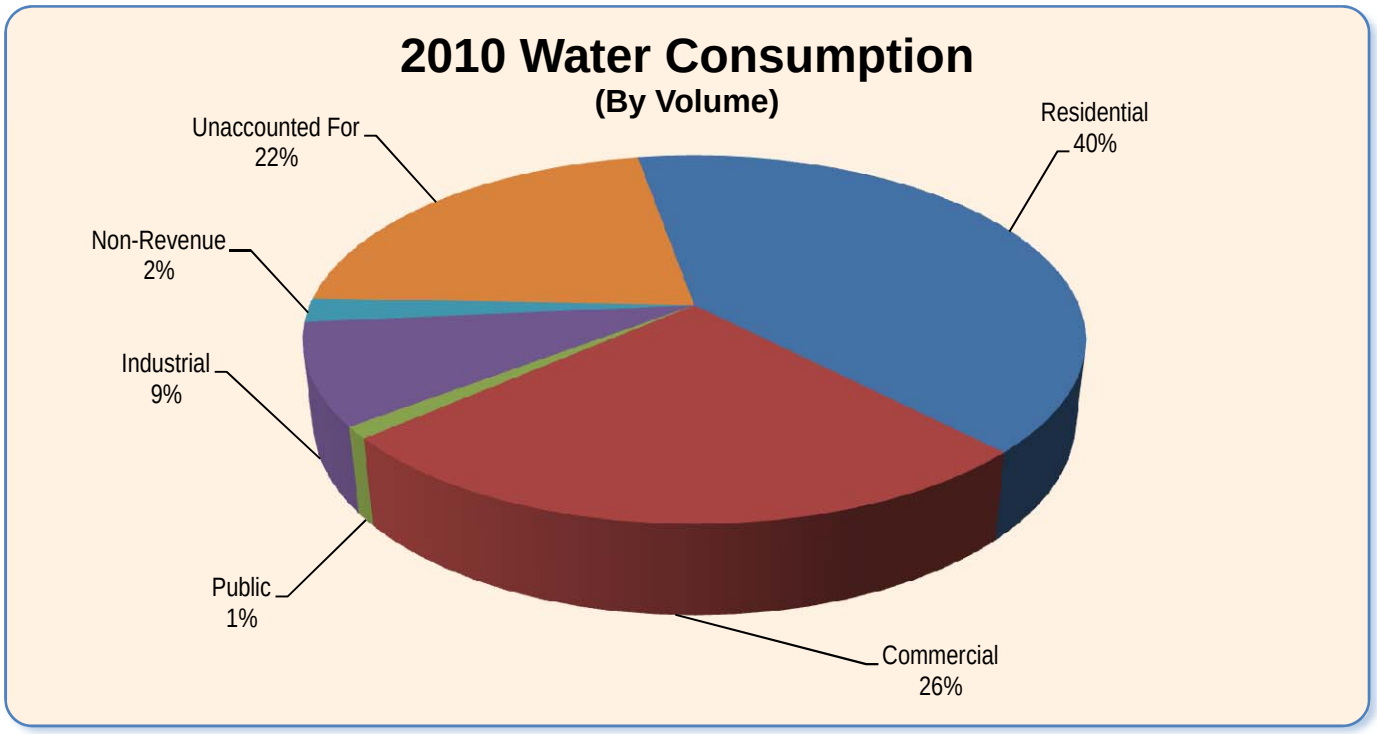
WATER CONSUMPTION HISTORY - METER RECORDS (2005-2010)

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

Year	Accounted for Water (MGY)				Non-Revenue Water (MGY)	Total Accounted For (MGY)	Total Pumpage (MGY)	% Accounted For
	Resi-dential	Com-mercial	Indust-rial	Public				
2005	369	154	93	9	30	655	766	85.6%
2006	358	163	107	11	23	662	733	90.4%
2007	365	164	117	12	6	663	732	90.6%
2008	301	142	95	12	7	557	623	89.4%
2009	283	166	**58**	9	7	523	643	81.4%
2010	254	162	**56**	7	13	492	627	78.4%

Note: 2005, 2006, and 2007 industrial use does not include billing records for Seaway Foods. OMNOVA was not included in industrial sales for 2009-2010 and was instead included in commercial sales for 2009-2010. Public records include available metering data for Village of Howard, Brown County, WDNR, and the school district. Total pumpage for 2009 and 2010 is from the DNR pumpage records, which differ from the PSC records for these years (570 MGY in 2009 and 631 MGY in 2010).

Differs from PSC Report



P:\FJ\H\HOWAV\117723\Project\Report\[Table 4-x for TM.xlsm]Tab 1B Meter Records

TABLE 8

COMPARISON OF WATER CONSUMPTION HISTORY

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

Year	Total Accounted for Water (MGY)			Total Accounted For Water (%)		
	PSC Report	Billing Spreadsheet Data	Meter Records	PSC Report	Billing Spreadsheet Data	Meter Records
1997	388	---	---	78.2%	---	---
1998	491	---	---	83.1%	---	---
1999	536	---	---	86.8%	---	---
2000	510	---	---	85.1%	---	---
2001	593	593	---	92.7%	92.7%	---
2002	586	586	---	92.7%	92.7%	---
2003	629	629	---	94.8%	94.8%	---
2004	644	644	---	91.9%	91.9%	---
2005	658	658	655	85.9%	85.9%	85.6%
2006	715	668	662	97.5%	91.1%	90.4%
2007	731	670	663	99.9%	91.5%	90.6%
2008	563	564	557	90.4%	90.5%	89.4%
2009	521	520	523	91.4%	80.9%	81.4%
2010	507	499	492	80.4%	79.6%	78.4%

TABLE 9

SUMMARY OF HIGH VOLUME CUSTOMERS
2008-2010

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

2010 Rank	Customer Name	Customer Classification	Water Sales (MGY)		
			2008	2009	2010
1	Eka Chemicals	Industrial	61.9	43.8	51.3
2	OMNOVA Solutions Inc.	Industrial	26.9	27.9	29.7
3	Beaver Dam Creek Apts	Commercial	11.1	12.1	11.6
4	Howard-Suamico Schools	Public Authority	16.5	12.0	10.4
5	United Health Group	Commercial	7.3	6.7	5.9
6	Sanimax	Industrial	5.2	4.8	5.4
7	Bruce Wolf	Commercial	4.5	4.2	4.6
8	Bay Port Shell	Commercial	3.4	3.2	3.2
9	Deer Run Apts	Commercial	3.6	3.4	3.1
10	YMCA	Commercial	3.5	3.2	3.0
11	Mills Fleet Farm	Commercial	2.7	2.8	2.8
		Top 11 High Volume Sales	146.6	124.1	131.1
		High Volume Sales Percent of Total Sales	26%	24%	26%

Note: Data is from billing spreadsheet records.

P:\FJ\H\HOWAV\117723\Project\Report\[Table 4-x for TM.xlsm]Large Water Users

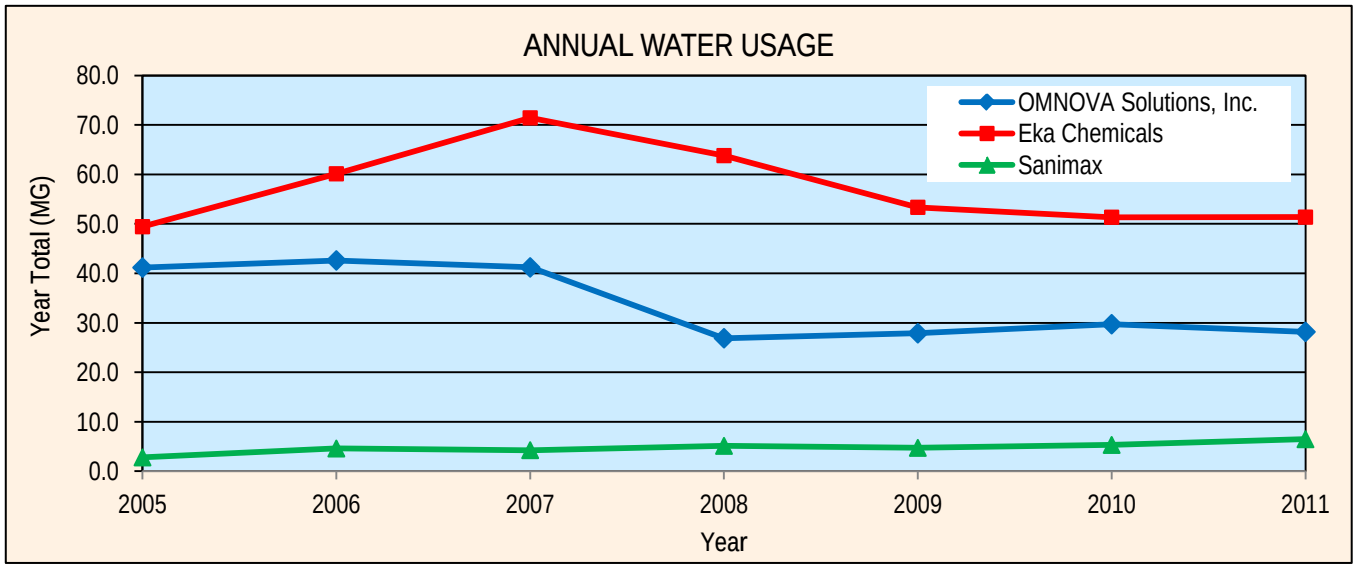
TABLE 10

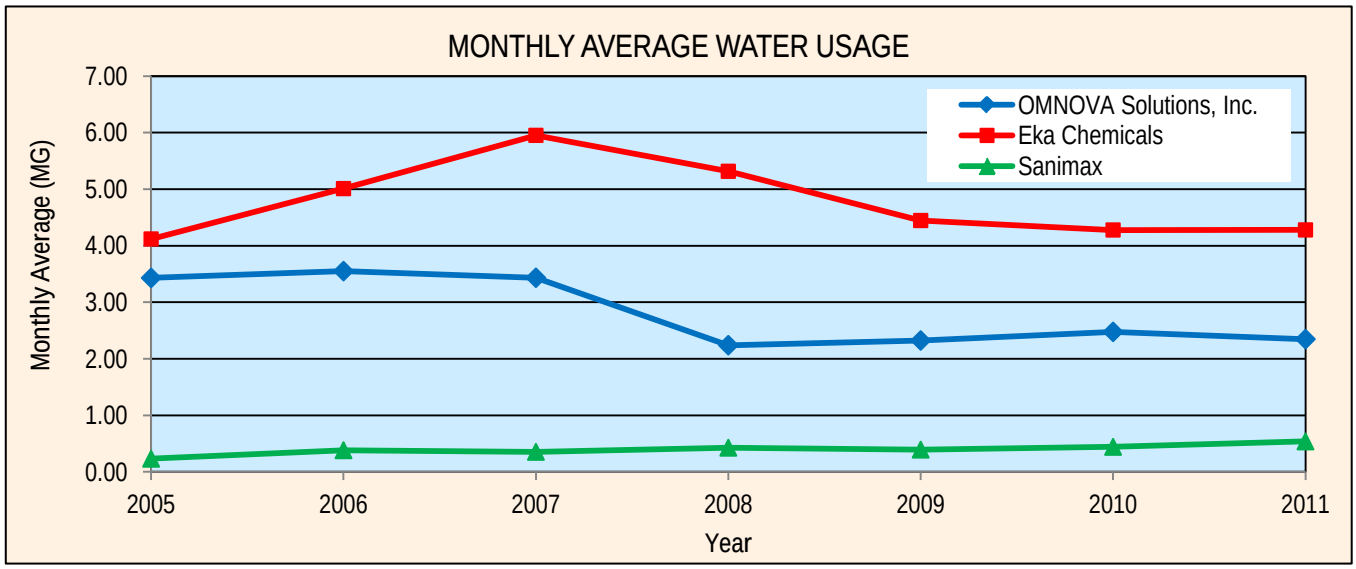
SUMMARY OF LARGEST WATER USERS - INDUSTRIAL USERS

HOWARD WATER & SEWER DEPARTMENT

VILLAGE OF HOWARD, WISCONSIN

Year	OMNOVA Solutions, Inc.		Eka Chemicals		Sanimax	
	Year Total (MGY)	Monthly Average (MG)	Year Total (MGY)	Monthly Average (MG)	Year Total (MGY)	Monthly Average (MG)
2011	28.2	2.35	51.4	4.28	6.47	0.54
2010	29.7	2.48	51.3	4.28	5.32	0.44
2009	27.9	2.32	53.4	4.45	4.73	0.39
2008	26.9	2.24	63.8	5.32	5.13	0.43
2007	41.2	3.43	71.4	5.95	4.26	0.35
2006	42.6	3.55	60.1	5.01	4.60	0.38
2005	41.2	3.43	49.4	4.12	2.79	0.23
Note: 2011 total usage is projected.						





P:\FJ\H\HOWAV\117723\Project\Demands\[Major Customer Usage.xlsx]Table 10

TABLE 11

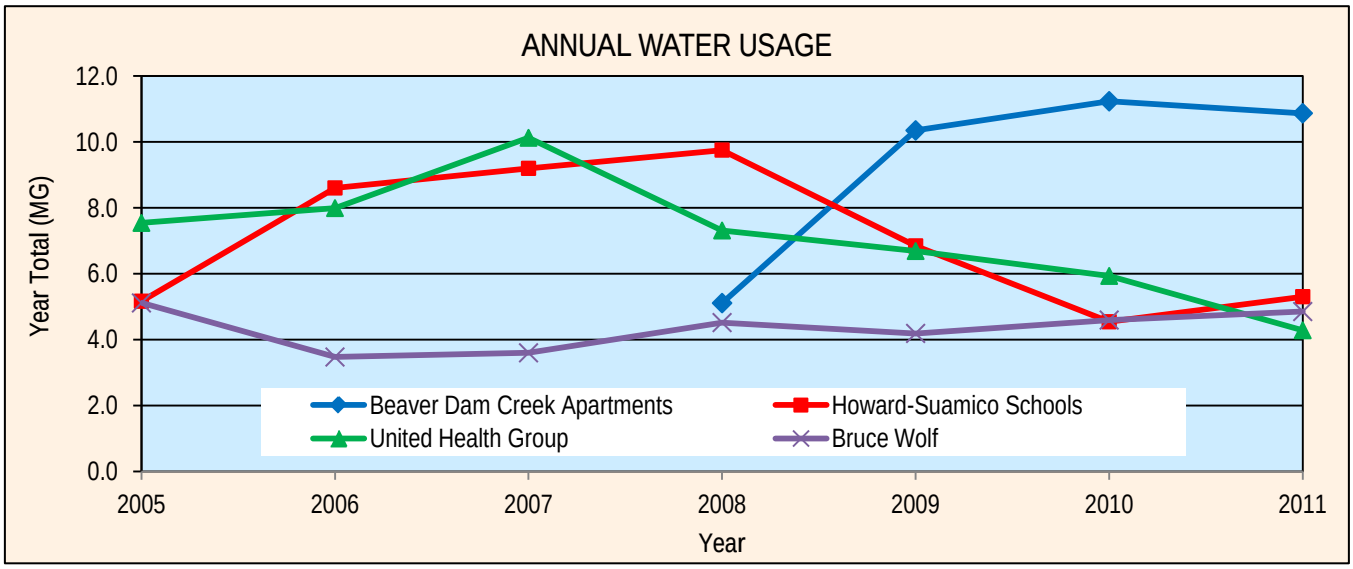
SUMMARY OF LARGEST WATER USERS - PUBLIC AND COMMERCIAL USERS

HOWARD WATER & SEWER DEPARTMENT

VILLAGE OF HOWARD, WISCONSIN

Year	Beaver Dam Creek Apartments		Howard-Suamico Schools		United Health Group		Bruce Wolf	
	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average
2011	10.9	0.91	5.3	0.44	4.3	0.36	*4.85*	*0.40*
2010	11.2	0.94	4.5	0.38	5.9	0.49	*4.60*	*0.38*
2009	10.3	0.86	6.8	0.57	6.7	0.56	*4.19*	*0.35*
2008	*5.1*	*0.43*	9.7	0.81	7.3	0.61	*4.52*	*0.38*
2007	-	-	*9.2*	*0.77*	10.1	0.84	3.60	0.30
2006	-	-	*8.6*	*0.72*	8.0	0.67	3.48	0.29
2005	-	-	*5.2*	*0.43*	7.5	0.63	5.11	0.43

Note: 2011 total usage is projected. Data in italics represents incomplete or missing records.



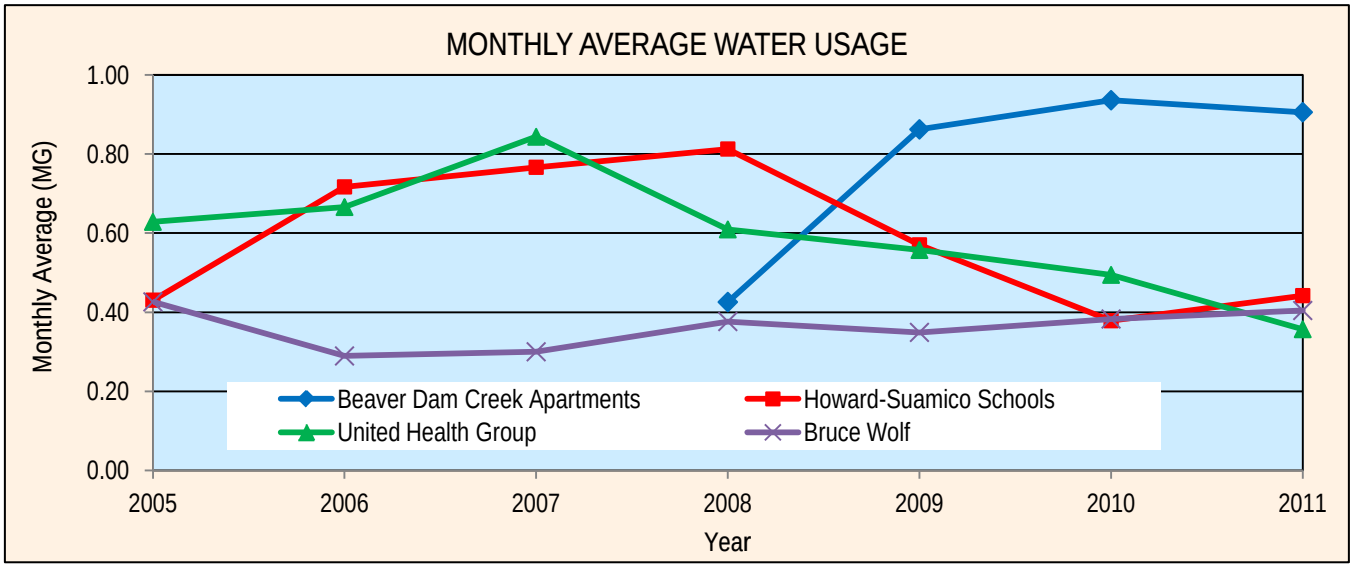


TABLE 12

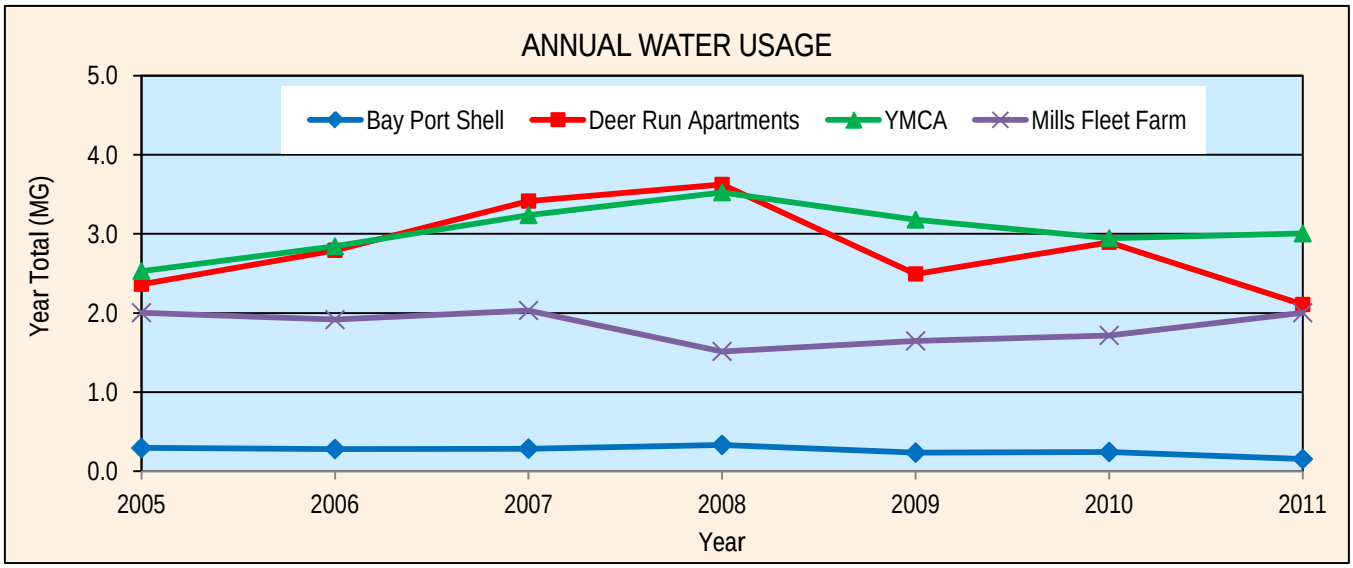
SUMMARY OF LARGEST WATER USERS - COMMERCIAL USERS

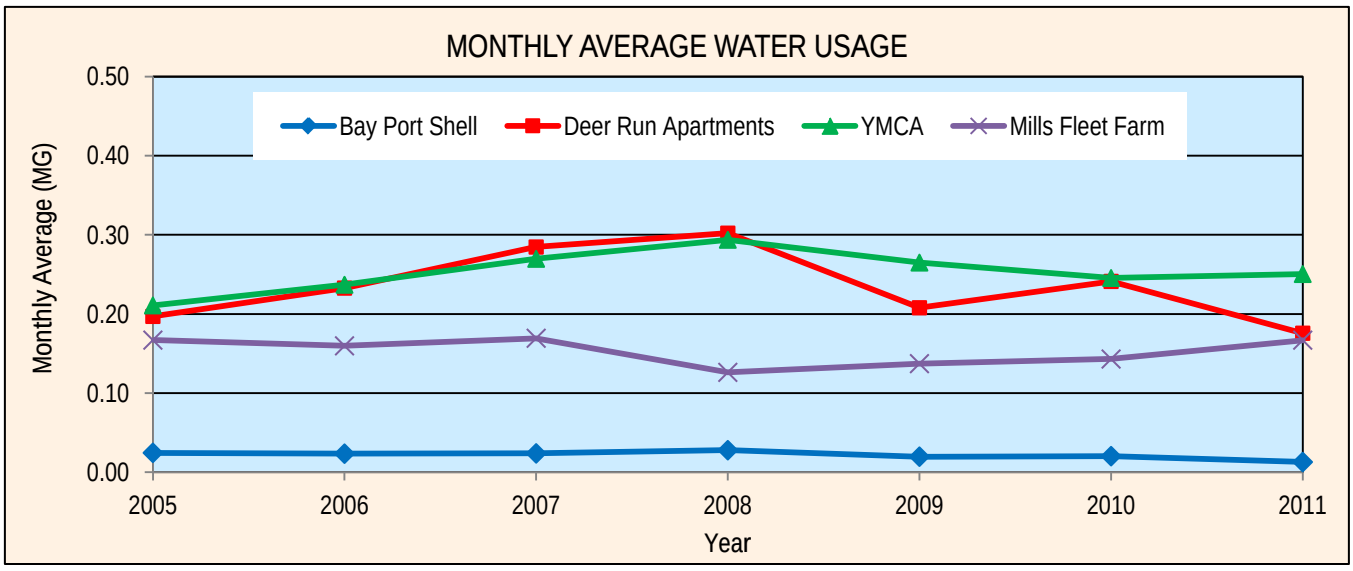
HOWARD WATER & SEWER DEPARTMENT

VILLAGE OF HOWARD, WISCONSIN

Year	Bay Port Shell		Deer Run Apartments		YMCA		Mills Fleet Farm	
	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average	Year Total (MGY)	Monthly Average
2011	0.2	0.01	2.1	0.18	3.0	0.25	2.00	0.17
2010	0.2	0.02	2.9	0.24	2.9	0.25	1.72	0.14
2009	0.2	0.02	*2.5*	*0.21*	3.2	0.26	1.65	0.14
2008	0.3	0.03	3.6	0.30	3.5	0.29	1.52	0.13
2007	0.3	0.02	3.4	0.28	3.2	0.27	2.03	0.17
2006	0.3	0.02	2.8	0.23	2.8	0.24	1.92	0.16
2005	0.3	0.02	2.4	0.20	2.5	0.21	2.00	0.17

Note: 2011 total usage is projected. Data in italics represents incomplete or missing records.





P:\FJ\H\HOWAV\117723\Project\Demands\[Major Customer Usage.xlsx]Table 12

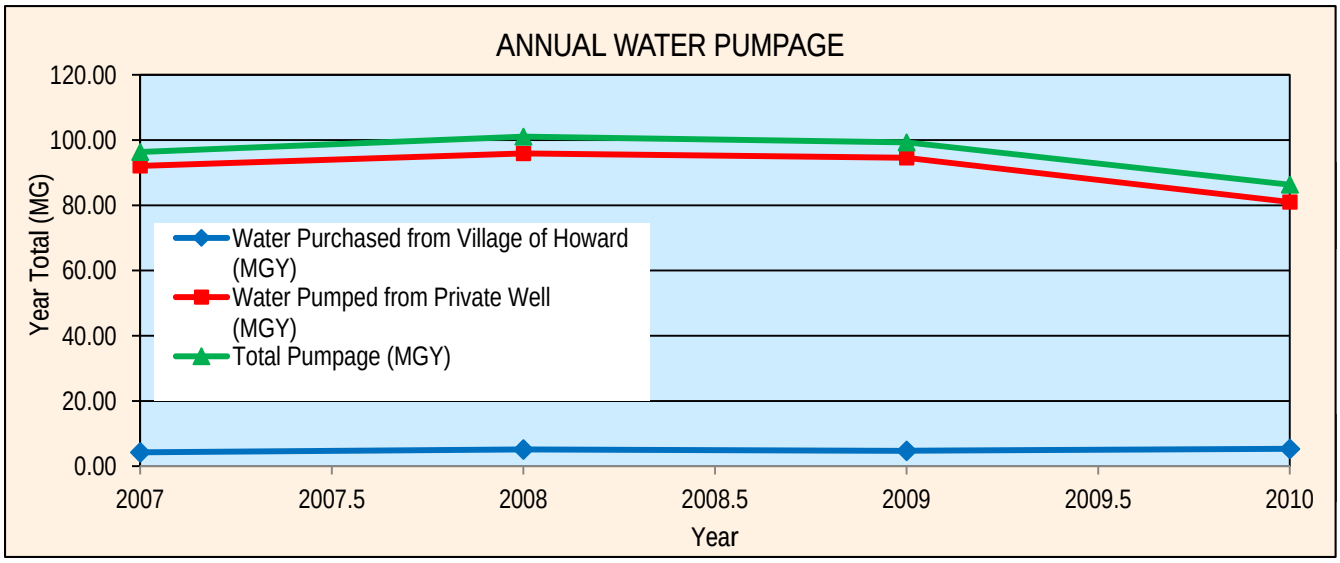
TABLE 13

SANIMAX PUMPAGE RECORDS

HOWARD WATER & SEWER DEPARTMENT

VILLAGE OF HOWARD, WISCONSIN

Year	Water Purchased from Village of Howard (MGY)	Water Pumped from Private Well (MGY)	Total Pumpage (MGY)
2010	5.32	81.0	86.3
2009	4.73	94.6	99.3
2008	5.13	95.9	101.0
2007	4.26	92.1	96.4



P:\FJ\H\HOWAV\117723\Project\Demands\[Major Customer Usage.xlsx]Sanimax Pumpage

FIGURES

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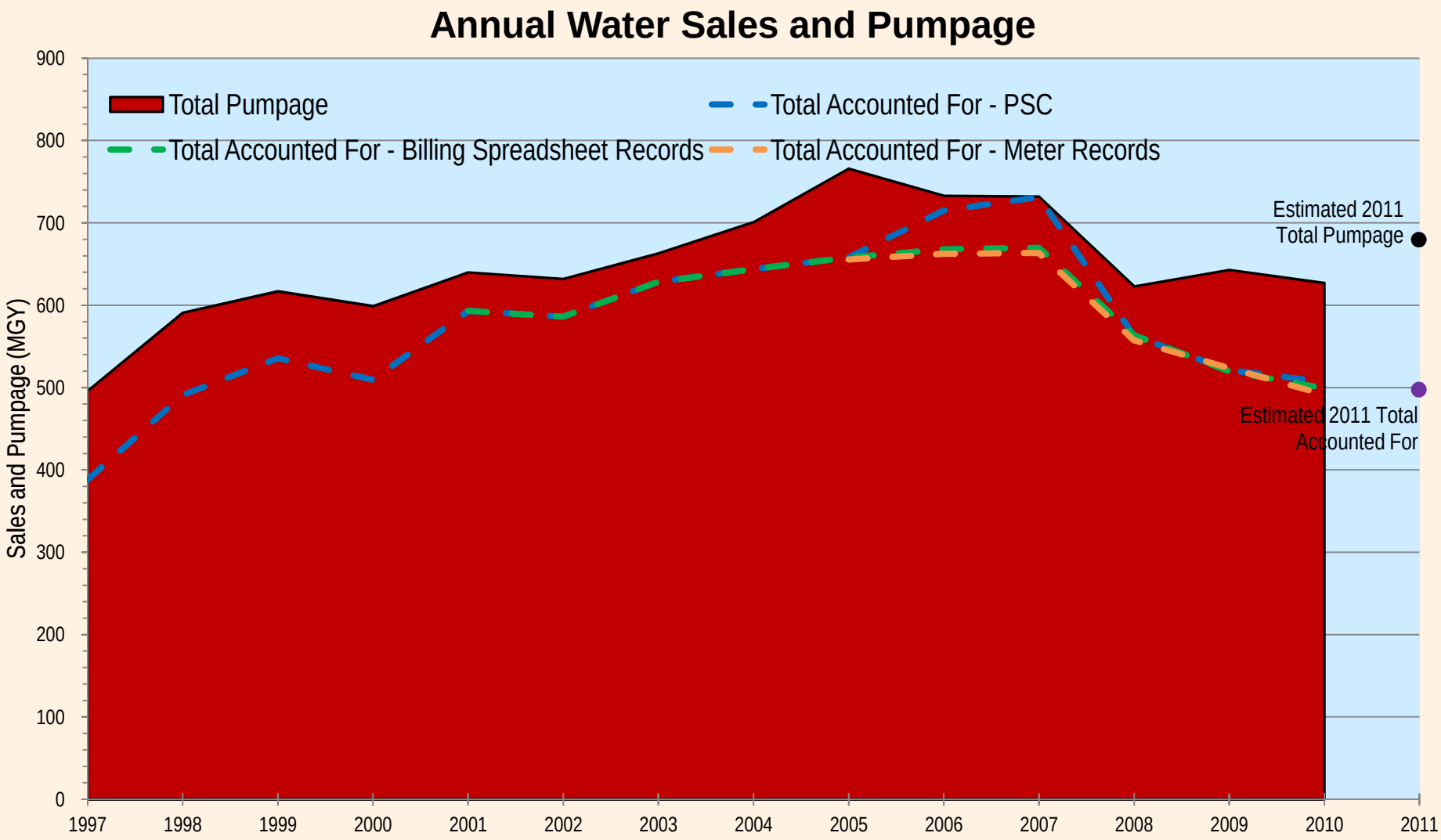

425 WEST WATER STREET
SUITE 300
APPLETON, WI 54911-6058
PHONE: (920) 380-2800

FIGURE 3

SALES AND PUMPAGE HISTORY

HOWARD WATER UTILITY

VILLAGE OF HOWARD, WISCONSIN

HOWAV 117723

APPENDIX A

VILLAGE OF HOWARD WATER SYSTEM PLANNING STUDY

Water Consumption Questionnaire

Name of Business: Eka Chemicals **Phone:** 920-434-0393

Name of Person Contacted: Jim Raiders (cell: 770-329-2935) **Title:** Plant & Process Engineer

Type of Product or Service: Silica Sol (98% of water use) and Non-Silica Sol

Number of Employees: 17 **Number of Shifts:** *One* *Two* *Three*

Average Size of Each Shift:
First: _____
Second: _____
Third: _____

Weekly Work Schedule: (Start-Finish)
Monday: _____ *Saturday:* _____
Tuesday: _____ *Sunday:* _____
Wednesday: _____
Thursday: _____
Friday: _____

Silica sol production is a 24 hour per day, 7 days a week, 363 days per year process. Non-silica sol production is a 12 hour per day, 5 days per week production.

Recent or Past Growth/Expansion which would have affected water consumption, specifically during 2007/2008?

NONE *YES-Explain*

From 2008-2009, the bad economy took a toll on plant production. Production is back up in in 2011.

Are any water conservation measures currently or planned to be employed? If already employed, when were they put in place?

NONE *YES-Explain*

Some water conservation/re-use measures were taken since purchasing CBCWA water. Water is re-used at least twice before discharging to waste. Howard plant is the largest water user in the company, so headquarters monitors the plant's water usage closely.

Describe water usage during a typical business day: (Domestic uses, industrial processes, cooling, irrigation, etc.)

The majority of the water is used for resin bed regeneration and chemical processing. Some is used for water softening. CBCWA water is fed into 25,000 gal tank, and Eka draws from tank for daily use. Tank has slow-fill and Fast-fill. Water is first used for cooling (which heats the water) and is then used in the process. Resin bed regeneration is staggered (2 x's per day/each reactor).

Is the water use constant throughout a shift/day or does it vary? If it varies, describe the reason for the variation.

Constant *Varies (Explain)*

Water use may vary with process, but draw from CBCWA is fairly consistant (use 25,000 gal tank for equalization).

Does water use vary throughout the year?

NO *YES-Explain*

May vary slightly (due to variation in production), but typically never more than 5 MG (September 2011 usage was 4.9 MG).

Do you operate any private wells? If so, how much water is pumped from your wells on a daily basis (approximate percentage of overall water use)?

NO *Yes-Explain*

A private well was considered, and went as far as getting a permit to drill a well. However, Eka Chemicals decided a private well would not be economically feasible.

Are there any immediate plant/building expansion plans that would affect water consumption volumes or rates?

NO *YES-Explain*

5 MG is most Eka Chemicals would expect to use in a month.

Are there any major long-term expansion plans (10-20 years) which could affect future water consumption?

NO *YES-Explain*

Process has been stable for last 10 years, so no major long-term expansion plans are expected.

Do you feel water rates are: *Too High* *About Right* *Too Low*

Water bills are higher than power bills.

Would water usage decline significantly if water rates increase?

YES NO MAYBE

Would consider drilling private well if water cost went up dramatically.

Is water quality a major concern to your plant's operation?

NO *YES-Explain*

Water with lower conductivity and hardness would be better. Cannot have iron in water because the silica sol will bond with the iron ions.

Thank you for your help.

VILLAGE OF HOWARD WATER SYSTEM PLANNING STUDY
Water Consumption Questionnaire

Name of Business: OMNOVA **Phone:** 920-434-4300

Name of Person Contacted: Victor Menting **Title:** Environmental Manager

Type of Product or Service: Emulsion polymer

Number of Employees: 55 **Number of Shifts:** *One* *Two* *Three*

Average Size of Each Shift:
First: _____
Second: _____
Third: _____

Weekly Work Schedule: (Start-Finish)
Monday: _____ *Saturday:* _____
Tuesday: _____ *Sunday:* _____
Wednesday: _____
Thursday: _____
Friday: _____

Production is 24 hours per day, 7 days per week, 365 days per year.

Recent or Past Growth/Expansion which would have affected water consumption, specifically during 2007/2008?

NONE *YES-Explain*

Production has increased; however, methodology has remained the same.

Are any water conservation measures currently or planned to be employed? If already employed, when were they put in place?

NONE *YES-Explain*

Two years ago, OMNOVA switched to a different water purification system that saves approximately 2 MG - 3 MG per year. Water re-use measures have also been implemented. OMNOVA is continually looking for ways to save water.

Describe water usage during a typical business day: (Domestic uses, industrial processes, cooling, irrigation, etc.)

Most of the water is used in the emulsion polymer product. Some is used for the cooling tower and boiler, and some is used for clean-up.

(Over)

Is the water use constant throughout a shift/day or does it vary? If it varies, describe the reason for the variation.

Constant *Varies (Explain)*

Does water use vary throughout the year?

NO *YES-Explain*

Fairly consistant throughout the year, but usage may increase in the summer due to greater evaporation from the cooling towers.

Do you operate any private wells? If so, how much water is pumped from your wells on a daily basis (approximate percentage of overall water use)?

NO *Yes-Explain*

Are there any immediate plant/building expansion plans that would affect water consumption volumes or rates?

NO *YES-Explain*

Are there any major long-term expansion plans (10-20 years) which could affect future water consumption?

NO *YES-Explain*

Do you feel water rates are: *Too High* *About Right* *Too Low*

Would water usage decline significantly if water rates increase?

YES NO MAYBE

Victor is unsure of the answer to this question. He forsees usage remaining consistent.

Is water quality a major concern to your plant's operation?

NO *YES-Explain*

OMNOVA uses ultra pure water (by means of RO) to manufacture the emulsion polymer.
The CBCWA water is of better quality than what was produced from the Village wells in the past.

Thank you for your help.

VILLAGE OF HOWARD WATER SYSTEM PLANNING STUDY

Water Consumption Questionnaire

Name of Business: Sanimax **Phone:** 800-955-6355

Name of Person Contacted: Mike McCormick 920-655-7276 **Title:** Environmental Supervisor

Type of Product or Service: Rendering plant. The majority of the water used for operation is from a private well (95%). Water from the Village is for potable use.

Number of Employees: 170 **Number of Shifts:** *One* *Two* *Three*

Average Size of Each Shift:

First:
Second:
Third:

Weekly Work Schedule: (Start-Finish)

Monday:	24 hr	*Saturday:*	24 hr
Tuesday:	24 hr	*Sunday:*	
Wednesday:	24 hr		
Thursday:	24 hr		
Friday:	24 hr		

Operation is 24 hours per day, 6 days per week

Recent or Past Growth/Expansion which would have affected water consumption, specifically during 2007/2008?

NONE *YES-Explain*

Are any water conservation measures currently or planned to be employed? If already employed, when were they put in place?

NONE *YES-Explain*

None currently planning to be employed, but water conservation measures are being evaluated.

Describe water usage during a typical business day: (Domestic uses, industrial processes, cooling, irrigation, etc.)

Water from the village is used primarily for showers, drinking water, and was also used for two scrubbers up until about September 2011. The water from the well is used for the plant operations.

(Over)

Is the water use constant throughout a shift/day or does it vary? If it varies, describe the reason for the variation.

Constant | *Varies (Explain)*

Water use from the Village is pretty consistent throughout the day. Water use from the well is inconsistent because the plant operation is variable. There are several peaks throughout the day for water use. There is a water tank/tower (~7,500 gal) to help buffer the peaks.

Does water use vary throughout the year?

NO | *YES-Explain*

Do you operate any private wells? If so, how much water is pumped from your wells on a daily basis (approximate percentage of overall water use)?

NO | *Yes-Explain*

Sanimax operates one private well that is non-potable.

Are there any immediate plant/building expansion plans that would affect water consumption volumes or rates?

NO | *YES-Explain*

Are there any major long-term expansion plans (10-20 years) which could affect future water consumption?

NO | *YES-Explain*

Do you feel water rates are: *Too High* | *About Right* | *Too Low*

Would water usage decline significantly if water rates increase?

YES | NO | MAYBE

Is water quality a major concern to your plant's operation?

NO | *YES-Explain*

Thank you for your help.

VILLAGE OF HOWARD WATER SYSTEM PLANNING STUDY

Water Consumption Questionnaire

Name of Business: Seaway Foods **Phone:** 920-434-1636

Name of Person Contacted: Dan Tonnon **Title:** President

Type of Product or Service: Food processing

Number of Employees: 8 **Number of Shifts:** *One* *Two* *Three*

Average Size of Each Shift:

First: _____
Second: _____
Third: _____

Weekly Work Schedule: (Start-Finish)

Monday:	7:00 - 5:00	*Saturday:*	_____
Tuesday:	7:00 - 5:00	*Sunday:*	_____
Wednesday:	7:00 - 5:00		
Thursday:	7:00 - 5:00		
Friday:	7:00 - 5:00		

Recent or Past Growth/Expansion which would have affected water consumption, specifically during 2007/2008?

NONE *YES-Explain*

Are any water conservation measures currently or planned to be employed? If already employed, when were they put in place?

NONE *YES-Explain*

Dan mentioned that they used to have a water cooled ice machine and now have an air cooled ice machine.

Describe water usage during a typical business day: (Domestic uses, industrial processes, cooling, irrigation, etc.)

Water is mostly used to clean fish. No potable water used for cooling or irrigation.

Is the water use constant throughout a shift/day or does it vary? If it varies, describe the reason for the variation.

Constant *Varies (Explain)*

More water is used in the morning, but overall, water use throughout the day is fairly constant.

Does water use vary throughout the year?

NO *YES-Explain*

Do you operate any private wells? If so, how much water is pumped from your wells on a daily basis (approximate percentage of overall water use)?

NO *Yes-Explain*

Are there any immediate plant/building expansion plans that would affect water consumption volumes or rates?

NO *YES-Explain*

Are there any major long-term expansion plans (10-20 years) which could affect future water consumption?

NO *YES-Explain*

Do you feel water rates are: *Too High* *About Right* *Too Low*

Water rates increased significantly, but it is understood why they increased.

Would water usage decline significantly if water rates increase?

YES NO MAYBE

Is water quality a major concern to your plant's operation?

NO *YES-Explain*

Water quality is important, and since purchasing water from CBCWA there are no water quality issues. When the Village pumped water from the wells, one well produced brown water, which was not desirable for fish cleaning.

Thank you for your help.

APPENDIX B

TABLE B-1

METER TEST RECORDS

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

SIZE	ID # - - AR	ID # - - IR	DATE TESTED	BY WHOM	PERCENT REGISTRATION						ADDRESS AND / OR REMARKS
					FLOW AS FOUND			FLOW AS LEFT			
					LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
3/4	70265910	18226781	2/9/2011	TB	101.4	100.5	99.5	101.4	100.2	99.4	
3/4	70337237	16375610			101.2	101.4	100.4	101.1	101.2	99.6	
3/4	70335548	16483414			101.4	100.1	100.4	101.3	100.2	99.6	
3/4	70233484	91273671			101.5	100.5	99.4	101.4	100.5	99.7	
3/4	70791038	98028032			101.5	101.1	99.3	100.5	99.9	99.5	
3/4	70684571	19143322			101.5	100.2	99	101.3	100.4	99.4	
3/4	70832061	33113904	2/16/2011		X	X	X	100.2	100.5	100	Froze/ Broke, Nichole will bill
3/4	70394536	97347347			X	X	X	100.9	100.5	99.7	Froze/ Broke, Nichole will bill
3/4	70791632	89532132			101.3	100.9	99.4	99.5	100	99	
3/4	70491771	16375642			101.5	101.1	99.4	99.8	101	99.9	
3/4	70151023	98989733			101.5	101	99.6	100.2	101.4	99.6	
3/4	70336344	95603125			101.4	100.5	99.9	99.5	101	99.9	
3/4	70429926	33113956	2/17/2011		100	101.1	100	100.5	101.4	100	New AR 70752958
3/4	70265958	95475083			100.1	100.5	100.1	101	100.1	99.4	
3/4	70429863	16375637			101.1	101	100.3	100.1	101.2	100	
3/4	70640265	32676044			100.4	100	99.7	101.1	101.5	100.3	New AR 70752882
3/4	74260948	29415463			99.9	100.7	99.9	100	100.9	99.4	
3/4	70684794	95100181			101.1	100.5	99.4	101.5	101	99.9	
3/4	70791814	98027999	2/25/2011		101.5	101.3	100	101.5	101	99.8	
3/4	70491776	95100241			101.4	101	99.1	101.5	101.1	98.7	
3/4	70335324	16691191			99.9	101	99.8	101.4	101.1	99.2	New AR 70753019
3/4	70335789	96103671			101	101.5	99.2	101	101.3	99.4	
3/4	70828501	17733429			101	100.5	99.3	101.5	101.4	99.7	New AR 70752988
3/4	70336967	93782944			101.5	101	99.6	101.5	101	99.1	
3/4	70828558	19781136	5/5/2011	TB	101.4	100.8	99.5	101.5	100	100.1	New AR 70685213
3/4	70492116	16691251			101.5	100.1	99.7	101.5	100.5	99.4	
3/4	70394809	89532103			101.5	100	99.7	99.4	101	99.8	
3/4	70203696	92510097			101.3	100	89.1	101.5	100.8	99.9	
3/4	70394049	98354952			101.4	100.1	100	101.5	101.5	100.9	New AR 70685719
3/4	70335467	93613776			101	99.8	99.6	99.8	101	100	
3/4	70098408	98354974	6/2/2011	TB	101.4	100.1	99.6	101.5	101.5	99.2	
3/4	70269737	93782941			101.1	100	99.7	101.5	100	99	Changed AR 70163137
3/4	70234039	89627996			101	100.3	99.5	92.3	101.5	99.2	New AR 70685692
3/4	70833307	95100204			101.5	100.4	99.5	100.5	101.5	98.5	New AR 70685720
3/4	70269987	96957424			101.3	100	99.8	101.4	101.1	98.6	New AR 70685727
3/4	70336793	94639601			101.4	100.1	99.8	100.7	101.4	98.8	

SIZE	ID # - - AR	ID # - - IR	DATE TESTED	BY WHOM	PERCENT REGISTRATION						ADDRESS AND / OR REMARKS
					FLOW AS FOUND			FLOW AS LEFT			
					LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
3/4	70161566	90400474	8/2/2011		X	X	X	100.5	101	99.4	Stuck
3/4	70336578	18226777			X	X	X	99.5	101.5	99.2	Stuck
3/4	70685052	96269549			X	X	X	99.4	101.3	99.5	Stuck
3/4	70685965	97567565			X	X	X	99.8	101	89.2	Stuck
3/4	70685950	97567601			101.4	100.1	99.3	99.8	101.4	99	
3/4	70791915	92814132			100.9	100	99.7	100.1	101.1	99.3	
3/4	70269977	99686294			101.3	100	99.5	101	100	98.9	
3/4	70791761	99407951			101.4	100.6	99.6	101.1	100	99.1	
3/4	70393929	91596775			101.1	100	99.3	100	99.5	97.4	
3/4	70394044	97034506			101.2	100.1	99.7	101	100.5	99.5	
3/4	70433552	97567552			101	100	99.7	98.9	100	98	
3/4	70161191	94024829			101.1	100.6	99.3	100.8	101.4	98.6	
3/4	70829673	33113954	2/16/2011	TB	101.1	99.9	99.7	100.9	100	99.8	
3/4	70684506	91465906			101.5	100	100	101.2	100	100.2	New AR 70752972
3/4	70163263	29077843			101	101.4	99.4	101.4	100.1	100	New AR 70752952
3/4	70791558	91465850			101.4	100	100.4	101	100.3	100.2	
3/4	70792088	16691218			101.2	99.9	99.7	100.5	100.5	100.3	New AR 70752960
3/4	70151121	90319739			100.2	100	100.5	100.2	100.6	99.6	New AR 70752974
3/4	70335434	95474965	2/24/2011		101.2	101.1	99.6	101.4	99.8	99.2	
3/4	70968775	95100192			100.9	100.1	100	101.3	100	98.8	New AR 70753475
3/4	70335319	16375661			101.3	100	99.9	101.2	100	99.9	
3/4	70336022	17542512			101.3	100.2	99.7	101.5	100	99	
3/4	70394632	91770562			101.4	99.9	100.1	99.6	100.2	99.2	
3/4	70174764	29516634	2/25/2011		100.1	101.1	99.7	101	100.6	99.8	
3/4	70491797	29322017			99.8	100	99.4	101	100	99.4	
3/4	70335615	91465904			99.8	101.5	99.9	99.8	100.9	99.9	New AR 70752975
3/4	70233689	95100273			X	X	X	100.5	100.1	98.9	Froze/ Broke
3/4	70752981	19781121			99.9	100.8	100	101.5	100.9	99.2	
3/4	71312369	19490593	3/28/2011		101.2	100.2	99.8	91	101	100	
3/4	70491990	97034534			101	101	99.9	101.1	99.8	99.8	
3/4	71311012	89049206			100.9	99.9	100.4	100	100	99.5	
3/4	70394813	89629038			101.3	99.8	100.1	101	99.6	99.3	
3/4	70336396	96719898			101	101.1	99.9	101.1	99.9	99.5	
3/4	70430049	16296796	4/7/2011		101.5	101.5	98.6	100.5	101.5	99.8	
3/4	70791657	35998962			101.4	101	99.5	101	101.5	98.7	
3/4	70491659	29516657			101.2	100	99.2	100.5	100.5	99.7	
3/4	70394617	92005822	4/7/2011	TB	101.5	100.7	99.5	99.7	101.4	98.5	
3/4	70492091	94452487			101.5	100	98.5	101.5	100.5	99.5	New AR 70685730
3/4	70491328	95475082	4/13/2011		101.1	99.5	99.3	99.8	98.8	98.6	New AR 70685729
3/4	70491555	17008798			101.5	100	99.7	101.4	100.1	98.7	New AR 70685725
3/4	70151180	91020987			101.5	100	99	101.5	99.7	99	
3/4	71311078	95774953			101.5	100	100	101.1	100.1	99.2	
3/4	70394599	97347345			101.4	100.1	99.6	101.1	100	99.2	

SIZE	ID # - - AR	ID # - - IR	DATE TESTED	BY WHOM	PERCENT REGISTRATION						ADDRESS AND / OR REMARKS
					FLOW AS FOUND			FLOW AS LEFT			
					LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
3/4	70394579	95100264	4/20/2011		101.3	101.3	99.5	101.5	101	99.5	
3/4	70335199	90613812			101.5	101.5	98.5	101.4	100	99	Changed AR 70429903
3/4	70491786	98554637			101	101	99.4	101.5	100	99.7	
3/4	70684660	98354986			101.1	101.4	99.5	101.4	99.9	98.3	
3/4	No AR	97150108			X	X	X	100.5	100.8	98.2	Base Froze - Broke / Base change only 1335 Cornell now AR 70685706. I talked to Nichole on 4-20-11. She will bill out for it.
3/4	70284171	97720282	5/5/2011		101.3	100.6	99.9	101	100	99	
3/4	70233987	19490572			101.5	100.1	99.6	101.5	100	99.5	New AR 70685721
3/4	70174248	29443100			X	X	X	101	99.5	99.3	Froze/ Broke
3/4	70163137	92792309			101.3	100.4	99.8	101.5	99.5	99	New AR 70685718
3/4	70791314	98354947			101.5	100.1	99.9	100.1	100	99.7	
3/4	70161283	88445037	5/6/2011		101.3	100.5	99.6	100	100.1	99.5	New AR 70685716
3/4	70429857	98706898			101.4	100.6	99.5	101	100.5	98.9	New AR 70685714
3/4	70968760	97347282			101.5	100	100	101.4	100	99.5	
3/4	70187099	97720291			101	100	99.9	100.6	99.7	98.8	
3/4	70491720	89058752			101.1	100.1	100.1	101.2	99.2	98.8	
3/4	70161283	88445037	8/2/2011		101.3	100.2	99.7	100	100.5	99.5	New AR 70685716
3/4	70429857	98706898			101	100.1	99.6	100	100.5	98.7	New AR 70685714

P:\FJ\H\HOWAV\117723\Project\Report\Appendix B\[Customer Meter Test Results.xlsx]Sheet1

TABLE B-2

COMPOUND TEST RECORDS

HOWARD WATER UTILITY
VILLAGE OF HOWARD, WISCONSIN

DATE TESTED	PROPERTY NAME	ADDRESS	SIZE	BY WHOM	SERIAL # BASE	SERIAL # AR	READING (GALLONS)		COMPLAINT TEST	FIRE PROTECTION LINE	WATER SERVICE LINE SIZE	NO. OF METERS ON SERVICE SUPPLY LINE	TEST RESULTS			
													HIGH SIDE		LOW SIDE	
							HIGH SIDE	LOW SIDE					GPM	%	GPM	%
10/11/2011	Nsight Telservices	450 Security Blvd.	-	TB	-	70014054	975,290.5	14,470	Pass	Yes	4"	1	255	97.9	25	100.4
													125	98.0	10	102.4
													53	100.5	-	-
10/5/2011	Green Bay Community Church	600 Cardinal Ln.	3" Compound	TB	-	-	509,680	1,209,782	Pass	No	4"? (insulated)	1	330	99.8	35	100.2
													150	101.2	25	99.2
													50	100.5	10	100.8
10/12/2011	YMCA	601 Cardinal Ln.	4" Compound	TB	-	-	5,553,265	1,592,548	-	No	Not sure - insulated	1	360	97.2	20	95.4
													180	98.5	5	100.0
													45	101.4	2	100.0
10/11/2011	American Medical	3100 AMS Blvd.	3" Compound	TB	-	-	6,057,365	33,277,520	Pass	Yes - separate 10" fire line	6"	2	365	102.9	25	101.4
													150	102.8	10	101.8
													50	102.0	-	-
10/6/2011	Brookview Meadows	1740 Condor Ln.	4" Compound	TB	-	-	585,009	1,507,651	Pass	Yes	8"	-	370	100.0	15	100.2
													100	101.0	7	100.0
													25	101.2	2	100.0
10/27/2011	Lineville Intermediate School	2700 Lineville Rd.	4" Compound	TB	05368060	70432995	267,338	5,846,225	Pass	No	4" - all pipes are wrapped	1	300	97.1	15	101.3
													80	99.0	4	101.0
													30	98.8	0.5	98.0
10/25/2011	Meadowbrook School	720 Hillcrest Heights	3" Compound	TB	04180635	70327024	2,674,625	2,962,350	Pass	No	4"	1	270	99.9	5	101.0
													100	99.2	1	102.0
													25	99.8	0.5	97.0
10/10/2011	Wipfli LLP	469 Security Blvd.	3" Compound	TB	02002918	70014052	3,137,417	1,187,230	Pass	Yes	6"	2	240	101.0	20	98.0
													100	102.0	5	97.0
													40	102.0	0.5	100.3
10/17/2011	American Inn	2032 Velp Ave.	3" Compound	TB	02001161	70014060	-	-	-	Yes	6"	2 - one 3" compound and one 3/4"	345	100.2	25	101.0
													100	102.2	7	101.0
													45	101.9	2	101.0
10/17/2011	Davies Water	1281-A Cornell Rd.	4" Compound	TB	04180636	70327019	184,218	277,212	Pass	No	8"	2	445	97.1	15	96.1
													103	99.0	7	99.4
													27	99.0	2	100.0
10/14/2011	Forest Glen School	1935 Cardinal Ln.	-	TB	-	-	1,693,830	2,788,555	Pass	Yes	4"	-	270	97.0	15	100.1
													100	99.4	7	100.0
													25	99.2	2	101.0
10/28/2011	Bay View Middle School	1217 Cardinal Ln.	4" Compound	TB	5368061	70432935	-	-	-	No	4"	1	280	97.6	14	98.6
													100	98.6	3	98.0
													30	100.3	0.5	99.0

P:\FJ\H\HOWAV\117723\Project\Report\Appendix B\[Compound Meter Test Results.xlsx]Sheet1

APPENDIX C

AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.2

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WAS v4.2

PURPOSE: This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format, and is not meant to take the place of a full-scale, comprehensive water audit format.

USE: The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

THE FOLLOWING KEY APPLIES THROUGHOUT:

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY: Village of Howard

COUNTRY: United States of America

REPORTING YEAR: 2010

START DATE(MM/YYYY): 01/2010

END DATE(MM/YYYY): 12/2010

NAME OF CONTACT PERSON: Geoff Farr

E-MAIL: gfarr@villageofhoward.com

TELEPHONE: 920-434-4060

Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME: Million gallons (US)

Click to advance to sheet…

Click here: ? for help about units and conversions

Instructions	The current sheet
Reporting Worksheet	Enter the required data on this worksheet to calculate the water balance
Water Balance	The values entered in the Reporting Worksheet are used to populate the water balance
Grading Matrix	Depending on the confidence of audit inputs, a grading is assigned to the audit score
Service Connections	Diagrams depicting possible customer service connection configurations
Definitions	Use this sheet to understand terms used in the audit process
Loss Control Planning	Use this sheet to interpret the results of the audit validity score and performance indicators

Comments:

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: wlc@awwa.org

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.2

Back to Instructions

? Click to access definition

Water Audit Report for: Village of Howard
Reporting Year: 2010 | 1/2010 - 12/2010

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

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	8	1.035	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment (enter positive value):	8	0.000	under-registered	MG/Yr
Water imported:	10	630.038	MG/Yr	
Water exported:	n/a	0.000	MG/Yr	
WATER SUPPLIED:		631.073	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:
Billed metered:	8	495.141	MG/Yr		
Billed unmetered:	6	0.000	MG/Yr		
Unbilled metered:	8	0.000	MG/Yr		
Unbilled unmetered:	8	13.170	MG/Yr		13.170
AUTHORIZED CONSUMPTION:		508.311	MG/Yr		

Use buttons to select percentage of water supplied **OR** value

WATER LOSSES (Water Supplied - Authorized Consumption)

122.762 MG/Yr

Apparent Losses

				Pcnt:	Value:
Unauthorized consumption:	7	0.001	MG/Yr		0.001
Customer metering inaccuracies:	7	0.000	MG/Yr	0.00%	
Systematic data handling errors:	6	0.001	MG/Yr		
Apparent Losses:		0.002			

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

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 122.760 MG/Yr

WATER LOSSES: 122.762 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 135.932 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	7	98.6	miles
Number of active AND inactive service connections:	7	5,862	
Connection density:		59	conn./mile main
Average length of customer service line:	7	40.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	9	72.0	psi

COST DATA

Total annual cost of operating water system:	9	$3,034,788	$/Year
Customer retail unit cost (applied to Apparent Losses):	7	$4.16	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	10	$0.00	$/Million gallons

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	21.5%
Non-revenue water as percent by cost of operating system:	0.0%
Annual cost of Apparent Losses:	$8
Annual cost of Real Losses:	$0

Operational Efficiency Indicators

Apparent Losses per service connection per day:	0.00	gallons/connection/day
Real Losses per service connection per day*:	57.37	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.80	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	45.87	million gallons/year
From Above, Real Losses = Current Annual Real Losses (CARL):	122.76	million gallons/year
Infrastructure Leakage Index (ILI) [CARL/UARL]:	2.68	

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

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 84 out of 100 *****

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

PRIORITY AREAS FOR ATTENTION:

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

1: Customer metering inaccuracies
2: Customer retail unit cost (applied to Apparent Losses)
3: Volume from own sources

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

AWWA WLCC Free Water Audit Software: Water Balance

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WAS v4.2

Water Audit Report For:	Report Yr:
Village of Howard	2010

Own Sources (Adjusted for known errors) 1.035	Water Exported 0.000	Billed Water Exported			
	Water Supplied 631.073	Authorized Consumption 508.311	Billed Authorized Consumption 495.141	Billed Metered Consumption (inc. water exported) 495.141	Revenue Water 495.141
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 13.170	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 135.932
				Unbilled Unmetered Consumption 13.170	
		Water Losses 122.762	Apparent Losses 0.002	Unauthorized Consumption 0.001	
				Customer Metering Inaccuracies 0.000	
				Systematic Data Handling Errors 0.001	
Water Imported 630.038			Real Losses 122.760	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

AWWA WLCC Free Water Audit Software: Grading Matrix

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WASv 4.2

Back to Instructions

In the Reporting Worksheet, grades were assigned to each component of the audit to describe the confidence and accuracy of the input data. The grading assigned to each audit component and the corresponding recommended improvements and actions are highlighted in yellow. Audit accuracy is likely to be improved by prioritizing those items shown in red

Grading

	n/a	1	2	3	4	5	6	7	8	9	10
Volume from own sources:	Select this grading only if the water utility purchases/imports all of its water resources (i.e. has no sources of its own)	Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of treated water production sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of treated water production sources are metered, other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of treated water production sources are metered, or at least 90% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of treated water production sources are metered, meter accuracy testing and electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of treated water production sources are metered, meter accuracy testing and electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy.
Improvements to attain higher data grading for "Volume from own Sources" component:		to qualify for 2: Organize efforts to begin to collect data for determining volume from own sources	to qualify for 4: Locate all water production sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered water production sources and replace any obsolete/defective meters		to qualify for 6: Formalize annual meter accuracy testing for all source meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.		to qualify for 8: Conduct annual meter accuracy testing on all meters. Complete project to install new, or replace defective existing, meters so that entire production meter population is metered. Repair or replace meters outside of +/- 6% accuracy.		to qualify for 10: Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.		to maintain 10: Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.
Master meter error adjustment:	Select n/a only if the water utility fails to have meters on its sources of supply, either its own source, and/or imported (purchased) water sources	Inventory information on meters and paper records of measured volumes in crude condition; data error cannot be determined	No automatic datalogging of production volumes; daily readings are scribed on paper records. Tank/storage elevation changes are not employed in calculating "Volume from own sources" component. Data is adjusted only when grossly evident data error occurs.	Conditions between 2 and 4	Production meter data is logged automatically in electronic format and reviewed at least on a monthly basis. "Volume from own sources" tabulations include estimate of daily changes in tanks/storage facilities. Meter data is adjusted when gross data errors occur, or occasional meter testing deems this necessary.	Conditions between 4 and 6	Hourly production meter data logged automatically & reviewed on at least a weekly basis. Data adjusted to correct gross error from equipment malfunction and error confirmed by meter accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a balanced "Volume from own sources" component.	Conditions between 6 and 8	Continuous production meter data logged automatically & reviewed daily. Data adjusted to correct gross error from equipment malfunction & results of meter accuracy testing. Tank/storage facility elevation changes are automatically used in "Volume from own sources" tabulations.	Conditions between 8 and 10	Computerized system (SCADA or similar) automatically balances flows from all sources and storages; results reviewed daily. Mass balance technique compares production meter data to raw (untreated) water and treatment volumes to detect anomalies. Regular calibrations between SCADA and sources meters ensures minimal data transfer error.
Improvements to attain higher data grading for "Master meter error adjustment" component:		to qualify for 2: Develop plan to restructure recordkeeping system to capture all flow data; set procedure to review data daily to detect input errors	to qualify for 4: Install automatic datalogging equipment on production meters. Identify tanks/storage facilities and include estimated daily volume of water added to, or subtracted from, "Water Supplied" volume based upon changes in storage		to qualify for 6: Review hourly production meter data for gross error on, at least, a weekly basis. Begin to install instrumentation on tanks/storage facilities to record elevation changes. Use daily net storage change to balance flows in calculating "Water Supplied" volume.		to qualify for 8: Complete installation of elevation instrumentation on all tanks/storage facilities. Continue to use daily net storage change in calculating balanced "Volume from own sources" component. Adjust production meter data for gross error and inaccuracy confirmed by testing.		to qualify for 10: Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.		to maintain 10: Monitor meter innovations for development of more accurate and less expensive flowmeters. Continue to replace or repair meters as they perform outside of desired accuracy limits.
Water Imported:	Select n/a if the water utility's supply is exclusively from its own water resources (no bulk purchased/ imported water)	Less than 25% of imported water sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of imported water sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of imported water sources are metered, other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy.
Improvements to attain higher data grading for "Water Imported Volume" component:		to qualify for 2: Review bulk water purchase agreements with partner suppliers; confirm requirements for use and maintenance of accurate metering. Identify needs for new or replacement meters with goal to meter all imported water sources.	To qualify for 4: Locate all imported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered imported water interconnections and replace obsolete/defective meters		to qualify for 6: Formalize annual meter accuracy testing for all imported water meters. Continue installation of meters on unmetered exported water interconnections and replacement of obsolete/defective meters.		to qualify for 8: Complete project to install new, or replace defective, meters on all imported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.		to qualify for 10: Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.		to maintain 10: Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Water Exported:	Select n/a if the water utility sells no bulk water to neighboring water utilities (no exported water sales)	Less than 25% of exported water sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of exported water sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of exported water sources are metered, other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy.
Improvements to attain higher data grading for "Water Exported Volume" component:		to qualify for 2: Review bulk water sales agreements with partner suppliers; confirm requirements for use & upkeep of accurate metering. Identify needs to install new, or replace defective meters as needed.	To qualify for 4: Locate all exported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered exported water interconnections and replace obsolete/defective meters		to qualify for 6: Formalize annual meter accuracy testing for all exported water meters. Continue installation of meters on unmetered exported water interconnections and replacement of obsolete/defective meters.		to qualify for 8: Complete project to install new, or replace defective, meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.		to qualify for 10: Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.		to maintain 10: Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.
AUTHORIZED CONSUMPTION											
Billed metered:	n/a (not applicable). Select n/a only if the entire customer population is not metered and is billed for water service on a flat or fixed rate basis. In such a case the volume entered must be zero.	Less than 50% of customers with volume-based billings from meter readings; flat or fixed rate billed for the majority of the customer population	At least 50% of customers with volume-based billing from meter reads; flat rate billed for others. Manual meter reading, under 50% read success rate, remainder estimated. Limited meter records, no regular meter testing or replacement. Billing data maintained on paper records, with no auditing.	Conditions between 2 and 4	At least 75% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, at least 50% meter read success rate, failed reads are estimated. Purchase records verify age of customer meters; only very limited meter accuracy testing is conducted. Customer meters replaced only upon complete failure. Computerized billing records, but only periodic internal auditing conducted.	Conditions between 4 and 6	At least 90% of customers with volume-based billing from meter reads; remaining accounts are estimated. Manual customer meter reading gives at least 80% customer meter reading success rate, failed reads are estimated. Good customer meter records, limited meter accuracy testing, regular replacement of oldest meters. Computerized billing records with routine auditing of global statistics.	Conditions between 6 and 8	At least 97% of customers with volume-based billing from meter reads. At least 90% customer meter read success rate; or minimum 80% read success rate with planning and budgeting for trials of Automatic Metering Reading (AMR) in one or more pilot areas. Good customer meter records. Regular meter accuracy testing guides replacement of statistically significant number of meters each year. Routine auditing of computerized billing records for global and detailed statistics; verified periodically by third party.	Conditions between 8 and 10	At least 99% of customers with volume-based billing from meter reads. At least 95% customer meter reading success rate; or minimum 80% meter reading success rate, with Automatic Meter Reading (AMR) trials underway. Statistically significant customer meter testing and replacement program in place. Computerized billing with routine, detailed auditing, including field investigation of representative sample of accounts. Annual audit verification by third party.
Improvements to attain higher data grading for "Billed Metered Consumption" component:	If n/a is selected because the customer meter population is unmetered, consider establishing a new policy to meter the customer population and employ water rates based upon metered volumes.	to qualify for 2: Conduct investigations or trials of customer meters to select appropriate meter models. Budget funding for meter installations. Investigate volume based water rate structures.	to qualify for 4: Purchase and install meters on unmetered accounts. Implement policies to improve meter reading success. Catalog meter information during meter read visits to identify age/model of existing meters. Test a minimal number of meters for accuracy. Install computerized billing system.		to qualify for 6: Purchase and install meters on unmetered accounts. Eliminate flat fee billing and establish appropriate water rate structure based upon measured consumption. Continue to achieve verifiable success in removing manual meter reading barriers. Expand meter accuracy testing. Launch regular meter replacement program. Conduct routine audit of global statistics.		to qualify for 8: Purchase and install meters on unmetered accounts. Assess cost-effectiveness of Automatic Meter Reading (AMR) system for portion or entire system; or achieve ongoing improvements in manual meter reading success rate. Refine meter accuracy testing program. Set meter replacement goals based upon accuracy test results. Refine routine auditing procedures based upon third party guidance.		to qualify for 10: Purchase and install meters on unmetered accounts. Launch Automatic Meter Reading (AMR) system trials if manual meter reading success rate of at least 95% is not achieved within a five-year program. Continue meter accuracy testing program. Conduct planning and budgeting for large scale meter replacement based upon meter life cycle analysis using cumulative flow target. Continue routine auditing and require annual third party review.		to maintain 10: Regular internal and third party auditing, and meter accuracy testing ensures that accurate customer meter readings are obtained and entered as the basis for volume based billing. Stay abreast of improvements in Advanced Metering Infrastructure (AMI) and information management. Plan and budget for justified upgrades in metering, meter reading and billing data management.
Billed unmetered:	Select n/a if it is the policy of the water utility to meter all customer connections and it has been confirmed by detailed auditing that all customers do indeed have a water meter; i.e. no unmetered accounts exist	Water utility policy does not require customer metering; flat or fixed fee billed. No data collected on customer consumption. Only estimates available are derived from data estimation methods using average fixture count multiplied by number of connections, or similar approach.	Water utility policy does not require customer metering; flat or fixed fee billed. Some metered accounts exist in parts of the system (pilot areas or District Metered Areas) with consumption recorded on portable dataloggers. Data from these sample meters are used to infer consumption for the total customer population. Site specific estimation methods are used for unusual buildings/water uses.	Conditions between 2 and 4	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Conditions between 4 and 6	Water utility policy does require metering and volume based billing but exemption exist for a portion of accounts such as municipal buildings. As many as 15% of billed accounts are unmetered due to this exemption or meter installation difficulties. Only a group estimate of annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Conditions between 6 and 8	Water utility policy requires metering and volume based billing for all customer accounts. However, less than 5% of billed accounts remain unmetered because because installation is hindered by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.	Conditions between 8 and 10	Water utility policy requires metering and volume based billing for all customer accounts. Less than 2% of billed accounts are unmetered and exist because meter installation is hindered by unusual circumstances. The goal exists to minimize the number of unmetered accounts to the extent that is economical. Reliable estimates of consumption are obtained at these accounts via site specific estimation methods.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Billed Unmetered Consumption" component:		to qualify for 2: Investigate a new water utility policy to require metering of the customer population, and a reduction of unmetered accounts. Conduct pilot metering project by installing water meters in small sample of customer accounts and datalogging the water consumption.	to qualify for 4: Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.		to qualify for 6: Budget for staff resources to review billing records to identify unmetered properties. Specify metering needs and funding requirements to install sufficient meters to significant reduce the number of unmetered accounts		to qualify for 8: Install customer meters on a full scale basis. Refine metering policy and procedures to ensure that all accounts, including municipal properties, are designated for meters. Implement procedures to obtain reliable consumption estimate for unmetered accounts awaiting meter installation.		to qualify for 10: Continue customer meter installation throughout the service area, with a goal to minimize unmetered accounts. Sustain the effort to investigate accounts with access difficulties to devise means to install water meters or otherwise measure water consumption.		to maintain 10: Continue to refine estimation methods for unmetered consumption and explore means to establish metering, for as many billed unmetered accounts as is economically feasible.
Unbilled metered:	select n/a if all billing-exempt consumption is unmetered.	Billing practices exempt certain accounts, such as municipal buildings, but written policies do not exist; and a reliable count of unbilled metered accounts is unavailable. Meter upkeep and meter reading on these accounts is rare and not considered a priority. Due to poor recordkeeping and lack of auditing, water consumption for all such accounts is purely guesstimated.	Billing practices exempt certain accounts, such as municipal buildings, but only scattered, dated written directives exist to justify this practice. A reliable count of unbilled metered accounts is unavailable. Sporadic meter replacement and meter reading occurs on an as-needed basis. The total annual water consumption for all unbilled, metered accounts is estimated based upon approximating the number of accounts and assigning consumption from actively billed accounts of same meter size.	Conditions between 2 and 4	Dated written procedures permit billing exemption for specific accounts, such as municipal properties, but are unclear regarding certain other types of accounts. Meter reading is given low priority and is sporadic. Consumption is quantified from meter readings where available. The total number of unbilled, unmetered accounts must be estimated along with consumption volumes.	Conditions between 4 and 6	Written policies regarding billing exemptions exist but adherence in practice is questionable. Metering and meter reading for municipal buildings is reliable but sporadic for other unbilled metered accounts. Periodic auditing of such accounts is conducted. Water consumption is quantified directly from meter readings where available, but the majority of the consumption is estimated.	Conditions between 6 and 8	Written policy identifies the types of accounts granted a billing exemption. Customer meter management and meter reading are considered secondary priorities, but meter reading is conducted at least annually to obtain consumption volumes for the annual water audit. High level auditing of billing records ensures that a reliable census of such accounts exists.	Conditions between 8 and 10	Clearly written policy identifies the types of accounts given a billing exemption, with emphasis on keeping such accounts to a minimum. Customer meter management and meter reading for these accounts is given proper priority and is reliably conducted. Regular auditing confirms this. Total water consumption for these accounts is taken from reliable readings from accurate meters.
Improvements to attain higher data grading for "Unbilled metered Consumption" component:		to qualify for 2: Reassess the water utility's policy allowing certain accounts to be granted a billing exemption. Draft an outline of a new written policy for billing exemptions, with clear justification as to why any accounts should be exempt from billing, and with the intention to keep the number of such accounts to a minimum.	to qualify for 4: Review historic written directives and policy documents allowing certain accounts to be billing-exempt. Draft an outline of a written policy for billing exemptions, identify criteria that grants an exemption, with a goal of keeping this number of accounts to a minimum.		to qualify for 6: Draft a new written policy regarding billing exemptions based upon consensus criteria allowing this occurrence. Assign resources to audit meter records and billing records to obtain census of unbilled metered accounts.		to qualify for 8: Communicate billing exemption policy throughout the organization and implement procedures that ensure proper account management. Conduct inspections of accounts confirmed in unbilled metered status and verify that accurate meters exist and are scheduled for routine meter readings.		to qualify for 10: Ensure that meter management (meter accuracy testing, meter replacement) and meter reading activities are accorded the same priority as billed accounts. Establish ongoing annual auditing process to ensure that water consumption is reliably collected and provided to the annual water audit process.		to maintain 10: Reassess philosophy in allowing any water uses to go "unbilled". It is possible to meter and bill all accounts, even if the fee charged for water consumption is discounted or waived. Metering and billing all accounts ensures that water consumption is tracked and water waste from plumbing leaks is detected and minimized.
Unbilled unmetered:		Extent of unbilled, unmetered consumption is unknown due to unclear policies and poor recordkeeping. Total consumption is quantified based upon a purely subjective estimate.	Clear extent of unbilled, unmetered consumption is unknown, but a number of events are randomly documented each year, confirming existence of such consumption, but without sufficient documentation to quantify an accurate estimate of the annual volume consumed.	Conditions between 2 and 4	Extent of unbilled, unmetered consumption is partially known, and procedures exist to document certain events such as miscellaneous fire hydrant uses. Formulae is used to quantify the consumption from such events (time running x typical flowrate x number of events).	Default value of 1.25% of system input volume is employed	Coherent policies exist for some forms of unbilled, unmetered consumption but others await closer evaluation. Reasonable recordkeeping for the managed uses exists and allows for annual volumes to be quantified by inference, but unsupervised uses are guesstimated.	Conditions between 6 and 8	Clear policies and good recordkeeping exist for some uses (ex: unmetered fire connections registering consumption), but other uses (ex: miscellaneous uses of fire hydrants) have limited oversight. Total consumption is a mix of well quantified use such as from formulae (time x typical flow) or temporary meters, and relatively subjective estimates of less regulated use.	Conditions between 8 and 10	Clear policies exist to identify permitted use of water in unbilled, unmetered fashion, with the intention of minimizing this type of consumption. Good records document each occurrence and consumption is quantified via formulae (time x typical flow) or use of temporary meters.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Unbilled Unmetered Consumption" component:		to qualify for 5: Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use. to qualify for 2: Establish a policy regarding what water uses should be allowed as unbilled and unmetered. Consider tracking a small sample of one such use (ex: fire hydrant flushings).	to qualify for 5: Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use. to qualify for 4: Evaluate the documentation of events that have been observed. Meet with user groups (ex: for fire hydrants - fire departments, contractors to ascertain their need for water from fire hydrants).		to qualify for 5: Utilize accepted default value of 1.25% of system input volume as expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.	to qualify for 6 or greater: Finalize policy and do field checks. Proceed if top-down audit exists and/or a great volume of such use is suspected.	to qualify for 8: Assess water utility policy and procedures to ensure that fire hydrant permits are issued for use by persons outside of the utility. Create written procedures for use and documentation of fire hydrants by water utility personnel.		to qualify for 10: Refine written procedures to ensure that all uses of unbilled, unmetered water are overseen by a structured permitting process managed by water utility personnel. Reassess policy to determine if some of these uses have value in being converted to billed and/or metered status.		to maintain 10: Continue to refine policy and procedures with intention of reducing the number of allowable uses of water in unbilled and unmetered fashion. Any uses that can feasibly become billed and metered should be converted eventually.
APPARENT LOSSES											
Unauthorized consumption:		Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is guesstimated.	Unauthorized consumption is a known occurrence, but its extent is a mystery. There are no requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is approximated from this limited data.	conditions between 2 and 4	Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulae to quantify this consumption (time running x typical flowrate x number of events).	Default value of 0.25% of system input volume is employed	Coherent policies exist for some forms of unauthorized consumption but others await closer evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.	Conditions between 6 and 8	Clear policies and good recordkeeping exist for certain events (ex: tampering with water meters); other occurrences have limited oversight. Total consumption is a combination of volumes from formulae (time x typical flow) and subjective estimates of unconfirmed consumption.	Conditions between 8 and 10	Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.
Improvements to attain higher data grading for "Unauthorized Consumption" component:		to qualify for 5: Use accepted default of 0.25% of system input volume. to qualify for 2: Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)	to qualify for 5: Use accepted default of 0.25% of system input volume to qualify for 4: Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)		to qualify for 5: Utilize accepted default value of 0.25% of system input volume as expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.	to qualify for 6 or greater: Finalize policy and do field checks. Proceed if top-down audit exists and/or a great volume of such use is suspected.	to quality for 8: Assess water utility policies to ensure that all known occurrences of unauthorized consumption are outlawed, and that appropriate penalties are prescribed. Create written procedures for use and documentation of various occurrences of unauthorized consumption as they are uncovered.		to qualify for 10: Refine written procedures and assign staff to seek out likely occurrences of unauthorized consumption. Explore new locking devices, monitors and other technologies designed to detect and thwart unauthorized consumption.		to maintain 10: Continue to refine policy and procedures to eliminate any loopholes that allow or tacitly encourage unauthorized consumption. Continue to be vigilant in documentation and enforcement efforts.
Customer metering inaccuracies:	select n/a only if the entire customer population is unmetered. In such a case the volume entered must be zero.	Customer meters exist, but with unorganized paper records on meters; no meter accuracy testing or meter replacement program. Workflow is driven chaotically by customer complaints with no proactive management. Loss volume due to aggregate meter inaccuracy is guesstimated.	Poor recordkeeping and meter oversight is recognized by water utility management who has allotted staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.	Conditions between 2 and 4	Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.	Conditions between 4 and 6	A reliable electronic recordkeeping system for meters exists. Population includes a mix of new high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.	Conditions between 6 and 8	Ongoing meter replacement and accuracy testing result in highly accurate customer meter population. Testing is conducted on samples of meters at varying lifespans to determine optimum replacement time for various types of meters.	Conditions between 8 and 10	Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.
Improvements to attain higher data grading for "Customer meter inaccuracy volume" component:	If n/a is selected because the customer meter population is unmetered, consider establishing a new policy to meter the customer population and employ water rates based upon metered volumes.	to qualify for 2: Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better organize meter management.	to qualify for 4: Implement a reliable record keeping system for customer meter histories, preferably using electronic methods typically linked to, or part of, the Customer Billing System or Customer Information System. Expand meter accuracy testing to a larger group of meters.		to qualify for 6: Standardize procedures for meter recordkeeping with the electronic information system. Accelerate meter accuracy testing and meter replacements guided by testing results.		to qualify for 8: Expand annual meter accuracy testing to evaluate a statistically significant number of meter makes/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.		to qualify for 10: Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.		to maintain 10: Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to grasp opportunities for greater accuracy in metering and customer consumption data.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Systematic Data Handling Error:	Note: all water utilities incur some amount of this error. Even in water utilities with unmetered customer populations and fixed rate billing, errors occur in annual billing tabulations. Enter a positive value for the volume and select a grading.	Vague policy for permitting (creating new customer accounts) and billing. Billing data maintained on paper records which are in disarray. No audits conducted to confirm billing data handling efficiency. Unknown number of customers escape routine billing due to lack of billing process oversight.	Policy for permitting and billing exists but needs refinement. Billing data maintained on paper records or insufficiently capable electronic database. Only periodic unstructured auditing work conducted to confirm billing data handling efficiency. Volume of unbilled water due to billing lapses is a guess.	Conditions between 2 and 4	Policy and procedures for permitting and billing exist but needs refinement. Computerized billing system exists, but is dated or lacks needed functionality. Periodic, limited internal audits conducted and confirm with approximate accuracy the consumption volumes lost to billing lapses.	Conditions between 4 and 6	Policy for permitting and billing is adequate and reviewed periodically. Computerized billing system in use with basic reporting available. Any effect of billing adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume lost to billing lapses is obtained.	Conditions between 6 and 8	Permitting and billing policy reviewed at least biannually. Computerized billing system includes an array of reports to confirm billing data and system functionality. Annual internal checks conducted with periodic third party audit. Accountability checks flag billing lapses. Consumption lost to billing lapses is well quantified and reducing year-by-year.	Conditions between 8 and 10	Sound policy exists for permitting of all customer billing accounts. Robust computerized billing system gives high functionality and reporting capabilities. Assessment of policy and data handling errors conducted internally and audited by third party annually, ensuring consumption lost to billing lapses is minimized and detected as it occurs.
Improvements to attain higher data grading for "Systematic Data Handling Error volume" component:		to qualify for 2: Draft written policy for permitting and billing. Investigate and budget for computerized customer billing system. Conduct initial audit of billing records by flow-charting the basic business processes of the customer account/billing function.	to qualify for 4: Finalize written policy for permitting and billing. Implement a computerized customer billing system. Conduct initial audit of billing records as part of this process.		to qualify for 6: Refine permitting and billing procedures and ensure consistency with the utility policy regarding billing, and minimize opportunity for missed billings. Upgrade or replace customer billing system for needed functionality - ensure that billing adjustments don't corrupt the value of consumption volumes. Procedurize internal annual audit process.		to qualify for 8: Formalize regular review of permitting and billing practices. Enhance reporting capability of computerized billing system. Formalize regular auditing process to reveal scope of data handling error.		to qualify for 10: Close policy/procedure loopholes that allow some customer accounts to go unbilled, or data handling errors to exist. Ensure that internal and third party audits are conducted annually.		to maintain 10: Stay abreast of customer information management developments and innovations. Monitor developments of Advanced Metering Infrastructure (AMI) and integrate technology to ensure that customer endpoint information is well-monitored and errors/lapses are at an economic minimum.
SYSTEM DATA											
Length of mains:		Poorly assembled and maintained paper as-built records of existing water main installations makes accurate determination of system pipe length impossible. Length of mains is guesstimated.	Paper records in poor condition (no annual tracking of installations & abandonments). Poor procedures to ensure that new water mains installed by developers are accurately documented.	Conditions between 2 and 4	Sound policy and procedures for permitting and documenting new water main installations, but gaps in management result in a uncertain degree of error in tabulation of mains length.	Conditions between 4 and 6	Sound policy and procedures exist for permitting and commissioning new water mains. Highly accurate paper records with regular field validation; or electronic records and asset management system in good condition. Includes system backup.	Conditions between 6 and 8	Sound policy and procedures exist for permitting and commissioning new water mains. Electronic recordkeeping and asset management system are used to store and manage data.	Conditions between 8 and 10	Sound policy exists for managing water mains extensions and replacements. Geographic Information System (GIS) data and asset management database agree and random field validation proves truth of databases.
Improvements to attain higher data grading for "Length of Water Mains" component:		to qualify for 2: Assign personnel to inventory current as-built records and compare with customer billing system records and highway plans. Assemble policy documents regarding permitting and documentation of water main installations by the utility and building developers; identify gaps in procedure that result in poor documentation.	to qualify for 4: Complete inventory of paper records of water main installations & abandonments for a number of years prior to audit year. Review policy and procedures for commissioning and documenting new water main installation and abandonments.		to qualify for 6: Finalize updates/improvements to policy and procedures for permitting/commissioning new main installations. Confirm inventory of records for five years prior to audit year; correct any errors or omissions.		to qualify for 8: Launch random field checks of limited number of locations. Convert to electronic databases with backup as justified.		to qualify for 10: Link Geographic Information System (GIS) and asset management databases, conduct field verification of data.		to maintain 10: Continue with standardization and random field validation to improve knowledge of system.
Number of active AND inactive service connections:		Vague permitting (of new service connections) policy and poor paper recordkeeping of customer connections/billings result in suspect determination of the number of service connections, which may be 10-15% in error from actual count.	General permitting policy exists but paper records, procedural gaps, and weak oversight result in questionable total for number of connections, which may vary 5-10% of actual count.	Conditions between 2 and 4	Permitting policy and procedures exist, but with some gaps in performance and oversight. Computerized information management system is being brought online to replace dated paper recordkeeping system. Reasonably accurate tracking of service connection installations & abandonments; but count can be up to 5% in error from actual total.	Conditions between 4 and 6	Permitting policy and procedures are adequate and reviewed periodically. Computerized information management system is in use with annual installations & abandonments totaled. Very limited field verifications and audits. Error in count of number of service connections is believed to be no more that 3%.	Conditions between 6 and 8	Permitting policy and procedures reviewed at least biannually. Well-managed computerized information management system and routine, periodic field checks and internal system audits allows counts of connections that is no more than 2% in error.	Conditions between 8 and 10	Sound permitting policy and well managed and audited procedures ensure reliable management of service connection population. Computerized information management system and Geographic Information System (GIS) information agree; field validation proves truth of databases. Count of connections believed to be in error by less than 1%.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Number of Active and Inactive customer service connections" component:		to qualify for 2: Draft new policy and procedures for permitting and billing. Research and collect paper records of installations & abandonments for several years prior to audit year.	to qualify for 4: Refine policy and procedures for permitting and billing. Research computerized recordkeeping system (Customer Information System or Customer Billing System) to improve documentation format for service connections.		to qualify for 6: Refine procedures to ensure consistency with permitting policy to establish new service connections or decommission existing connections. Improve process to include all totals for at least five years prior to audit year.		to qualify for 8: Formalize regular review of permitting policy and procedures. Launch random field checks of limited number of locations. Develop reports and auditing mechanisms for computerized information management system.		to qualify for 10: Close any procedural loopholes that allow installations to go undocumented. Link computerized information management system with Geographic Information System (GIS) and formalize field inspection and information system auditing processes. Documentation of new or decommissioned service connections encounters several levels of checks and balances.		to maintain 10: Continue with standardization and random field validation to improve knowledge of system.
Average length of customer service line:	Note: if customer water meters are located outside of the customer building next to the curbstop or boundary separating utility/customer responsibility, follow the grading description for 10(a). Also see the Service Connection Diagram worksheet.	Gradings 1-9 apply if customer properties are **unmetered**, if customer meters exist and are located **inside the customer building premises, or if the water utility owns and is responsible for the entire service connection piping from the water main to the customer building**. In any of these cases the average distance between the curbstop or boundary separating utility/customer responsibility for service connection piping, and the typical first point of use (ex: faucet) or the customer meter must be quantified. Gradings of 1-9 are used to grade the validity of the means to quantify this value. (See the "Service Connection Diagram" worksheet)									Either of two conditions can be met to obtain a grading of 10: a) The customer water meter is located outside of the customer building adjacent to the curbstop or boundary separating utility/customer responsibility for the service connection piping. In this case enter a value of zero in the Reporting Worksheet with a grading of 10. b). Customer water meters are located inside customer buildings, or the properties are unmetered. In either case the distance is highly reliable since data is drawn from a Geographic Information System (GIS) and confirmed by routine field checks.
		Vague policy exists to define the delineation of water utility ownership and customer ownership of the service connection piping. Curbstops are perceived as the breakpoint but these have not been well-maintained or documented. Most are buried or obscured. Their location varies widely from site-to-site, and estimating this distance is arbitrary due to the unknown location of many curbstops.	Policy requires that the curbstop serves as the delineation point between water utility ownership and customer ownership of the service connection piping. The piping from the water main to the curbstop is the property of the water utility; and the piping from the curbstop to the customer building is owned by the customer. Curbstop locations are not well documented and the average distance is based upon a limited number of locations measured in the field.	Conditions between 2 and 4	Good policy requires that the curbstop serves as the delineation point between water utility ownership and customer ownership of the service connection piping. Curbstops are generally installed as needed and are reasonably documented. Their location varies widely from site-to-site, and an estimate of this distance is hindered by the availability of paper records.	Conditions between 4 and 6	Clear policy exists to define utility/customer responsibility for service connection piping. Accurate, well-maintained paper or basic electronic recordkeeping system exists. Periodic field checks confirm piping lengths for a sample of customer properties.	Conditions between 6 and 8	Clearly worded policy standardizes the location of curbstops and meters, which are inspected upon installation. Accurate and well maintained electronic records exist with periodic field checks to confirm locations of service lines, curbstops and customer meter pits. An accurate number of customer properties from the customer billing system allows for reliable averaging of this length.	Conditions between 8 and 10	
Improvements to attain higher data grading for "Average Length of Customer Service Line" component:		to qualify for 2: Research and collect paper records of service line installations. Inspect several sites in the field using pipe locators to locate curbstops. Obtain the length of this small sample of connections in this manner.	to qualify for 4: Formalize and communicate policy delineating utility/customer responsibilities for service connection piping. Assess accuracy of paper records by field inspection of a small sample of service connections using pipe locators as needed. Research the potential migration to a computerized information management system to store service connection data.		to qualify for 6: Establish coherent procedures to ensure that policy for curbstop, meter installation and documentation is followed. Gain consensus within the water utility for the establishment of a computerized information management system.		to qualify for 8: Implement an electronic means of recordkeeping, typically via a customer information system or customer billing system. Standardize the process to conduct field checks of limited number of locations.		to qualify for 10: Link customer information management system and Geographic Information System (GIS), standardize process for field verification of data.		to maintain 10: Continue with standardization and random field validation to improve knowledge of system.
Average operating pressure:		Available records are poorly assembled and maintained paper records of supply pump characteristics and water distribution system operating conditions. Average pressure is guesstimated based upon this information and ground elevations from crude topographical maps. Widely varying distribution system pressures due to undulating terrain, high system head loss and weak/erratic pressure controls further compromise the validity of the average pressure calculation.	Limited telemetry monitoring of scattered sites provides some static pressure data, which is recorded in handwritten logbooks. Pressure data is gathered at individual sites only when low pressure complaints arise. Average pressure is determined by averaging relatively crude data, and is affected by significant variation in ground elevations, system head loss and gaps in pressure controls in the distribution system.	Conditions between 2 and 4	Effective pressure controls separate different pressure zones; moderate pressure variation across the system, occasional open boundary valves are discovered that breech pressure zones. Basic telemetry monitoring of the distribution system logs pressure data electronically. Pressure data gathered by gauges or dataloggers at fire hydrants or buildings when low pressure complaints arise, and during fire flow tests and system flushing. Reliable topographical data exists. Average pressure is calculated using this mix of data.	Conditions between 4 and 6	Reliable pressure controls separate distinct pressure zones; only very occasional open boundary valves are encountered that breech pressure zones. Well-covered telemetry monitoring of the distribution system logs extensive pressure data electronically. Pressure gathered by gauges/dataloggers at fire hydrants and buildings when low pressure complaints arise, and during fire flow tests and system flushing. Average pressure is determined by using this mix of reliable data.	Conditions between 6 and 8	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Conditions between 8 and 10	Well-managed pressure districts/zones, SCADA System and hydraulic model exist to give very precise pressure data across the water distribution system. Average system pressure is reliably calculated from extensive, reliable, and cross-checked data.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Average Operating Pressure" component:		to qualify for 2: Employ pressure gauging and/or datalogging equipment to obtain pressure measurements from fire hydrants. Locate accurate topographical maps of service area in order to confirm ground elevations. Research pump data sheets to find pump pressure/flow characteristics	to qualify for 4: Formalize a procedure to use pressure gauging/datalogging equipment to gather pressure data during various system events such as low pressure complaints, or operational testing. Gather pump pressure and flow data at different flow regimes. Identify faulty pressure controls (pressure reducing valves, altitude valves, partially open boundary valves) and plan to properly configure pressure zones. Make all pressure data from these efforts available to generate system-wide average pressure.		to qualify for 6: Expand the use of pressure gauging/datalogging equipment to gather scattered pressure data at a representative set of sites, based upon pressure zones or areas. Utilize pump pressure and flow data to determine supply head entering each pressure zone or district. Correct any faulty pressure controls (pressure reducing valves, altitude valves, partially open boundary valves) to ensure properly configured pressure zones. Use expanded pressure dataset from these activities to generate system-wide average pressure.		to qualify for 8: Install a Supervisory Control and Data Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to insure data accuracy. Obtain accurate topographical data and utilize pressure data gathered from field surveys to provide extensive, reliable data for pressure averaging.		to qualify for 10: Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.		to maintain 10: Continue to refine the hydraulic model of the distribution system and consider linking it with SCADA System for real-time pressure data calibration, and averaging.

Grading											
	n/a	1	2	3	4	5	6	7	8	9	10
COST DATA											
Total annual cost of operating water system:		Incomplete paper records and lack of documentation on many operating functions making calculation of water system operating costs a pure guesstimate	Reasonably maintained, but incomplete, paper or electronic accounting provides data to estimate the major portion of water system operating costs.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Gaps in data known to exist, periodic internal reviews conducted but not a structured audit.	Conditions between 4 and 6	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited periodically by utility personnel, not a Certified Public Accountant (CPA).	Conditions between 6 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party CPA.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited annually by utility personnel and by third-party CPA.
Improvements to attain higher data grading for "Total Annual Cost of Operating the Water System" component:		to qualify for 2: Gather available records, institute new procedures to regularly collect and audit basic cost data of most important operations functions.	to qualify for 4: Implement an electronic cost accounting system, structured according to accounting standards for water utilities		to qualify for 6: Establish process for periodic internal audit of water system operating costs; identify cost data gaps and institute procedures for tracking these outstanding costs.		to qualify for 8: Standardize the process to conduct routine financial audit on an annual basis.		to qualify for 10: Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.		to maintain 10: Maintain program, stay abreast of expenses subject to erratic cost changes and budget/track costs proactively
Customer retail unit cost (applied to Apparent Losses):		Antiquated, cumbersome water rate structure is use, with periodic historic amendments that were poorly documented and implemented; resulting in classes of customers being billed inconsistent charges. The actual composite billing rate likely differs significantly from the published water rate structure, but a lack of auditing leaves the degree of error indeterminate.	Dated, cumbersome water rate structure, not always employed consistently in actual billing operations. The actual composite billing rate is known to differ from the published water rate structure, and a reasonably accurate estimate of the degree of error is determined, allowing a composite billing rate to be quantified.	Conditions between 2 and 4	Straight-forward water rate structure in use, but not updated in several years. Billing operations reliably employ the rate structure. The composite billing rate is derived from a single customer class such as residential customer accounts, neglecting the effect of different rates from varying customer classes.	Customer population unmetered. Fixed fee charged; single composite number derived from multiple customer classes.	Clearly written, up-to-date water rate structure is in force and is applied reliably in billing operations. Composite customer rate is determined using a weighted average residential rate using volumes of water in each rate block.	Conditions between 6 and 8	Effective water rate structure is in force and is applied reliably in billing operations. Composite customer rate is determined using a weighted average composite consumption rate, including residential, commercial, industrial and any other customer classes within the water rate structure.	Conditions between 8 and 10	Third party reviewed weighted average composite consumption rate (includes residential, commercial, industrial, etc.)
Improvements to attain higher data grading for "Customer Retail Unit Cost" component:		to qualify for 2: Formalize the process to implement water rates, including a secure documentation procedure. Create a current, formal water rate document and gain approval from all stakeholders.	to qualify for 4: Review the water rate structure and update/formalize as needed. Assess billing operations to ensure that actual billing operations incorporate the established water rate structure.		to qualify for 6: Evaluate volume of water used in each usage block by residential users. Multiply volumes by full rate structure.	Meter customers and charge rates based upon water volumes	to qualify for 8: Evaluate volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.		to qualify for 10: Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.		to maintain 10: Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified.
Variable production cost (applied to Real Losses):	Note: if the water utility purchases/imports its entire water supply, then enter the unit purchase cost of the bulk water supply in the Reporting Worksheet with a grading of 10	Incomplete paper records and lack of documentation on primary operating functions (electric power and treatment costs most importantly) makes calculation of variable production costs a pure guesstimate	Reasonably maintained, but incomplete, paper or electronic accounting provides data to roughly estimate the basic operations costs (pumping power costs and treatment costs) and calculate a unit variable production cost.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Electric power and treatment costs are reliably tracked and allow accurate calculation of unit variable production costs based on these two inputs only. All costs are audited internally on a periodic basis.	Conditions between 4 and 6	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Pertinent additional costs beyond power and treatment (ex: liability, residuals management, etc.) are included in the unit variable production cost. Data audited at least annually by utility personnel.	Conditions between 6 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent variable production costs tracked. Data audited at least annually by utility personnel, and periodically by third-party.	Conditions between 8 and 10	Either of two conditions can be met to obtain a grading of 10: 1) Third party CPA audit of all primary and secondary cost components on an annual basis. or: 2) Water supply is entirely purchased as bulk imported water, and unit purchase cost serves as the variable production cost.
Improvements to attain higher data grading for "Variable Production Cost" component:		to qualify for 2: Gather available records, institute new procedures to regularly collect and audit basic cost data and most important operations functions.	to qualify for 4: Implement an electronic cost accounting system, structured according to accounting standards for water utilities		to qualify for 6: Formalize process for regular internal audits of production costs. Assess whether additional costs (liability, residuals management, etc.) should be included to calculate a more accurate variable production cost.		to qualify for 8: Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.) Conduct periodic third-party audits.		to qualify for 10: Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.		to maintain 10: Maintain program, stay abreast of expenses subject to erratic cost changes and budget/track costs proactively

AWWA WLCC Free Water Audit Software: Customer Service Line Diagrams

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Average Length of Customer Service Line

The three figures shown on this worksheet display the assignment of the Average Length of Customer Service Line, Lp, for the three most common piping configurations.

Figure 1 shows the configuration of the water meter outside of the customer building next to the curbstop valve. In this configuration Lp = 0 since the distance between the curbstop and the customer metering point is essentially zero.

Figure 2 shows the configuration of the customer water meter located inside the customer building, where Lp is the distance from the curbstop to the water meter.

Figure 3 shows the configuration of an unmetered customer building , where Lp is the distance from the curbstop to the first point of customer water consumption, or, more simply, the building line.

In any water system the Lp will vary notably in a community of different structures, therefore the average Lp value is used and this should be approximated or calculated if a sample of service line measurements has been gathered.

Click for more information

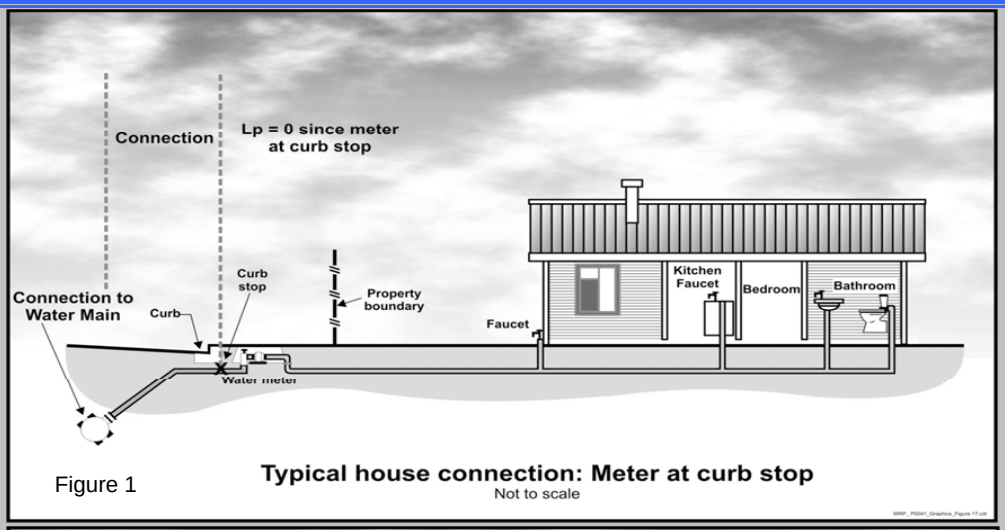

Figure 1 **Typical house connection: Meter at curb stop**
Not to scale

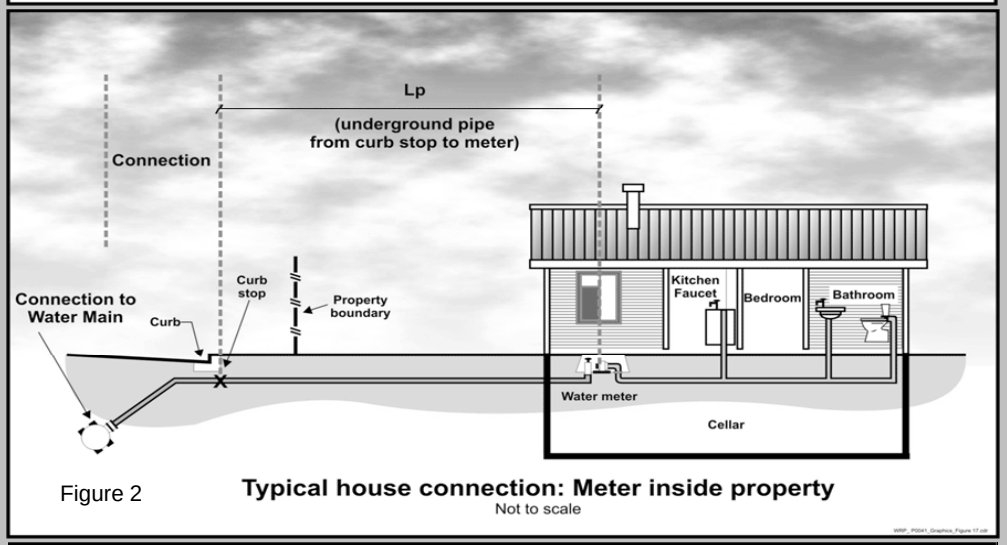

Figure 2 **Typical house connection: Meter inside property**
Not to scale

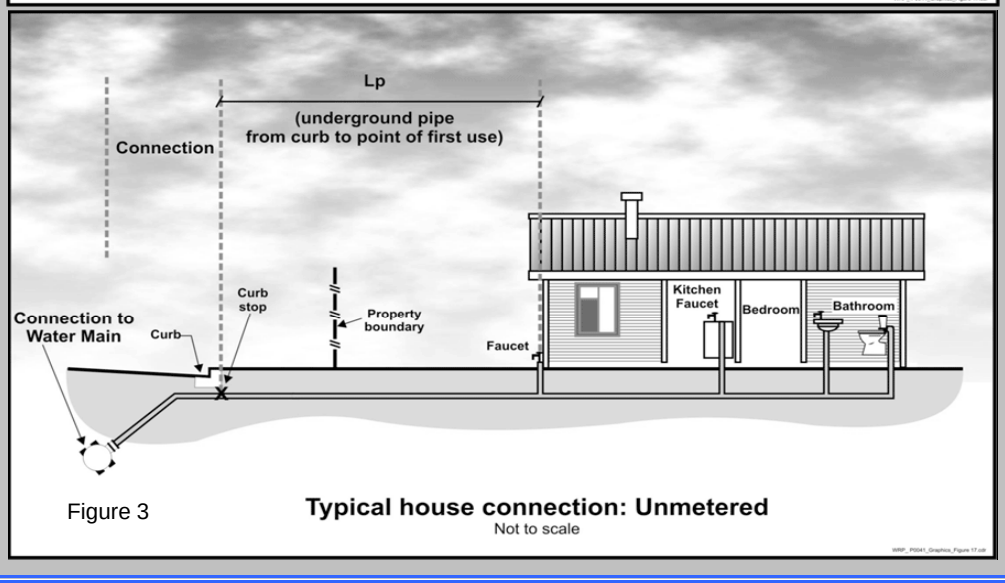

Figure 3 **Typical house connection: Unmetered**
Not to scale

AWWA WLCC Free Water Audit Software: Definitions

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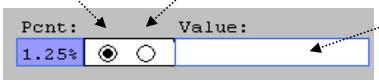
Item Name		Description
Apparent Losses	Find	= unauthorized consumption + meter under-registration + data handling errors Includes all types of inaccuracies associated with customer metering as well as data handling errors (meter reading and billing), plus unauthorized consumption (theft or illegal use). NOTE: Over-registration of customer meters, leads to under-estimation of Real Losses. Under-registration of customer meters, leads to over-estimation of Real Losses.
AUTHORIZED CONSUMPTION	Find	= billed metered + billed unmetered + unbilled metered + unbilled unmetered The volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial and industrial purposes. This does NOT include water sold to neighboring utilities (water exported). Authorized consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered.
Average length of customer service line	Find	This is entered for unmetered services and in cold or other areas where meters are installed inside homes and buildings. It is the length of customer service line either between the utility's service connection (often at the curbstop) and the meter, or to the building line (first point of customer consumption) if customers are unmetered. Note that the length of service connection between the main and customer service line is owned by the utility and its length and potential leakage is accounted for in the UARL formula by the number of service connections. **What role does the "Average Length of Customer Service Line" parameter serve in the Water Audit?** In many water distribution systems the water utility has maintenance responsibility for a portion of the customer service piping from its connection point at the water main to the curbstop valve located midway to the customer building. The customer is responsible to maintain the customer service piping from the curbstop to the building premises. When leaks arise on customer service piping, water utilities respond faster to repair leaks than customers when the leak is on piping under their responsibility. Leak durations are longer on the customer-maintained piping than the utility-maintained piping. The total length of pipe maintained by customers is one of the components of the Unavoidable Annual Real Loss (UARL) equation and is determined by multiplying the average length of customer maintained pipe, Lp by the number of customer service connections. Therefore this parameter is important to the calculation of the UARL and the Infrastructure leakage Index (ILI). Click to see Service Connection Diagram
Average operating pressure	Find	The average pressure may be approximated when compiling the preliminary water audit. Once routine water auditing has been established, a more accurate assessment of average pressure should be pursued. If the water utility infrastructure is recorded in a Geographical Information System (GIS) the average pressure at many locations in the distribution system can be readily obtained. If a GIS does not exist, a weighted average of pressure data can be calculated from water pressure measured at various fire hydrants scattered across the water distribution system.
Billed Authorized Consumption		All consumption that is billed and authorized by the utility. This may include both metered and unmetered consumption. See "Authorized Consumption" for more information.
Billed metered consumption	Find	All metered consumption which is billed. This includes all groups of customers such as domestic, commercial, industrial or institutional. It does NOT include water sold to neighboring utilities (water exported) which is metered and billed. The metered consumption data can be taken directly from billing records for the water audit period. The accuracy of yearly metered consumption data can be refined by including an adjustment to account for customer meter reading lagtime, however additional analysis is necessary to determine the adjustment value, which may or may not be significant.
Billed unmetered consumption	Find	All billed consumption which is calculated based on estimates or norms but is not metered. This might be a very small component in fully metered systems (for example billing based on estimates for the period a customer meter is out of order) but can be the key consumption component in systems without universal metering. It does NOT include water sold to neighboring utilities (water exported) which is unmetered but billed.
Connection density		=number of connections / length of mains

Item Name		Description
Customer metering inaccuracies	Find	Apparent water losses caused by the collective under-registration of customer water meters. Many customer water meters will wear as large cumulative volumes of water are passed through them over time. This causes the meters to under-register. The auditor has two options for entering data for this component of the audit. The auditor can enter a percentage under-registration (typically an estimated value), this will apply the selected percentage to the two categories of metered consumption to determine the volume of water not recorded due to customer meter inaccuracy. Alternatively, if the auditor has substantial data from meter testing to arrive at their own volumes of such losses, this volume may be entered directly. Note that a value of zero will be accepted but an alert will appear asking if the customer population is unmetered. Since all metered systems have some degree of inaccuracy, then a positive value should be entered. A value of zero in this component is valid only if the water utility does not meter its customer population.
Customer retail unit cost	Find	The Customer Retail Unit Cost represents the charge that customers pay for water service. This unit cost is applied to the components of apparent loss, since these losses represent water reaching customers but not (fully) paid for. It is important to compile these costs per the same unit cost basis as the volume measure included in the water audit. For example, if all water volumes are measured in million gallons, then the unit cost should be dollars per million gallon ($/mil gal). The software allows the user to select the units that are charged to customers (either $/1,000 gallons, $/hundred cubic feet or $/1,000 litres) and automatically converts these units to the units that appear in the "WATER SUPPLIED" box. Since most water utilities have a rate structure that includes a variety of different costs based upon class of customer, a weighted average of individual costs and number of customer accounts in each class can be calculated to determine a single composite cost that should be entered into this cell. Finally, the weighted average cost should also include additional charges for sewer, stormwater or biosolids processing, if these charges are based upon the volume of potable water consumed.
Infrastructure Leakage Index (ILI)	Find	The ratio of the Current Annual Real Losses (Real Losses) to the Unavoidable Annual Real Losses (UARL). The ILI is a highly effective performance indicator for comparing (benchmarking) the performance of utilities in operational management of real losses.
Length of mains	Find	Length of all pipelines (except service connections) in the system starting from the point of system input metering (for example at the outlet of the treatment plant). It is also recommended to include in this measure the total length of fire hydrant lead pipe. Hydrant lead pipe is the pipe branching from the water main to the fire hydrant. Fire hydrant leads are typically of a sufficiently large size that is more representative of a pipeline than a service connection. The average length of hydrant leads across the entire system can be assumed if not known, and multiplied by the number of fire hydrants in the system, which can also be assumed if not known. This value can then be added to the total pipeline length. Total length of mains can therefore be calculated as: Length of Mains, miles = (total pipeline length, miles) + [{(average fire hydrant lead length, ft) x (number of fire hydrants)} / 5,280 ft/mile] or Length of Mains, kilometres = (total pipeline length, kilometres) + [{(average fire hydrant lead length, metres) x (number of fire hydrants)} / 1,000 metres/kilometre]
Master meter error adjustment	Find	An estimate or measure of the degree of any inaccuracy that exists in the master meters measuring the Volume from own sources. Please also indicate if this adjustment is because the master meters under-registered (did not capture all the flow) or over-registered (overstated the actual flow). All systems encounter some degree of error in their Master Meter data. Please enter a positive value.
NON-REVENUE WATER	Find	= Apparent Losses + Real Losses + Unbilled Metered + Unbilled Unmetered Water which does not provide any revenue to the utility
Number of active AND inactive service connections	Find	Number of service connections, main to curb stop. Please note that this includes the actual number of distinct piping connections including fire connections whether active or inactive. This may differ substantially from the number of Customers (or number of accounts)
Real Losses	Find	Physical water losses from the pressurized system and the utility's storage tanks, up to the point of customer consumption. In metered systems this is the customer meter, in unmetered situations this is the first point of consumption (stop tap/tap) within the property. The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows.
Revenue Water		Water which is charged to customers to provide revenue to the utility.
Systematic data handling errors	Find	Apparent water losses caused by systematic data handling errors in the meter reading and billing system.
Total annual cost of operating the water system	Find	These costs include those for operations, maintenance and any annually incurred costs for long-term upkeep of the system, such as repayment of capital bonds for infrastructure expansion or improvement. Typical costs include employee salaries and benefits, materials, equipment, insurance, fees, administrative costs and all other costs that exist to sustain the drinking water supply. These costs should not include any costs to operate wastewater, biosolids or other systems outside of drinking water.

Item Name		Description
Unauthorized consumption	Find	Includes water illegally withdrawn from hydrants, illegal connections, bypasses to consumption meter or meter reading equipment tampering. While this component has a direct impact on revenue, in most water utilities the volume is low and it is recommended that the auditor apply a default value of 0.25% of the volume from own sources. If the auditor has well validated data that indicates the volume from unauthorized consumption is substantially higher or lower than that generated by the default value then this value can be entered. However, for most water utilities it is recommended to apply the default value. Note that a value of zero will not be accepted since all water utilities have some volume of unauthorized consumption occurring in their system.
Unavoidable Annual Real Losses (UARL)	Find	UARL (gallons/day)=(5.41Lm + 0.15Nc + 7.5Lc) xP, or UARL (litres/day)=(18.0Lm + 0.8Nc + 25.0Lc) xP where: Lm = length of mains (miles or kilometres) Nc = number of service connections Lc = total length of customer service lines (miles or km) = Nc multiplied by the average distance of customer service line, Lp (miles or km) P = Pressure (psi or metres) Click to see Service Connection Diagram The UARL is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. It is a key variable in the calculation of the Infrastructure Leakage Index (ILI). It is not necessary that water utilities set this level as the target level of leakage, unless water is unusually expensive, scarce or both. NOTE: The UARL calculation has not yet been fully proven as effective for very small, or low pressure water distribution systems. If, in gallons per day: (Lm x 32) + Nc < 3000 or P <35psi in litres per day: (Lm x 20) + Nc < 3000 or P < 25m then the calculated UARL value may not be valid. The software does not display a value of UARL or ILI if either of these conditions is true.
Unbilled Authorized Consumption		All consumption that is unbilled, but still authorized by the utility. See "Authorized Consumption" for more information.
Unbilled metered consumption	Find	Metered Consumption which is for any reason unbilled. This might for example include metered consumption of the utility itself or water provided to institutions free of charge. It does NOT include water sold to neighboring utilities (water exported) which is metered but unbilled.
Unbilled unmetered consumption	Find	Any kind of Authorized Consumption which is neither billed nor metered. This component typically includes items such as fire fighting, flushing of mains and sewers, street cleaning, frost protection, etc. In most water utilities it is a small component which is very often substantially overestimated. It does NOT include water sold to neighboring utilities (water exported) which is unmetered and unbilled – an unlikely case. 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. Select the default percentage to enter this value. If the water utility already has well validated data that gives a value substantially higher or lower than the default volume, then the auditor should enter their own volume. However the default approach is recommended for most water utilities. Note that a value of zero is not permitted, since all water utilities have some volume of water in this component occurring in their system.
Units and Conversions	Find	The user may develop an audit based on one of three unit selections: 1) Million Gallons (US) 2) Megalitres (Thousand Cubic Metres) 3) Acre-feet Once this selection has been made in the instructions sheet, all calculations are made on the basis of the chosen units. Should the user wish to make additional conversions, a unit converter is provided below (use drop down menus to select units from the yellow unit boxes): Enter Units: Convert From… **Converts to…..** **1** **Million Gallons (US)** = **3.068883** **Acre-feet** (conversion factor = 3.06888328973723)

Item Name		Description
Use of Option Buttons	Find	To use the percent value choose this button To enter a value choose this button and enter the value in the cell to the right  **NOTE:** For unbilled unmetered consumption and unauthorized consumption, a recommended default value can be applied by selecting the Percent option. The default values are based on fixed percentages of water supplied and are recommended for use in this audit unless the auditor has well validated data for their system. Default values are shown by purple cells, as shown in the example above. If a default value is selected, the user does not need to grade the item; a grading value of 3 is automatically applied (however, this grade will not be displayed).
Variable production cost (applied to Real Losses)	Find	The cost to produce and supply the next unit of water. (E.g., $/million gallons) This cost is determined by calculating the summed unit costs for ground and surface water treatment and all power used for pumping from the source to the customer. It should also include the unit cost of bulk water purchased as an import if applicable.
Volume from own sources	Find	The volume of treated water input to system from own production facilities
Water exported	Find	Bulk water sold and conveyed out of the water distribution system. Typically this is water sold to a neighboring water utility. Be sure to account for any export meter inaccuracy in reporting this volume
Water imported	Find	Bulk water purchased to become part of the water supplied. Typically this is water purchased from a neighboring water utility or regional water authority. Be sure to account for any import meter inaccuracy in reporting this volume
WATER LOSSES	Find	= apparent losses + real losses The difference between System Input and Authorized Consumption. Water losses can be considered as a total volume for the whole system, or for partial systems such as transmission or distribution systems, or individual zones. Water Losses consist of Real Losses and Apparent Losses.

AWWA WLCC Free Water Audit Software: Determining Water Loss Standing

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Back to Instructions

Water Loss Control Planning Guide

Functional Focus Area	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)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.

Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities is gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.
Note: this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

General Guidelines for Setting a Target ILI
(without doing a full economic analysis of leakage control options)

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

APPENDIX D

TECHNICAL MEMORANDUM

TO: Geoff Farr, Village Engineer

FROM: Scott Beduhn

DATE: February 8, 2012

RE: Village of Howard District Metering
SEH No. HOWAV 117723

District metering is a method that is used in leakage analyses to help identify unaccounted for water. To develop a district metering plan, a water system is divided into discrete areas that are sufficiently small to measure and segregate leakage flow rates from customer consumption rates (AWWA, 2009). These areas are identified as district metering areas (DMAs).

To create a district metered area, a portion of the water distribution system is hydraulically isolated and supplied via inflow points equipped with flow meters. Valves on water mains are closed to create these isolated areas. Typically, supply flow rates are measured during minimal consumption periods. This is because leakage will account for the highest proportion of the supply flow during low customer demand times. The total supply is measured to each individual DMA and then compared to a predetermined baseline flow or billed usage for that measured time period.

The first step in district metering is to develop a district metering plan. This includes establishing distinct DMAs. In general, each DMA should be limited in size to allow determine leakage flow yet large enough to allow for accurate flow measurements. Approximately 500 to 3,000 properties is often utilized in creating DMAs, but the actual size of the DMA should be determined based upon the geometry of the water distribution system as well as the ability to accurately meter flow. In some cases, a pressure zone may serve as a DMA (depending on the size). For larger pressure zones it may be necessary to segment the zone into smaller areas to create the DMAs. The supply into the DMAs should be limited to one or two water mains. Ideally, the DMA boundary should be configured so that boundary valves are located on smaller mains to avoid creating dead ends on large transmission mains. Once the configuration of the DMA is determined, baseline measurements should be taken to document system conditions prior to implement the DMA in the distribution system. Pressure and water quality data as well as maintenance and customer complaint histories (water main breaks and leaks, valve and fire hydrant problems, low pressure or water quality complaints) should be reviewed in the proposed DMA to compare with system performance once the DMA is established. Pressure data should be recorded for at least one 24-hour period. Additionally, boundary valves that will be used to isolate the DMA should be inspected to ensure they are functional and will provide a watertight closure.

Once the DMA has been implemented in the water distribution system, it is important to measure the flow and pressure of the DMA for at least one 24-hour period. These measurements will provide useful information about the maximum and minimum flow ranges that occur in the area. This will help determine the appropriate size of the inflow and bypass piping. To ensure accurate flow measurements into the DMA, the inflow piping should be sized to accurately measure typical daily flows, not peak flows for fire fighting. However, the inflow piping must also be capable of providing peak daily demands. To test this, fire hydrants can be opened during low demand periods to simulate high demands while monitoring pressure in the area to ensure it will not drop too low. To ensure that the boundary valves are

closed watertight, a pressure drop test should be performed during a low demand period while the valves are being closed.

After it has been determined that the inflow piping is capable to serve customers within the DMA, the total inflow into the DMA should be monitored under normal operation for several days and compared with automatic meter reading (AMR) data for the corresponding time period. Additional leakage in the DMA can be identified by analyzing DMA flow patterns. As leakage rises, an increase in the minimum flow conditions will be observed and leak detection personnel should be sent into the DMA to pinpoint the leaks and arrange for repairs. Because of the level of effort required to collect baseline and metering data and the temporary metering equipment that is required to test each individual DMA, generally, only one DMA is monitored at a time.

A district metering plan for the Village of Howard would likely consist of DMAs separated by the existing pressure zones. The Medium and Low Pressure Zones would be split into smaller, sub-DMAs. Due to the limited number of connections between the pressure zones and the small diameter of some of these connections, some DMAs may not be completely isolated. Therefore, the temporary meters will also be measuring the flow exiting the DMA as well. Careful consideration will need to be taken in determining where to install the temporary meters to ensure that the existing PRVs and isolation valves do not interfere with the flow readings. Since accurate readings are imperative for a successful district metering plan, it is very important to consider the location of meters in relation to any valves and fittings that may impact the accuracy of the meter.

While district metering does not pinpoint individual leaks, it does give an approximate quantity of the collective leakage occurring in a DMA. A study done by the AWWA Water Loss Control Committee found that roughly half of the leakage volume in a system can be background leakage (which reflects poor infrastructure or service connection piping conditions), which cannot be handled by acoustic leak detection. Therefore, a district metering plan can be helpful for the Village of Howard in determining leaks that were not identified during the leak detection surveys performed in late 2009 and 2011.

rlb
Attachments as noted
c: Patrick Planton, SEH

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