State Water Resources Control Board
Order WR 2010-0018-DWR

Provision 15 – Assessment of Transmission System Conditions and Non-Revenue Water

June 30, 2011

Prepared by

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1 Purpose of Report

This report has been prepared by the Sonoma County Water Agency (Water Agency) to fulfill the requirements of Provision 15 of the State Water Resources Control Board (State Board) Order WR 2010-0018 DWR (Order).

Provision 15 of the Order directs the Water Agency to take the following actions:

> SCWA shall evaluate (1) physical conditions and integrity of its transmission system pipelines, and (2) opportunities for increased automated operational data sharing between the SCWA and its water contractors' respective systems, with the goal of reducing water loss and promoting increases in water use efficiency. SCWA shall require that each of its water contractors provide an assessment of unaccounted[1] water associated with their distribution systems. This assessment shall include, as appropriate, any programs or projects identified by each water contractor to reduce unaccounted water and system losses. SCWA shall update the Deputy Director on the progress of these efforts by June 30, 2011.

2 Water Transmission System Condition Assessment Program

Early in 2010, the Water Agency initiated a comprehensive program to assess the condition of the overall transmission system. In October of that year, Water Agency staff performed the first pipeline inspection of the Santa Rosa Aqueduct since its installation in 1959. The inspection was conducted during a scheduled air valve replacement project on the Santa Rosa Aqueduct. The project required partial dewatering of several miles of pipeline and presented a rare opportunity to perform a video inspection using a tethered, camera-mounted rover. Figure 1 shows the rover ready in place for pipe inspection. A total of 3,500 linear feet of pipeline from several different locations were inspected in one day. In general, the pipeline appeared to be in good condition with only isolated areas where cracks and spalling of the mortar lining were observed. Figure 2 shows an example of a mortar crack that was found. Prior to this limited study, there had been no interior inspections of the pipelines.

[1] Provision 15 uses the term 'unaccounted;' however, in this report the term 'non-revenue water' is preferred. Non-revenue water is defined by the American Water Works Association (AWWA) as water that is produced but lost before it reaches the customer, through real losses (e.g. system leaks) or apparent losses (e.g. theft, metering inaccuracies).

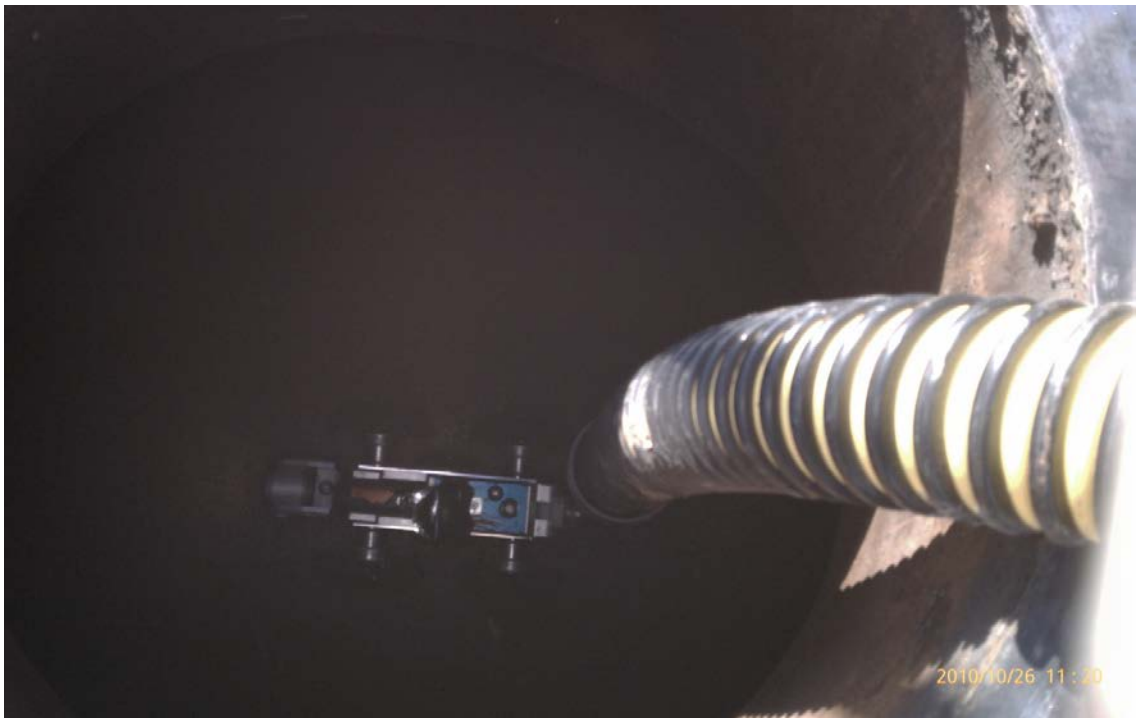

Figure 1. Video Inspection Rover In Pipe

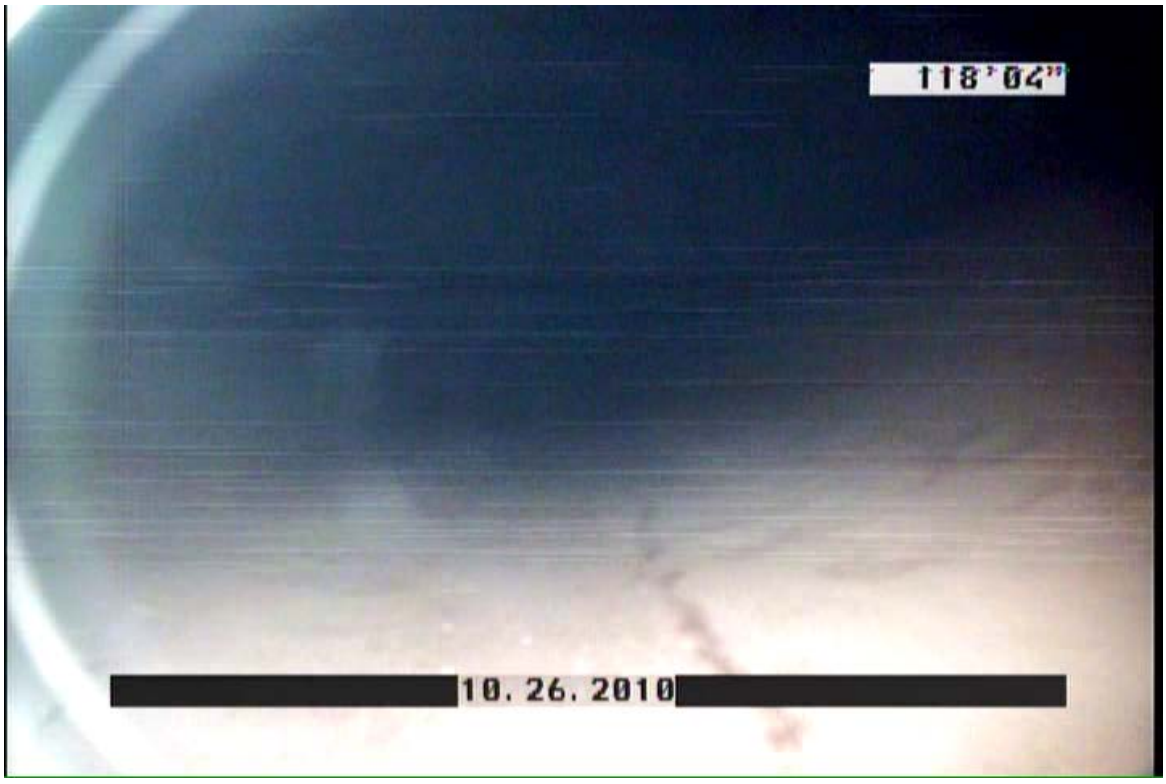

Figure 2. Image Captured by Video Inspection Rover

Another pipeline condition assessment activity conducted to date has been the visual inspection of pipe coupons[2] retrieved from various installations of appurtenances. Based on the review of several coupons, there may be sections of the transmission system where wearing and degradation of the mortar lining have occurred. Additionally, pieces of mortar have been retrieved from screens located at turnouts along the pipelines, as well as in the system's storage tanks. This summer, the Water Agency plans to confirm the mechanism of mortar loss that has been observed on the pipe coupons with petrographic analysis, which analyzes the surface of the mortar and its aggregate minerals.

Due to the age and some signs of compromised integrity of the mortar lining, the Water Agency has prioritized the inspection of its pipelines. The Water Agency is particularly interested in conducting visual inspections of the piping interior, measurements of mortar lining, and assessments of the integrity of the mortar lining. In addition, leak detection, while not believed to be a major issue in the transmission system, will be considered.

In April 2011, the Water Agency issued a Request for Qualifications to contractors interested in providing closed circuit television (CCTV), sonar, and laser profiling services in support of the condition assessment program. From the Statements of Qualifications received, the Water Agency intends to develop a short list of contractors who can be utilized for both a pilot study and a comprehensive study of the entire transmission system.

The Water Agency is developing a strategy and schedule to perform condition assessments for the entire water transmission system. The program will begin with a pilot-study project on the Petaluma Aqueduct. The Petaluma Aqueduct project will cover approximately 6,500 linear feet of 33-inch diameter concrete cylinder pipe. This region was selected for its relative accessibility and because it has experienced some of the highest velocities in the transmission system (~10 feet per second). After completion of the pilot study and subsequent analysis of the results, the Water Agency will move forward to complete the condition assessment of the rest of the system.

3 Water Transmission System Assessment of Non-Revenue Water

On a monthly basis, the Water Agency analyzes records of daily water production (supplies) and monthly water sales (deliveries) to determine the amount of non-revenue water (NRW). Overall system production is calculated from flow measurements at the following five locations:

- Santa Rosa Aqueduct (42-inch ultrasonic meter)
- Cotati Intertie (48-inch ultrasonic meter)

[2] Coupon – A small piece of pipe cut out from a pipeline that may serve as a test specimen.

- Occidental Road Well (12-inch electromagnetic meter)
- Sebastopol Road Well (12-inch electromagnetic meter)
- Todd Road Well (10-inch electromagnetic meter)

Deliveries are calculated by totaling the measurements from 175 turnout meters. The table below presents the results of the non-revenue water analyses on an annual basis for the last five years.

Year	Water Supplied (ac-ft)	Water Delivered (ac-ft)	Non-Revenue Water (ac-ft)	NRW %
2006	62,457	64,866	-2,409	-3.9%
2007	60,046	60,995	-948	-1.6%
2008	58,754	58,746	8	0.0%
2009	51,406	49,764	1,642	3.2%
2010	49,302	48,055	1,247	2.5%

In 2006 and 2007, there were no losses observed based on the meter records for the transmission system. This may be attributed to problems with the system meters used for calculating production volumes. In 2008, the system meters were replaced and the subsequent years' non-revenue water analysis shows reasonable transmission system losses reflecting significant improvements in the production meter data quality.

In addition to its internal non-revenue water analysis, the Water Agency conducts annual water audits as specified in California Urban Water Conservation Council (CUWCC) Best Management Practice (BMP) 1.2. The analysis for BMP 1.2 is prepared according to the American Water Works Association (AWWA) Third Edition M36 Manual*, Water Audits and Loss Control Programs,* and uses the AWWA Water Loss Control Committee Water Audit software, which quantifies the Agency's current volume of apparent and real water losses.

4 Advanced Metering Infrastructure Project

The Water Agency has embarked on a two-phase project to improve metering of transmission system deliveries, which is expected to be complete by the end of 2012. The Advanced Metering Infrastructure (AMI) Project will install the communications infrastructure to report customer turnout delivery meter readings to the Supervisory Control and Data Acquisition (SCADA) system. The completed project will provide the Water Agency with near real-time delivery flow rates at all of the system's turnout meters. Phase 1 will include the construction of three gateway towers and the installation of new transmitters for approximately half of the turnout meters. Phase 2 will complete the conversion of the remainder of the turnout meters and install two to three more gateway towers and repeater stations. The project will significantly improve the Water Agency's response time to meter malfunctions and potential system

failures. Under the current protocol, these meters are only read on a monthly basis and any problems are discovered after this data is processed. With this data integrated into the Water Agency's SCADA system, direct meter readings and water balance calculations will be used to set alert and alarm conditions to notify staff immediately of anomalous measurements or operational conditions.

5 IBM Collaboration with Water Agency and Valley of the Moon Water District

The Water Agency, VOMWD, and the IBM Corporation are currently collaborating on a pilot study to identify system leakage and demonstrate the ability to reduce non-revenue water. Non-revenue water is defined as water that is produced, but lost before it reaches the customer through real losses (e.g., system leaks) or apparent losses (e.g., theft, metering inaccuracies).

The pilot study will evaluate the application of advanced analytics and optimization techniques to reduce non-revenue water, as well as provide improved pressure management of both the Water Agency's and VOMWD's distribution networks using operational data that the Water Agency and VOMWD are currently collecting.

The pilot study is part of the First-of-a Kind program offered through IBM. This program is an attempt to bring IBM researchers and clients together in the marketplace to test new technologies on real business problems and growth opportunities.

The Water Agency-VOMWD pilot study was selected through a competitive process between more than 25 projects submitted to IBM. The study has received a funding commitment from IBM of approximately $3,000,000 for product development.

Because the pilot study is a research project, there is a risk of not developing a working solution. However, if proven successful, the leak detection system will be of interest to other retail water contractors that purchase wholesale water from the Water Agency and could contribute to collaborative efforts to improve the efficiency and sustainability of Water Agency activities. Furthermore, the Water Agency anticipates that if the system becomes generally available, it will likely attract strong interest from water utilities in general.

6 Water Contractor Distribution System Assessments of Non-Revenue Water

The Water Agency's transmission system provides wholesale water to utilities and water districts in Sonoma and Marin County. The Water Agency's eight water contractors have each evaluated their distribution systems for non-revenue water for the last five years. This section includes the results of the non-revenue water analysis for:

- City of Cotati
- North Marin Water District
- City of Santa Rosa
- City of Sonoma

- City of Petaluma
- City of Rohnert Park
- Valley of the Moon Water District
- Town of Windsor

The following information was reported to the Water Agency by its water contractors.

6.1 City of Cotati

6.1.1 Five-Year Average Non-Revenue Water

The City of Cotati's (Cotati) five-year average for non-revenue water is 9.94%. The annual figures are given below:

Year	Water Produced/Imported (gallons)	Water Usage (gallons)	Non-Revenue Water (gallons)	Non-Revenue Water (ac-ft)
2006	364,214,061	338,511,578	25,702,483	79
2007	372,915,955	328,539,720	44,376,235	136
2008	342,299,426	335,940,117	6,359,309	20
2009	329,762,168	280,835,998	48,926,170	150
2010	306,705,919	261,521,641	45,184,278	139
			Five-Year Average of Non-Revenue Water =	105 acre-feet

6.1.2 Methods for Controlling System Water Loss

Production and consumption data is tabulated on a bi-monthly basis and reviewed for potential issues. Cotati responds to and repairs any reported leaks within 1 day.

Cotati continually checks for leaks in its system by responding immediately to customer calls on potential leaks, and visually checking for abnormal wet areas or green spots during routine work activities. Cotati checks for leaks during bi-monthly meter reads by visually checking and listening for leaks, and by checking for abnormally high reads. Cotati also periodically hires professional leak detection survey companies to investigate the water distribution system. To date, very few leaks have been found.

Cotati is in the process of performing pilot programs on automated meter reading systems. Automated meter reading (AMR), while primarily installed for billing purposes, allows for real-time monitoring of customer-side leaks, vandalism, and top of the hour reads to get a clear picture of actual water losses. In addition, the AMR infrastructure allows for deployment of city-wide system leak detectors, which is currently being explored.

For the future, Cotati is investigating district metering in order to isolate problem areas and give highest priority to those areas with the highest apparent losses.

6.2 North Marin Water District

6.2.1 Five-Year Average Non-Revenue Water

North Marin Water District's (NMWD) five-year-average for non-revenue water is -3.30%.The annual percentages are given below:

Year	NRW %
2006	(1.6%)
2007	4.5%
2008	0.8%
2009	(7.2%)
2010	0.2%

This average that shows negative water loss is primarily due to the anomaly of the 2009 data. While the 2006 data shows a negative water loss, this figure can be attributed to minor meter inaccuracies. The non-revenue water value for 2009 identifies significant production metering issues.

6.2.2 Methods for Controlling System Water Loss

NMWD employs the following methods to control its system water loss.

1. NMWD annually completes the Standard Water Audit and Water Balance Worksheet using AWWA software and has submitted the worksheets to CUWCC as part of the BMP reporting for FY2009/2010.
2. NMWD has no unmetered water use.
3. NMWD water repair crews respond and typically repair all leaks in one day.
4. NMWD monitors all water coming into its distribution system, both imported and locally produced, on a continuous basis with a SCADA system and produces daily and monthly water production and storage reports.
5. NMWD has a service line replacement program prioritized to target high failure rate installations, typically polybutelyne services.
6. NMWD has staff on call at all times to respond to leaks and emergency conditions. The on call staff are notified via the Novato Police Department dispatch or telephone alarms triggered by SCADA system monitors.

6.3 City of Petaluma

6.3.1 Five-Year Average Non-Revenue Water

The City of Petaluma's (Petaluma) five-year average for non-revenue water is 6.59%. The annual percentages are given below:

Year	NRW %
2006	8.58%
2007	5.97%
2008	6.47%
2009	7.65%
2010	4.28%

6.3.2 Methods for Controlling System Water Loss

Petaluma employs the following methods to control its system water loss.

1. Petaluma has areas of its water distribution that are over 100 years old. Its capital replacement program targets replacement of these sections.
2. Petaluma has a very active meter repair and replacement program. All meters over 2" are individually analyzed as they are read and tested at least every 3 years.
3. Petaluma uses AMR meters which include a memory chip. This allows for detailed water use analysis and many conservation opportunities.
4. Petaluma Water Repair Crews respond to all leaks in one day and average 2 days for repairs to be completed.
5. Petaluma has no unmetered water use.
6. Petaluma monitors all water coming into its system on a continuous basis with daily water production and storage reports produced.
7. Petaluma produces a monthly production and water sales report.
8. Petaluma has a service line replacement program prioritized to target high failure rate installations.

6.4 City of Rohnert Park

6.4.1 Five-Year Average Non-Revenue Water

The City of Rohnert Park's (Rohnert Park) five-year average for non-revenue water is 6.52%. The annual percentages are given below:

Year	Water Produced (MG)	Water Sold (MG)	Non-Revenue Water (MG)	NRW %
2006	1795.8	1680.5	115	6.4%
2007	1690.6	1662.0	29	1.7%
2008	1683.6	1582.5	101	6%
2009	1497.5	1398.9	98.6	7%
2010	1465.9	1251.4	162	11.5%

6.4.2 Methods for Controlling System Water Loss

Rohnert Park immediately repairs all leaks reported or discovered by system operators. Rohnert Park periodically uses audio leak detection specialist to "listen" to the entire water system to locate leaks that do not result in water coming to the surface. All detected leaks are repaired immediately.

Rohnert Park is embarking on the last of its metering projects to meter the few remaining unmetered services. These are on Rohnert Park services to landscape islands and a small number of other Rohnert Park facilities.

6.5 City of Santa Rosa

6.5.1 Five-Year Average Non-Revenue Water

The City of Santa Rosa's (Santa Rosa) five-year average for non-revenue water is 7.71%. The annual percentages are given below:

Year	Total Produced (gallons)	Non-Revenue Water (gallons)	NRW %
2006	7,756,164,553	578,164,553	7.45%
2007	7,667,773,939	592,385,799	7.73%
2008	7,626,452,875	564,171,931	7.40%
2009	6,596,712,539	415,657,492	6.30%
2010	6,325,370,345	623,407,886	9.86%
Total	35,972,474,251	2,773,787,661	7.71%

6.5.2 Methods for Controlling System Water Loss

Santa Rosa uses the American Water Works Association (AWWA) Standard Water Audit and Water Balance in the Third Edition M36 Manual, *Water Audits and Loss Control Programs,* to determine and analyze the annual water loss for the system. Santa Rosa implements a number of programs to control system water loss, including meter testing and calibration on a routine schedule based on meter size, hydrant maintenance to insure valves are exercised appropriately, metering of all City field crew trucks that use water as part of their routine maintenance activities and metering all construction use. Santa Rosa's field crews also implement a leak detection program where field staff uses traditional sounding equipment to complete a survey of the City's distribution system annually. Any leaks that are detected are repaired immediately. Santa Rosa maintains a database that records the date, time and location of the leak, as well as the repair information and estimated amount of water lost due to the leak. In addition, as a preventative measure, Santa Rosa implements a service replacement

program for plastic services and certain copper services where Santa Rosa has identified areas of high leaks from services.

Santa Rosa's billing department notifies customers of potential property leaks by analyzing water use records for dramatic increases in water use and contacting customers individually and offering assistance. In addition, the Santa Rosa Water Conservation Program analyzes dedicated irrigation customers water use records to determine which accounts have high water use and contacts those customers offering assistance. Santa Rosa's robust program has led to non-revenue water being less than 10% over the past ten years.

6.6 City of Sonoma

6.6.1 Five-Year Average Non-Revenue Water

The City of Sonoma's (Sonoma) five-year average for non-revenue water is 7.38%. The annual percentages are given below:

Year	NRW %
2006	7.5%
2007	7.5%
2008	3.5%
2009	10.5%
2010	7.9%

6.6.2 Methods for Controlling System Water Loss

Sonoma is committed to doing the maximum extent practical to account for all water. Currently Sonoma employs a leak detection company to survey the water system twice a year. Sonoma has also purchased leak detection equipment for its own use. Based on its AMR data, Sonoma send out monthly "leak letters" to residents who appear to have a continuous flow of water, which could indicate a water leak and offers indoor and outdoor water audits. For the past two years Sonoma has put an emphasis on tracking its own use when hydrant flushing and exercising valves, as well as partnering with the fire department to track water used for fires and training. As part of its education and outreach, Sonoma hosts an annual Water Wisdom Fair, which this year will focus on sustainability. At outreach events, Sonoma gives away water conserving hardware and educational material and actively promotes its rebate programs, the most popular program being cash for grass.

Sonoma has an aggressive water service replacement program that replaces leaky polybutylene (PB) service laterals throughout the city. As of 2010, this program has replaced 768 service lines at an average cost of approximately $4,000 per service. Sonoma's Capital Improvement Program

includes replacing an additional 856 service lines, which would bring the total replacement to approximately two-thirds of all PB installations. Leaks in customer service lines and at the meter box were repaired. Another program undertaken by Sonoma, which is believed to have reduced leakage and improved meter accuracy, is its meter replacement program. Virtually all of the meters in the system have been replaced with automatic reading equipment, with the task being completed in 2008.

6.7 Valley of the Moon Water District

6.7.1 Five-Year Average Non-Revenue Water

The Valley of the Moon Water District (VOMWD) five-year average for non-revenue water is 8.94%. The annual percentages are given below:

Year	NRW %
2006	14.3%
2007	9.3%
2008	11.2%
2009	6.8%
2010	3.1%

6.7.2 Methods for Controlling System Water Loss

VOMWD implements a number of programs to control system water loss, some of which are described below:

1. VOMWD uses the American Water Works Association (AWWA) Standard Water Audit and Water Balance in the Third Edition M36 Manual, *Water Audits and Loss Control Programs* to determine and analyze the annual water loss for the system.
2. VOMWD monitors all water coming into its distribution system, both imported and locally produced, on a continuous basis with a SCADA system, and using daily and monthly water production and storage reports.
3. VOMWD field crews respond and typically attempts to repair all leaks the same day. VOMWD has staff on-call at non-regular hours to respond to leaks and emergency conditions. The on-call staff responds to both customer calls and telephone alarms triggered by SCADA.
4. As a preventative measure, VOMWD implements a service replacement program for polybutylyne service lines, where the District has identified areas of high leaks.
5. VOMWD field crews use traditional sounding equipment to routinely survey parts of the District's distribution system. The District also hires outside help to conduct leak detection surveys periodically. Any leaks that are detected are repaired immediately.

6. In May 2011, VOMWD entered into an agreement with the Water Agency and IBM to collaborate on a pilot study using advanced analytics and optimization techniques to reduce Non-Revenue Water as well as provide improved pressure management of both the Water Agency's transmission system and the VOMWD's distribution network using data that is currently being collecting.
7. VOMWD has no un-metered water use and implements these additional measures: a) meter testing and calibration on a routine schedule based on meter size; b) hydrant maintenance to insure valves are exercised appropriately; c) metering of all field crew trucks that use water as part of their routine maintenance activities; and d) metering all construction use.

6.8 Town of Windsor

6.8.1 Five-Year Average Non-Revenue Water

The Town of Windsor (Windsor) five-year average for non-revenue water is approximately 4.20%. The annual percentages are given below:

Year	NRW %
2006	5%
2007	6%
2008	3%
2009	2%
2010	5%

6.8.2 Methods for Controlling System Water Loss

Prior to 2009, Windsor completed informal annual audits in the process of tabulating sales and production data. Most of Windsor's transmission and distribution system is less than 15 years old and is in excellent condition. Consequently, Windsor experiences relatively few pipe leaks or failures. Windsor has leak detection equipment and all leaks are traced and repaired as quickly as possible when noticed. In addition, Windsor has an aggressive corrosion control program that is intended, in part, to prolong the useful life of the distribution system pipes.

In July 2009, Windsor began implementing new water loss management procedures as detailed in the American Water Works Association (AWWA) Third Edition M36 Manual, *Water Audits and Loss Control Programs.* In March 2011, staff received CUWCC training on the use of AWWA's Water Loss Audit software. This software is now being utilized by Windsor to complete a standard water audit and balance annually.