Utah Water System Efficiency
and
Water Loss Control Program
Phase 2 Report

Prepared for
Utah Division of Water Resources
Utah Division of Drinking Water
Utah Division of Water Rights

October 2018
Utah Water System Efficiency and Water Loss Control Pilot Program Phase 2 Report

Be SMART! Cut Water Loss!

Prepared for
Utah Division of Water Resources
Utah Division of Drinking Water
Utah Division of Water Rights

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October 2018
Utah Water System Efficiency
and
Water Loss Control Pilot Program
Pilot #2

In Cooperation With the Following Pilot Utilities

Lehi City
Murray City
Granger Hunter Improvement District
Jordan Valley Water Conservancy District
Kearns Improvement District
Nibley City
Orem City
Provo City
Riverton City
Taylorsville Bennion Improvement District
WaterPro
Weber Basin Water Conservancy District

October 2018
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  MURRAY CITY
  NIBLEY CITY
  RIVERTON CITY
  TAYLORSVILLE BENNION IMPROVEMENT DISTRICT
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Executive Summary

The Intermountain Section of the American Water Works Association (Section), in conjunction with the Utah Division of Water Resources (DWRe), Division of Drinking Water (DDW), and Division of Water Rights (DWR), collectively called Water Agencies, completed the Utah Water Efficiency and Water Loss Control Program (Program) for water utilities to learn how to improve water efficiency within their systems and to control water loss through a water system audit process. This report summarizes the components of the training program, the outcomes for each of the 9 pilot utilities, results regarding utility perceptions of performing a water audit, and recommendations for moving forward with a Statewide program.

The program was also designed to provide the Water Agencies with:

- A demonstration of a nationally recognized process to collect Reliable Water Use Data
- A Data Validation Process to assess the credibility of data inputs of the water audit.
- Consumption Estimates to provide data for Source Sizing & Infrastructure Capacity
- A mechanism to measure actual water use improvements over time.
- A tool to identify ways to reduce water losses which will help stretch existing supplies
- A cost / benefit tool to assess financial impacts from water loss control

Goals and Objectives

The specific goal of the Program was to explore and learn about the effectiveness of the water system audit process to collect reliable water supply and use data and pilot this system with water systems. The objectives included:

- Evaluate the water audit as a method to gather verifiable, annual M&I data from water systems.
- Confirm and validate water use data to improve the accuracy and integrity of water use data.
- Promote accountability and efficiency in water supply operations
- Assess the water audit process as a tool to improve water efficiency and conservation.
- Help water systems identify ways to reduce real losses
- Identify peak monthly and peak daily source demands
- Compare data from utilities to identify ways and means to track water audit data over time.

Program Overview

In 2016, a Water System Efficiency Assessment & Water Loss Control Pilot Program (Program) was initiated to enhance the state’s water loss programs (Phase 1) by demonstrating the usefulness of the AWWA Water Audit with three utilities. In 2018 Phase 2 of the program initiated and was designed to work one-on-one with nine utilities to establish a validated AWWA M36 water audit for the baseline year (2016), and use this to inform next steps for water efficiency improvements. The nine utilities were:

- Jordan Valley Water Conservancy District
- Lehi City Water Department
- Murray City
- Nibley City
- Provo City Water Resources Department
- Riverton City
In addition, two of the three pilot utilities from the Phase 1 (2016) of the program completed a water audit for a second year of data. These utilities were

- Orem City
- Kearns Improvement District

The methods and standards outlined in the American Water Works Association's (AWWA) M36 Manual on Water Audits and Loss Control Programs, Fourth Edition, along with the AWWA Free Water Audit Software© (Audit Software), were used by the utilities in the program to gather and validate data.

The Utilities participated in a webcast and a full day workshop to develop their water audits. Through these training touchpoints the utilities learned the basic concepts of the water audit and creating a water balance, disaggregated water losses into both apparent and real, and performed a Level 1 Validation. During the workshop, the project team worked closely with each utility's team to conduct the validation interview. A third-party validation was completed for each utility by the project team. Finally, each utility identified areas where their utility could improve their data validity score.

Utility Results

A summary of the pilot utilities is provided below. Notice that each has unique situations and distinct priority areas for improvement.
In addition to performing the Water Audit the pilot utilities were asked to provide data on peak day and peak month source water quantities and give some additional data regarding ERUs served and percentage of the water system that is used for irrigation. This was done to assist the Utah Division of Drinking Water with their source water capacity regulations. Below is a summary of responses:

<table>
<thead>
<tr>
<th></th>
<th>Lehi</th>
<th>Murray</th>
<th>Taylorsville-Bonniele</th>
<th>Water Pro</th>
<th>Provo</th>
<th>Riverton</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Connections</strong></td>
<td>16,986</td>
<td>10,330</td>
<td>17,224</td>
<td>8,327</td>
<td>19,394</td>
<td>9,623</td>
</tr>
<tr>
<td><strong>Peak Day</strong></td>
<td>5,984,000 gallons</td>
<td>2,302,000 gallons</td>
<td>29.461 MGD</td>
<td>15.02 MGD</td>
<td>49.096 MGD</td>
<td>Culinary 8.5 MGD Secondary 35 MGD</td>
</tr>
<tr>
<td><strong>Peak Month</strong></td>
<td>141.0 MG</td>
<td>539 MG</td>
<td>2594.63-acre feet</td>
<td>442 MG</td>
<td>1,402.6 MG</td>
<td>Culinary 8.5 MGD Secondary 35 MGD</td>
</tr>
<tr>
<td><strong>ERUs</strong></td>
<td>20,665</td>
<td>25,691</td>
<td>10,432</td>
<td>26,692</td>
<td>9,812</td>
<td></td>
</tr>
<tr>
<td><strong>% System used for Irrigation</strong></td>
<td>100%</td>
<td>99%</td>
<td>50%</td>
<td>99%</td>
<td>4.16%</td>
<td></td>
</tr>
</tbody>
</table>

**Utility Feedback**

Feedback from program participants was gathered through both general discussions with the pilot utilities and through detailed reports provided by eight of the nine pilot utilities which are included in the Appendix. Also, two of the three pilot utilities from Phase 1 of the Program prepared water audits on a second year of data and reevaluated their data validity score.

The pilot utilities were asked about the difference between the Water Use Data report to the State of Utah versus the data requirements for the AWWA Water Audit. They indicated that much of the data needed to complete a water audit is similar to the data that water systems submit for the Utah Water Use Program. The additional time to gather the extra data was minimal.

All pilot utilities felt that the water audit process helped their utility. The pilot utilities agreed that the Free AWWA Water Audit Software was a great tool to thoroughly review their system and processes. Overall the process helped the water systems identify priority areas to increase the reliability of their data. Long term benefits will be improved system efficiency. They also realized the importance of documenting authorized nonbilled water use. Each has a plan to move forward in identifying their water loss and improving water efficiency.
How the State of Utah Can Utilize Validated Water Audit Results

In addition to the Audit Software, AWWA’s Water Loss Control Committee created and maintains a companion spreadsheet tool—the Water Audit Compiler—which is used to quickly assemble and analyze data from multiple water audits. Using the Compiler with the collection of validated AWWA M36 water audits annually will enable the State of Utah to conduct analyses in support of strategic objectives such as:

- Trending improvements in audit data reliability.
- Trending water supply volumes to guide source and facility sizing requirements.
- Trending improvements in water system efficiency and conservation.

Recommendations for Water Loss Control in the State of Utah

The Water Efficiency and Water Loss Control program, through the two pilot programs with utilities, has arrived at a comprehensive, state-wide plan for moving the program forward. This four-point program is targeted to water systems in the State of Utah serving a population greater than 3,300. The reasoning behind each of these recommendations is to ensure reliable data, confirm that the data is valid, have a standard input tool for ease and uniformity, and consistent procedures for data input, storage, extraction and analytics.

Four Integrated Recommendations to Deliver Accurate and Validated Data

**Total Costs:** $1,030,000 to $1,200,000  
**Timing:** Two Years  
**Results:** More Accurate and Validated Water Use Data  
**Targeted Program:** Utilities serving a population >3,300. Approximately 104 (92 remaining to be trained) Utilities Represents 92% of the Service Population in Utah

<table>
<thead>
<tr>
<th>GOAL</th>
<th>Implementation Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENSURE RELIABLE DATA</strong> - To ensure date submitted to the State is reliable utilities would need to examine and balance their water use data prior to submission to the State.</td>
<td>Provide Technical Assistance Program for Utilities (Water Loss TAP)</td>
</tr>
<tr>
<td><strong>CONFIRM DATA IS VALID</strong> – To validate that the water audit data reflects the best available data and ensure that the methodology is correct utilities would need to have a validation performed by an independent certified professional which would result in a Data Validation Score (DVS) that can be tracked over time. This is the QA/QC portion of the water audit and the DVS is one of the metrics that can be tracked to determine improvements.</td>
<td>Develop Level 1 Water Audit Validation Certification Program</td>
</tr>
<tr>
<td><strong>SUPPORT A STANDARD INPUT TOOL</strong> – Given that various State Agencies will use the data provided by utilities it is imperative that the data sets are translated consistently and easily. A standardized tool is needed for reporting the data that includes current water use data, balanced water data from the AWWA Water Audit, as well as additional information required by Utah Division of Drinking Water for facility sizing requirements (i.e. peak day, peak month, etc..)</td>
<td>Develop Data Input Module That integrates current data input</td>
</tr>
<tr>
<td>CREATE CONSISTENT PROCEDURES - State Agencies should have a coordinated and consistent set of rules outlining data required by utilities. This will reduce confusion for those supplying the data and those utilizing the data for planning purposes. Making data input, storage, extraction and analytics processes as consistent as possible is key to ensuring that the data itself also remains consistent. Consistent procedures are based on clearly documented steps that everyone follows. Creating and enforcing procedural rules for handling data will do much to help avoid common data quality problems.</td>
<td>Develop Rules for Data &amp; Water Audit Submittal</td>
</tr>
</tbody>
</table>
Introduction
The Intermountain Section of the American Water Works Association (Section), in conjunction with the Utah Division of Water Resources (DWR), Division of Drinking Water (DDW), and Division of Water Rights (DWR), collectively called Water Agencies, completed the Utah Water Efficiency and Water Loss Control Program (Program) for water utilities to learn how to improve water efficiency within their systems and to control water loss through a water system audit process. This report summarizes the components of the training program, the outcomes for each of the 9 pilot utilities, results regarding utility perceptions of performing a water audit, and recommendations for moving forward with a Statewide program.

Purpose
The purpose of the Utah Water System Efficiency Assessment & Water Loss Control Program (Program) is multifaceted to meet the needs of State Agencies, Water Utilities, and Elected Public Officials. These elements are:

- Introduce the American Water Works Association (AWWA) methodology and tools to reduce water loss,
- Teach the effectiveness of the water system audit process to collect reliable water supply and use data,
- Evaluate the potential for driving utilities' water loss programs from audit to action to reduce water loss, and
- Inform state agencies and policy makers of broad scale needs for statewide training and technical assistance.

Background
In 2016, a Water System Efficiency Assessment & Water Loss Control Pilot Program (Program) was initiated to enhance the state’s water loss programs by implementing a pilot program to train utilities in analysis and management of non-revenue water. The Program was conceived and executed through a collaborative effort from the Department of Water Resources (DWR), the Intermountain Section of the American Water Works Association (IMSAWWA), and Cavanaugh.

Recommendations from the 2016 Program (Phase 1) were to:

- Develop a Data Input Module for the Free AWWA Water Audit Software that would collect monthly consumption volumes by class and monthly supply volumes by source.
- Request that public water systems greater than 3300 population submit a self-reported water audit and data validity grade, along with the data from the Input Module to the State of Utah in lieu of the Utah Water Use Data Form on an annual basis.
- Develop a Level 1 Water Audit Validation Program through DWRe to confirm the accurate application of AWWA M36 water audit methodology, identify data inaccuracies, and verify data.
- Create a Water Audit and Validation Technical Assistance Program (Water Loss TAP) to provide training and technical assistance in the State of Utah on water auditing and validation.
The outcomes of Phase 1 reinforced the AWWA M36 methodology of water auditing and water loss control as the industry standard and its applicability a best management practice for Utah water systems. The Phase 1 guided and advanced adoption of best-practices for water loss control in the State of Utah and demonstrated willingness and ability of the pilot utilities to learn the AWWA water loss auditing & validation practices.

The three pilot utilities from the 2016 program were large utilities located along the Wasatch Front. In 2018, a second round (Phase 2) of the Program to train utilities in analysis and management of non-revenue water was conducted. This second phase continued to build on the key concepts of water auditing and application of system specific data from Phase 1 with 9 new utilities:

- Jordan Valley Water Conservancy District
- Lehi City Water Department
- Murray City
- Nibley City
- Provo City Water Resources Department
- Riverton City
- Taylorsville Bennion Improvement District
- WaterPro
- Weber Basin Water Conservancy District

The intention for the Phase 2 Pilot Program was to include small, medium and large utilities in the process and cover a larger geographic area of Utah. Additionally, the Phase 1 Pilot Utilities updated their utility's audits with a second year of data and provided results and feedback during Phase 2.

**Stakeholders**

There are several key stakeholders and utility partners invested in Phase 2:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Role</th>
<th>Primary Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermountain Section AWWA</td>
<td>Project management; Association support; Funding coordination, Report Preparation</td>
<td>Alane Boyd, P.E.</td>
</tr>
<tr>
<td>Utah Division of Water Resources</td>
<td>Agency and Funding Support</td>
<td>Todd Adams, P.E.</td>
</tr>
<tr>
<td>Utah Division of Drinking Water</td>
<td>Analysis / Data Compilation</td>
<td>Todd Stonely, P.E.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rachel Shilton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Russ Barrus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marie Owens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Michael Grange</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ying-Ying Macauley</td>
</tr>
</tbody>
</table>
Goals and Objectives
The specific goal of the Program was to explore and learn about the effectiveness of the water system audit process to collect reliable water supply and use data and pilot this system with water systems. The Program was structured to provide the Division of Drinking Water (DDW), the Division of Water Resources (DWRe), and the Division of Water Rights (DWR), known collectively as the State Agencies, with clear guidance and a standardized method for validating water system supply and demand data, and assessing water system capacity. Also, technical training was provided on system auditing and data validation to help utilities improve and maintain technical, financial and managerial capacity, accomplish water loss control, improve water efficiency, and implement supply side conservation.

The objectives included:

- Evaluate the water audit as a method to gather verifiable, annual M&I data from water systems. Determine if additional software functionality would need to be developed to work along with the Audit Software to meet the data collection requirements of the State’s M&I Supply and Use Data submittal.

- Confirm and validate water use data to improve the accuracy and integrity of water system supply volumes and customer consumption. This will aid in long-term planning and water conservation tracking and goal setting.

- Promote accountability and efficiency in water supply operations to limit unnecessary or wasteful source water withdrawals
• Assess the water audit process as a tool for water systems to improve water efficiency and conservation.

• Help water systems identify ways to reduce real losses within water systems to stretch existing resources and defer the expansion of new resources.

• Identify peak monthly and peak daily source demands to assist the State of Utah in their development of requirements for source capacity.

• Compare data from utilities to identify ways and means to track water audit data over time.
Program Overview

Phase 2 Pilot Program

Phase 2 was designed to work one-on-one with nine utilities to establish a validated AWWA M36 water audit for the baseline year (2016), and use this to inform next steps for water efficiency improvements. In contrast to Phase 1, Phase 2 did not include a 1-day high level training event; the utilities invited to participate had already attended this event in Phase 1. A refresher webcast was developed (Figure 1) leveraging content from the Phase 1 webcast for the participants and was made available for on-demand viewing via the IMSAWWA website. The webcast can be viewed at [https://www.youtube.com/user/IMSAWWA](https://www.youtube.com/user/IMSAWWA). To date the webcast has been viewed 45 times.

In conjunction with the refresher webcast, a formal written data request was provided to each utility as shown in Figure 2. The pilot utilities were asked to submit the requested data to the project team approximately one week prior to the workshop scheduled for early January 2018. The requested data items were organized in concert with the AWWA water audit sequence of data inputs: Water Supply, Finished water & purchase water meter testing data, Consumption data, Customer meter testing data, System data, and Cost Data. To facilitate the validation review process, specifications were provided for the supporting documentation associated with key inputs.

The validation process in Phase 2 followed a methodology established with Water Research Foundation Project 4639\(^1\) (2016), which is termed Level 1 validation. The Level 1 validation process identifies areas of uncertainty and verifies that the water audit methodology is applied, through a combination of summary level document review and an extended interview with the team who prepared the audit. Level 1 validation does not guarantee the audit's accuracy, but instead appropriately characterizes the audit's reliability and identifies where data improvements are warranted. With this validation review, the results of the audit can be

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\(^{1}\) Water Research Foundation Project 4639, available here: [http://www.waterrf.org/Pages/Projects.aspx?PID=4639](http://www.waterrf.org/Pages/Projects.aspx?PID=4639)
considered in the proper context, to determine where the utility’s next steps should be focused for improvement.

During the Phase 2 workshop (early January 2018), the project team worked closely with each utility’s team to conduct the validation interview. Five utilities attended on day 1, and the remaining four utilities attended on day 2. Groups were configured such that no more than two utilities were matched to an expert trainer, to maximize individual utility attention. The flow of the interview followed the AWWA water audit sequence of data inputs, and each small group had its own shared screen to display the water audit and supporting documents as necessary for the discussion. Interview questions were structured around the AWWA Data Grading Matrix which pertain to instrument maintenance practices, data management practices, and other quality control practices around the generation and handling of source data for the water audit. Through this validation process, water audit input derivations were confirmed to comply with the AWWA M36 methodology and water audit data grade selections were confirmed to comply with consistent interpretation of the AWWA Data Grading Matrix. A validation document was produced to capture the interview content and basis of data grade selections for each utility.

As warranted, any essential data or supporting documents still missing were assigned as homework for the given utility team. In some cases, follow up calls were held with the utility after the workshop to ensure the team was comfortable with the process and outstanding items had been resolved. Through the validation process, inclusive of preparatory supporting document review, during-workshop interview with utility team, and post-workshop finalization of validation documents, a set of recommendations for improvement was developed for each utility. Common themes of these recommendations for all nine utilities included increased rigor for verification of supply metering, enhancement of customer meter testing practices, and the recommendation to proceed with preparing their next water audit in the near term to reinforce concepts learned in this Program.

Development of these recommendations is reflected in the overarching goal of the M36 methodology, further illustrated below in Figure 3. The natural progression of a M36 methodology is explained in a 4-step series. The pilot utilities during Phases 1 and 2 participated in the first step, Determine Loss Volumes. This step includes learning the basic concepts of the water audit and creating a water balance, disaggregating water losses into both apparent and real, and performing a Level 1 Validation.

![Figure 3: The M36 Methodology](image-url)
During the workshop, the project team worked closely with the pilot utilities completing the inputs and assigning appropriate data grades, reinforcing the basic concepts from the workshop held the day prior with utility-specific data. A summary of the pilot utilities is provided below (Table 1). Notice that each has unique situations and distinct priority areas for improvement.

**Phase 1 Pilot Utilities**
In addition to the nine Phase 2 Pilot Utilities completing a water audit, the Phase 1 Pilot Utilities prepared a second-year audit for their systems. This provided the Program with information about the usefulness of the water audit tool to:

- Confirm and validate water use data to improve the accuracy and integrity of the water system supply volumes and customer consumption.
- Assess the water audit process as a tool for water systems to improve water efficiency and conservation.
- Assess how utilities utilize the water audit in long-term planning, water conservation tracking and goal setting.
- Promote accountability and efficiency in water supply operations to limit unnecessary or wasteful source water withdrawals.
- Help water systems identify ways to reduce real losses within water systems to stretch existing resources and defer the expansion of new resources.
- Identify peak monthly and peak daily source demands to assist the State of Utah in their development of requirements for source capacity.
Utility Results

The results are assessed in terms of volumes, value, and validity, or the 3-Vs as indicated below in Figure 4. Assessing non-revenue water in terms of volume and value is more insightful to utilities water loss as a percentage. Water loss percentage is sensitive to changes in supply and consumption which inappropriately skew the indicator. Instead, looking at NRW in terms of volume shows you where the greatest amount of loss is occurring, and value shows where the greatest cost of those losses occur. The cost NRW is will be unique for each component, and at each utility. This allows for utilities to make informed and cost-effective decisions when evaluating water loss intervention strategies. The validity is an indication of data reliability as well as a check for errors. Each input in the water audit assess the reliability based on the practices and policies for the utility and an overall Data Validity Score is calculated to help facilitate the next steps in Water Loss Control Planning.

Validity as a check against errors embedded in the data is critical to accurate output information. For example, a major discrepancy was detected in the Authorized Consumption volumes for Riverton City during the validation process. This discovery led to an implausible negative water loss volume to a positive and more realistic quantification of losses. Just as volume and value of non-revenue water can help inform cost-effective decisions, data validity can also help assess whether the next steps should be focused on improving the reliability of the data alone or concurrently with an appropriate loss intervention action. The retail systems are presented first, followed by wholesaler systems including discussion of unique considerations when assessing water loss in wholesaler systems.

Figure 4: The 3-Vs
<table>
<thead>
<tr>
<th></th>
<th>Lehi</th>
<th>Murray</th>
<th>Nibley</th>
<th>Taylorsville-Bennion</th>
<th>Water Pro</th>
<th>Provo</th>
<th>Riverton</th>
<th>Jordan Valley</th>
<th>Weber Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predominate System Type</strong></td>
<td>Retail</td>
<td>Retail</td>
<td>Retail</td>
<td>Retail</td>
<td>Retail</td>
<td>Retail</td>
<td>Retail</td>
<td>Wholesale</td>
<td>Wholesale</td>
</tr>
<tr>
<td><strong>Supply Profile</strong></td>
<td>Own and Imported Sources</td>
<td>Own Sources only</td>
<td>Own Sources only</td>
<td>Own and Imported Sources</td>
<td>Own and Imported Sources</td>
<td>Import Sources only</td>
<td>Own and Imported Sources</td>
<td>Own Sources only</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Connections</strong></td>
<td>16,986</td>
<td>10,330</td>
<td>1,818</td>
<td>17,224</td>
<td>8,327</td>
<td>19,394</td>
<td>9,623</td>
<td>9,091</td>
<td>97</td>
</tr>
<tr>
<td><strong>Data Validity Score</strong></td>
<td>52</td>
<td>49</td>
<td>43</td>
<td>58</td>
<td>53</td>
<td>58</td>
<td>38</td>
<td>55</td>
<td>48</td>
</tr>
<tr>
<td><strong>Leakage (gal/connection/day)</strong></td>
<td>40</td>
<td>41</td>
<td>141</td>
<td>30</td>
<td>8*</td>
<td>279</td>
<td>58.36</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Infrastructure Leakage Index</strong></td>
<td>1.8</td>
<td>2.2</td>
<td>5.4</td>
<td>1.3</td>
<td>0.4*</td>
<td>14.2</td>
<td>2.78</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Priority areas for attention</strong></td>
<td>Volume from Own Sources Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Volume from Own Sources Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Volume from Own Sources Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Volume from Own Sources Water Import Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Unrealistically low leakage metrics indicate advanced validation is a priority</td>
<td>Volume from Own Sources Water Import Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Volume from Own Sources Water Import Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td>Volume from Own Sources Water Import Customer Metering Inaccuracies Unbilled Unmetered Authorized Consumption Billed Metered Authorized Consumption</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: Summary of pilot utilities*

*Water Pro anomalous results discussed on their profiles that follow.*
Water Audit Reporting Year:

- Fiscal Year 2016
  - Data Validity Score: 52
  - Service Connections: 16,986
  - Miles of Main: 310.8
  - Average Operating Pressure: 90.0 psi
  - Apparent Losses per service connection per day: 2.61 gallons/connection/day
  - Real Losses per service connection per day: 39.89 gallons/connection/day
  - Infrastructure Leakage Index: 1.78

Level 1 validated DVS score of 52/100 suggests that next steps may be focused simultaneously on **improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery**. Priority areas for attention are:

- Volume from Own Sources
- Customer Metering Inaccuracies
- Variable Production Cost

Detailed recommendations are presented on the following page.
Lehi City

The Data Validity Score falling within Band III (51-70) suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery.

Opportunities to improve the reliability of audit inputs and outputs include:

*Improved understanding of Supply Meter (Own and Import) Master Meter Error: consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.*

- Volume from Own Sources – next steps
  - Assess all 6 well sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
  - Establish annual testing program
- Water Imported – next steps
  - Confirm what the water purchase agreement with CUWCD says regarding testing/calibration protocols.
  - Contact CUWCD to determine what practices are actually in place for signal calibration and/or volumetric testing of the 2 existing import meters, and obtain associated documentation.
  - Incorporate results into water audit data grade for Water Imported and ‘Master Meter Error Adjustment’ as appropriate.

*Improved estimation of CMI: consider a customer meter testing program which tests a sample of random meters whose stratification represents the entire customer meter stock.*

- Since meter stock is relatively homogenous (most less than 3 years, electronic, Sensus), stratification could be considered for just size, age and throughput.
- AWWA M6 Manual provides more information on sampling and testing protocols.

*Customized estimate of Unbilled Unmetered Authorized Consumption: consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.*

- Inventory all unmetered uses, including all types of flushing, intentional tank overflows, and any others.
- Begin tracking unmetered usage events as they occur, with best estimation of volume used using estimated flowrates and estimated timestamps. Utilize these estimated volumes in place of the default in future audits.

*Temporal alignment of Billed Metered Authorized Consumption with Water Supplied*

- Consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Validity

Level 1 validated DVS score of 49/100 indicates that next steps should be generally focused on **improving data reliability**. Priority areas for attention are:

- Volume from Own Sources
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

Detailed recommendations are presented on the following page.
Murray City

The Data Validity Score falling within Band II (26-50) indicates that next steps should be generally focused on improving data reliability. Opportunities to improve the reliability of audit inputs and outputs include:

*Improved understanding of Supply Meter (Own) Master Meter Error: consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.*

- Volume from Own Sources – next steps
  - Assess all 20 well sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
- Establish annual testing program
- Establish a regular data review process for trends and anomalies.

*Improved estimation of CMI: consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.*

AWWA M6 Manual provides more information on sampling and testing protocols.

*Customized estimate of Unbilled Unmetered Authorized Consumption*

Consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.

*Temporal alignment of Billed Metered Authorized Consumption with Water Supplied*

Consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Validity

Level 1 validated DVS score of 43/100 indicates that next steps should be generally focused on improving data reliability. Priority areas for attention are:

- Volume from Own Sources
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

Detailed recommendations are presented on the following page.

Total Volume of NRW = 109 MG/Yr
(335 Acre-feet/Yr)

Total Cost of NRW =$22,808
**Nibley City**

The Data Validity Score falling within Band II (26-50) indicates that next steps should be generally focused on improving data reliability. Band II (26-50) indicates that next steps should be generally focused on improving data reliability. Opportunities to improve the reliability of audit inputs and outputs include:

*Improved understanding of Supply Meter (Own Sources) Master Meter Error: consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.*

- Volume from Own Sources – next steps
  - Assess 2 well sites (and 3rd coming online soon) to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
  - Establish annual testing program

*Improved estimation of CMI*

Consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.

*Customized estimate of Unbilled Unmetered Authorized Consumption*

Consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.

*Temporal alignment of Billed Metered Authorized Consumption with Water Supplied*

Consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Validity

Level 1 validated DVS score of 38/100 indicates that next steps should be generally focused on improving data reliability. Priority areas for attention are:

- Volume from Own Sources
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

Detailed recommendations are present on the following page.
Riverton City

The Data Validity Score falling within Band II (26-50) indicates that next steps should be focused on improving data reliability. Opportunities to improve the reliability of audit inputs and outputs include:

With these corrections and additions, your Data Validity Score will likely see improvement by incorporating the following:

- **Improved understanding of Import Supply Meter and Master Meter Error:** consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in *AWWA Manual M36 – Appendix A.*
  
  - Confirm what the water purchase agreement with JRVWD says regarding testing/calibration protocols.
  - Contact CUWCD to determine what practices are actually in place for signal calibration and/or volumetric testing of the 2 existing import meters and obtain associated documentation.
  - Incorporate results into water audit data grade for Water Imported and ‘Master Meter Error Adjustment’ as appropriate.

- **Improved estimation of CMI:** consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.
  
  - Since meter stock is relatively homogenous (most less than 5 years), stratification could be considered for just size, age and throughput.
  - AWWA M6 Manual provides more information on sampling and testing protocols.

- **Customized estimate of Unbilled Unmetered Authorized Consumption:** consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.
  
  - Inventory all unmetered uses, including all types of flushing, intentional tank overflows, and any others.
  - Begin tracking unmetered usage events as they occur, with best estimation of volume used using estimated flowrates and estimated timestamps.

- **Temporal alignment of Billed Metered Authorized Consumption with Water Supplied:** consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use and using read date as basis for reporting.
Validity

Level 1 validated DVS score of 58/10 suggests that next steps may be focused simultaneously on **improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery**. Priority areas for attention are:

- Volume from Own Sources
- Water Imported
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

**Volume**

Total Volume of NRW = 1,055 Acre-ft/Yr (344 MG/yr)

**Value**

Total Cost of NRW =$294,963
The Data Validity Score falling within Band III (51-70) suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Opportunities to improve the reliability of audit inputs and outputs include:

**Improved understanding of Supply Meter, both own and import, Master Meter Error:** consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.

- **Volume from Own Sources – next steps**
  - Assess all 8 well sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
  - Establish annual testing program

- **Water Imported – next steps**
  - Confirm what the water purchase agreement with JVWCD says regarding testing/calibration protocols.
  - Contact JVWCD to determine what practices are actually in place for signal calibration and/or volumetric testing of the 2 existing import meters, and obtain associated documentation.
  - Incorporate results into water audit data grade for Water Imported and ‘Master Meter Error Adjustment’ as appropriate.

**Improved estimation of CMI**

Consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.

**Customized estimate of Unbilled Unmetered Authorized Consumption**

Consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.

**Temporal alignment of Billed Metered Authorized Consumption with Water Supplied**

Consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Validity

Level 1 validated DVS score of 53/100 suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. However, the unrealistically low leakage metrics indicate advanced validation is a priority. Priority areas for attention are:

- Volume from Own Sources
- Water Imported
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

Detailed recommendations are presented on the following page.
Water Pro

While this system may experience low volumes of leakage, the ILI after level 1 validation indicates that advanced validation is warranted before conclusions can be made regarding the system's leakage. At least one of the following scenarios may contribute to this result:

- **Water Supplied (both Own Source and Imported Water) may be understated.** This can occur if supply meters are under-registering more significantly than is currently reflected in the Master Meter Error & Supply Adjustment (MMSEA). This can also occur if the supply volumes include uncorrected inaccuracies in the data archives due to data gaps or SCADA formula errors.

- **Authorized consumption may be overstated.** This can occur if sales volumes have not been pro-rated to align consumption with dates of actual use instead of the dates of meter reads. This can also occur if the BMAC input includes any non-potable volumes or duplication/exclusion of potable volumes.

- **The estimate of average operating pressure may be too high,** thereby overestimating the technical minimum volume of leakage for the system.

The Data Validity Score falling within Band III (51-70) suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Opportunities to improve the reliability of audit inputs and outputs include:

**Improved understanding of Supply Meter (Own or Import) Master Meter Error:** consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.

- Volume from Own Sources – next steps
  - Assess all well sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
  - If supply meter testing is not feasible due to meter location, consider planning for meter relocation.

- Water Imported – next steps
  - Confirm what the water purchase agreement with JVWCD says regarding testing/calibration protocols.
  - Contact JVWCD to determine what practices are actually in place for signal calibration and/or volumetric testing of the 2 existing import meters, and obtain associated documentation.
  - Incorporate results into water audit data grade for Water Imported and ‘Master Meter Error Adjustment’ as appropriate.

**Improved estimation of CMI:** consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock. AWWA M6 Manual provides more information on sampling and testing protocols.

**Improve estimation of Billed Unmetered Authorized Consumption**

Consider plan to reduce the number of accounts that are unmetered, review utility policy towards metering exemptions.
Customized estimate of Unbilled Unmetered Authorized Consumption: consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.

- Inventory all unmetered uses, including all types of flushing, fire suppression, and any others.
- Begin tracking unmetered usage events as they occur, with best estimation of volume used using estimated flowrates and estimated timestamps. Utilize these estimated volumes in place of the default in future audits.
Level 1 validated DVS score of 58/100 suggests that next steps may be focused simultaneously on
improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Priority areas for attention are:

- Volume from Own Sources
- Water Imported
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption
Provo City

The Data Validity Score falling within Band III (51-70) suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Opportunities to improve the reliability of audit inputs and outputs include:

The Infrastructure Leakage Index (ILI) of 14.31 describes a system that experiences leakage at 14.31 times the modeled technical minimum for its system characteristics. The other real loss indicator shows ~281 gal/conn/day. Both indicators are at the very high end of their observed ranges in validated water audits across the U.S. This could be a result of either an overstatement of the volume of supply or an understatement of billed meter consumption. Monthly summary data did not reveal an evident error.

If error exists at the raw data level – either through supply meter over-registration or billed volume omissions, this will require advanced validation activities to investigate. Recommendations to improve the reliability of audit inputs and outputs include:

- Improved understanding of Supply Meter (Own and Import) Master Meter Error: consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.
  - Volume from Own Sources - next steps
    - Assess 12 well sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus)
    - Establish annual testing program
    - Augment existing signal calibration practices by adding multipoint span-verification at least annually

- Improved estimation of CMI: consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.

- Customized estimate of Unbilled UnmeteredAuthorized Consumption: consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.

- Temporal alignment of Billed Metered Authorized Consumption with Water Supplied: consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Wholesale Water Agencies and the Water Audit

The AWWA Free Water Audit Software was developed primarily for use by retail water agencies, but it can also be adapted for use by wholesale water agencies. Wholesale water agencies and retail water agencies differ with regards to customer types and methods of distribution of water. However, the principle of the water balance applies to both wholesale and retail agencies. Water supplied less authorized consumption determines water loss, which is comprised of both real and apparent loss.

The AWWA Free Water Audit Software generates a suite of performance indicators. The performance indicators are introduced by a summary of system attributes. Most system attributes accurately describe both wholesale and retail systems, as the system attributes capture performance in absolute terms. However, the calculation of Unavoidable Annual Real Losses (UARL) does not apply to wholesale systems, as the parameters used in the modeling of this volume are based in physical characteristics of retail systems. However, the concept of UARL does still have applicability in a wholesale system, such that some low threshold would be expected for any system. Thus the goal is not zero leakage even for wholesale systems. Regarding the software's built-in performance indicators, the UARL and therefore the Infrastructure Leakage Index are not applicable for drawing conclusions on wholesaler leakage performance. The most applicable indicators for wholesale water loss performance are Apparent Losses per Service Connection per Day and Real Losses per Length of Main per Day. It is also important to look at Total Cost of NRW and cost by NRW component when assessing cost-effectiveness of potential interventions.

Weber Basin Water Conservation District and Jordan Valley Water Conservation District water audit results are presented on the following pages.
Validity

Level 1 validated DVS score of 55/100 suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Priority areas for attention are:

- Volume from Own Sources
- Water Imported
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption

Detailed recommendations are presented on the following page.
Jordan Valley Water Conservancy District

The Data Validity Score falling within Band III (51-70) suggests that next steps may be focused simultaneously on improving data reliability and evaluating cost-effective interventions for water & revenue loss recovery. Opportunities to improve the reliability of audit inputs and outputs include:

*Improved understanding of Supply Meter (Own and Import) Master Meter Error: consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.*

- **Volume from Own Sources – next steps**
  - Assess all 30 well sites and 3 WTP effluent meter sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus).
  - Recognizing this is a high number of sites, it may be necessary to prioritize to work with resource constraints. Aim for testing activity to cover at least 90% of volume supplied; if this level of testing is not feasible, aim for the highest amount feasible in the short term and work to improve over time.
  - Establish testing program targeting at least annual frequency.
  - Incorporate testing results into Master Meter Error Adjustment for future annual water audits.

- **Water Imported – next steps**
  - Confirm what the water purchase agreements with CUWCD, Metro and Bingham says regarding testing/calibration protocols.
  - Contact Metro to determine what practices are actually in place for signal calibration and/or volumetric testing of the 7 existing import meters, and obtain associated documentation.
  - Incorporate results into water audit data grade for Water Imported and ‘Master Meter Error Adjustment’ as appropriate.

*Improved estimation of CMI: consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.*

- Focus on the 137 wholesale meters. Conduct a site review and inventory of all wholesale connections to determine which have poor or marginal lay lengths upstream/downstream of the meter.
- Prioritize marginally plumbed wholesale connection for volumetric testing (in-situ).
- Develop schedule for conducting volumetric testing (in-situ) on the remainder of the high-volume sites.
- Evaluate initial test results to determine appropriate next steps re: annual volumetric testing program.

*Customized estimate of Unbilled Unmetered Authorized Consumption: consider producing itemized, agency-specific estimates of unbilled unmetered (operational) uses, rather than using the default. Ensure leakage estimates are excluded.*

- Inventory all unmetered uses, including all types of flushing, and fire department usage. This would mainly be applicable for the retail distribution system.
Begin tracking unmetered usage events as they occur, with best estimation of volume used using estimated flowrates and estimated timestamps. Utilize these estimated volumes in place of the default in future audits.
Validity

Level 1 validated DVS score of 48/100 indicates that next steps should be generally focused on improving data reliability. Priority areas for attention are:

- Volume from Own Sources
- Customer Metering Inaccuracies
- Unbilled Unmetered Authorized Consumption
- Billed Metered Authorized Consumption

Detailed recommendations are presented on the following page.
The Data Validity Score falling within Band II (26-50) indicates that next steps should be generally focused on improving data reliability. Opportunities to improve the reliability of audit inputs and outputs include:

**Improved understanding of Supply Meter Master Meter Error:** consider adopting or increasing the rigor of a source meter volumetric testing and calibration program, informed by the guidance provided in AWWA Manual M36 – Appendix A.

- Volume from Own Sources – next steps
  - Diagnose underlying issues of concern at 2 WTP effluent meters where pump-run calculations are being used in lieu of meter readings.
  - Assess all 15 well sites and 3 WTP effluent meter sites to determine feasibility and best method for volumetric testing (e.g. insertion, clamp-on, volumetric displacement, comparative apparatus).
  - Recognizing this is a high number of sites, it may be necessary to prioritize to work with resource constraints. Aim for testing activity to cover at least 90% of volume supplied; if this level of testing is not feasible, aim for the highest amount feasible in the short term and work to improve over time.
  - Establish testing program targeting at least annual frequency.
  - Establish multi-point signal calibration practices for all supply meters targeting at least annual frequency.
  - Incorporate testing results into Master Meter Error Adjustment for future annual water audits.

**Improved estimation of CMI:** consider a customer meter testing program which tests a sample of random meters whose stratification (by size, age, or other characteristics) represents the entire customer meter stock.

- Conduct a site review and inventory of all wholesale connections to determine which have poor or marginal lay lengths upstream/downstream of the meter.
- Prioritize marginally plumbed wholesale connection for volumetric testing (in-situ).
- Develop schedule for conducting volumetric testing (in-situ) on the remainder of the high-volume sites.
- Evaluate initial test results to determine appropriate next steps re: annual volumetric testing program.

**Customized estimate of Unbilled Unmetered Authorized Consumption**

Track and estimate well-site usage as it occurs, and use these estimates in future water audits.

**Temporal alignment of Billed Metered Authorized Consumption with Water Supplied**

Consider pro-rating the first and last months of the audit period to better align consumption with actual dates of use, and using read date as basis for reporting.
Utility Feedback

Feedback from program participants was gathered through both general discussions with the pilot utilities and through detailed reports provided by eight of the nine pilot utilities (included in Appendix):

- Appendix A – Lehi City
- Appendix B – Murray City
- Appendix C – Taylorsville Bennion Improvement District
- Appendix D - Water Pro
- Appendix E - Provo City
- Appendix F - Jordan Valley Water Conservancy District
- Appendix G - Weber Basin Water Conservancy District
- Appendix H – Riverton City

Additionally, two of the three pilot utilities from Phase 1 of the Program prepared water audits on a second year of data and reevaluated their data validity score. Orem City's data was then independently validated by Cavanaugh. Results and reports from these two utilities are also included in the Appendix:

- Appendix I – Orem City
- Appendix J – Kearns Improvement District

Data Requirements

The data required to complete the pilot utilities’ water audits included:

1. Water supply data – Monthly Volumes of treated water entering the distribution system.
2. Finished water & purchase water meter testing data
3. Consumption data - Volumes sold by rate code, by month for billed water. For unbilled water, any available summary of tracking data such as flushing and fire estimates.
4. Customer meter testing data – General inventory of customer meters including count by meter size
5. System data – Miles of main, Number of active and inactive taps, General description of pressure – how many pressure zones, and what are the ranges of pressure in each zone.
6. Cost data – Total annual operating cost for the water system, including admin (billing, management) and water debt service, List of rate codes, and volume of water sold by rate code, Total costs for power, treatment chemicals, residuals management, and any water purchased, depreciation schedule for water system assets.

Much of the data needed to complete a water audit is similar to the data that water systems submit for the Utah Water Use Program. The Utah Water Use Program is a cooperative effort administered by the US Geological Survey and the Utah Divisions of Water Resources, Drinking Water, and Water Rights. The purpose of the program is to collect and compile water use and water diversion data from public water suppliers throughout the state of Utah. The resolution of the data submitted to the State is monthly for supply volumes by source and annual for consumption volumes by class. The Level 1 Validation process for the AWWA M36 Water Audit requires summary and supporting documentation of similar data. A key difference is that the Level 1 Validation looks at consumption volumes by class by month rather than by year. Additionally, source production information is more detailed in the Water Use Data report.
The current Free AWWA Water Audit Software does not have detailed input for disaggregated segments for water consumption. However, the pilot utilities indicated that their existing data can easily be disaggregated into residential, commercial, industrial, and institutional use. This type of data could be helpful for the DWRe in their development of water resource studies and water management policy. The pilot utilities indicated that they were not able to easily disaggregate the consumption data by land use, region, pressure zone or topographic areas.

The Pilot Utilities made comments as to the data requirements and how they relate to the Utah Water Use Data Report. Excerpts from the individual Pilot Utilities are given below.

**Lehi City** - This program is very similar to the State’s Water Usage Report. Most of the requested information is very similar. The main difference between the two is that the AWWA has a grading section, which helps identify possible sources of water loss.

**Provo City** - the data submitted to the state is more detailed and granular than the data used for the water audit. Otherwise the data is the same.

**Weber Basin Water Conservancy District** - It’s also worth mentioning that the data that is used in performing this audit is the same data that is submitted to the Division of Water Rights every year for the Water Use Reports. However, this audit process does require some additional information for system and cost data.

**Murray City** - We are collecting most of the data used in this water audit for other reports, so the costs and resource hours were minimal (to complete the water audit).

**WaterPro/Draper Irrigation** - Water Audit Software as a tool gives use information that can be put in monthly and prepares us for the statewide M&I data that is needed every five years. We see no data gap.

**Taylorsville-Bennion Improvement District** - One of the spread sheets we set up for tracking information for the water audit can now be used to fill out the Utah Water Use Data Form or report the M and I Data to the State of Utah.

**Riverton City** - Now that we have been through an audit our perception is that the whole process “wasn’t all that bad.” In other words, it wasn't as painful as we originally thought. Previous perceptions, especially because it was called an “audit” tended to instill fear, or at least some trepidation, to the concept of performing an audit. As we progressed through the process, and because our own personnel were the one’s collecting and analyzing much of the data (using the provided software and analysis tools), it became evident that this “tool” was actually a benefit to not only the compilation of pertinent data, but also to the analysis and understanding of that data.

The water audit software (M36) used for this evaluation and analysis is a great tool for collecting the same data that is required to report to the State of Utah for the M&I Data every five years. Therefore, we are excited to use this tool in an on-going capacity, each and every year for the dual benefit of performing our own personal “self-audit” each year, and then compiling that same data every five years for the State’s M&I Report.
Jordan Valley Water Conservancy District - We feel that results of the audit were extremely beneficial in helping us identify areas of improvement without being overly burdensome to complete. Consequently, it is something that we feel we can do annually to maximize the benefit. ...Much of the data requested by the state is the same data that is needed to complete the audit. However, the audit software goes further in trying to validate the accuracy of the data provided. Consequently, there is an opportunity for the water audit software to support and help validate the data requested by the state to improve the accuracy of the data provided to the state.

Kearns Improvement District (Phase 1) - As a year has passed since we completed the water audit, we have been able to streamline the data gathering process. This has been accomplished my requesting certain employees to compile information throughout the year. When it is time to prepare our annual water loss report with the AWWA software, we can simply use the information that has already been provided by our staff instead of taking the time to try to estimate water used at that point. An example of this is our crew that flushes our sewer lines. Each time they fill up their flush truck tank, they record the usage and then provide that usage to our Operations Manager. This information is then used when we complete our annual water loss report.

Benefits to Utilities
All pilot utilities felt that the water audit process helped their utility. The pilot utilities agreed that the Free AWWA Water Audit Software was a great tool to thoroughly review their system and processes. Overall the process helped the water systems identify priority areas to increase the reliability of their data. Long term benefits will be improved system efficiency. They also realized the importance of documenting authorized nonbilled water use. Each has a plan to move forward in identifying their water loss and improving water efficiency.

Many of the pilot utilities plan to complete a water audit each year using the Free AWWA Water Audit Software. Various portions of the Pilot Utilities' Reports are given below:

Provo City - The water audit helped bring together multiple individuals that work in different areas of the city and gave them a better understanding of the work that others are performing. The water audit also made apparent questionable data, such as months when the billed water greatly outnumbered the water supplied to the system, which could then be looked into and evaluated. It also helped identify areas of the system that need more attention. Provo City predicts that over time, by using the water audit software, water losses will be minimized, and revenue water will increase.

Lehi City - The audit revealed that our non-revenue is 286 MG/YR. Our apparent losses are around 16.81 MG/YR and the real losses are 247 MG/YR. We were surprised at how much water was found to be a non-revenue. We realize the importance of tracking and reporting unmetered water.

WaterPro/Draper Irrigation - The Water Audit showed us immediately what to concentrate on. We found that leak detection is a low priority; our high priorities include replacing our meters and installing a master meter outside our water treatment plant.... We will know what is happening in our water system, what our losses are, and where we should concentrate our dollars.

Murray City - Being able to account for water loss is huge, having accurate metering will affect water accounts.
**Weber Basin Water Conservancy District** - The financial savings for the District are a little harder to quantify since it is strictly a water wholesaler with take or pay contracts (all contracted water is paid for whether consumed or not). However, having a better understanding of where all water is going and that it is being accurately measured could result in some water savings. District customers can also be assured that all steps are being taken to run as efficiently as possible.

**Taylorsville-Bennion Improvement District** - The District has always prided itself on running an efficient water and wastewater operation. The benefits of the water audit really impact our organization and the community we serve. Having accurate data and specific areas to work on recovering non-revenue water the District will make more accurate and informed decisions.

**Riverton City** - Longer-term benefits that were estimated and revealed during this auditing process include an organized, systematic method of record keeping, data preservation and analysis, and a logical approach to evaluating the entire system. As we perform an audit, each year, similar to how we did through this process, we predict that we will be able to identify and discover new areas of operation, maintenance, delivery and conservation that will benefit the system and the community we serve.

**Orem City (Phase 1 Utility)** - One of the greatest short-term benefits from performing the water loss audit is that it has initiated staff to think differently in many ways. Staff now has a greater focus toward the importance of identifying and accurately recording non-revenue water, namely city-owned facilities and green spaces.

**Jordan Valley Water Conservancy District** - Implementing the actions and recommendations identified with the audit will benefit Jordan Valley Water from an overall efficiency and cost standpoint, which in turn directly benefits the customers we serve. We advocate for conservation and water-wise practices by our customers, and as a water district we need to be practicing those same principles in our operations.
How the State of Utah Can Utilize Validated Water Audit Results

In addition to the Audit Software, AWWA's Water Loss Control Committee created and maintains a companion spreadsheet tool—the Water Audit Compiler—which is used to quickly assemble and analyze data from multiple water audits. Data from water audits from many utilities can be easily transferred into this spreadsheet, or the water audit data from a single water utility for a multiyear period can be assembled and trends identified.

The Compiler was developed to improve the management of water audit datasets containing multiple water audits in small or large number. It was originally devised to help state and regional water resources agencies to easily aggregate and analyze large datasets and to provide trending and analysis tools to guide the process.

Once data are assembled in the Compiler, graphics can be displayed and sorted easily with any of the audit inputs and outputs. The data gathered into the Compiler can also be exported to a separate Microsoft Excel spreadsheet where further analysis of their own design using standard Excel features.

The Compiler is a highly complementary tool to the Audit Software, and together these software tools give users strong capabilities to compile the water audit, assess data, and make comparisons with other water utilities.

The DWRe completed an analysis of the pilot utility data utilizing the AWWA Water Audit Compiler (Appendix K). However, with limited data the information is not very useful. The usefulness of the AWWA Compiler is seen when multiple years of data are assembled and analyzed for such things as improving data validity scores.

Moving forward, the collection of validated AWWA M36 water audits annually will enable the State of Utah to conduct analyses in support of strategic objectives as discussed below. As of 2018, Georgia is the only state with multiple years of validated AWWA M36 water audits, though California is now in its 2nd year of required validated audit submittals and will soon be in a similar position. The analyses discussed below and examples cited come from the Georgia validated water audit data set representing audit years 2011 (large systems) and 2012 (small systems) to 2017, which was assembled using the AWWA Water Audit Compiler tool (v5.0).

Analyses that can be conducted utilizing multiple years of validated water audit results are presented below.

1. **Trending improvements in audit data reliability.** As the Utah Legislative Audit identified, water supply and demand data reliability is an issue of concern in Utah. The AWWA M36 water audit method includes quantification of water supply and demand volumes, and a grading process for quality of the data sources and data management.
practices. With audit validation, the grading process has been confirmed to align with the technical criteria and standardized interpretations. As such the validated water audit is known to be based on the best-available source data, and remaining uncertainty is communicated via the Data Validity Score. An increasing trend in the Data Validity Score can reveal an improvement in audit reliability. Beyond this, improvements in audit reliability can be discerned with multiple years of validated water audit data by observing the variability in total water loss volume. Total water loss does not under typical circumstances show wild swings up or down, but rather gradual trends. A sharp change in total water loss can indicate a potential data issue with the supply or demand volume, as it is simply the mathematical difference between the two. Below is an example of high variability over time reflecting poor reliability, for a system that is still struggling with data validity.

Conversely, smooth trending on the total water loss volume suggests improved reliability on the supply and demand volumes. Below is an example of high variability in earlier years that stabilizes in recent years, reflecting a system that has made improvements in data reliability.

2. **Trending water supply volumes to guide source and facility sizing requirements.** Volume of water supplied is a direct input in the AWWA M36 water audit, and the validation process requires verification of water production (and/or water purchase) records against this number. The water supplied volumes for a given utility can trended to observe true rates of change in system demand, including both growth and decline (example below).
3. **Trending improvements in water system efficiency.** For systems demonstrating reliability through sufficient Data Validity Score and smooth trending for total water loss volume over many years (up, down or level), then changes in total water loss provide insights to how the system efficiency is performing over time. Conservation and efficiency are ultimate outcomes of the AWWA M36 method, and this is an important measure to be able to observe and quantify. Below is an example of a system with successful water loss reductions over time.
Another compelling case study in water loss reductions comes from Asheville, North Carolina and was featured in *Best Practices to Consider When Evaluating Conservation and Efficiency as an Alternative for Water Supply Expansion*, a conservation reference guide published by EPA in 2016. Over the past 10 years, the City of Asheville’s water loss improvements represent a powerful story of resource conservation. The 10-year window is relevant because 2007 was the approximate start of the City’s revenue bond-funded waterline replacement projects, followed by the full conversion of the City’s customer metering system from 2009-2012, followed by the formal start in 2012 to the City’s Non-Revenue Water (NRW) program including full time leak detection, meter testing efforts, AWWA auditing/validation, and other analyses. While normal monthly and seasonal variability can be observed, the overall trend is clear: *The City has sustained 10 years of growth without increasing its water supply withdrawals.*

This has been made possible because of the City’s proactive efforts to identify and enact efficiency improvements, through capital projects – including the waterline and meter conversion projects mentioned, and through enhanced business practices under a formal NRW program. Resource conservation that has resulted from the City’s efforts has come in two forms: water savings and avoided costs. Over the last 10-years, water loss reductions have resulted in a cumulative water savings of nearly 6 billion gallons, and cumulative avoided cost of nearly $3M.
The results to date have been a win for both the environment and the rate payer alike – as avoided costs correlate to an offset of where water rates would have been, had those costs been incurred.

The City has improved its audit reliability concurrent with system efficiency improvements over this same time period.
Recommendations for Water Loss Control in the State of Utah

The Water Efficiency and Water Loss Control program, through the two pilot programs with utilities, has arrived at a comprehensive, state-wide plan for moving the program forward. This four-point program is targeted to water systems in the State of Utah serving a population greater than 3,300. The reasoning behind each of these recommendations is to ensure reliable data, confirm that the data is valid, have a standard input tool for ease and uniformity, and consistent procedures for data input, storage, extraction and analytics.
<table>
<thead>
<tr>
<th>GOAL</th>
<th>Implementation Recommendation</th>
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<tbody>
<tr>
<td><strong>ENSURE RELIABLE DATA</strong> - To ensure data submitted to the State is reliable utilities would need to examine and balance their water use data prior to submission to the State.</td>
<td>Provide Technical Assistance Program for Utilities (Water Loss TAP)</td>
</tr>
<tr>
<td><strong>CONFIRM DATA IS VALID</strong> – To validate that the water audit data reflects the best available data and ensure that the methodology is correct utilities would need to have a validation performed by an independent certified professional which would result in a Data Validation Score (DVS) that can be tracked over time. This is the QA/QC portion of the water audit and the DVS is one of the metrics that can be tracked to determine improvements.</td>
<td>Develop Level 1 Water Audit Validation Certification Program</td>
</tr>
<tr>
<td><strong>SUPPORT A STANDARD INPUT TOOL</strong> – Given that various State Agencies will use the data provided by utilities it is imperative that the data sets are translated consistently and easily. A standardized tool is needed for reporting the data that includes current water use data, balanced water data from the AWWA Water Audit, as well as additional information required by Utah Division of Drinking Water for facility sizing requirements (i.e. peak day, peak month, etc..)</td>
<td>Develop Data Input Module That integrates current data input</td>
</tr>
<tr>
<td><strong>CREATE CONSISTENT PROCEDURES</strong> - State Agencies should have a coordinated and consistent set of rules outlining data required by utilities. This will reduce confusion for those supplying the data and those utilizing the data for planning purposes. Making data input, storage, extraction and analytics processes as consistent as possible is key to ensuring that the data itself also remains consistent. Consistent procedures are based on clearly documented steps that everyone follows. Creating and enforcing procedural rules for handling data will do much to help avoid common data quality problems.</td>
<td>Develop Rules for Data &amp; Water Audit Submittal</td>
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**Four Integrated Recommendations to Deliver Accurate and Validated Data**

*Total Costs: $1,030,000 to $1,200,000*

*Timing: Two Years*

*Results: More Accurate and Validated Water Use Data*

*Targeted Program: Utilities serving a population >3,300. Approximately 104 (92 remaining to be trained) Utilities Represents 92% of the Service Population in Utah*
Provide Technical Assistance Program for Utilities

Costs: $800,000 to $900,000
Timing: 18 Months to 2 Years

Who? Utilities serving a population >3,300. Approximately 104 Utilities in the State

The approach for the next phase of a full-scale program implementation is a recommendation to focus on conducting the top-down M36 water audit (using AWWA Free Water Audit Software) with utilities that serve a population of 3,300 or greater. This involves approximately 104 utilities in the State.

The proposed statewide Water Loss TAP would follow an implementation model (below) that has been proven very effective in Georgia, Hawaii, New Mexico and California. It is recommended that the Water Loss TAP be implemented through the Intermountain Section AWWA, as the guiding association for the best-practices involved. IMS AWWA is also the member organization for most of the participating utilities, which provides an advantage for follow on activities moving forward.

Develop Level 1 Water Audit Validation Certification Program

Costs: $200,000 to $250,000 (first 18 months) $80,000 (future annual cost)
Timing: 18 months

To ensure that submitted water data reliability is vetted and understood, a validation program should be in-place. The Free AWWA Water Audit Software includes a comprehensive scoring system to assess the validity, or trustworthiness, of the data inputs of the water audit. A Level 1 validation represents an essential quality control step. Level 1 validation would also be a necessary step for the State to make fair comparisons among water utilities as they perform their municipal and industrial water supply studies and prepare River Basin Plans.

It is proposed that a Certification Program be developed to train and certify independent Technical Reviewers that could validate a utility's data. This would include establishing the Certification Program governance and bylaws, eligibility requirements, procedures and training of potential Technical Reviewers. It is recommended that the Certification Program be implemented through the Intermountain Section AWWA, as the guiding association for the best-practices involved.
Develop Data Input / Output Module
Costs: $30,000 to $50,000 plus State Technical Participation
Timing: 6 months

It is recommended that a general input module be developed that summarizes water use data that could simultaneously support the functions of State data acquisition and Level 1 Validation in the Water Audit. This would assist Utilities in their submission of data along with completing the water audit.

Develop Rules for Data & Water Audit Submittal

State Agencies should have a coordinated and consistent set of rules outlining data required by utilities. This will reduce confusion for those supplying the data and those utilizing the data for planning purposes. Making data input, storage, extraction and analytics processes as consistent as possible is key to ensuring that the data itself also remains consistent.

Consistent procedures are based on clearly documented steps that everyone follows. Creating and enforcing procedural rules for handling data will do much to help avoid common data quality problems.

Benefits Many
The benefits of this proposed program are many and touch various entities. Below we have listed the benefits to the State Agencies, Utilities, the Public, and the Legislature.

State Agencies
- Nationally recognized process to collect Reliable Water Use Data
- Data Validation Process to assess the credibility of data inputs of the water audit.
- Consumption Estimates provide data for Source Sizing & Infrastructure Capacity
- Track actual water use improvements.
- Reduces losses which helps stretch existing supplies

Legislature
- Data Validation Process shows credibility of water use data
- Provides Budget Controls by Targeting the Economic Optimum loss and intervention

Public
- Supply Side Conservation measures stretch existing supplies
- Cost Controls by targeting the Economic Optimum loss and intervention

Utilities
- Easy process to develop Reliable and Accurate Water Use Data
- identify water use improvement plan and track actual improvements.
- Saves Water by Reducing losses
- Saves Energy
- May Increase Revenue
- Saves money by targeting the Economic Optimum loss and intervention
The water audit is a powerful tool because it provides a standardized, systematic method for volumetric accounting based on precise definitions. Key water audit terms and corresponding definitions are listed below as well as a standard water balance. Definitions are drawn from the American Water Works Association manual M36: Water Audits and Loss Control Programs (4th edition, 2016).

**Apparent Loss:** Losses in customer consumption attributed to inaccuracies associated with customer metering, systematic data handling error and unauthorized consumption (theft). Apparent losses represent ‘paper losses’ or ‘commercial losses’ that result in uncaptured revenue for the water utility and distortion of customer consumption data. Apparent losses are valued at the retail rate.

**Data Validity:** A measure of the reliability of the audit input data, and therefore the reliability of the audit output. Data Validity is quantified on a 1 – 100 scale.

**Data Validity Score (DVS):** Data gradings are a user-selected rating of the validity—or trustworthiness—of the individual volumetric and system data inputs to the audit. By attaching a grading to each of the volumetric and system data inputs, a composite Data Validity Score (DVS) is calculated by the Audit Software and serves as a measure of the overall validity of the input data of the water audit.

**Infrastructure Leak Index (ILI):** The ratio of current leakage to the UARL. The ILI can be an effective performance indicator for comparing (benchmarking) the performance of utilities in operational management of real losses, once all justifiable pressure management measures have been undertaken. If rigorous leakage control existed such that the current leakage was equal to the UARL, the ILI would then equal a value of “1”. However, such low leakage levels are rarely possible or economically justified for most water utilities. An ILI value less than “1” is typically indicative of embedded data inaccuracies in the water audit. ILI applicability is limited when it comes to very small and wholesale systems.

**Non-Revenue Water (NRW):** Water treated and supplied into distribution that does not return revenue to the utility. NRW is derived as real loss plus apparent loss plus authorized unbilled consumption.

**Real Loss:** Physical losses, largely leakage from the infrastructure: mains, valves, service lines, and tank overflows. Leakage occurrences are categorized as “reported” events, “unreported” events and background leakage. Real Losses are often valued at the variable production rate, but may also be valued at the customer retail rate if the source water resources are greatly constrained, such that any water saved in leakage control could be sold to an expanding customer base.

**Unbilled Consumption:** Any authorized consumption occurring in the water system for which no bill is issued, and no revenue collected. This includes unbilled metered consumption, such as municipal buildings, and also includes unbilled unmetered consumption, such as flushing and fire-suppression.
**Unavoidable Annual Real Loss (UARL):** UARL is the lowest real loss technically achievable in a water utility based on its key characteristics. The derivation of the UARL calculation is based on leakage data gathered from well-maintained and well-managed systems. Equations for calculating UARL for individual systems were developed and tested by the International Water Association’s Water Loss Task Force and published in 2000. The equations take into account measured frequencies, flow rates and durations of background losses, reported leaks and unreported leaks, as well as the pressure-leakage relationship (assumed to be linear for most large systems). Note: The UARL is strictly a reference value used in calculating performance indicators; it is not an actual component of leakage. UARL applicability is limited when it comes to very small and wholesale systems.

**Water Loss:** The difference between water supplied and authorized consumption. Water loss consists of apparent loss plus real loss.

**Water Balance:** The summary of key water audit data that shows water management from source to customer, with the sum of quantities in all columns equal and thus balancing.

![Figure 5: The Water Balance](image-url)
Appendix A

Lehi City

Water System Efficiency and Water Loss Control Program Report

-Introduction and Summary

When reached out to by AWWA Section and Central Utah, Lehi City chose to become a pilot utility for this program.

Attending the class and gathering data revealed beneficial information. We started to consider more seriously the issue of unaccountable water and the need to track construction water and water used for maintenance more efficiently. We’re also planning to put meters at our city facilities and have set a goal to have installation completed by the end of the year. We believe that it will promote better water conservation as well as save money.

-Benefits of the Water Audit to our Organization

After completing the audit we realized that we have some unaccounted water that we can easily track. We need to be proactive with our record keeping of construction water, flushing maintenance and tank overflow.

We believe that this will help with water conservation and long term cost savings. This program has given us good information and the tools to move forward. We’re looking forward to doing some meter testing to verify the accuracy.

-Data Collection and Compiling Water Audit Data

Five staff members were involved in the audit process. It took approximately 1.5 hours per employee to gather the information requested. We also attended an 8 hour review class.

After experiencing the audit we are more comfortable with the prospect of future audits.

Now that we have experienced the audit we feel like it will be much easier to participate in future audits. We understand more clearly the process of gathering correct information and arriving at the resulting beneficial conclusions.

The Lehi City billing system is broken down and billed into the following categories: Residential, multi-family, commercial, industrial, and institutional. The city also provides pressurized irrigation that is billed at a flat rate. As of 2016 all new construction is required to have a meter.

-Water Audit and Water use Data
The audit revealed that our non-revenue is 286 MG/YR. Our apparent losses are around 16.81 MG/YR and the real losses are 247 MG/YR. We were surprised at how much water was found to be a non-revenue. We realize the importance of tracking and reporting unmetered water. With better records we should be able to increase our Data Validity Score from 52.

The study involved 16,986 culinary services combined. Of those combined services, 15,473 were recorded as residential. Our records show that on June 8, 2017, we reached our peak demand day of the year. On that day we produced 5,984,000 gallons. June was also our peak demand month, using 141,005,867 gallons.

This program is very similar to the State’s Water Usage Report. Most of the requested information is very similar. The main difference between the two is that the AWWA has a grading section, which helps identify possible sources of water loss.

**Water Loss Control Program**

We plan to do meter testing, which should help regulate some of our apparent losses. For our real losses we should be able to control them by monitoring the flows more accurately. In addition, we intend to track construction water, maintenance flushing and tank overflow. With improved monitoring and reporting we believe it will decrease our real loss numbers.
Introduction and Summary

In this section discuss the following:

a. Reason why your organization became a pilot utility
   To help determine where we can make improvements in water loss.

b. Summarize Short-term and long-term benefits your organization found from completing a Water Audit
   By participating in this program we have seen ways to analyze our system and has given us ideas for future projects to correct water loss.

c. Evaluate the water audit process as a tool to improve water efficiency and to optimize your system operations.
   The software was an important tool to help understand our water system.

d. Summarize areas for improvement and implementation plan
   Was a lot of information to take in, software is good but not clear for first time user.

e. How will your organization use the water audit process in the future?
   We will use the knowledge gained from this experience to help correct unaccountable water loss.

Benefits of the Water Audit to your Organization

In this section discuss the following:

a. Give a brief description of the short-term benefits that your utility found from completing the audit.
   We were able to identify possible areas of water loss.

b. Give a brief description of the longer-term benefits that your utility predicts will be found from completing the audit.
   Can now work on future projects that we have now identified as possible water loss.

c. Identify whether these benefits impact your utility’s performance or affect the community that is served.
   Being able to account for water loss is huge, having accurate metering will affect water accounts.

d. Discuss how you will use the audit process and M36 methodology in the future and how often you will update your audit.
   The methodology will always be in place as a tool, the process should be reviewed every 5 years.
Data Collection and Compiling Water Audit Data

In this section discuss the following:

a. Costs and Resource Needed – Estimate the costs and resource hours needed to collect data and compile the Water Audit (refer to data request from Cavanaugh). The water supply data that was requested included:
   i. Finished water & purchase water meter testing data
   ii. Consumption data
   iii. Customer meter testing data
   iv. System data
   v. Cost data
   
   We are collecting most of the data used in this water audit for other reports, so the costs and resource hours were minimal.

b. Now that you have been through an audit, give your perception of what it will take to complete future water audits at the same level of validation for your system
   
   Because we are collecting most of the needed data for other reports, completing future audits at the same validity level would take little effort.

c. Water Audit Software as a tool for reporting M&I Data to the State of Utah - Identify data gaps between the Statewide M&I Data that is collected every five years for your system and the data needed to complete a Top-Down Water Audit.

d. Consumption Data – The current Water Audit Software does not have detailed input for disaggregated segments for water consumption. However, please address the following:
   Discuss your billings system’s functionality in disaggregating total billings into residential, commercial, industrial, municipal or public facilities.
   
   Our billing system is only set up for commercial and residential.

Water Audit and Water Use Data

In this Section discuss the following:

a. Provide a snap-shot of your utility’s water balance.
   
   In 2016 our system supplied 3.077 billion gallons of water. 2.824 billion gallons was billed leaving 252.5 million gallons as non-revenue water.

b. Identify your utility’s Apparent and Real Losses.
   
   According to the water audit our apparent losses are mainly from customer meter inaccuracies. Our real losses were not broken down or determined.

c. Discuss areas where you were surprised at the outcome.
   
   Not necessarily surprised in any area. This water audit is a different way to look at water loss.

d. Provide a discussion of your utility’s Data Validity Score (DVS)
   
   Our validity score was 49 out of 100. Going into the water audit I thought we would have scored higher. In the past we have only taken into account the difference between source meters and customer meters, and felt that our water loss percentage (7.75%) was fairly good.

e. To assist the Utah Division of Drinking Water Please provide the following:
What is the source demand on the peak day of the year?
Our 2016 peak day demand was 21,302,000 gallons on July 26th.

What is the source demand for the peak month of the year?
July was our 2016 peak month demand with 538,997,000 gallons.

How many equivalent residential connections do you serve?
We have used equivalent residential units (ERU) to determine our system demand. Our ERU is 20,665.

What percentage of your system uses your water for outdoor use (as opposed to a separate irrigation connection)?
100%. There isn't any pressurized irrigation in Murray City Water's service area.

In an effort to address the Legislature's concerns about data validity please provide a comparison of your Water Use Data that was submitted to the Utah Division of Water Rights to the data used in your water audit? Comment on any differences that you see between the two.
The data collected from source meters and customer meters is entered into the Division of Water Rights' water use form, but there isn't necessarily any data validity. In the water audit we are using the same data, but are also asking questions about data accuracy and actively looking for ways to limit water loss to raise our validity score. As we work toward raising our validity score the water use data will become more accurate.

Water Loss Control Program

a. Identify ways you will control Apparent Losses
We have started a meter meter/meter box check program to that will help minimize unauthorized consumption. We are looking into a meter accuracy test program to check for meter inaccuracies.

b. Identify ways you will control Real Losses
This water audit identified that our area of priority is in apparent losses, so we will focus on that area first.

c. Discuss ways that you will continue a Water Loss Control Program (Describe steps you will take to do a Bottom-Up Approach Audit)
Water loss is always a concern for a water utility, we will always be looking for ways to improve methods and ways. We have recently been involved in satellite leak detection. Our approach will be to first control obvious leaks causing water loss. Having a metering system that is up to date and that has been calibrated. We will look in to testing meters from our well stations and on the customer end. We understand the importance for accounting for all water pumped and sold and realize the value in a good water audit.
Taylorsville-Bennion Improvement District

Water System Efficiency and Water Loss Control Program Final Report

Introduction and Summary

Taylorsville-Bennion Improvement District (District) started researching the AWWA Water Audit in 2015 and downloaded the audit software in 2015. A few months later we purchased the AWWA M36 manual to help us gain a better understanding of the M36 methodology. In early 2016, not having a complete understanding of the software or the methodology, we performed our first audit with our 2015 data. It was evident that we scored ourselves way too high and created more questions than we had answered. Later that year we heard about the First Pilot Program and attended the day long training that was offered at Jordan Valley Water Conservancy District (JVWCD). The training was very informative and educational giving us a better understanding of the M36 methodology, but we still had several unanswered questions.

The District created a four-member Non-Revenue Water Team. Everyone on the team has an expertise in a specific field of the water audit. As a District we saw the benefit of the water audit and decided that we wanted to update it annually. We were proceeding with our 2016 water audit when we got the opportunity to participate in the Second Pilot Program. All three entities from the first program spoke very highly of Cavanaugh and their expertise with Non-Revenue Water and the AWWA Water Audit Software. The District was excited to get this opportunity. The one-on-one training with Cavanaugh was a great learning experience. All the questions we had come up with over the last year and a half were answered.

Over the last five years the difference in the amount of water the District produces/purchases has been increasing in comparison to what has been sold. By utilizing the water audit, we can separate water losses down into specific categories. We can look at specific categories and our data validity score to make a sound business decision. Being able to ask the question, “Is this an area where the District wants to spend time and money to improve our water efficiency and optimize our system operations?” The water audit also gives us a check list to review our internal processes. If we are not confident in our data or we have a low data validity score the water audit gives us direction on how to improve our processes and our business practices.

Completing the 2016 water audit gave the District three priority areas for attention; Volume from our Own Sources, Water Imported, and Billed Metered. We are currently looking into ways to test or have our source meters tested and not just calibrated. The water audit has us looking into our record keeping practices and the documentation of our source meter calibrations. We need to get with JVWCD and review our contract with them and find out more information on their meter testing and calibration practices. The District has already started randomly testing customer meters and we are working on internally auditing our billing system to improve on our Billed Metered data validity score.
Benefits of the Water Audit to your Organization

The District plans on updating our water audit data annually and using it as a tool to help us make better long-term decisions in the future. We will be able to make informed operational decisions with actual dollar amounts and quantities of non-revenue water.

Some of the benefits we have already received by participating in the pilot program and completing the water audit are better record keeping practices and looking at our processes more in depth to assure accurate information is being collected. We are now tracking and monitoring internal uses of water that we have not previously tracked. We keep track of the water used for flushing and cleaning our sewer collection system. We are attempting to account for any water used from our fire hydrants. The District has tested 3 inch and larger meters annually for several years now but we have never had a meter testing program for our residential meters. The water audit has shown us the importance of a residential meter testing program influencing the scheduling of the next district wide meter replacement project. We are currently researching and developing a leak detection program that will help us capture some of our non-revenue water.

The District has always prided itself on running an efficient water and wastewater operation. The benefits of the water audit really impact our organization and the community we serve. Having accurate data and specific areas to work on recovering non-revenue water the District will make more accurate and informed decisions.

Data Collection and Compiling Water Audit Data

After completing our 2015 water audit and attending the day long training at JVWCD in 2016 the District put several processes in place to collect and evaluate the information needed to complete an annual water audit. When the opportunity to participate in the second pilot program came we already had a good framework in place for the data collection process. The data request from Cavanaugh included finished and purchased water meter testing data, consumption data, customer meter testing data, and system data.

Our data is collected throughout the year and entered in spreadsheets monthly. We review the information at that time and make any corrections. When the end of the year comes the information is already compiled and ready to be entered in the water audit. Already having the data collection process in place really helped us out with the pilot program. All our interactions with Cavanaugh went very smooth and we had more time to ask specific questions about the M36 methodology and our operational procedures.

The initial set up of our spreadsheets and deciding exactly what data we needed to collect took roughly 20 hours. We created our four-member Non-Revenue Water Team, held several meetings and watched the webinar which took about 24 hours. All four members of our team attended the day-long session with Cavanaugh hosted at Kearns Improvement District. We had an hour long follow up phone conversation with Cavanaugh to review our audit and ask any last questions. Since we started the process in 2015 the District has invested about 80 hours into the water audit.

Now that we have participated in the second pilot program there is a better understanding of the M36 methodology and all our data collection procedures are in place. We anticipate compiling the next water audit will be very quick.
One of the spreadsheets we set up for tracking information for the water audit can now be used to fill out the Utah Water Use Data Form or report the M and I Data to the State of Utah. The water audit software does not disaggregate the distinct types of billed metered water. Our billing software does segment the data into 15 categories including residential, commercial, industrial, institutional, and irrigation. All though our current billing system is not set up to provide data by land-use patterns, regions, or pressure zones it can be in the future.

**Water Audit and Water Use Data**

The water audit revealed that the District had 569.72-acre feet of Real Losses and 253.86-acre feet of Apparent Losses in 2016. We were very surprised that our Apparent Losses were so high. Recent meter testing by our water crew indicate that number has increased. Cavanaugh’s third-party verification of our water audit put our Data Validity Score at 58 out of a possible 100. We feel a 58 is a good starting point and are going to focus on three priority areas from the water audit. The three priorities are: water volume from our own sources, imported water, and our billed metered water.

In 2016 the Districts peak day was on July 25 at 29.461 million gallons. Our peak month was July where we produced and purchased 2594.63-acre feet of water. The District serves 25,691 equivalent residential connections of which 99.9% use the water for indoor and outdoor use. We have one small pressurized irrigation company that serves 85 customers.
The Water Use Data that was submitted to the Utah Division of Water Rights and the data we used in our water audit totaled the same amount 12,435-acre feet. Our data validity score was 5 out of 10 for the billed metered consumption. This was also one of the priority areas for attention by the water audit.

**Water Loss Control Program**

Apparent Losses - We have already started looking at ways we can internally audit our billing and meter reading processes. We need to develop some clear policies for our unauthorized consumption and come up with an effective way of tracking the incidents that do occur. Testing our residential meters commenced in January 2017, with a random sample that consisted of about 1% of our 5/8-meter population. The District was surprised by the results. The 5/8 meters tested about 3% lower than we expected.

Real Losses - We are currently looking into some leak detection equipment and putting a leak detection program in place that we can run with our valve exercising program.

The District enjoyed participating in the Second Water Audit Pilot Program. We gained a strong understanding of the M36 methodology and will continue to update our water audit annually.
**Introduction and Summary**

In this section discuss the following:

a. *Reason why your organization became a pilot utility:* We were pleased to be offered this opportunity because we want to be a progressive company. We want to take advantage of tools that will benefit our company and make it a leader in the industry.

b. *Summarize Short-term and long-term benefits your organization found from completing a Water Audit:* Short term benefits – The Water Audit showed us immediately what to concentrate on. We found that leak detection is a low priority; our high priorities include replacing our meters and installing a master meter outside our water treatment plant. Long-term benefits – We will know what is happening in our water system, what our losses are, and where we should concentrate our dollars.

c. *Evaluate the water audit process as a tool to improve water efficiency and to optimize your system operations.* We feel that it can be a good tool to give us a picture of where we are so we can set goals to move forward.

d. *Summarize areas for improvement and implementation plan:* See B above.

e. *How will your organization use the water audit process in the future?* See B above.

**Benefits of the Water Audit to your Organization**

In this section discuss the following:

a. *Give a brief description of the short-term benefits that your utility found from completing the audit.* The Water Audit showed us immediately what to concentrate on. We found that leak detection is a low priority; our high priorities include replacing our meters and installing a master meter outside our water treatment plant.

b. *Give a brief description of the longer-term benefits that your utility predicts will be found from completing the audit.* We will know what is happening in our water system, what our losses are, and where we should concentrate our dollars.

c. *Identify whether these benefits impact your utility’s performance or affect the community that is served:* There are benefits in seeing what our needs are and making long-term goals.

d. *Discuss how you will use the audit process and M36 methodology in the future and how often you will update your audit:* We plan on updating our audit monthly and taking a hard look at it yearly.

**Data Collection and Compiling Water Audit Data**

In this section discuss the following:
a. Costs and Resource Needed – Estimate the costs and resource hours needed to collect data and compile the Water Audit (refer to data request from Cavanaugh). Overall estimate of costs and resources: We estimate that to install a new meter vault on a 30” main would be around $80,000. Hours needed 4 hours a month with 8 hours for final summary. The water supply data that was requested included:
   i. Finished water & purchase water meter testing data—Not available
   ii. Consumption data—Not available
   iii. Customer meter testing data: At this point we are not doing meter tests because we are doing a meter change-out.
   iv. System data—Not available
   v. Cost data—Not available

b. Now that you have been through an audit, give your perception of what it will take to complete future water audits at the same level of validation for your system. We perceive that we would want to install a large meter so the supply information is more accurate.

c. Water Audit Software as a tool for reporting M&I Data to the State of Utah - Identify data gaps between the Statewide M&I Data that is collected every five years for your system and the data needed to complete a Top-Down Water Audit. Water Audit Software as a tool gives use information that can be put in monthly and prepares us for the statewide M&I data that is needed every five years. We see no data gap.

d. Consumption Data – The current Water Audit Software does not have detailed input for disaggregated segments for water consumption. However, please address the following:
   i. Discuss your billing system's functionality in disaggregating total billings into residential, commercial, industrial, municipal or public facilities. Our billing system has the capability to break the billing down into these categories.
   ii. Is your billing system capable of segmenting the data further into single family and multifamily residential, institutional, and irrigator accounts? Yes
   iii. Can your utility provide billing data by land-use patterns, region, district, pressure zone, and/or topographic areas? No

Water Audit and Water Use Data
In this Section discuss the following:

a. Provide a snapshot of your utility’s water balance. We found that our system appears to have a very close balance.

b. Identify your utility’s Apparent and Real Losses. We found that our real losses were fairly small, which surprised us. That is why we are not pursuing leak detection equipment.

c. Discuss areas where you were surprised at the outcome. See B above.

d. Provide a discussion of your utility's Data Validity Score (DVS). We find that this is one area that we will need to work on to increase that score. Putting in a meter testing bench and installing a large meter for the plant are two of the key elements.

e. To assist the Utah Division of Drinking Water please provide the following:
   Note: It will be Monday or Tuesday before we can send this information.
   i. What is the source demand on the peak day of the year?
   ii. What is the source demand for the peak month of the year?
iii. How many equivalent residential connections do you serve?

iv. What percentage of your system uses your water for outdoor use (as opposed to a separate irrigation connection)? About 50% of our system uses culinary water for irrigation and 50% uses a separate irrigation connection.

f. In an effort to address the Legislature’s concerns about data validity please provide a comparison of your Water Use Data that was submitted to the Utah Division of Water Rights to the data used in your water audit. Comment on any differences that you see between the two. The only difference that we see between the two reports is that in the Division of Water Rights report we do not put in a category for apparent and real losses.

**Water Loss Control Program**

a. *Identify ways you will control Apparent Losses.* We are going to do more reporting of flushing of mains, filling of new construction mains, fire hydrant meters, and installing new meters on our system.

b. *Identify ways you will control Real Losses:* We found these to be quite low and at this time we don’t have any plans to control those.

c. *Discuss ways that you will continue a Water Loss Control Program (Describe steps you will take to do a Bottom-Up Approach Audit).* Information not available at this time.
Introduction and Summary

Provo City became a pilot utility hoping to utilize the water audit software to identify trouble spots in the system. This would help the city make improvements that will save water and increase revenue. By completing a water audit, Provo found that it was beneficial for multiple members of the city to come together and analyze the system. Completing the audit as a team allowed for a more in-depth analysis that will eventually allow the city to reduce water losses and increase revenue.

The water audit is a good starting point for a utility that can help them better understand how their system is operating and how the water in the system is being consumed or lost. However, for the audit to be truly beneficial the audit must be performed for several years. There are also several assumptions that the audit allows the user to make that can bring into question the validity of the audit. For example, using a default value for the volume of water that is unbilled unmetered or approximating an average operating pressure for a city like Provo that has approximately 33 pressure zones can reduce the legitimacy of the audit.

Provo can make improvements to the accuracy of the water audit and their system by beginning more regular meter accuracy testing. The city can also provide better supporting documentation to help increase the data validity score (DVS). The audit can be made more reliable by improving the accuracy of the average operating pressure.

In the future, Provo City will continue to use the audit to make system improvements and complete a new audit annually.

Benefits of the Water Audit to Provo City

The water audit helped bring together multiple individuals that work in different areas of the city and gave them a better understanding of the work that others are performing. The water audit also made apparent questionable data, such as months when the billed water greatly outnumbered the water supplied to the system, which could then be looked into and evaluated. It also helped identify areas of the system that need more attention. Provo City predicts that over time, by using the water audit software, water losses will be minimized and revenue water will increase.

Initially, performing the audit and trying to identify and improve areas of the system that need it could be burdensome on the city. Performing the audit takes time and understanding. It also requires work from many individuals throughout the city to complete. Identifying and making system repairs and improvements would also add additional work to city work crews that are already very busy. However in the long-term, once the city is more familiar with the audit and has already begun to make improvements, the system would function better and the city may be able to provide the community with lower rates.
Provo City will continue to use the audit process and M36 methodology in the future and will update the audit annually.

**Data Collection and Compiling Water Audit Data**

In order to compile all of the data requested by the consultant contracted to help facilitate the audit, Cavanaugh, which included, finished water and purchased water metering testing data, consumption data, customer meter testing data, system data and cost data, it is estimated that approximately 70 man hours were required with an estimated cost of roughly $2,500. In addition to this cost, the fee for participating in the AWWA Water Loss Audit Training was $10,000. The city anticipates future audits to require less time and money as the city employees gain a better understanding of how to perform the water audit.

In order to complete future water audits at the same level of validation for Provo City's system, it will require the help of multiple individuals throughout the city. It will also require these individuals to provide documentation to back up the numbers they provide for the audit. The city will also have to continue the same level of inspection and maintenance to achieve the same level of validation.

Assuming the M&I data sent to the State of Utah is the same as the water use data that is collected by the division of water rights, the data submitted to the state is more detailed and granular than the data used for the water audit. Otherwise the data is the same.

Provo's billing system is currently set up under different rates, types and classes. The categories that the city uses are commercial, residential and BYU (Brigham Young University). The billing does not break down the data into single family and multifamily residential, institutional, and irrigator accounts. Also, the billing system does not provide billing data by land-use patterns, region, district, pressure zone, and/or topographic areas.

**Water Audit and Water Use Data**

Below is a copy of Provo City's water balance. Numbers are in millions of gallons (8,949.664 MG = 8,949,664,000 gallons).
For the year of 2017 Provo City had 8,949.664 MG supplied to the system. This resulted in 6,718.311 MG of revenue water and 2,231.353 MG of non-revenue water. The city had 141.485 MG of apparent losses and 1,977.621 MG of real losses.

Looking back at the audit, it was surprising to see how high the water lost due to customer metering inaccuracies was considering the city is actively replacing all the old customer meters with new AMI meters.

Provo City's Data Validity Score (DVS) which is a measure of how reliable the data used is was 58 out of 100. In order for the audit to have any credibility the DVS needs to be at least 50. The City's score was not much higher, which indicates there is room for improvement for future audits.

The source demand on the peak day of the year was 49,096,000 gallons and the source demand on the peak month of the year was 1,402,566,000 gallons. Provo City serves 17,275 residential connections, 2,016 commercial connections and 26,692 equivalent residential connections. Approximately 99% of the system uses water for outdoor use as opposed to having a separate irrigation connection.

The water use data that Provo City submitted to the Utah Division of Water Rights was the same as the data used in completing the water audit. There were no differences.

**Water Loss Control Program**

The water balance indicates that the largest source of apparent losses is customer metering inaccuracies at 102,315 MG/Yr. The City takes exception to this metric because 85% of the City's meters aren't more than seven years old and the only reason the City has not been as proactive in testing meters in the recent past is because of the percentage of new meters in the system and the plan to replace the remainder within a few
years. Provo City has actually been more proactive than most cities in that the city has a test bench of their own which it has historically used regularly to verify meter accuracy. This being said the City will continue to replace old meters with new AMI meters. Once this is complete, meter accuracy testing will be implemented on a more regular basis. The city will also make a more concerted effort to verify the accuracy of source metering. To control real losses the city will continue to search for and repair system leaks as they become apparent.

Provo City will continue to perform a water loss audit every year. Following the audit the city will address issues flagged by the audit with emphasis on the priority areas for attention that the audit identifies. Doing this will help the city improve the audit’s accuracy and the functionality of the system.
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years. Provo City has actually been more proactive than most cities in that the city has a test bench of their own which it has historically used regularly to verify meter accuracy. This being said the City will continue to replace old meters with new AMI meters. Once this is complete, meter accuracy testing will be implemented on a more regular basis. The city will also make a more concerted effort to verify the accuracy of source metering. To control real losses the city will continue to search for and repair system leaks as they become apparent.

Provo City will continue to perform a water loss audit every year. Following the audit the city will address issues flagged by the audit with emphasis on the priority areas for attention that the audit identifies. Doing this will help the city improve the audit’s accuracy and the functionality of the system.
Introduction and Summary
Jordan Valley Water Conservancy District (Jordan Valley Water) was approached about becoming a pilot utility for this program with the idea that we could pave the way and be an example to the many member agencies that we work with. Staff were previously aware of the program and knew it would be a good opportunity to further evaluate water loss within our system. We had already identified this an area where we knew we had an opportunity to improve. Completing the audit was a great way to identify the areas where we were already doing well and where we were falling short. The software is straightforward and easy to use and something that the operations staff could utilize quickly and easily without a hefty learning curve. The results were practical recommendations that we could prioritize for both short-term and long-term implementation.

Benefits of the Water Audit to your Organization
By completing the audit, Jordan Valley Water identified several actions that could be implemented immediately to improve our overall water loss control program. These included maintaining better records of meter maintenance, calibration, etc.; and measuring or estimating water loss from mainline breaks, maintenance drainages, hydrant flushing, etc. to better account for these various internal uses. Long-term, there is an opportunity to extend the water audit concept to our raw water supply and treatment systems and develop and implement a formal leak detection program.

Implementing the actions and recommendations identified with the audit will benefit Jordan Valley Water from an overall efficiency and cost standpoint, which in turn directly benefits the customers we serve. We advocate for conservation and water-wise practices by our customers, and as a water district we need to be practicing those same principles in our operations.

Data Collection and Compiling Water Audit Data
Jordan Valley Water does a better than average job at data collection and analysis related to water quality, water deliveries, power usage, costs, etc. so we had most of the data that was needed for the audit already compiled in some fashion. Staff spent approximately 4 hours pulling the data needed and populating the audit software outside of the workshops and training provided by AWWA and Cavanaugh. This is one reason that participating in the audit was so attractive. We feel that results of the audit were extremely beneficial in helping us identify areas of improvement without being overly burdensome to complete. Consequently, it is something that we feel we can do annually to maximize the benefit.

Ever since the 2015 Legislative audit regarding the accuracy of water use data in Utah, several state agencies and water utilities have been looking at better ways capture the most accurate water use data possible. Much of the data requested by the state is the same data that is needed to complete the audit. However, the audit software goes further in trying to validate the accuracy of the data provided. Consequently, there
is an opportunity for the water audit software to support and help validate the data requested by the state to improve the accuracy of the data provided to the state.

One area that Jordan Valley Water is currently heavily focused on improving is to be able to accurately disaggregate water use data into categories such as residential, commercial, industrial, institutional, etc. so that we can develop targeted messaging and education materials regarding water conservation and other water-wise practices. Fortunately, Jordan Valley Water has the staff with the data analysis expertise to be able to do this detailed work with data from our AMI, GIS, and SCADA databases in house.

**Water Audit and Water Use Data**

Below is the water balance for Jordan Valley Water that resulted from the audit of our calendar year 2016 data. Overall staff were a surprised that the non-revenue water was as low as 3.2%. We were also surprised that our validity score was not higher as we thought we had accurate and detailed record keeping going into the process.

*In this Section discuss the following:*

<table>
<thead>
<tr>
<th>Water Audit Report for</th>
<th>Reporting Year</th>
<th>Data Validity Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jordan Valley Water Conservancy District</td>
<td>2016</td>
<td>66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Exported 8,213,830</th>
<th>Billed Water Exported 96,895,910</th>
<th>Revenue Water 9,213,030</th>
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</thead>
<tbody>
<tr>
<td>Own Sources (Adjusted for known errors) 91,329,880</td>
<td>Billed Authorized Consumption 96,895,910</td>
<td>Revenue Water 96,886,510</td>
</tr>
<tr>
<td>System Input 169,705,400</td>
<td>Unbilled Authorized Consumption 111,675</td>
<td>Non-Revenue Water (NRW) 3,604,569</td>
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<tr>
<td>Water Supplied 100,491,470</td>
<td>Unbilled Metered Consumption 0.600</td>
<td>Unauthorized Consumption 22,215</td>
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<tr>
<td>Water Losses 3,453,485</td>
<td>Customer Metering Inaccuracies 929,254</td>
<td>Systematic Data Handling Errors 22,215</td>
</tr>
<tr>
<td>Water Imported 18,275,510</td>
<td>Real Losses 2,519,801</td>
<td>Leakage on Transmission and/or Distribution Mains Not broken down</td>
</tr>
</tbody>
</table>

The 2016 data Jordan Valley Water submitted to the Utah State Division of Water Rights database and consequently also used by Utah Division of Water Resources and the Utah Division of Drinking Water is a bit different, more so on the source side. That likely due to the complexity of our system, the exchanges that we do, along with how the questions specifically worded in the various databases. There is clearly some work that needs to be done by Jordan Valley Water, but also by the others if the State wants to use the audit software as a tool for utilities to validate the data for the state database.
Total Source Water In: 107,915.09 AF
Total Water Delivered: 106,910.84 AF
Non-Revenue Water: 1,004.25 AF

Wholesale Deliveries: 86,981.10 AF
Retail Deliveries: 8,721.34 AF
Exchange Deliveries: 11,208.40 AF

Peak Day Source Demand: July 20, 2016 332 cfs
Peak Month Source Demand: July 2016 17,480.58 AF
% of System Water Used for Outdoor Use: 54%

**Water Loss Control Program**

Most of our wholesale meters, which account for approximately 90% of our total deliveries, have been automated and connected to our SCADA system to provide real-time data for many years. In addition, we have a robust maintenance, replacement, and calibration program for our wholesale meters giving us a high level of confidence in their accuracy. However, historically we have not been as diligent with our retail meter program and in 2016 and 2017 Jordan Valley Water switched over to an AMI system for our retail connections. This included replacing all 8200 plus retail meters. We have spent 2018 working out bugs on both the hardware and software side and learning how to best utilize the vast amount of data generated. This new AMI system was a huge step forward for our overall water loss program and one of the best ways to identify and control both real and apparent losses.

Jordan Valley Water will continue to enhance our Water Loss Control Program with the initial focus on the following:

- Completing a water loss audit at least annually
- Improving record keeping regarding internal uses of water such as drainage for maintenance, flushing, mainline breaks, etc.
- Expanding the water loss audit to include our raw water and treatment systems.
- Developing a way to do an abbreviated audit on monthly, weekly, or even daily basis as a means of discovering potential leaks or problems earlier.
- Establishing a formal leak detection program.

Jordan Valley Water is very happy to have participated as a utility in this pilot study and hope that our experience has help to inform others and improve the overall process for future participants.
Introduction and Summary

The purpose of this report is to provide results from the Weber Basin Water Conservancy District’s involvement in a water loss audit and system efficiency evaluation using the procedures outlined in the American Water Works Association (AWWA) M36 Manual – “Water Audits and Loss Control Programs.” This audit was conducted in association with the AWWA Intermountain Section and Cavanaugh & Associates. The District has four separate water systems that are operated in Weber and Davis counties. It also operates two small systems in Summit county which were not included in this audit. Although we recognize the need to do an audit on each system individually, this audit included all District systems in Weber and Davis counties collectively. The District agreed to become a pilot utility in the hopes of improving on its overall system operations and processes, as well as provide some assistance to our wholesale customer agencies. District staff have always performed a cursory water audit at the end of each year, simply looking at the difference of water measured from water supplied, but had not previously done an in-depth water audit and were interested on what additional information could be gained.

Initially, performing the water audit seemed like it would be overwhelming given the District’s limited staff time. However, after the training given by Cavanaugh and the one-on-one workshop the task seemed less daunting. Performing the water audit has provided information that the District can use to identify both short and long-term goals as they relate to the water accountability in its distribution system. Through the audit process, the need to conduct a more thorough analysis of all water supply information and to verify the accuracy of effluent water meters, both at the water treatment plants and at our wells has become apparent. Also recognized is the necessity of evaluating all customer meter vaults for proper layout of the meters with adequate pipe diameters both up and downstream of each meter.

The AWWA software was found to be both easy to use and beneficial in the information it provided. Providing a clearly defined scale to grade District operations in each area allows it to honestly assess where improvements are needed. District staff can see where the ‘biggest bang for the buck’ will come from by manipulating the grades in the different areas of water supply, consumption, losses, cost etc.

The most difficult task in doing this water audit was getting started on compiling the data and researching all the information needed. Now having performed the initial audit and finding it to be beneficial, the District intends to complete a water audit each year using the AWWA software and M36 Manual to evaluate the effectiveness of any improvements it undertakes to improve on the data validity score and system efficiency.
Benefits of the Water Audit to the Organization

One of the initial benefits of performing this audit was gaining a better understanding of the free AWWA audit software from the consultants at Cavanaugh. Another benefit realized was the interaction with peers at some of the other water utilities and exchanging ideas. Also, it brought to the forefront the need to test and calibrate all the District meters.

Longer term benefits may include the need to allocate the resources necessary to establish a meter testing and calibration program. The financial savings for the District are a little harder to quantify since it is strictly a water wholesaler with take or pay contracts (all contracted water is paid for whether consumed or not). However, having a better understanding of where all water is going and that it is being accurately measured could result in some water savings. District customers can also be assured that all steps are being taken to run as efficiently as possible.

The District plans moving forward include updating system information during the annual water audit using the AWWA software. Also, the District will continue to review the AWWA M36 manual to improve on its understanding of the water audit process. In addition, staff will begin identifying meter vaults where layouts show the greatest chances for measuring inaccuracies. Resources and time can then be allocated to address each one as necessary.

Data Collection and Compiling Water Audit Data

Much of the information needed for the water audit was readily available in spreadsheets that District staff have been using for years and in the District GIS. The data used in this audit included water supplied and consumed during the 2016 calendar year. The time required to gather, compile, evaluate and input all the system and water data was roughly 24 man hours. The data was mostly compiled by one person with some assistance on cost data from the finance department. The cost data was also challenging to quantify for the District since it delivers both culinary and secondary water. The water loss audit team consisted of a department manager for municipal and industrial water, an engineer and an assistant general manager over operations.

The water data that was required included the following:

- Finished water supply data
- Consumption data
- Finished water and customer meter testing data
- System data
- Cost Data

The District submits a water use data report to the Division of Water Rights every year. Much of the information required for that report is also what is used in conducting the water audit. The noticeable difference between the water audit process and the water use data report is the audit requires more accountability of apparent and real losses and non-revenue water.
The District, as a wholesaler, does not disaggregate usage into residential, commercial, industrial and institutional. The District does not know with certainty how the water is used after it is delivered to the wholesale customer. Also, the District does not provide billing data by land-use patterns, region, district, pressure zone or topographic areas.

**Water Audit and Water Use Data**

The following is a snap-shot of the District’s water balance from the AWWA software:

![Water Audit and Water Use Data](image)

The District’s balance above indicates a total water loss of around 1.4%. Almost all the water loss shows up as real losses. There are little to no apparent losses due to the District having fewer individual customers than a retail utility and that its distribution system primarily consists of larger diameter pipelines with very limited access points and no hydrants. Revenue water accounts for 98.6% with the remaining 1.4% being non-revenue water.

After inputting all the data, the AWWA software came up with a relatively low data validity score of 50. The District realizes there are many areas where improvements can be made to raise this score. A program that can improve this score dramatically is implementing testing and calibration for the water supply meters. The District also intends to establish a testing and calibration program of its customer meters. Both programs will be established using principles and guidelines identified in Appendix A of the AWWA M36 Manual.
Water Loss Control Program and Conclusions

To address real water loss due to leaks, the District has been identifying older pipelines and prioritizing each for replacement and/or rehabilitation. By being proactive in this area the District hopes to realize further water savings. The District does not have as much to do as some other utilities with regards to apparent losses mostly due to the fewer number of meters and the fact that it has no retail customers.

It’s also worth mentioning that the data that is used in performing this audit is the same data that is submitted to the Division of Water Rights every year for the Water Use Reports. However, this audit process does require some additional information for system and cost data.

As mentioned previously the District intends to do an audit annually on each system separately using the AWWA software and the M36 Manual. The District will also reevaluate the data validity score for each as part of this process to determine the effectiveness of improvements implemented or planned.
Introduction and Summary

Riverton City has had a long-standing reputation for providing good reliable culinary and secondary water to its residential and commercial customers. However, as with any water system from anywhere across the country, there are improvements, investments, procedural changes, management philosophies, and operational tweaks, that could be made to improve the efficiencies of the system and decrease water losses. Other ancillary benefits of such modifications and changes include, but are not limited to, increased productivity, a more educated workforce, reduction in lost time, increase in safety, and improvement in moral.

Riverton City is somewhat unique in the fact that they own, operate and maintain two completely different water delivery systems City wide. One is for the potable (culinary) water use throughout the city, just as any other city system might provide. However, the second delivery system that Riverton City provides is for the pressurized secondary water delivered to each and every resident and commercial site within Riverton City boundaries. As Riverton City looked at the overall performance of both (culinary and secondary) of the delivery systems, they felt it would be beneficial to perform the water audit as outlined and guided by AWWA and their organizational team. Indeed, when AWWA extended the invitation, a little over a year ago, for water systems to join the Water Auditing pilot program, Riverton City immediately jumped at the opportunity to join other municipalities and agencies in utilizing this useful tool.

- Looking for improvements to the entire system; physical changes as well as operational modifications
- Short-term benefits: immediate savings from reduction of power consumption, identification of apparent losses – savings in the revenue arena, reducing un-authorized losses.
- Long-term benefits: overall system can grow (add additional development) without investing in new infrastructure (to the extent, at least, of what the conservation savings was equivalent to.
- Having gone through the process, and learning how to use the auditing software, it became (developed into) a “tool” to use in identifying areas to target for improvement and enhancement. What’s more, it is now in place - to be used again during next year’s analysis cycle and the year after that, and the year after that. It has developed into a tool to be used year after year. Not only as a tool to use, but “the“ force by which to guide us through the process each and every year.

Benefits of the Water Audit to your Organization

Short-term benefits realized by Riverton City in performing this water audit include: becoming aware of what to look for, and how to look for various facets of water usage. Immediately identifying those that are NRS (non-revenue source) and how they impact the City’s system. How to use the audit in ways that help find and pinpoint where losses might occur, and then field
investigate those areas. In fact, upon performance of some of these field investigations, some of
the indicated areas bore out to the fact that the losses were occurring. Awareness of NRS
situations, highlighted by the audit evaluation has been a great asset to our City. The process
helped to specifically identify through particular scenarios, those areas that could benefit from
specific actions.

Longer-term benefits that were estimated and revealed during this auditing process include an
organized, systematic method of record keeping, data preservation and analysis, and a logical
approach to evaluating the entire system. As we perform an audit, each year, similar to how we did
through this process, we predict that we will be able to identify and discover new areas of
operation, maintenance, delivery and conservation that will benefit the system and the community
we serve.

As we performed this audit, we immediately could see areas in which we could improve our
operations and implementation of delivering water that would result in a measurable improvement
to the system. Short-term benefits as well as long-term benefits will be realized in the performance
of the system, which in turn has a direct impact on the community we serve. Conservation will be
improved, which helps reduce the overall supply demand, extending the need for immediate (and
expensive) expansion and upgrade costs.

It was made evident, as we moved through this auditing process, the benefit of evaluating our
system in this manner. We were impressed with the scale of the evaluation and hope to be able to
implement a recurring review and analysis of our system each and every year.

Data Collection and Compiling Water Audit Data

This section discusses the following:

a. Costs and Resource Needed – Estimate the costs and resource hours needed to
collect data and compile the Water Audit (refer to data request from Cavanaugh). The
water supply data that was requested included:

i. Finished water & purchase water meter testing data.
Data was collected relatively quickly from metering records (from JVWCD) and
compared with our own metering data. Finished water quality is of constant concern
and is constantly monitored, tested, and verified. Metering of this water is also under
constant scrutiny. Meters are calibrated and checked for accuracy on a recurring
basis. Total amount of time used for this task:
Person I. 3 hours,

ii. Consumption data.
Consumption data is collected monthly, at the meter locations via our electronic
drive-by meter data collection system (AMR). We are currently evaluating the AMI
technology and giving serious consideration to installing such a system. Time for this
task:
Person I. 2 hours,
iii. Customer meter testing data.

Customer meter testing data is performed on an on-going basis in our Water Department, by a specialist that refurbishes, cleans, and repairs meters for our entire system. He tests each meter after performing the repair. Estimated Time used for this task:

Person I. 1 hours

iv. System data.

System data was collected and compiled for usage in the auditing process. Because much of the data was already compiled and being utilized in daily operations, the gathering of data for this audit was minimal. Estimated time used for this task:

Person I. 4 hours,
Person II. 1 hours.

v. Cost data.

Cost data was compiled from previously existing reports that summarize the value and financial status of the existing system. Such reports include, but are not limited to: Capital Improvement Plan, Infrastructure Financial Fee Plan (IFFP), Master Plans, etc.

Person I. 2 hours,

b. Now that we have been through an audit our perception is that the whole process “wasn’t all that bad.” In other words, it wasn’t as painful as we originally thought. Previous perceptions, especially because it was called an “audit” tended to instill fear, or at least some trepidation, to the concept of performing an audit. As we progressed through the process, and because our own personnel were the one’s collecting and analyzing much of the data (using the provided software and analysis tools), it became evident that this “tool” was actually a benefit to not only the compilation of pertinent data, but also to the analysis and understanding of that data. Future water audits will benefit from the data gathering process of this particular audit and performing future audits will certainly be streamlined and better enhanced because of the work efforts of this year’s analysis.

c. Water Audit Software as a tool for reporting M&I Data to the State of Utah - Identify data gaps between the Statewide M&I Data that is collected every five years for your system and the data needed to complete a Top-Down Water Audit.

The water audit software (M36) used for this evaluation and analysis is a great tool for collecting the same data that is required to report to the State of Utah for the M&I Data every five years. Therefore, we are excited to use this tool in an on-going capacity, each and every year for the dual benefit of performing our own personal “self-audit” each year, and then compiling that same data every five years for the State’s M&I Report.

d. Consumption Data – (The current Water Audit Software does not have detailed input for disaggregated segments for water consumption.)

The Riverton City system is capable of providing billing data that is divided into categorical segments, such as residential vs commercial use, and it can define
in institutional users like schools, churches, golf courses, cemeteries, etc. However, to try and disaggregate the billing system into further uses such as land-use patterns, region, district, pressure zone, and/or topographic areas would take a monumental effort of work and coordination between multiple departments at the City. Not only would the finance department be involved heavily with the water department, but the GIS department and planning and zoning departments would need to be involved in such an undertaking. Additionally, the parks and recreation departments would need to provide valuable input for land use, regional and district input. Since the Water Audit Software does not currently have the capability to disaggregate these segments into differently defined water consumption categories, Riverton City is not planning to modify or change the already established categories of water usage beyond what is currently in their system. However, on an additional note: Riverton City, with our separate pressurized irrigation system, has the ability to define the irrigation use (and accounts) separately from the culinary accounts.

Water Audit and Water Use Data

This Section discusses the following:

   To quickly summarize our water system’s water balance, it could be stated that we have some work cut out for us to do, to try to minimize our losses – both apparent and real. We found (and highlighted) areas where there seems to be apparent losses in our system, as well as indicating areas where we suspect real losses likely exist. These areas appear to be so evident, that we have scheduled to immediately investigate through field observations and operational changes, so that we can verify, and rectify the indicated issues.

   b. Riverton City’s Apparent and Real Losses:
      Apparent losses consist of losses from unauthorized consumption. Some of the unauthorized consumption losses would include customer metering inaccuracies and/or systematic data handling errors. Such errors, or losses, might appear to be minor on an individual account or location, but added up over the entire system could prove to be quite significant.

      Real losses consist of water consumption through unmetered connections. Some of the large users in this category are our own uses; ie: parks, park strips, unmetered connections, etc. Also, real losses include areas such as: construction water (jumpers allowed on new construction), hydrant flushing (whether by the Fire Department, the City, or a developer, it all contributes to a real loss), breaks, theft, illegal connections, or just bad functioning systems (bleeding of check valves, meters, etc.)

   c. Areas of surprising outcome:
      Some of the areas that caught us by surprise are: the actual amount of water used by the City itself on City owned facilities (ie: parks, park strips, landscaping of unmetered buildings, etc.) Another surprise was the usage by the fire department for non-incident (fire) water. An example of this is their training and hookup to hydrants for training of personnel and equipment. Our own maintenance personnel hooking up to flush lines. The length of time used for flushing, hence the total amount of water used for each flushing.
**d. Riverton City’s Data Validity Score (DVS):**

One of the results developed during the auditing process is a number, that represents a score called the “Data Validity Score, or DVS” for the entire utility as a whole. Our DVS was approximately 57. As was discussed, this is neither good nor bad, but rather a number that helps to identify where we are, and areas where we can spend some effort to improve the quality of data that we are gathering and analyzing. Our goal is to become more precise in the gathering of certain aspects of the data, so that the analysis is more accurate and productive. Consistency and reliability of data is the name of the game, when it comes to gathering this data. In the end, we want a high confidence that whatever data we collect and gather is valid and accurate, so as to improve our DVS score.

**e. To assist the Utah Division of Drinking Water Please provide the following:**

1. **What is the source demand on the peak day of the year?**
   The 2018 water year source demand on the peak day of the year is:
   - Culinary = 8.5 MGD; and
   - Secondary = 35 MGD

   Riverton City anticipates that the demand for both the culinary and secondary systems will go up in future years. Increases are anticipated to be due to not only an increase in population, and density increases, but also because of individual usage increases at the meter. Our hope (and therefore, our push for better education) is to reduce the individual usage increase at the meter. In fact, we are committed to the goal of reducing (through conservation) the individual meter usage. Much of this usage reduction will be brought about by educational efforts, but it is anticipated that much will also be brought about by financial impacts and incentives. One financial impact is an actual increase to the fee structure, but somehow structuring the fee schedule to allow for an incentive if conservation can be demonstrated. This structuring is not yet in place, and will likely take significant work by both the administrative staff and the elected officials.

2. **What is the source demand for the peak month of the year?**
   The source demand for the peak month of the year is:
   - Culinary = 8.5 MGD; and
   - Secondary = 35 MGD

   The discussion for the demand of the peak month of the year is the same as just discussed for the peak day, in the preceding paragraph.

3. **How many equivalent residential connections do you serve?**
   The number of equivalent residential connections served by Riverton City is approximately 10,000 connections. At the time of gathering data for the audit analysis the equivalent connections were 9,812 connections. Since that time, various developments, both commercial and residential, have been constructed within the boundaries of Riverton City. Developments are continuing to place a demand on the system. Therefore, we loosely use the term “approximately” in reporting this number, because at the time of this writing, the number is now more than 10,087.
iv. What percentage of your system uses your water for outdoor use (as opposed to a separate irrigation connection)?

The percentage of the culinary system used for outdoor use does exist in Riverton City, but it is quite small, because we do have a separate pressurized irrigation system to supply outdoor use. When the secondary (pressurized irrigation) system was approved and installed, in 1999 through 2002, provision was made for those who already had their own secondary system to opt out of the secondary system. These amounted to just a few hundred users. Additionally, approximately 416 users indicated that they did not want to use secondary water for their outdoor use, but would rather continue using the potable water of the culinary delivery system. They were allowed to operate this way, but still had to pay the development fees and monthly usage fees that were assessed to all of the other residences within Riverton City. Therefore, by number of connections, the percentage is 4.16 percent, but by usage, the percentage is much lower, because the usage for non-residential uses has not yet been factored in.

f. In an effort to address the Legislature’s concerns about data validity please provide a comparison of your Water Use Data that was submitted to the Utah Division of Water Rights to the data used in your water audit? Comment on any differences that you see between the two.

Water Use Data for this water audit is the same as the data submitted to the Utah Division of Water Rights. Therefore, there are no differences between the two different data sets. Information and data from one set should be seamless and universally usable in the other data set.

**Water Loss Control Program**

a. Identify ways you will control Apparent Losses

Apparent losses in our system come from a multitude of sources. One significant step that we are currently undertaking to help in this area is to gain better control over the reporting of usage to more accurately represent the actual usage out in the system. Our proposal to facilitate this effort is being prepared to present to the City Council an implementation of an AMI system.

b. Identify ways you will control Real Losses

We have already started an investigation of water meter and system configuration accuracy to help control our Real Losses. We isolated various systems in an effort to compare them against “standard” usage systems and for those that are in question, we will cross test, and possibly even replace with temporary meters, to check the validity of data. Unmetered usage also accounts for some of our Real Losses. We are implementing a program to eliminate and/or at least monitor those unmetered uses to reduce the amount of Real Loss. One example is the usage by the fire department during training exercises, where they open up hydrants to flow water. Our recommendation is that they hydrants at least have a meter installed on them (much like a contractor using a hydrant meter), so that we are at least aware of the amount of water that is used, whether we collect revenue from the usage or not. It will help us in our accounting of Real Losses.
c. Discuss ways that you will continue a Water Loss Control Program (Describe steps you will take to do a Bottom-Up Approach Audit)

One way that we will continue a Water Loss Control Program is by implementing a monthly reporting procedure that will summarize, on a monthly basis, the same data that we will need on the yearly basis for the audit. This way, we will be current and up-to-date with 12 smaller data sets, that can and will be compiled into one large data set for the yearly audit. Using the data on a monthly, and even daily basis, will keep us focused on the desired outcome of the system, and in the long-run improve our performance, maintenance, and operation of the entire system.

For this recent audit, we gathered data and plugged it in to the auditing software package to perform the audit from a top-down approach. As we move forward, we will be gathering data daily, and can plug that information in to the auditing and monitoring software, thus creating a bottom-up approach to the system - resulting in an audit at the end of the year. The end result after 12 months of data gathering and analysis will give an analysis from the bottom-up approach, because it is being analyzed each and every day as the data is gathered, rather than gathering the data and doing the analysis in one day at the conclusion of the year.
Benefits of the Water Audit to your Organization

1) *Give a brief description of the short-term benefits that your utility found from completing the audit.*

One of the greatest short-term benefits from performing the water loss audit is that it has initiated staff to think differently in many ways. Staff now has a greater focus toward the importance of identifying and accurately recording non-revenue water, namely city-owned facilities and green spaces. Staff has evaluated the entire water system which revealed small issues that were initially overlooked, but quickly resolved. For example; source meter and SCADA recording accuracy, and water used for chlorination and cooling that was bypassing the source meter and not recorded. Performing the water loss audit, provided an opportunity for staff to examine ordinary day-to-day system operations and water uses in a different light. It is now more of a priority for staff to accurately record and understand how much water is produced and how much is going out and where it is going.

2) *Give a brief description of the longer-term benefits that your utility predicts will be found from completing the audit.*

Prior to performing the water loss audit, staff was aware of areas where improvements could and should be made, but didn't consider making changes a priority. Some areas of improvement include water used at city facilities and green spaces, such as parks. Many of the meters at park locations are old, inaccurate and in need of repair. Frankly, it was not a priority to repair or replace these meters because water delivered to park locations is considered authorized non-revenue water. Through the water audit process, we realized that more accurately tracking this water, is critical to identifying areas where improvements can be made. Although large meters are expensive to replace, some have been replaced since the initial audit in 2016. This past year, is the first year in many, where these meters have been routinely read and maintenance performed. This trend will continue as we are now budgeting funds to replace non-working meters.

Greater emphasis is placed on metering all incoming and out-going water, regardless of use, this will be both a short and long-term benefit. During the audit, the more apparent and real losses were quantified which also brought greater understanding of why water supplied or system production numbers, compared to the amount billed did not correspond. Staff is much more conscientious of and taking measures to diligently quantify unbilled authorized consumption.

Another area where improvements can be made is source meters. Approximately, sixty percent of the water used in Orem is surface water. The City of Orem owns this water and it is treated at the Don A. Christiansen Regional Water Treatment Plant which is owned and operated by Central Utah Water Conservancy District (CUWCD). There are essentially two large source meters that deliver water from
this treatment plant to Orem's distribution system. We have come to realize how important it is to confirm the accuracy of these meters and receive documented proof of test data from CUWCD. We have taken measures to address this this action item.

In addition, we also have meters at each of our water sources, nine deep wells and two natural flowing springs. Currently, we have magnetic flow meters at these sources. These meters are all relatively new and in good repair. Through the water loss audit process, it has brought to light how important it is to ensure each meter is installed properly to ensure meter accuracy, and that precise testing and calibration occurs frequently. In the past, we tested source meters annually at best. We now have plans to increase testing frequency.

In recent years, our large meter testing program has been considered one of the programs that will be done when we have time, which is far too infrequent. We rarely have the time, unless we make it a priority. Staff understands the importance of frequently testing these meters, but limited resources stood in the way of accomplishing this task as often as needed and desired. Through the water loss audit process, we were reminded how important it is to get back on track with large meter testing. We are planning to give the large meter testing program more attention.

One of the most important long-term benefits from participating in a water loss audit has to do with accountability. Water system operators are more aware and more accountable for water production and water use, which has led to changes in operations and placed emphasis on the need for an AMI meter reading system where usage can be tracked and recorded twelve months of the year. We are currently reading meters manually eight months of the year, avoiding the winter months. Operational changes and enhancements will certainly be a long-term benefit.

3) **Identify whether these benefits impact your utility's performance or affect the community that you serve.**

The long-term benefits from the water loss audit have a positive impact on Water Section personnel as well as the community. Because an annual water loss audit will be implemented, it allows city staff to identify areas where improvements can be made and identify the need for additional resources, which will lead to improved processes throughout the entire organization.

Our plan moving forward is to more fully understand the water audit process, specifically M36 methodology. Now that we have basic knowledge of water loss auditing processes, we understand the benefits of frequently performing an audit. During the audit, action items will be identified and addressed as time and resources allow. Through this process, we will become better stewards of a precious resource, encourage conservation, become more accountable, set a good example for Orem resident's, and gain the confidence of city leaders and the community.

4) **How has the information gained from completing the Water Audit helped you in your daily operations and/or communication with your customers and stakeholders?**
As mentioned above, water operators are becoming more aware and more accountable for water production and water use, which has led to operational changes. We are becoming more accountable to stakeholders were we export water by increasing meter testing frequency. In turn, we are also requesting greater accountability for the meters that CUWCD uses to deliver water to Orem. Overall stakeholder communication and relationships have been affected in a positive way as testing procedures and policy are being adjusted accordingly. We also feel we are setting a better example for our community by being better stewards of the water we deliver to our customers.

**Data Collection**

1) *Have you been able to streamline the data gathering process? If so, how?*

Now that we have been through a water loss audit and are familiar with the data needed to accurately perform an audit, it is not a difficult task to gather the required data. Most of the data needed is already being tracked so it’s just a matter of performing a few queries to access the data.

2) *Please provide the following:*
   a) *What is the source demand on the peak day of the year?*

   The peak day for FY17 was 60.24 million gallons on June 28, 2017.

   b) *What is the source demand for the peak month of the year?*

   The peak month for FY17 was July 2016 at 1,576.43 million gallons.

   c) *How many equivalent residential connections do you serve?*

   38,275

   d) *What percentage of your system uses your water for outdoor use (as opposed to a separate irrigation connection)?*

   100%

3) *In an effort to address the Legislature’s concerns about data validity would you do a comparison of your Water Use Data that was submitted to the Utah Division of Water Rights to the data used in your water audit? Comment on any differences that you see between the two.*

The data used for the water loss audit is the same data used when completing the ‘Water Use Data Report.’ When completing the Water Use Data Report, we provide information based on a fiscal year as we will do with the water loss audit so it remains consistent.

**Water Balance**

*In this Section discuss the following:*

1) *Provide a snap-shot of your utility's most recent water balance, including real and apparent loss volumes & costs. How do those metrics compare to the audit you completed in the pilot program?*
For comparison, a snap-shot of the water balance from the pilot water loss audit completed in the fall of 2016 and the most recent audit December 2017, have been included. You will see the ‘Unbilled Authorized Consumption,’ among others, actually increased from 2016. This is due to improved and more reliable data.

Water Balance 2016 Pilot Program

![AWWA Free Water Audit Software: Water Balance](image)

Water Exported 1,119,760
Water Exported

Authorized Consumption 7,664,773
Billed Authorized Consumption 6,672,059
Billled Water Exported

Unbilled Authorized Consumption 382,714
Unbilled Water Exported

System Input 8,947,215

Water Supplied 7,827,465

Apparent Losses 217,929
Unauthorized Consumption

Water Losses 772,002
Real Losses 566,653
Leakage on Transmission and/or Distribution Mains

Non-Revenue Water (NRW) 1,153,396

Revenue Water 6,672,059

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Revenue Water 1,119,760

Water Balance 2016 Pilot Program

[Diagram of Water Balance]

Orem City Water Audit Report (Year 2) Appendix I - Page 4
2) Was developing the AWWA audit an easier process after having completed one in the pilot training program? If so, in what ways was it easier?

This year’s audit compared to last was much easier as we knew what information was needed and where to find it. It was a matter of updating the data and reviewing the reporting worksheet. During the year, we worked on the action items from the first water audit. We were hoping to do a little better in regard to completing some of our action items, the important thing is we are moving forward in a positive direction.

3) Have you been able to improve your Data Validity Score (DVS)? If so, in what ways?

Our validity score improved from 55 to 66 as a result of addressing some of the less costly and time consuming action items identified in the initial audit. Some of the action items addressed include; more frequent source meter testing and better record keeping, better mapping records identifying inactive service connections, adjustments to account for production water previously by-passing source meters, replaced inaccurate meters supplying water to city-owned facilities to improve accountability for ‘Unbilled Authorized Consumption’ and we made a conscientious effort to be more aggressive with a leak detection program.

4) What are your next actions to improve the DVS for the coming water audit period?
We still have much to do in regard to activities mentioned above where we were able to improve from our initial audit. We will continue with these activities and one by one complete our ‘Action Items’ as well as improve in the area of receiving source meter testing data from our water wholesaler. This also includes the recommendations in the ‘Reporting Worksheet’ that calls for third-party auditing. Other than the financial auditing, we do not use third-party auditors, we need to look into this area more aggressively.

**Water Loss Control Planning**

1) *Identify steps you have taken/will take to control Apparent Losses*

We have reviewed administrative procedures for a customer to obtain a water meter and sign up for water service. There have been some minor changes to this procedure to ensure meters are not being set before a customer has properly signed up for water service. We have increased testing frequency on some large production meters and customer meters. We still must do better in this area, at least, it is on our list of ‘Action Items’. We are also in the process of implementing an AMI program. We recently received proposals from AMI providers and are very close in making a decision to move this program forward.

2) *Identify steps you have taken/will take to control Real Losses*

We are committed to continue with our leak detection program, which has proven to be effective in identifying leaks that are not surfacing. As these leaks are identified, immediate measures are taken to make repairs. Measures have been taken to ensure all water produced is accurately accounted for and not bypassing meters or not metered at all.

3) *Have you been able to analyze and identify data gaps between business process for customer metering and billing functions and water supply operations? If so, what steps have you taken to remedy the gaps?*

When comparing total ‘Water Supplied’ to the total amount of ‘Authorized Consumption’, there is a sizeable difference. The water loss audit has provided us better direction to identify why we have this gap and the areas of focus to reduce this gap. We have reviewed our utility billing processes and made adjustments as needed.

4) *Have you conducted any loss assessment investigations on any part of your system such as customer meter testing, leak survey, unauthorized consumption? If so, what did you find?*

In the past year, we have not performed meter testing on residential meters. There has been some commercial meter testing performed, but not as much as we had hoped for. This is an area where we need to improve, it essentially boils down to prioritizing personnel to make it happen. We currently have a fairly aggressive leak detection program where we hire an outside leak detection service to perform this work. We provide the leak detection service company a map of the area we want to perform leak detection and allow them to do the work. This method is proven effective were several leaks have been detected in main and service lines this past year.
5) Have you identified mechanisms to improve meter accuracy testing, active leakage control and infrastructure monitoring?

We are implementing a plan to more frequently test large meters. This program requires additional resources (personnel and equipment) which we are hoping to address in future budgets. We have a proposed budget to install AMI over the entire city, every service connection over the next five years. Our governing body is currently supportive of this program. We are in the final selection process and hope to be moving forward with this program in the next few months. As previously mentioned, we currently have a fairly aggressive leak detection program where we have hired an outside water leak detection service company to provide leak detection services. Several leaks have been detected in the past year through this program.

6) Are you including resources in your upcoming budget to advance your water loss control program? If so, how?

We are planning to fund the replacement of additional large meters supplying city-owned facilities and green spaces. We are currently researching better meter testing equipment so funds can be budgeted to purchase this equipment. We will continue to fund a leak detection program, with the idea of increasing our efforts in this area. We have a real need for additional personnel to assist with meter testing, this will be a topic of conversation in upcoming budget meetings.
Benefits of the Water Audit to your Organization

When Kearns Improvement District heard of the opportunity to be a pilot utility for this study, we were immediately interested because we were in the process of trying to identify the reason(s) that our unaccounted for water had increased in the previous year. Additionally, we believed that participation in the program would greatly benefit our District and our ability to better track our water loss.

Some of the short term benefits that we found as a result of participating in the Water Audit program include gaining a stronger understanding of how to use the AWWA Free Water Audit Software, networking with other utilities and identifying areas that we can work on to increase our data reliability.

Long term benefits will include better tracking of various aspects of our system; including unmetered water use and authorized but unbilled water use. Additionally, by participating in the audit, we will eventually be able to have a better understanding of our system and a more accurate measure of unaccounted for water as we increase our data reliability.

These short term and long term benefits will impact our performance as a District and the community that we serve by increasing our efficiencies related to unaccounted for water. If we are able to decrease our unaccounted for water by 1%, it would result in savings of 72.3 acre feet of water or approximately $36,000 annually. This reduction in costs (and increase in our system efficiency) will help us to be able to pass this efficiency on to our customers by way of smaller water rate increases.

The information gained from completing the Water Audit helped us in your daily operations by assisting us in identifying specific areas of our system that we can improve as it relates to our measurement of water loss. For example, estimating and accounting for water used by our crews to clean or flush our system will help us more accurately identify the true water loss of the District system.

Data Collection

As a year has passed since we completed the water audit, we have been able to streamline the data gathering process. This has been accomplished my requesting certain employees to compile information throughout the year. When it is time to prepare our annual water loss report with the AWWA software, we can simply use the information that has already been provided by our staff instead of taking the time to try to estimate water used at that point. An example of this is our crew that flushes our sewer lines. Each time they fill up their flush truck tank, they record the usage and then provide that usage to our Operations Manager. This information is then used when we complete our annual water loss report.

Various information about our system includes the following:
- The source demand for the peak month of the 2017 was 1,442.88 acre feet in July
- The District serves approximately 19,500 equivalent residential connections
- Outdoor water use accounts for approximately 43% of our overall District water use

There are some similarities between the Water Use Data that was submitted to the Utah Division of Water Rights to the data used in your water audit. Some of the differences include the following:
- The Water Use report includes information regarding number of connections (residential, commercial, industrial, etc.) while the Water Audit report does not
- The Water Use report includes reporting each individual water source while the Water Audit looks at the information more in the aggregate
- The Water Audit report takes more time to complete that the Water Use report, but also provides recommendations of actions that can help increase the data reliability

**Water Balance**

The Districts 2016 water balance, including real and apparent loss volumes & costs, is shown below:

<table>
<thead>
<tr>
<th>AWWA Free Water Audit Software: Water Balance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kearns Improvement District</strong></td>
<td><strong>WAS v5.0</strong></td>
</tr>
<tr>
<td><strong>Reporting Year:</strong> 2016</td>
<td><strong>系统的数据处理错误</strong></td>
</tr>
<tr>
<td><strong>Data Validity Score:</strong> 75</td>
<td><strong>非营收水</strong></td>
</tr>
</tbody>
</table>

| **Water Exported** | 0.000 |
| **Billed Water Exported** | 2,563,810 |
| **Revenue Water** | 0.000 |

| **Own Sources** | 139,790 |
| **System Input** | 2,684,930 |
| **Water Supplied** | 2,684,930 |
| **Unbilled Authorized Consumption** | 70,022 |
| **Unbilled Metered Consumption** | 36,062 |
| **Unbilled Unmetered Consumption** | 33,960 |
| **Billed Authorized Consumption** | 2,633,832 |
| **Billed Unmetered Consumption** | 0.000 |
| **Billed Water Exported** | 2,563,810 |
| **Revenue Water Exported** | 0.000 |
| ** Authorized Consumption** | 2,563,810 |
| **Authorized Water Exported** | 2,563,810 |
| **Non-Revenue Water (NRW)** | 321,120 |
| **Unbilled Authorized Consumption** | 70,022 |
| **Unbilled Metered Consumption** | 36,062 |
| **Unbilled Unmetered Consumption** | 33,960 |
| **Billed Authorized Consumption** | 2,633,832 |
| **Billed Unmetered Consumption** | 0.000 |
| **Billed Water Exported** | 2,563,810 |
| **Revenue Water Exported** | 0.000 |

Some of the key differences between our 2015 (the year we did the pilot program) and 2016 Water Audits are summarized as follows:
- Data validity score increased from 46 to 75 mainly as a result of verifying and confirming the calibration of source meters that supply our District
- Real loss volume decreased from 225,327,000 gallons to 157,133,000
- Unbilled, authorized consumption increased from 63,991,000 gallons to 70,022,000 as we more accurately reported our use of water for line flushing
Developing the AWWA audit was an easier process after having completed pilot training program because of the training that we received during the audit process. We had downloaded the AWWA audit software years ago, but lacked some understanding of how it worked and were unable to complete the water loss audit. After going through the pilot program, we were able to increase our understanding and we are now able to complete the annual water loss audit.

We have you been able to improve your Data Validity Score (DVS) from 46 in 2015 to 75 in 2016. As we purchase over 90% of our water, verifying that the source meters are being tested and calibrated was the biggest factor in increasing our DVS. Additionally, we documented any instances of water provided that we do not bill for and we now measure and report water that is used for District purposes.

Future actions that we plan to implement that will improve the DVS for the coming water audit period include implementing a residential meter testing program, testing the accuracy of the meters that report the water production on our wells and implementing a large meter replacement program.

**Water Loss Control Planning**

Steps that we have completed or plan to complete to control Apparent Losses include the following:
- Documenting and reporting situations of unbilled, but authorized water usage
- Estimating and tracking authorized water use by District employees for system purposes
- Reporting estimates of water lost due to significant water leaks in our system
- Measuring and reporting water leakage that we identify via our leak detection program

Steps that we have completed or plan to complete to control Real Losses include the following:
- Continuing our leak detection program to identify and repair leaks in both customer and District leaks
- Tracking work orders to identify and repair specific District lines that are in need of repair and / or replacement

The biggest opportunity that we have identified that will help reduce the gap between actual water used by commercial accounts and billed water usage is to test and verify commercial meters. Many of our commercial meters are relatively old and we plan to test such meters and replace them if necessary.

We have implemented a meter testing program of our residential meters starting in 2017. We are testing various types of meters with different remaining useful life throughout our entire District. So far, all meters have tested with our expected range but we will continue this program so we can ensure accurate readings and billings. Additionally, we plan on purchasing equipment in 2018 that will allow us to test the accuracy of our larger commercial type meters.

We have identified mechanisms to improve meter accuracy testing, active leakage control and infrastructure monitoring including purchasing equipment for meter testing, purchasing additional leak detection equipment and contracting with a company to perform an infrared leak detection analysis in the future.

Our 2018 budget includes several items as a result of participating in the water loss audit pilot program. We are planning on purchasing equipment to allow us to test large meters and also test the water production
from our wells. Additionally, we are budgeting money in 2018 to be able to replace large commercial meters that we identify in our testing process that are not accurately measuring water flow.
The AWWA Compiler can be a powerful tool for analyzing audit results. Using the compiler, the different components of the AWWA water audit can be compared graphically and anomalies then become apparent. Large numbers of audits can also be compared en masse. One system can compare multiple years of its own audits, or many audits from different systems can be used to gauge system performance or improvement.

Of course anyone using the compiler should be familiar with each component of the AWWA audit and what comprises it. They should also understand how a system’s audit evolves over successive years of auditing. First audits typically have a low data validity score, while succeeding years of audits may improve gradually or dramatically. Often, comparing one system to another is problematic in that system sizes, audit data validity, and the proportions of industrial, commercial and residential water delivery (among much else) may be very disparate between systems, rendering comparisons between them questionable.

Realizing the limitations of the compiler charts, the charts can still be very useful. Comparisons made with the charts can point to areas where individual audit components may not be accurate and where improvements for “bottom up” activities should be investigated. These anomalies can help point auditors and system managers in the right direction for improvements to the water system or the accuracy of the audit itself.

Side by Side Comparisons
Our first look at the compiler charts revealed a problem when the Data Validity Score (DVS) of the Kearns Improvement District that showed as 17. The error in the data input was immediately identified and corrected.

While Data Validity scores range from 0 to 100, it should be noted that all of these audits in the sample are the first AWWA audit performed by each system. Data Validity Scores of around 50 are typical for first audits. A score of 17 is not. With successive audits a system’s DVS will gradually improve as weak areas of an audit are recognized.
and corrective actions are taken. In a similar manner to having an Infrastructure Leakage Index of 0 being unrealistic or impractical, a DVS score of 100 would also be very difficult for any system to attain.

The AWWA software itself also suggests three specific areas each Utility should concentrate on next to improve the audit score or to reduce losses within the system. Suggested improvement areas also change as a system’s audit evolves. As the DVS improves over successive years, the accuracy of the audit improves. When system DVS scores reach around 70 then the audit results are considered reliable enough to start basing critical decisions on such as investments in leak detection programs or areas of the system to rehabilitate.

Utility managers can use the compiler charts when presenting to city councils or boards of directors to display system efficiencies or inefficiencies. They can display supporting evidence for investments that may achieve the greatest water savings or for much-needed improvements (such as where service is often compromised).

Histograms
When looking at histograms for the eleven systems showing the priority areas for each to concentrate improvement efforts, in priority area #1 eight systems are directed to concentrate on improving the accuracy of the volume from their own sources, and three systems should concentrate on imported water.

In priority area #2, two systems should look at billed-metered, and one each at billed-unmetered, customer retail unit cost (applied to apparent losses), total annual cost of operating water system, unbilled-metered, volume from own sources and water imported.
In priority area #3, three systems were directed to improve their billed-metered accuracy, five customer meter inaccuracies, one customer retail unit cost (applied to apparent losses), and two systems variable unit production cost (applied to real losses).

By focusing on any of these priority areas the utilities can improve the accuracy of their individual audits and the DVS. As the DVS of the audits improve, the recommendations in each of the priority areas will change. The histogram for priority area #1 demonstrates the importance of large meters in the accuracy of the system audits. Small errors in big meters can disproportionately skew audit results. As the accuracy of the large meters is brought up to standards, the priorities recommended in area #1 will change for each system.