Metropolitan Planning Council

Drinking Water 123 Academy

VILLAGE OF SAUK VILLAGE

Water Loss Control Plan

2021

ACKNOWLEDGEMENTS

DRINKING WATER 1-2-3 INITIATIVE PARTNERS

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ABOUT MPC

Since 1934, the Metropolitan Planning Council (MPC) has been dedicated to shaping a more equitable, sustainable, and prosperous greater Chicago region. As an independent, nonprofit, nonpartisan organization, MPC serves communities and residents by developing, promoting, and implementing solutions for sound regional growth.

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EXECUTIVE SUMMARY

The Village of Sauk Village applied and was selected for the Metropolitan Planning Council's Drinking Water 1-2-3 Technical Assistance program. **The primary deliverables in the Scope of Work are: 1) conduct a water audit, based on the American Water Works Association's M36 methodology; and 2) recommend next steps for the development of a water loss control program.**

The Metropolitan Planning Council analyzed data provided by Sauk Village's Public Works Department and Billing Department and conducted a "top-down" audit utilizing the American Water Works Association's free Water Audit Software. The range of data spanned three years, from 2017 to 2019, and found water losses of 28.44%, 23.47%, and 26.86%, respectively. This equates to an **average annual water loss of 26.25%, which is above the national average of 16%**.

Water loss is made up of **real losses** (i.e., water lost through leaks, breaks, and overflows on mains and distribution reservoirs) and **apparent losses** (i.e., non-physical loss attributed to systematic data handling errors, meter readings inaccuracies, and unauthorized consumption). To address these issues, **this report recommends a number of steps which can be taken by Sauk Village**, including:

- Identify existing leaks in the transmission and distribution system and determine which can be economically recovered;
- Manage the pressure throughout the system to reduce the frequency of new leaks and breaks resulting from high pressure;
- Identify and develop a plan to repair or replace water meters with insufficient accuracies;
- Improve the quality and accuracy of the customer billing system via the installation of automated meter reading (AMR) or advanced metering infrastructure (AMI) systems; and
- Create routine customer billing system output reports to easily reveal unusual consumption trends and suspicious activities, thereby helping to identify and reduce unauthorized consumption.

Again, this report presents the results of the "top-down" audit. **These results should be validated through two additional steps**. First, a **leakage component analysis** quantifies the volume of leaks and pinpoints their location. Next, a **"bottom-up" approach** should be conducted, which uses field measurements and physical inspection.

Safe drinking water is the bedrock of any community. It is required for public health, is necessary for local businesses and industries, and a sustainable supply of water supports a growing population and other economic development initiatives. Water loss is a universal problem among water systems, often caused by aging infrastructure. **Efficient and timely planning will help avoid higher costs in the future, and it is imperative that municipalities make data-informed plans to address the current and future needs of their system.**

PROJECT BACKGROUND

HOW TO USE THIS REPORT

The purpose of this report is to provide staff and elected officials in Sauk Village with a preliminary understanding of water audits and water loss in the village. Recommended next steps and strategies are offered to help staff and officials make informed decisions as Sauk Village tackles this important issue.

MPC'S WATER RESOURCES PROGRAM

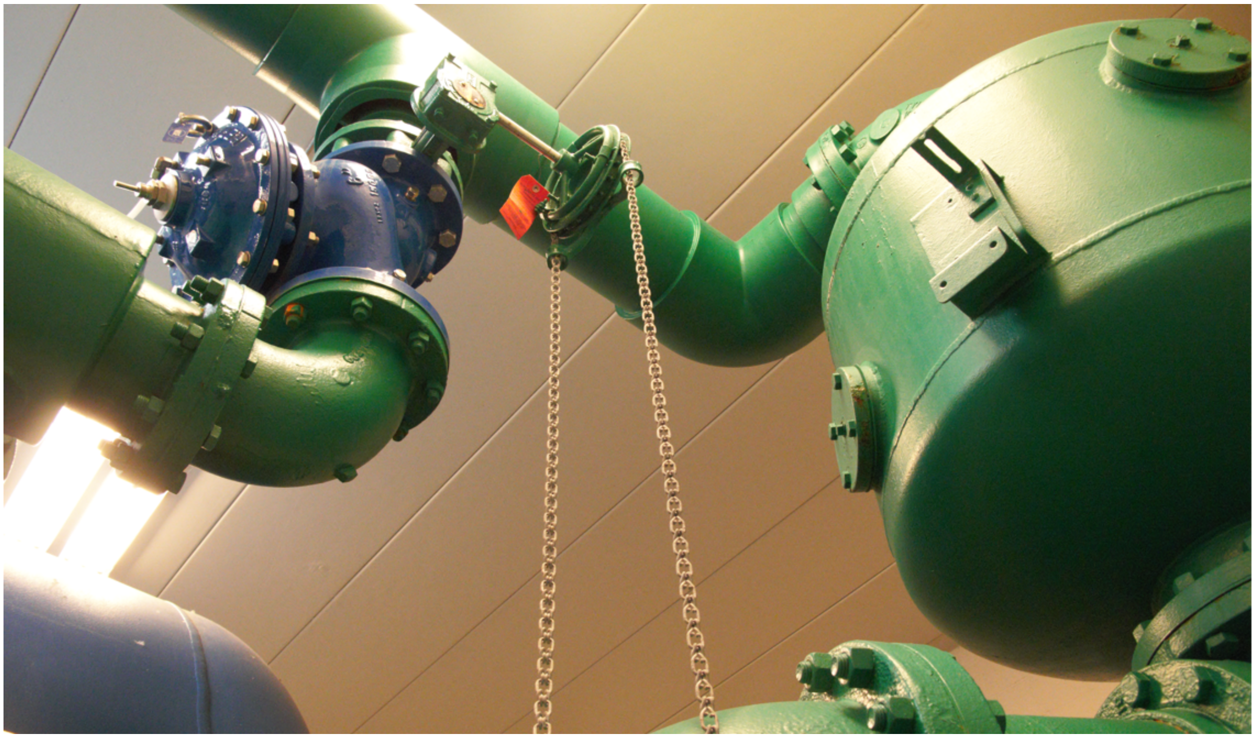
Northeastern Illinois' proximity to the Great Lakes and access to multiple rivers and underground aquifers mean that we generally enjoy abundant water resources. While our region's water assets are considerable, they are also finite – in the case of Lake Michigan, governed by a Supreme Court Decree – and face a multitude of challenges due to infrastructure age, fragmented system management, and potential contamination. As climate change advances, shorter duration but increasingly intense and more frequent storm events – much of which cannot infiltrate nor evapotranspirate because of storm intensity and urban land use decisions – overwhelm stormwater infrastructure, which is undersized and aging. The result is negative impacts for humans, aquatic ecosystems, and the ecosystem services they provide from Chicago to the Mississippi River and beyond. These realities jeopardize both public health and economic growth.

In response to these challenges, the Metropolitan Planning Council's (MPC) Water Resources program uses research, advocacy, education, and technical assistance to: 1) ensure clean, equitable, and abundant drinking water; 2) prevent flooding and improve water quality; 3) facilitate and encourage stewardship of our natural assets; and 4) foster social, economic, and environmental benefits within communities.

DRINKING WATER 1-2-3

Drinking Water 1-2-3 is a collection of initiatives that assist communities in the Chicago metropolitan area with water-related issues. In 2017, MPC released the Drinking Water 1-2-3 guide, designed for elected officials and local leaders to help communities take the necessary steps to ensure livability through quality drinking water service. Read more at: drinkingwater123.metroplanning.org

In 2019, MPC launched the Drinking Water 1-2-3 Academy to assist with continued education and training for community officials and establish a peer network that fosters learning and coordination. To assist with on-the-ground technical assistance projects, which implement many of the best practices featured in the guide, MPC administers the Drinking Water 1-2-3 Technical Assistance program. Throughout 2020, MPC coordinated expert services to help communities – including Sauk Village – tackle their most pressing drinking water needs.



PLANNING PROCESS

Sauk Village applied to the Drinking Water 1-2-3 Technical Assistance program and was selected to fulfill the following scope:

SCOPE OF WORK

1. **Conduct a water audit**

   Purpose. To identify where real loss (e.g., leakage, theft) and apparent loss (e.g., meter or billing error) are occurring in the village's water distribution system.

   Task. MPC and its contractor will work with village officials and staff to collect available data and conduct a water audit based on the American Water Works Association's M36 Water Audits and Loss Control Programs manual.

   Deliverables. Completion of a water audit or, if necessary, a plan to gather the required data in order to do so.

2. **Analyze the results of the water audit and identify next steps for water loss control**

   Purpose. To provide a pathway to control real and apparent losses, including short-term and long-term goals for a control program.

   Task. MPC and its contractor will develop a plan which includes tools and approaches to address real and apparent water loss in the village related to leakage, pressure management, metering, billing, etc. The plan will also include practices to be implemented for long-term loss control.

Deliverables. Completion of a water audit or, if necessary, a plan to gather the required data in order to do so.

3. **Provide educational sessions with the village's Board of Trustees**

   Purpose. To help the Board understand the value of water, the need to attend to the system, costs related to operations and maintenance, and how the results of the Technical Assistance project should be used.

   Task. MPC will work with village staff to develop and provide up to two educational sessions with the village's Board of Trustees, potentially at the outset and conclusion of the Technical Assistance project.

   Deliverables. Completion of up to two educational sessions.

PLANNING CONTEXT

The Village of Sauk Village, Illinois, occupies an area along the Sauk Trail, a pathway between Detroit and the Mississippi River, first used by the Native Americans and, later, European travellers.[1] Settlement began in the 1830s.[2] In 1913, Lincoln Highway was laid through the village, spurring Main Street development and a housing boom in the 1950s, brought on by the regional growth of manufacturing.

Sauk Village is located in far south Cook County, with a small portion extending into Will County. The village is intersected by Lincoln Highway (US 30) and Illinois Route 394 (IL-394) and is approximately two miles from the Illinois-Indiana state line. Neighboring municipalities include Chicago Heights, Crete, Ford Heights, Lynwood, Steger, and Willowbrook.

DEMOGRAPHICS AND LAND USE

The village incorporated in 1957, and the population more than doubled between 1960 and 1990.[3] Currently, the population of Sauk Village is 10,516 individuals, which reflects a growth of 1% between 2000-2018.[4] Sauk Village is comprised of 2,485.4 total acres. The predominant land uses are Single-Family Residential (28%), Transportation and Other (26%), and Agricultural (19%).[5]

In 1960, nearly 100% of the residential population was White, falling to 75% in 1990 and 60% in 2000. In the American Community Survey 5-year estimate for 2014-2018, race and ethnicity was listed as: 68.5% Black non-Hispanic, 17.6% White non-Hispanic, 10.3% Hispanic or Latino, and 0.9% Asian non-Hispanic. Median Household Income (MHI) is $42,105, which is below the Cook County MHI of $62,088. Eighty-one percent of housing units are occupied, with an ownership rate of roughly 50%.

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[1] McClellan, L.A. (2005). Sauk VIllage, IL. Encyclopedia of Chicago. http://www.encyclopedia.chicagohistory.org/pages/1116.html
[2] Sauk Village. (2010). Our Town. www.saukvillage.org/OurTown.html
[3] see Citation 1.
[4] Chicago Metropolitan Agency for Planning (CMAP). (2020). Community Data Snapshot: Sauk Village, Municipality. https://www.cmap.illinois.gov/documents/10180/102881/Sauk+Village.pdf
[5] CMAP. (2021). Community Data Snapshot: Sauk Village, Municipality. https://www.cmap.illinois.gov/documents/10180/102881/Sauk+Village.pdf

WATER

IMPORTANCE OF WATER

Safe drinking water is the bedrock of any community. It is required for public health – which has become even more evident during the pandemic. It is necessary for local businesses and industries. And a sustainable supply of water supports a growing population and other economic development initiatives. There is virtually no aspect of life that water does not touch.

Despite this, today's water systems face a variety of challenges. These include aging infrastructure, potential contamination from road salts and stormwater runoff, a changing climate and other environmental stressors, growing populations, new regulations, and, perhaps most importantly, financial constraints.

ATTENDING TO THE SYSTEM

Since its initial, expensive construction during the 20th century, the nation's water infrastructure has remained largely out of sight and out of mind. Much of this vital infrastructure is now approaching the end of its useful life. According to the American Water Works Association (AWWA), "we are coming face-to-face with a serious challenge that could become a crisis if we ignore it."[6]

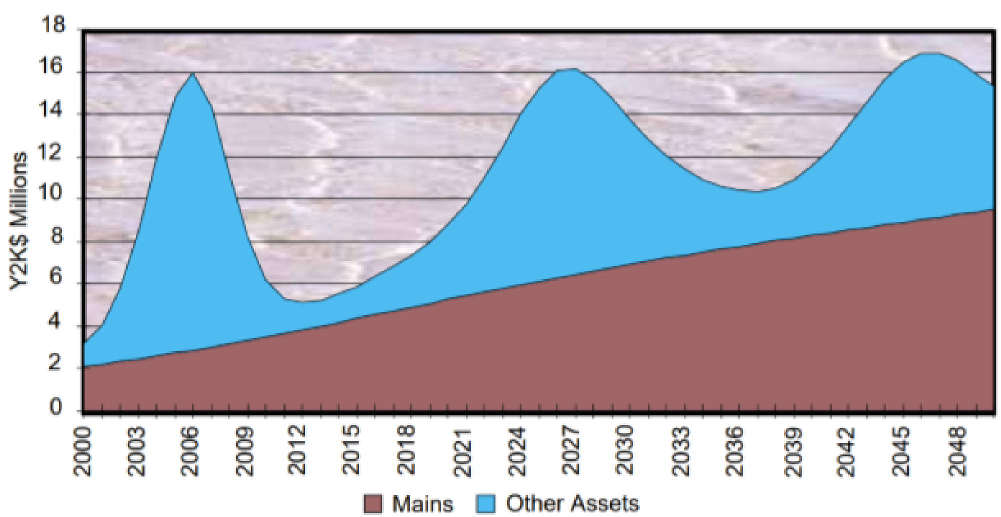
[6] AWWA. (2001). Dawn of the replacement era: Reinvesting in drinking water infrastructure. https://www.win-water.org/reports/infrastructure.pdf

Aging public water systems will require significant investment, and costs will vary by region and locality depending on the age and material of the infrastructure. Efficient and timely planning will help avoid sky-rocketing costs in the future. Cost projection models published by AWWA show “Nessie” curves – named for their visual similarity to the Loch Ness Monster – which illustrate future increases in total replacement and repair costs. By modeling demographic data and the life expectancy of infrastructure, Nessie curves can predict a water system’s trajectory of infrastructure aging and expenditure. In most cases, the analysis shows:

> [The] deferral of replacement will produce higher overall costs due to increased repairs than would be the case if replacement occurred on time. If replacement is deferred too far beyond the economic trade-off point between replacement and repair costs, the repair cost burden will spiral upwards and have significant impacts on utility cash flows. Such a scenario will indeed impair a utility’s ability to repay debt.[7]

Fig. 1 is an example of this projected scenario of the concurrent need to finance pipes and other facilities. “Mains” represents pipe replacement as these gradually age and eventually break. “Other Assets” includes water treatment plants, pumping stations, etc. which will require large investments and have shorter lifespans than the mains.

Figure 1. Example Nessie Curve, which shows the pattern of projected replacement costs for water infrastructure out to the year 2050.[8]



This example Nessie curve shows “the manner in which spending for the replacement of pipes rises like a ramp over the first part of the century, pushing up the overall level of annual expenditure required.”[9] The costs are expected not only to increase in the foreseeable future, but the overall cost will vary in waves,

[7] see Citation 6
[8] see Citation 6
[9] see Citation 6

depending on the local demographic changes and condition of the infrastructure.[10] As this example shows, deferring replacement will have a much higher cost in the long run.

Key message. The vast underground network of water systems across the U.S. has been revolutionary in its ability to distribute clean drinking water, but funding for repair and replacement of this vital infrastructure must be prioritized to secure public health and safety. To ensure that communities continue to have unrestricted access to safe drinking water, large investments will be required. While state and federal governments have a significant role to play in financing water infrastructure repair and replacement, it is imperative that water service providers make plans to address the needs of their system.

[10] see Citation 6

SAUK VILLAGE WATER SYSTEM

Sauk Village's current average water usage is 75 gallons per day per person. This is comparable to the regional average of 74.3 gallons per day per person.[11] The village pumps and treats groundwater for its public water supply and has three active community water supply wells – Well #1 (Illinois EPA #20600), Well #2 (Illinois EPA #20601), and Well #3 (Illinois EPA #20602) – with an average daily production of 772,000 gallons per day (gpd).

Table 1. Well Data.

Well ID	Status	Depth (feet)	Minimum Setback (feet)	Total Pumpage (gallons)	Aquifer Code	Aquifer Description	Max Zone (feet)
20600	A	470	200	166,897,500	5656	Shallow Bedrock	1,000
20601	A	480	200	166,897,500	5656	Shallow Bedrock	1,000
20602	A	450	200	90,796,000	5656	Shallow Bedrock	1,000

[11] CMAP. (n.d.). Indicator: Water Demand. https://www.cmap.illinois.gov/2050/indicators/water-demand

Sauk Village has three water storage sites in the system and a total storage capacity of 1,200,000 gallons. A ground storage tank at the main pumping station located at 2222 Sauk Trail has a 300,000-gallon capacity. Two elevated storage tanks – one located at 21400 Merrill Avenue and the other at 22550 Sauk Point Drive – have a 400,000-gallon and a 500,000-gallon capacity, respectively.

Sauk Village provides water to two satellite systems: Candlelight Village and Weatherstone Estates via approximately 30 miles of water mains.

WATER AUDIT

BACKGROUND

Aging infrastructure, inadequate resources, more stringent regulatory standards, and increasing concerns of water quantity and quality are the emerging challenges for most public drinking water systems in the United States. Based on the Drinking Water Infrastructure Needs Survey Fact Sheet published by the U.S. Environmental Protection Agency (U. S. EPA), the total cost to improve and upgrade water transmission and distribution systems over the next 20 years is estimated to be $247.5 billion dollars, of which 29% is estimated to be needed for water loss control.[12]

Water loss is a universal problem among water systems, often caused by aging infrastructure. The average estimated water loss is 16%, while water loss of some individual systems can be over 30%. Up to 75% of those losses can be recoverable.[13] Developing a system specific water loss control program helps water systems conserve valuable water resources, protect public health, and recover revenue.

The first step in establishing an effective water loss control program is performing a water audit. A properly conducted water audit can help identify leaks, monitor performance over time, make comparisons with other systems, and correct billing inaccuracies. Water audits are considered the foundation of production-side water resource management and a benchmarking step for addressing unnecessary water and revenue losses.

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[12] U.S. EPA (2011). EPA's 2011 Drinking Water Infrastructure Needs Survey and Assessment Fact Sheet.
[13] see Citation 12

WATER BALANCE

A significant source of water loss can be attributed to leaks through pipes and valves, also referred to as "real losses." In addition to physical leaks, the type of water loss referred to as "apparent losses" often results from meter inaccuracy, data reading and transfer errors, and data analysis errors. These are explained in the AWWA Water Balance, shown in Fig. 2.

Figure 2. The Water Balance.[14]

<table>
<tr><td rowspan="8">Volume from Own Sources (corrected for known errors)</td><td rowspan="11">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="10">Water Supplied</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Unmetered Consumption</td><td rowspan="8">Non-revenue Water</td></tr>
<tr><td>Unbilled Metered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Unauthorized Consumption</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Water Imported (corrected for known errors)</td><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the point of Customer Metering</td></tr>
</table>

In this table, Water Supplied (i.e., from the water system to the user) is broken into Authorized Consumption and Water Losses. Authorized Consumption is further broken down into Billed and Unbilled, but it is important to note that both of these are authorized uses. Among the types of authorized consumption, Unbilled Unmetered Consumption often includes uses such as fire suppression, municipal landscaping and irrigation, and water used by Public Works and other municipal departments. Unbilled Metered Consumption often includes many of the same uses, but some water systems use meters to track how much water is used for these purposes even if they will not bill for the consumption.

The rest of the chart breaks down the different uses, ultimately, into Revenue Water (for which the system bills users) and Non-revenue Water (for which the system does not – or cannot – bill). AWWA made a deliberate shift to using the term "Non-revenue Water" rather than the previous industry standard, "unaccounted for water." The rationale is that every drop should be accounted for, and, when Non-revenue Water is the result of Real or Apparent Water Losses, water systems must work to identify the causes and make a plan to address them.

[14] AWWA. (2017). The State of Water Loss Control in Drinking Water Utilities.
https://www.awwa.org/Portals/0/AWWA/ETS/Resources/WLCWhitePaper.pdf?ver=2017-09-11-153507-487

Some solutions include: identifying and repairing leaks; managing the pressure in parts of the system where, for example, high pressure results in leakage; fixing metering or billing inaccuracies, such as data transfer errors; and more.

METHODOLOGY

AWWA has standardized terminology and methods for performing water audits. The auditing process occurs at three levels with increasing refinement:

1. Top-down approach
2. Leakage component analysis
3. Bottom-up approach

First, the top-down audit is a desktop audit using existing records and reasonable estimates to provide an overall picture of water losses occurring in the system. After obtaining broadly quantified real loss components from the top-down approach, next, a leakage component analysis (LCA) is generally performed. This is a technique that can provide a structural analysis to quantify the volume of leaks and pinpoint their location. The LCA model can be a valuable tool for water systems to monitor and record background leakage, unreported leakage, and reported leakage and to develop a leakage management plan. Finally, to validate the results of the top-down approach, a bottom-up approach uses actual field measurements and physical inspection. **This report contains the results of the top-down approach. It is recommended that Sauk Village use the results to proceed with an LCA and the bottom-up approach.**

The top-down approach provides a preliminary assessment of water loss, helps identify water loss components that need further investigation and validation, and identifies urgent needs for water loss control practices. For the current water audit in Sauk Village, the first steps were to establish the system boundary and identify a study period. Next, interviews were conducted with staff to determine the availability of datasets, and data requests were generated for the Public Works Department and the Billing Department. Data were then collected and incorporated into AWWA's free Water Audit Software.

RESULTS

PREVIOUS SAUK VILLAGE WATER AUDITS

To provide a baseline for comparison with the current audit, the results of two previous audits are provided. Robinson Engineering conducted two previous water audits for Sauk Village as part of water quality improvement plans in 2011 and 2015, and determined that Sauk Village experienced a water loss of 23% in 2011 and 32% in 2014.[15]

WATER BALANCES

The data utilized for this audit were provided by the Sauk Village Public Works Department and the Billing Department for a period of three years from 2017 to 2019. The audit results generated from AWWA's free Water Audit Software (2021 release) are broken down by year; see the Appendices A, B, and C for the full results. An analysis of the results follows.

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[15] The water audit conducted in 2015 reflects water loss for 2014.

WATER PRODUCTION

Sauk Village's drinking water comes from three groundwater wells and is launched into the system from two sites: Wells #1 and #2 (Main pump station, 2222 Sauk Trail) and Well #3 (2050 Evergreen). Sauk Village provided water production data via internal documents. Comparisons of total water production by year, and broken down by month, are shown in Tables 2 and 3.

Table 2. Annual Water Production (in million gallons per year).

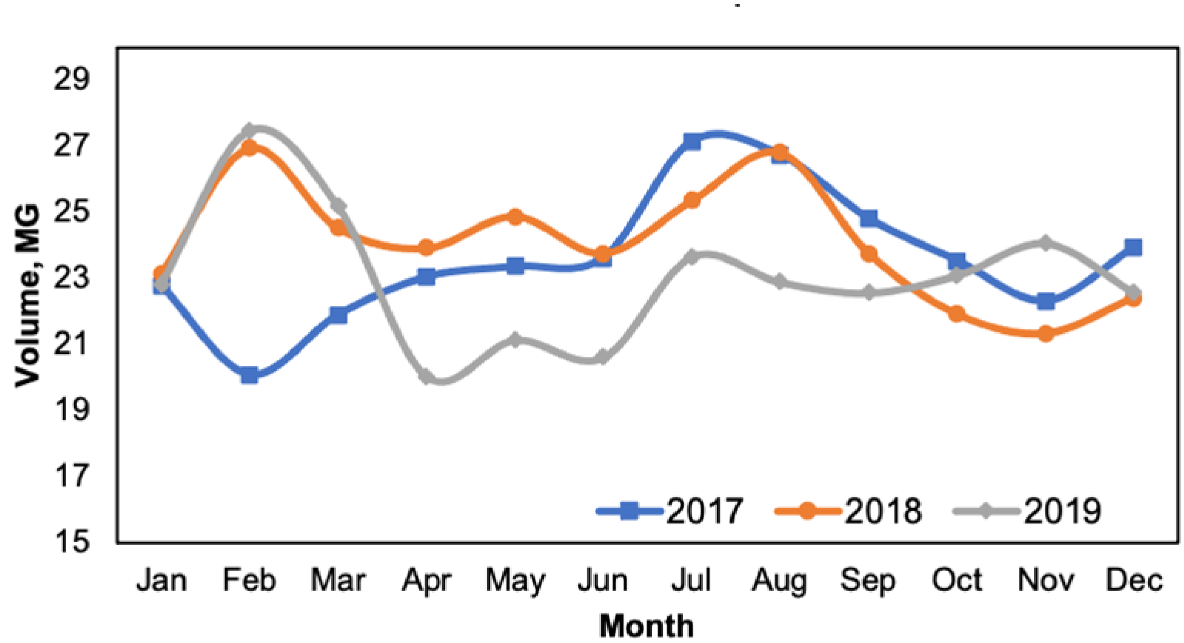
Production	2017	2018	2019
Volume from Own Sources	283.161	288.683	276.070

Table 3. Monthly Water Production (in million gallons per year).

	Year		
Month	**2017**	**2018**	**2019**
January	22.773	23.127	22.821
February	20.076	26.955	27.486
March	21.883	24.519	25.194
April	23.031	23.907	20.030
May	23.347	24.876	21.130
June	23.618	23.747	20.603
July	27.143	25.355	23.652
August	26.726	26.810	22.884
September	24.801	23.751	22.554
October	23.526	21.904	23.088
November	22.304	21.320	24.060
December	23.934	22.411	22.566
Total	**283.161**	**288.682**	**276.070**

As shown in Fig. 3, the largest production increase generally occurs during the summer months (June-August). It is common for communities to experience production and consumption increases during summer months when the weather is hot and dry. Production also spiked in February of 2018 and 2019. Further investigation is needed to identify possible reasons for these production increases.

Figure 3. Seasonal Production Comparison.



WATER CONSUMPTION

Authorized consumption is calculated with the following formula:

Authorized Consumption = billed metered + billed unmetered + unbilled metered + unbilled unmetered

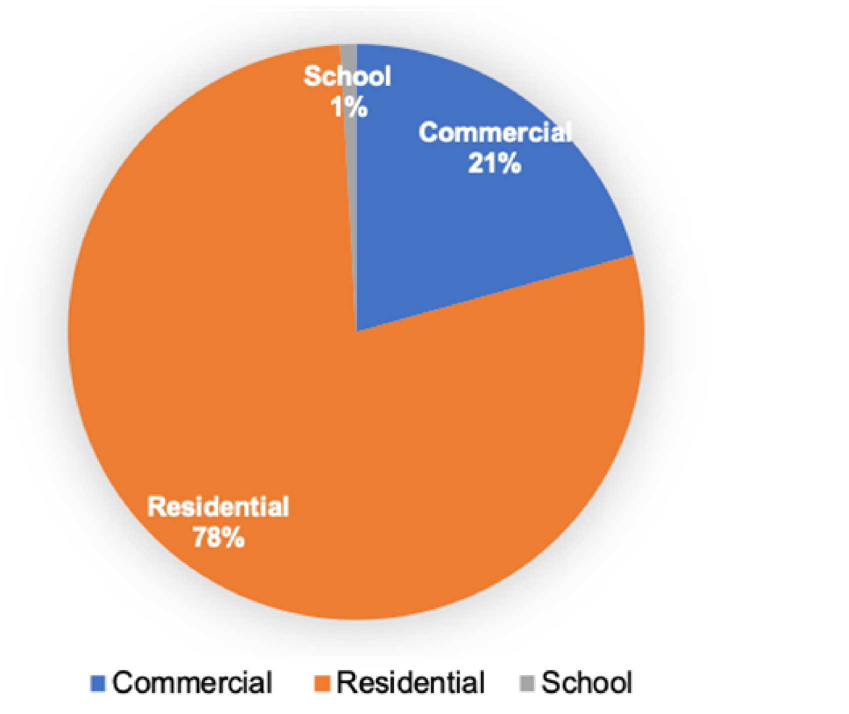
- **Billed metered consumption** represents the collective amount of water delivered to customers that have accounts in the customer billing system. This value is the basis for revenue generation for the water system.
- **Billed unmetered consumption** generally applies to water systems which charge customers either a flat rate or only bill some accounts. This can occur when municipalities have difficulties in maintaining or keeping all meters fully functional or when readings are unattainable.
- **Unbilled authorized consumption** generally describes the water taken from fire hydrants for firefighting, flushing, testing, street cleaning, and other public purposes. This type of water usage can be, but rarely is, metered or directly billed. Therefore, a default value is used rather than attempting to quantify these water uses.

Sauk Village has approximately 3,000 service connections, with residential and commercial being the highest volume billed metered consumers (see Table 4 and Fig. 4). Residential accounts comprise the majority of water usage at 78%. Sauk Village collects customer consumption data utilizing a hybrid approach of manual reading and automatic meter reading (AMR). To improve the accuracy of billing data and the process to read, transmit, archive, and report customer consumption totals, the village is in the process of eliminating manually read accounts and improving estimating methods.

Table 4. Billed Metered Consumption by Account Type (in gallons per year).

Type	2017	2018	2019
Commercial	36,932,500	38,465,200	39,323,100
Residential	151,253,900	151,406,800	133,958,200
School	1,811,500	2,184,700	1,032,200

Figure 4. Share of Billed Metered Consumption by Account Type.



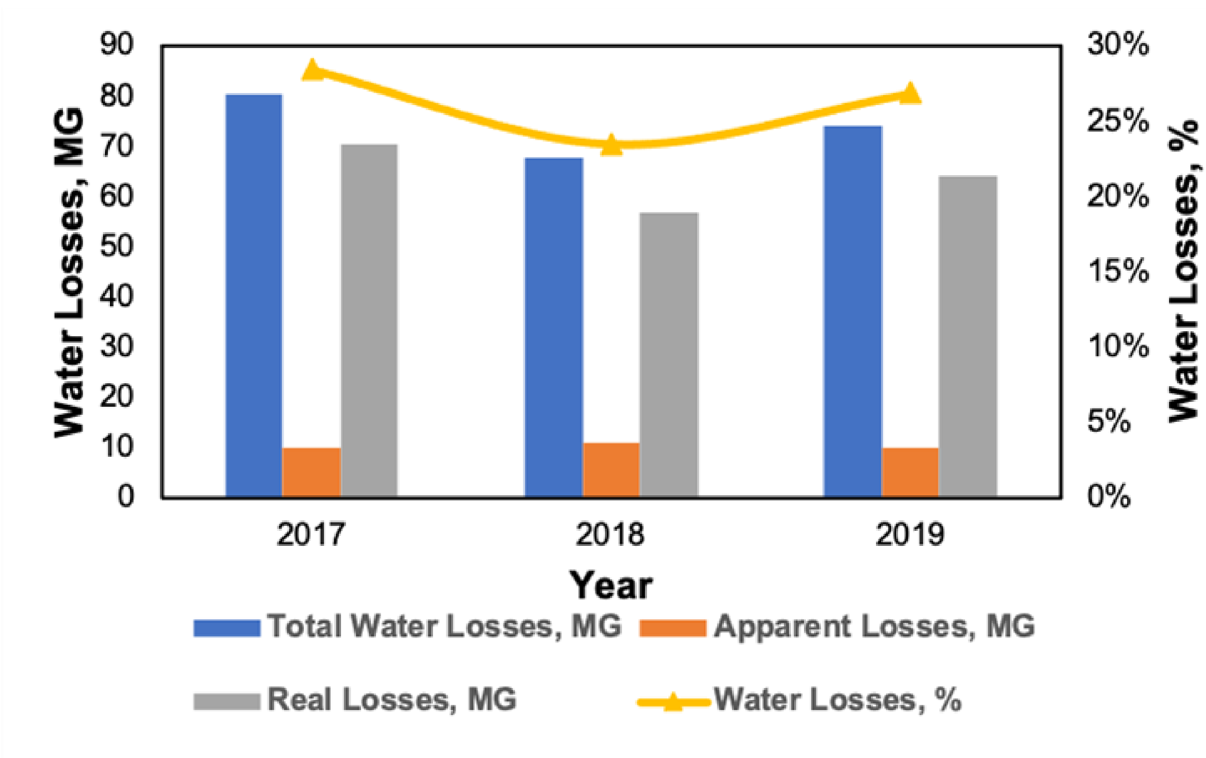
WATER LOSS

Water loss is made up of **real losses** (water lost through all types of leaks, breaks, and overflows on mains and distribution reservoirs) and **apparent losses** (non-physical loss attributed to systematic data handling errors, meter readings inaccuracies, and unauthorized consumption). The audit results generated from AWWA's free Water Audit Software are summarized in Table 5 and Fig. 5.

Table 5. Water Loss Results (in million gallons).

Type	2017	2018	2019
Apparent Losses	10.046	11.069	10.046
Real Losses	70.485	56.689	64.103
Total Water Losses	80.531	67.758	74.149
Water Loss %	**28.44%**	**23.47%**	**26.86%**

Figure 5. Water Losses.



Annual average water losses for the study period (2017-2019) are approximately 26.25%. The billing department has reduced the billing and estimation errors substantially by improving billing methods and tracking potential data handling errors for the last several years. The majority of total water losses (85.9%) can be attributed to real losses, such as water main leakage and breaks.

Sauk Village's average annual water losses of 26.25% is above the national average of 16% as well as above the 8% limit for non-revenue water for Lake Michigan Water Allocation Program permittees, developed by Illinois Department of Natural Resources (IDNR). Although Sauk Village is not a Lake Michigan permittee, the 8% benchmark is a useful consideration when developing a plan for improving the village's water distribution and transmission system.

RECOMMENDATIONS

Across the United States, millions of gallons of water are lost daily due to aging and failing drinking water infrastructure. Drinking water asset management practices have evolved over the past ten years, and states across the country have started implementing more rigorous regulations in regards to water loss assessment and reporting requirements, including the AWWA water audit methodology used in this report.

Although Sauk Village does not receive water from Lake Michigan, the requirements for Lake Michigan permittees is a useful comparison for setting water loss goals. Regulated by IDNR, the Lake Michigan Water Allocation Program requires all permittees to submit an annual water audit form (i.e., LMO-2 form), and annual water losses must be limited to 8% or less of a permittee's net annual pumpage.[16]

The switch to Lake Michigan water as drinking water supply was briefly discussed when the village's source water was contaminated with vinyl chloride. This issue was resolved by the addition of air stripping systems and iron removal filter systems. Even without the intention to switch the water supply to Lake

[16] IDNR. (n.d.) Lake Michigan Water Allocation. https://www2.illinois.gov/dnr/WaterResources/Pages/LakeMichiganWaterAllocation.aspx

Michigan, the village's water loss is above national average (16%), which has a cost in terms of revenue as well as natural resource management.[17] Therefore, it is crucial to develop an effective water loss control program tailored to Sauk Village's water infrastructure.

REAL LOSS MANAGEMENT

Infrastructure Management. First and foremost, to actively control leakage in the water system, it is essential that the village identify and quantify existing leaks in the transmission and distribution system. This can be done by conducting acoustic leak detection surveys and monitoring flows to the two satellite systems. Secondly, to optimize leak repair activities, it is recommended to maintain an inventory of all sizes of pipes, valves, and hydrants to ensure timely repairs of main breaks and for general maintenance activities.

A common recommendation is to develop and maintain a database of system components, such as valves, hydrants, water mains, service connections, etc. and update the system with known leaks, repairs, complaints, theft, and vandalism by geographic location. If feasible, it is recommended for the village to develop a GIS-based system map to better monitor and record the occurrence and duration of leaks. Doing so will allow the village to calculate the cost of water lost versus the cost of repairs and make data-driven decisions regarding specific leaks.

Real losses can be considered economically recoverable when the value of the water savings from leak reduction exceeds the cost of the leakage control measures and repairs. When a water system experiences excessive real losses, it generally indicates that considerable reductions can be achieved early in a loss control program at a relatively low cost.

Lastly, all pipe assets and water mains should be inspected periodically and rehabilitated/replaced when they reach the end of their service life.

Pressure Management. Pressure management is defined as "the practice of managing system pressures to the optimum levels of service, ensuring sufficient and efficient supply to legitimate uses and consumers, while reducing unnecessary or excess pressures, eliminating transients and faulty level controls, all of which cause the distribution systems to leak unnecessarily."[18]

The water in a system is pressurized for a variety of reasons, including preventing contaminants from entering the system, preventing backflow, accommodating elevation gradients across the service area, and meeting special service needs for fire hydrants or irrigation. System pressure can be supplied by pump station or gravity from a water tower or storage structure.

Pressure management should not be interpreted as whole system pressure reduction, and appropriate pressure levels vary greatly from system to system based on specific needs and infrastructure condition.

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[17] Water Quality and Health Council. (n.d.). Water Loss: Challenges, Costs and Opportunities. https://waterandhealth.org/safe-drinking-water/water-loss-challenges-costs-opportunities/
[18] AWWA. (2016). Water Audits and Loss Control Programs.

Common pressure management practices include proper installation of pressure relieving valves or other pressure regulating infrastructure that can be isolated and regulated based on water demand.

Dividing service areas into smaller pressure zones is a common practice, if feasible. This allows a system to monitor pressure on a zone-by-zone basis via a supervisory control and data acquisition (aka SCADA, pictured at the top of this chapter) system and record real-time pressure data to provide guidance on how to effectively control the system pressure. Proactive pressure management can effectively reduce the frequency of new leaks and breaks occurring within the distribution system due to high pressure and extend water infrastructure life by reducing stress on infrastructure.

APPARENT LOSS MANAGEMENT

Meter Accuracy Testing. The number and size of water meters in Sauk Village is shown in Table 6. Regular testing is required to determine the physical accuracy of meters and identify meters with declining performance, particularly large meters. Large meters need to be tested on an annual basis, while small and medium meters should be tested at least once every two years.

After identifying meters with insufficient accuracies, the village should develop a plan either to repair or replace those meters, thereby reducing apparent losses from customer metering inaccuracies. Village staff and technicians should test meters for higher consumption users on a regular basis.

Table 6. Sauk Village Water Meter Sizes.

Types	Size	Numbers of Meters
Small Meters	1/2"	21
	5/8"	16
	3/4"	880
	1"	22
Medium Meters	1 1/2"	12
	2"	21
Large Meters	3"	5
	4"	3

Customer Billing System Improvement. AMR and advanced metering infrastructure (AMI) systems are innovative technologies that can provide high operational efficiency, positive financial benefits, and reliable meter readings. Sauk Village utilizes manual reading as part of the customer billing system, which is more labor intensive and time-consuming. Installation of new AMR and AMI systems to replace manual reading meters will improve the quality and accuracy of the customer billing system and reduce apparent losses. AWWA and other online resources provide a wealth of information about these metering systems and their benefits.

Unauthorized Consumption Monitoring. The billing department should create routine output reports that present data from the customer billing system that can easily reveal unusual consumption trends and suspicious activities. For example, if public works staff notice a significant amount of accounts that register zero consumption for more than two consecutive billing cycles, they should plan to inspect the customer's premises to determine possible reasons for unusual water meter readings.

Other precautions the village can take to minimize unauthorized consumption include conducting inspections after service termination, identifying potential tampering of metering systems, inspecting the system for illegal bypass piping and connections, and installing proper valves on interconnecting water systems. If the village does not plan to meter fire hydrants, irrigation systems, regular system flushing, and street cleaning water, the village should endeavor to identify a way to record and accurately estimate this type of public water usage.

CONCLUSION

Sauk Village, along with other municipalities and water service providers throughout the country, faces many challenges in providing safe, clean, sustainable drinking water. Among these, one of the most significant concerns tends to be financing repair and replacement of aging infrastructure.

This report provides Sauk Village elected officials and staff the results of a water audit conducted using the methodology established by the AWWA and recommends next steps for the development of a water loss control program. While Sauk Village's average annual water loss of 26.25% is higher than the national average, steps can be taken to recover and prevent future real losses (i.e., water lost through leaks, breaks, and overflows on mains and distribution reservoirs) and apparent losses (i.e., non-physical loss attributed to systematic data handling errors, meter readings inaccuracies, and unauthorized consumption).

This report recommends preliminary steps for the development of a water loss control program, including:

- Infrastructure Management
- Pressure Management
- Meter Accuracy Testing
- Customer Billing System Improvement
- Unauthorized Consumption Monitoring

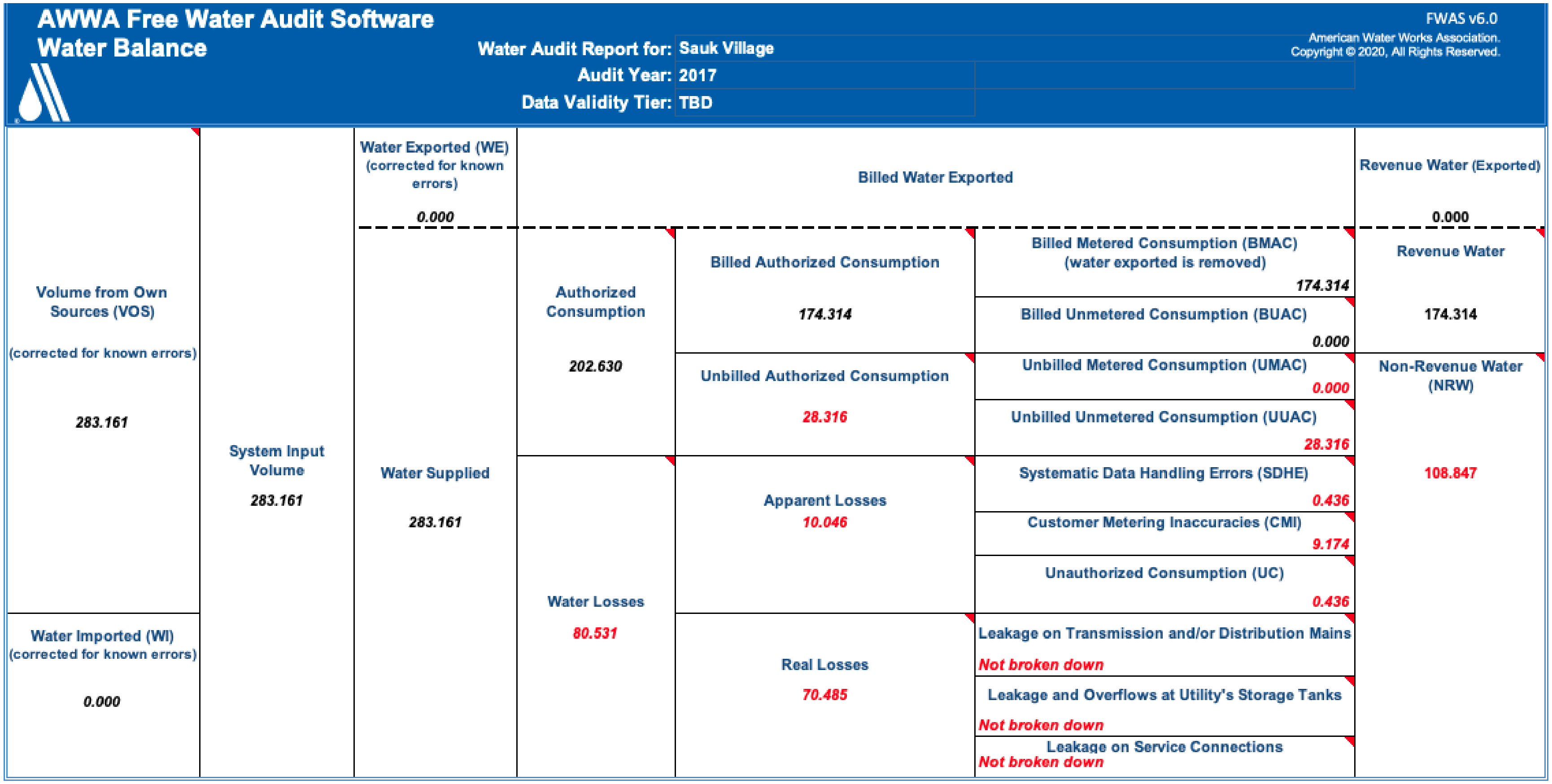
In addition to the development of a water loss control program, the result of this “top-down” audit should be validated with a leakage component analysis and “bottom-up” approach, which require hands-on detailed investigation, meter testing, site visits, and more. The village's Public Works staff and water-related contractors and consultants will be instrumental in prioritizing and carrying out these next steps.

Throughout the implementation phases of this report and beyond, the Metropolitan Planning Council continues to be a resource for Sauk Village. Contact Justin Keller, Manager of Water Resources, at jkeller@metroplanning.org or by phone at (312) 863-6033.

APPENDICES

A. Sauk Village Water Balance 2017
B. Sauk Village Water Balance 2018
C. Sauk Village Water Balance 2019

APPENDIX A: SAUK VILLAGE WATER BALANCE 2017



APPENDIX B: SAUK VILLAGE WATER BALANCE 2018

AWWA Free Water Audit Software
Water Balance

FWAS v6.0

Water Audit Report for: Sauk Village
Audit Year: 2018
Data Validity Tier: TBD

Volume from Own Sources (VOS) (corrected for known errors) 288.683	System Input Volume 288.683	Water Exported (WE) (corrected for known errors) 0.000	Billed Water Exported			Revenue Water (Exported) 0.000
		Water Supplied 288.683	Authorized Consumption 220.925	Billed Authorized Consumption 192.057	Billed Metered Consumption (BMAC) (water exported is removed) 192.057	Revenue Water 192.057
					Billed Unmetered Consumption (BUAC) 0.000	
				Unbilled Authorized Consumption 28.868	Unbilled Metered Consumption (UMAC) 0.000	Non-Revenue Water (NRW) 96.626
					Unbilled Unmetered Consumption (UUAC) 28.868	
			Water Losses 67.758	Apparent Losses 11.069	Systematic Data Handling Errors (SDHE) 0.480	
					Customer Metering Inaccuracies (CMI) 10.108	
					Unauthorized Consumption (UC) 0.480	
Water Imported (WI) (corrected for known errors) 0.000				Real Losses 56.689	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	

APPENDIX C: SAUK VILLAGE WATER BALANCE 2019

AWWA Free Water Audit Software
Water Balance

Water Audit Report for: Sauk Village
Audit Year: 2019
Data Validity Tier: TBD

Volume from Own Sources (VOS) (corrected for known errors) 276.070	System Input Volume 276.070	Water Exported (WE) (corrected for known errors) 0.000	Billed Water Exported			Revenue Water (Exported) 0.000
		Water Supplied 276.070	Authorized Consumption 201.921	Billed Authorized Consumption 174.314	Billed Metered Consumption (BMAC) (water exported is removed) 174.314	Revenue Water 174.314
					Billed Unmetered Consumption (BUAC) 0.000	
				Unbilled Authorized Consumption 27.607	Unbilled Metered Consumption (UMAC) 0.000	Non-Revenue Water (NRW) 101.756
					Unbilled Unmetered Consumption (UUAC) 27.607	
			Water Losses 74.149	Apparent Losses 10.046	Systematic Data Handling Errors (SDHE) 0.436	
					Customer Metering Inaccuracies (CMI) 9.174	
					Unauthorized Consumption (UC) 0.436	
Water Imported (WI) (corrected for known errors) 0.000				Real Losses 64.103	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	