State of Rhode Island and Providence Plantations

DEPARTMENT OF ATTORNEY GENERAL
150 South Main Street • Providence, RI 02903
(401) 274-4400
TDD (401) 453-0410

Patrick C. Lynch, Attorney General

August 18, 2008

Luly Massaro, Clerk
Public Utilities Commission
89 Jefferson Blvd.
Warwick, RI 02888

Re: Pawtucket Water Supply Board – General Rate Filing
Docket No. 3945

Dear Ms. Massaro:

Enclosed please find the Rhode Island Division of Public Utilities & Carriers responses to the Rhode Island Public Utilities Commission First Set of Data Request's in the above-referenced matter. If you have any questions, please do not hesitate to contact me.

Very Truly Yours,

Leo J. Wold (H.T.)

Leo J. Wold
Special Assistant Attorney General
(401) 274-4400 x 2218

LJW/mt
Enclosure

cc: Service List

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
PUBLIC UTILITIES COMMISSION

IN RE: PAWTUCKET WATER SUPPLY :
BOARD GENERAL RATE FILING : DOCKET NO. 3945

DIVISION OF PUBLIC UTILITIES AND CARRIERS RESPONSES TO THE COMMISSION'S FIRST SET OF DATA REQUESTS

1. Why does Mr. Mierzwa accept Mr. Woodcock's approach to the calculation of lost and accounted for water?

Response

Mr. Mierzwa accepted Mr. Woodcock's approach to the calculation of lost and unaccounted-for water ("LUFW") for the PWSB system. The inch-foot method of allocating LUFW implicitly assumes that a greater percentage of water is lost through leaks from large mains. Mr. Mierzwa is not aware of PWSB experiencing any large leaks in its transmission mains. Mr. Mierzwa's independent research found several articles which indicated that smaller leaks contributed more to LUFW than large leaks because large leaks are generally quickly found, isolated and repaired. For example, see the following: Leak Detection and Water Loss Control, by Z. Michael Lahlou, Ph.D. and Water Leak Detection and Repair Program of the Georgia Environmental Protection Division (Attachments 1 & 2 to this data response).

In addition, the articles referenced by Mr. Woodcock indicate that LUFW is a function of the length of water mains and service lines. Mr. Woodcock's allocation of LUFW considers the length of water mains and service lines. See the response to Request 2 for additional detail.

Respondent: Jerome D. Mierzwa

Attachment 1
to Comm 1-1

National Drinking Water Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV
26506-6064

Leak Detection and Water Loss Control

by Z. Michael Lahlou,Ph.D.,
Ph.D. Civil and Environmental Engineer, Wiley and Wilson, Lynchburg, VA

Summary Utilities can no longer tolerate inefficiencies in water distribution systems and the resulting loss of revenue associated with underground water system leakage. Increases in pumping, treatment and operational costs make these losses prohibitive. To combat water loss, many utilities are developing methods to detect, locate, and correct leaks.

Old and poorly constructed pipelines, inadequate corrosion protection, poorly maintained valves and mechanical damage are some of the factors contributing to leakage. One effect of water leakage, besides the loss of water resources, is reduced pressure in the supply system. Raising pressures to make up for such losses increases energy consumption. This rise in pressure makes leaking worse and has adverse environmental impacts.

Of the many options available for conserving water, leak detection is a logical first step. If a utility does what it can to conserve water, customers will tend to be more cooperative in other water conservation programs, many of which hinge on individual efforts. A leak detection program can be highly visible, encouraging people to think about water conservation before they are asked to take action to reduce their own water use. Leak detection is an opportunity to improve services to existing customers and to extend services to the population not served. In general, a 10 to 20 percent allowance for unaccounted-for-water is normal. But a loss of more than 20 percent requires priority attention and corrective actions. However advances in technologies and expertise should make it possible to reduce losses and unaccounted-for-water to less than 10 percent. While percentages are great for guidelines, a more meaningful measure is volume of lost water. Once the volume is known, revenue losses can be determined and cost effectiveness of implementing corrective action can then be determined.

Benefits of Leak Detection and Repair

The economic benefits of leak detection and repair can be easily estimated. For an individual leak, the amount lost in a given period of time, multiplied by the retail value of that water will provide a dollar amount. Remember to factor in the

costs of developing new water supplies and other "hidden" costs.

Some other potential benefits of leak detection and repair that are difficult to quantify include:

- increased knowledge about the distribution system, which can be used, for example, to respond more quickly to emergencies and to set priorities for replacement or rehabilitation programs;
- more efficient use of existing supplies and delayed capacity expansion;
- improved relations with both the public and utility employees;
- improved environmental quality;
- increased firefighting capability;
- reduced property damage, reduced legal liability, and reduced insurance because of the fewer main breaks; and
- reduced risk of contamination.

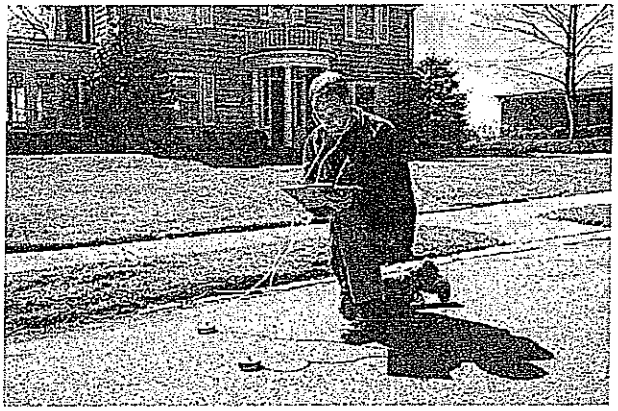


Photo Caption-Shawn Menear, a graduate student in Technology Education at West Virginia University, uses geophones to listen for water main leaks. Similar to a doctor or nurse's stethoscope, geophones are an inexpensive leak detection device used by water utilities. Photo by Eric Merrill.

Causes of Leaks

Water produced and delivered to the distribution system is intended to be sold to the customer, not lost or siphoned from the distribution system without authorization. Not long ago, water companies sold water at a flat rate without metering. As water has become more valuable and metering technology has improved, more and more water systems in the U.S. meter their customers. Although all customers may be metered in a given utility, a fairly sizable portion of the water most utilities produce does not pass through customer meters. Unmetered water includes unauthorized uses, including losses from accounting errors, malfunctioning distribution system controls, thefts, inaccurate meters, or leaks. Some unauthorized uses may be identifiable. When they are not, these unauthorized uses constitute unaccounted-for water. Some unmetered water is taken for authorized purposes, such as fire fighting and flushing and blowoffs for water-quality reasons. These quantities are usually fairly small. The primary cause of excessive unaccounted-for water is often leaks.

There are different types of leaks, including service line leaks, and valve leaks, but in most cases, the largest portion of unaccounted-for water is lost through leaks in the mains. There are many possible causes of leaks, and often a combination of factors leads to their occurrence. The material, composition, age, and joining methods of the distribution system components can influence leak occurrence. Another related factor is the quality of the initial installation of distribution system components. Water conditions are also a factor, including temperature, aggressiveness, and pressure. External conditions, such as stray electric current; contact with other structures; and stress from traffic vibrations, frost loads, and freezing soil around a pipe can also contribute to leaks. All water plants will benefit from a water accounting system that helps track water throughout the distribution system and identifies areas that may need attention, particularly large volumes of unaccounted-for water.

Leak Detection and Repair Strategy

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground. In addition, correlator devices can listen at two points simultaneously to pinpoint the exact location of a leak. (See the drawing.)

Large leaks do not necessarily contribute to a greater volume of lost water, particularly if water reaches the surface; they are usually found quickly, isolated, and repaired. Undetected leaks, even small ones, can lead to large quantities of lost water since these leaks might exist for long periods of time. Ironically, small leaks are easier to detect because they are noisier and easier to hear using hydrophones. The most difficult leaks to detect and repair are usually those under stream crossings.

Leak detection efforts should focus on the portion of the distribution system with the greatest expected problems, including:

- areas with a history of excessive leak and break rates;
- areas where leaks and breaks can result in the heaviest property damage;
- areas where system pressure is high;
- areas exposed to stray electric current and traffic vibration;
- areas near stream crossings; and
- areas where loads on pipe exceed design loads.

Of course, detecting leaks is only the first step in eliminating leakage. Leak repair is the more costly step in the process. Repair clamps, or collars, are the preferred method for repairing small leaks, whereas larger leaks may require replacing one or more sections of pipe.

On average, the savings in water no longer lost to leakage outweigh the cost of leak detection and repair. In most systems, assuming detection is followed by repair, it is economical to completely survey the system every one to three years.

Instead of repairing leaking mains, some argue it is preferable to replace more leak-prone (generally older) pipes. Selecting a strategy depends upon the frequency of leaks in a given pipe and the relative costs to replace and repair them. Deciding whether to emphasize detection and repair over replacement depends upon site-specific leakage rates and costs. In general, detection and repair result in an immediate reduction in lost water, whereas replacement will have a longer-lasting impact to the extent that it eliminates the root cause of leaks.

The most important factor in a leak detection and repair program is the need for accurate, detailed records that are consistent over time and easy to analyze. Records concerning water production and sales, and leak and break costs and benefits, will become increasingly important as water costs and leak and break damage costs increase and as leak detection and rehabilitation programs become more important. In order to optimize these programs by allocating funds in such a way that results in the greatest net benefits, adequate information is needed on which to base decisions and determine needs. Three sets of records should be kept: (1) monthly reports on unaccounted-for water comparing cumulative sales and production (for the last 12 months, to adjust discrepancies caused by the billing cycle); (2) leak-repair report forms; and (3) updated maps of the distribution system showing the location, type, and class of each leak.

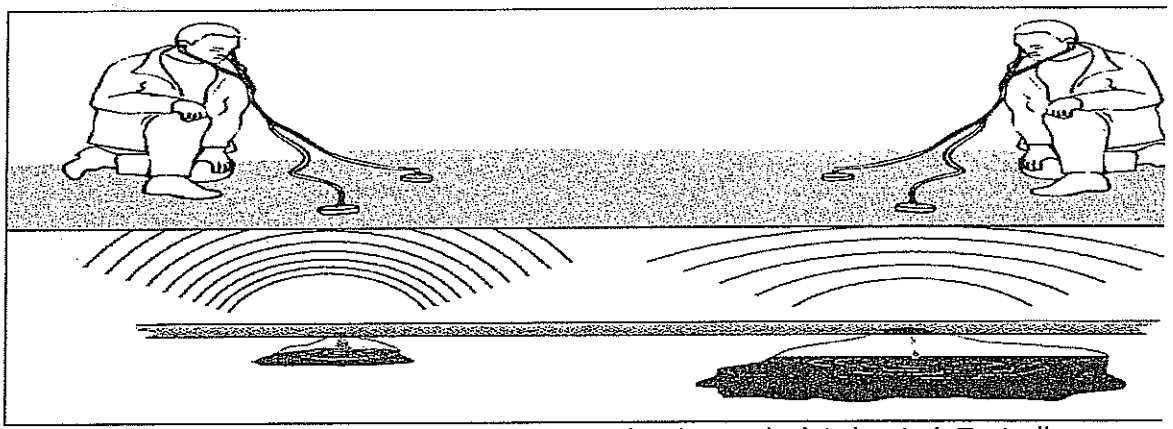
Coordinating Leak Detection and Repair with Other Activities In addition to assisting with decisions about rehabilitation and replacement, the leak detection and repair program can further other water utility activities, including:

- inspecting hydrants and valves in a distribution system;
- updating distribution system maps;
- using remote sensor and telemetry technologies for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns; and
- inspecting pipes, cleaning, lining, and other maintenance efforts to improve the distribution system and prevent leaks and ruptures from occurring. Utilities might also consider methods for minimizing water used in routine water system maintenance.

Beyond Leak Detection and Repair
Detecting and repairing leaks is only one water conservation alternative; others include: meter testing and repair/replacement, rehabilitation and replacement programs, installing flow-reducing devices, corrosion control, water pricing policies that encourage conservation, public education programs, pressure reduction, requests for voluntary cutbacks or bans on certain water uses, and water recycling.

Calculating Unaccounted-for Water
Unaccounted-for water is the difference between water produced (metered at the treatment facility) and metered use (i.e., sales plus non-revenue producing metered water). Unaccounted-for water can be expressed in millions of gallons per day (mgd) but is usually discussed as a percentage of water production:

Unaccounted-for water (%) = (Production - metered use) x 100% ÷ (Production)



An important goal of leak detection is to find exactly where a leak is located. Typically, the louder the noise, the closer you are to the leak. Small leaks under high pressure usualy make more noise than larger leaks under low pressure. In fact, many large leaks make almost no sound whatsoever.

Where can I find more information?
Jeffs, C., C. Lloyd, and D. Pospishill. 1989. *An Introduction to Water Loss and Leak Detection*. Duncan OK: National Rural Water Association.

Mays, W. L. 2000. *Water Distribution Systems Handbook*. American Water Works

Association. New York: McGraw-Hill.

Moyer, E. M. 1985. *Economics of Leak Detection: A Case Study Approach.* Denver: American Water Works Association

Pask, David. "50 Percent Loss? How to Detect Small Utility Water Leaks." *On Tap.* Winter 1993. Morgantown WV: National Drinking Water Clearinghouse.

U.S. Environmental Protection Agency. 1998. *Water Conservation Plan Guidelines.* Washington, D.C.: Office of Water. EPA-832-D-98-001

For further information, comments about this fact sheet, or to suggest topics, contact Lahlou via e-mail at lahloum@hotmail.com.

About the Author
Zacharia M. Lahlou, Ph.D., formerly technical assistance coordinator with the National Drinking Water Clearinghouse, is a civil and environmental engineer with Wiley & Wilson, Lynchburg, VA. Lahlou received a PhD in environmental and natural resources economics, an MBA, and an MS in civil and environmental engineering from West Virginia University. He may be reached by e-mail at lahloum@hotmail.com.

Attachment 2
to Comm 1-1

WATER LEAK DETECTION AND REPAIR PROGRAM

EPD Guidance Document
August 2007

TABLE OF CONTENTS

PART 1: ESSENTIALS OF LEAK DETECTION AND REPAIR ____ 3

SUMMARY ____ 3

Benefits of Leak Detection and Repair ____ 3

Unaccounted-for Water ____ 4

Types of Leaks ____ 4

Leak Detection and Repair Strategies ____ 5

Checking for Leaks ____ 6

PART 2: MAIN ELEMENTS OF A COMPREHENSIVE LEAK DETECTION AND REPAIR PROGRAM ____ 7

PART 3: LEAK DETECTION AND REPAIR REPORT FORM ____ 11

Georgia Environmental Protection Division
Watershed Protection Branch

Guidance Document
Leak Detection and Repair Programs

Developed by the Georgia Environmental Protection Division (EPD)
To support the *"Coastal Georgia Water and Wastewater Permitting Plan for Managing Saltwater Intrusion"*

This guidance document is principally intended for entities in the 24-county area of Georgia's coast addressed in the "Coastal Georgia Water and Wastewater Permitting Plan for Managing Saltwater Intrusion", located in Sub-Regions 1, 2 and 3, that are:

- Private Industrial Transient and Non-Transient Non-Community Water Systems (TNCWS and NTNCWS) with an Operating Permit and a Water Withdrawal Permit; or
- Private Industrial Transient and Non-Transient Non-Community Water Systems (TNCWS and NTNCWS) with ONLY an Operating Permit.

It is designed to guide the development and implementation of a leak detection and repair program for industrial or small commercial water system permittees, who are required to address leak detection and repair as a condition of their permit. However, Community Water Systems of all types could also greatly benefit from this document.

When to use this guidance document: For permittees described above using water derived from the Upper Floridan aquifer in the coastal counties of Georgia, a special condition of all new or modified withdrawal permits will be development and implementation of a water leak detection and repair program. The permittee must submit a detailed description of that program to the Georgia Environmental Protection Division's District Office for concurrence no later than 18 months from the permit issue date. The program must be updated at intervals determined by EPD.

How to use this guidance document: This guidance document is organized into three parts: Part 1: Essentials of Leak Detection and Repair – Provides a discussion of the importance of leak detection and repair, the major causes of leaks, and how to identify leaks. Part 2: Main Elements of a Leak Detection and Repair Program – Provides a detailed description of the type of program permittees should implement, and related compliance requirements. Part 3: Leak Detection and Repair Form – Provides a form for small commercial users or industrial permittees to use to assure compliance with the various requirements of the program described in Part 2. This form must be submitted to EPD with the detailed description of the leak detection and repair program.

EPD Contact: If you have any questions, or require additional information, please contact the EPD Drinking Water Program, at 404-656-4807. As the July 2006 Coastal Permitting Plan is implemented, EPD will welcome feedback from permittees regarding this guidance document.

PART 1: ESSENTIALS OF LEAK DETECTION AND REPAIR

SUMMARY

Detecting and repairing leaks is one of the main components of water conservation. This guidance document will address the strategies to reduce water loss due to leaks, and acknowledges the concepts developed by organizations such as the International Water Association (http://www.iwahq.org) October 2000 Reference Paper "**Losses from Water Supply Systems**", and the American Water Works Association (www.awwa.org) Manuals of Water Supply Practices.

Old or poorly constructed pipelines, inadequate corrosion protection, poorly maintained valves and mechanical damage are some of the factors contributing to leakage. Leak detection has historically assumed that all, if not most, leaks rise to the surface and are visible. In fact, many leaks continue below the surface for long periods of time and remain undetected. With an aggressive leak detection program, water systems can search for and reduce previously undetected leaks. Water lost after treatment and pressurization, but before delivered for the intended use, is water, money and energy wasted. Accurate location and repair of leaking water pipes in a supply system greatly reduces these losses. Once a leak is detected, the water utility must take corrective action to minimize water losses in the water distribution system.

Unaccounted-for-water for industrial/commercial systems should not be more than 10 percent of the total water produced. It is preferred that more than 95% of the water delivered be accounted for. Any loss of more than 10 percent in a system requires priority attention and corrective action. Advances in technology and expertise should make it possible to reduce losses and unaccounted-for-water to less than 10 percent.

Every industrial and commercial water system facility should implement cost effective water loss control measures that will minimize distribution system water losses. Water systems with pressurized distribution systems should promote water auditing, leak detection, and leak repair as a means to reduce operating costs and conserve water. The water audit can be used on systems with customer meters, while leak detection and repair can be used on any pressurized water system. The difference between produced water and the total of metered use and authorized non-metered use estimates is an indicator of the severity of unauthorized use problems or system water leaks.

Benefits of Leak Detection and Repair

Minimizing leakage in water systems has many benefits for water customers (and their suppliers). These benefits include:

- Improved operational efficiency.
- Lowered water system operational costs.
- Reduced potential for contamination.
- Extended life of facilities.
- Reduced potential property damage and water system liability.
- Reduced water outage events.
- Improved public relations.

Some added benefits of leak detection and repair that are difficult to quantify include:

- increased knowledge about the distribution system, which can be used to respond more quickly to emergencies and set priorities for replacement or rehabilitation programs;
- more efficient use of existing supplies and delayed capacity expansion;
- increased firefighting capability.

Leak detection and repair programs can lead other important water system activities, such as:

- inspecting hydrants and valves in a distribution system;
- updating distribution system maps;
- using remote sensor and telemetry technologies for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns; and
- inspecting pipes, cleaning, lining, and other maintenance efforts to improve the distribution system and prevent leaks and ruptures from occurring. Systems might also consider methods for minimizing water used in routine water system maintenance.

Unaccounted-for Water

Unaccounted-for-water includes unmeasured water put to beneficial use as well as water losses from the system. It is the difference between water produced (metered at the treatment facility) and metered use (i.e., water sales plus non-revenue producing metered water). Unaccounted-for water can be expressed in millions of gallons per day (mgd) but is usually discussed as a percentage of water production:

$$\text{Unaccounted-for water (\%)} = [(\text{Production} - \text{metered use}) / (\text{Production})] \times 100\%.$$

Authorized un-metered uses include firefighting, main flushing, process water for water treatment plants, landscaping of public areas, etc. Water losses include all water that is not identified as authorized metered water use or authorized un-metered use.

Types of Leaks

There are different types of leaks, including service line leaks, and valve leaks, but in most cases, the largest portion of unaccounted-for water is lost through leaks in supply lines. There are many possible causes of leaks, and often a combination of factors leads to their occurrence. The material, composition, age, and joining methods of the distribution system components can influence leak occurrence. Another related factor is the quality of the initial installation of distribution system components. Water conditions are also a factor, including temperature, velocity, and pressure. External conditions, such as stray electric current; contact with other structures; and stress from traffic vibrations, frost loads, and freezing soil around a pipe can also contribute to leaks.

Underground Leaks

The underground piping on either side of a water meter should be maintained. Leaks in underground plumbing can be caused by many different factors, including rusting through from age or from stray electric currents from other underground utilities that can prematurely rust metallic piping, driving over piping with heavy trucks or equipment, poor initial installation, freezing and thawing of a pipeline,

leaking joints or valves, or transient high pressure events such as opening and closing valves or starting and stopping pumps quickly.

Signs of underground leaks include:

- Unusually wet spots in landscaped areas and/or water pooling on the ground surface.
- An area that is green, moldy, soft, or mossy surrounded by drier conditions.
- A notable drop in water pressure/flow volume.
- A sudden problem with rusty water or dirt or air in the water supply (there are other causes for this besides a leak).
- A portion of an irrigated area is suddenly brown/dead/dying when it used to be thriving (water pressure is too low to enable distant heads to pop up properly).
- Heaving or cracking of paved areas.
- Sink holes or potholes.
- Uneven floor grade or leaning of a structure.
- Unexplained sudden increase in water use, consistently high water use, or water use that has been climbing at a fairly steady rate for several billing cycles.

If any of these conditions exist at a property, there may be a leak. If a leak is suspected, a professional leak detection company may be required to pinpoint its exact location and a contractor hired to perform repairs. There are leak detection service companies listed in the yellow pages. Any utility contractor should be able to repair a leak once the location is known.

Leak Detection and Repair Strategies

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground. In addition, correlator devices can listen at two points simultaneously to pinpoint the exact location of a leak.

Large leaks do not necessarily constitute the greatest volume of lost water, particularly if water reaches the surface where they are usually found quickly, isolated, and repaired. However, undetected leaks, even small ones, can lead to large quantities of lost water since these leaks might exist for a long time. Ironically, many small leaks are easier to detect because they are noisier and easier to hear using hydrophones. The most difficult leaks to detect and repair are usually those under stream crossings. Leak detection efforts should focus on that portion of the distribution system.

Active leak detection is crucial in identifying unreported water leakage and losses in the distribution system. Finding and repairing water losses through an active leak detection program will reduce water loss and, in many cases, save substantial money. Without a leak detection program, leaks may only be found when they become visible at the surface, or when major infrastructure collapses. Active leak control will reduce expensive emergency overtime repairs and the associated liability costs. The impact on customers is also greater in emergency repair situations as is the possible impact on other infrastructure (roads, sewers, utilities) and on the environment due to possible discharges of chlorinated water. Detecting leaks is only the first step in eliminating leakage. Leak repair is the more costly step in the process. On average, the savings in water no longer lost to leakage outweigh the cost of leak detection and repair.

In most systems, assuming detection is followed by repair, it is usually cost effective to completely survey the system every one to three years. Selecting a strategy depends upon the frequency of leaks in a

given pipe and the relative costs to replace and repair them. For example, instead of repairing older, leaking mains, some argue it is preferable to replace leak-prone older pipes. Deciding whether to emphasize detection and repair over replacement depends upon site-specific leakage rates and costs.

In general, leak detection and repair result in an immediate reduction in lost water, whereas replacement will have a longer-lasting impact to the extent that it eliminates the root cause of leaks. The most important factor in a leak detection and repair program is the need for accurate, detailed records that are consistent over time and easy to analyze. Records concerning water production and sales, and leak and break costs and benefits, will become increasingly important as water costs and leak and break damage costs increase and as leak detection and rehabilitation programs become more important. Generally, the water system should keep three sets of records: (1) monthly reports on unaccounted-for water; (2) leak-repair report forms; and (3) updated maps of the distribution system showing the location, type, and class of each leak.

Checking for Leaks

Identifying leaks can be difficult; however, at minimum the following should be performed:

- Inspect irrigation systems for obvious above ground leaks. Extremely wet areas above an underground pipe can be an indication of a broken pipe or joint.
- Examine equipment routinely and look at exposed pipes to see if you can visually see any leaking water.
- Compare your records with the same month of previous years. While the amount of water used will vary due to weather and processes, look for sharp increases in your consumption that could indicate a leak.

If you suspect a leak at your facility, take steps to get the leak fixed.

Business and Commercial Leak Detection

Costs related to leakage can add up quickly. Not only do businesses pay water and sewer charges for a leak, but there can be considerable additional costs for repairing water damage or from production down time caused by larger leaks. Some leaks may continue for years without being noticed, finally culminating in a sudden major failure from the gradual undermining of a footing or foundation segment. In some cases, failures from a long-term leak can endanger lives.

Because leaks are continuous and can cause damage over time, checking for leaks on a regular basis can prevent considerable expense on utilities and property repairs. Common sources of leaks are toilets, faucets or showerheads, broken mechanical equipment or valves and underground piping including water service lines and irrigation systems.

Equipment Malfunction: One of the largest sources of leakage at business/commercial properties is equipment malfunction. Often these kinds of "leaks" go on for extended periods because they are not causing any damage or disruption to daily operations. Common areas where malfunctions can occur include:

- Overflow valves or float valves on cooling towers, water features, swimming pool equipment, storage tanks, etc. can malfunction in the open position allowing equipment to continuously overflow water to the sewer.

- By-pass valves can be left open following equipment maintenance, allowing a piece of equipment that is normally on a closed cooling loop to operate in a single pass mode, wasting thousands of gallons of water every day.
- Temperature control valves fail, causing substantially more water to be passed through a piece of equipment than is necessary to cool it sufficiently.
- Off/on switches or sensors can stick in the on position, running water through machinery that normally would be shut off when not in use.
- Rusting through or separation of internal parts that allow water to escape and drain from a machine that normally contains and/or re-circulates the water.
- Nozzles that are supposed to shut off drip continuously or stick on.

A weekly or monthly visual inspection of water using equipment will usually uncover these types of problems.

Even businesses that do not use water as part of their operations can be harmed by water leaks. For example, it is estimated that, in an average residence, 20 or more gallons of water are lost to leakage each day, and the most common culprits are leaking toilets or dripping faucets. It is not uncommon to find toilets causing much more leakage than the average 20 gallons. Silent toilets leaks can account for up to 300 gallons of day of lost water without anybody noticing the leakage. This size of leak is very costly and should be repaired immediately. Leaks in flush valve style toilet are less obvious and need to be fixed by a person familiar with this procedure.

PART 2: MAIN ELEMENTS OF A COMPREHENSIVE LEAK DETECTION AND REPAIR PROGRAM

Private Industrial Transient and Non-Transient Non-Community Water Systems permittees must implement a comprehensive leak detection and repair program to attain a 10 percent or less unaccounted-for water loss in their systems. The program must include auditing procedures, and in-field leak detection and repair efforts, and be submitted to EPD as a condition of the withdrawal or operating permit.

Implementation of the comprehensive program submitted to EPD must consist of at least the following actions:

1) In accordance with permit requirements, the water system must adopt an industrial/commercial leak detection and repair program and submit an implementation schedule to EPD no later than 18 months from the permit issue date. The program prepared by the system must outline an implementation schedule to achieve unaccounted-for-water of not more than 10 percent within 5 years, or sooner, as outlined in this section.

2) The industrial/commercial leak detection and repair program to be submitted to the EPD should, at minimum, include the following information:

   (a) Actual annual water production volume by the supplier.

   (b) Annual distribution system leakage (unaccounted-for water) expressed in percentage and volume.

Distribution system leakage totals calculated in accordance with the formula below shall be recorded in annual percent and volume;

$$DSL(\%) = [(TP - AC) / (TP)] \times 100$$

Where:

DSL	=	Percent of Distribution System Leakage (%)
TP	=	Total Water Produced and Purchased
AC	=	Authorized Consumption

These numbers should be entered on the "Leak Detection and Repair Form" in Part 3 of this Guidance Document. Note that:

(i) Total water produced and purchased, and authorized consumption must be calculated. Elements of authorized consumption that cannot be metered, such as fire flow, must be estimated;

(ii) All or portions of transmission lines may be excluded when determining distribution system leakage; and,

(iii) Any water that cannot be accounted for shall be considered distribution system leakage.

(c) You must maintain reportable evidence documenting that:

(i) A leak detection survey using best available technologies has been completed on the system within the past three years;

(ii) All leaks found have been repaired;

(iii) The system is unable to locate additional leaks; and,

(iv) Ongoing efforts to minimize leakage are included as part of the system's water-use efficiency program.

(d) If the calculated annual distribution system leakage is greater than 10 percent, you must provide an explanation of any technical or economic concerns, or other system characteristics, contributing to exceedance of the 10% standard.

(e) If an alternative method is being used to calculate distribution system leakage totals, then it must include annual figures and the chosen methodology's numerical standard(s). The alternative methodology used must be included in one of the recognized national publications on water loss and/or leakage. Furthermore, any alternative method must provide a better evaluation of distribution system leakage than calculating the percent of total water produced and purchased; it must be appropriate for the system requesting to use it; and it must use numerical standards so that compliance and action levels can be assessed.

(f) For systems not fully metered, you must maintain documentation to report the status of meter installation and any actions taken to minimize leakage.

(g) You must maintain reportable evidence documenting that whether the system has developed and implemented a general water loss control action plan for the water system and whether the implementation schedule is being met.

(h) Maintain reportable evidence showing that the distribution system leakage has been calculated annually for the past three years, and whether the calculated annual distribution system leakage is 10 percent or less.

(i) If the average distribution system leakage for the last three years has not met the standard 10 percent or less, EPD will work collaboratively with the water system to ensure the control methods and level of activity are commensurate with the level of leakage. This may require the water system to develop and implement a water loss control action plan, and submit it to EPD's District Office for review and concurrence. The water loss control action plan shall, at minimum, address: (i) the control methods necessary to achieve compliance with the distribution system leakage standard of 10 percent or less; (ii) an implementation schedule; (iii) a budget (or Business Plan) that demonstrates how the control methods will be funded; (iv) any technical or economic concerns which may affect the system's ability to implement a program or comply with the standard including past efforts and investments to minimize leakage; (v) if the average distribution system leakage calculated is greater than 10 percent of total water produced and purchased, the water loss control action plan must assess data accuracy and data collection, implementation of field activities such as actively repairing leaks or maintaining meters within twelve months of determining standard exceedance.

3) The water system shall implement corrective actions measures that yield apparent and real water savings. Leak detection and repair must be a continuous effort. The water system shall reduce system leakage to an economic minimum and repair leaks when reported and cost-effective to repair. In addition to repairing all reported leaks, the water system should consider the following intervention measures to reduce components of un-reported leakage and background leakage:

i. Sonic Leak detection surveys;
ii. Installation of acoustic data loggers;
iii. Accelerated repair of reported leaks;
iv. Regular measurement of District Metered Area flows, when applicable;
v. Replacement of leaky water mains and laterals; and
vi. Pressure management.

4) Based on the percent value, the leakage levels within the industrial/commercial water systems shall be classified into four different categories: Category A (less than 10%); Category B (11% - 12%); Category C (13% -14%); and, Category D (15% or greater).

5) The water system may use up to five years to implement measures to recover all economically recoverable losses and achieve compliance with the unaccounted-for- water of less than 10 percent, as follows:

a) No later than Year 3: Must achieve Category C status or better with unaccounted-for-water of between 13% and 14%.

b) No later than Year 4: Must achieve Category B status or better with unaccounted-for-water of between 11% and 12%.

c) No later than Year 5: Must achieve Category A status with unaccounted-for-water of less than 10 percent.

6) You must annually record and maintain leak detection and repair program activities by completing the *Leak Detection and Repair Report Form* in Part 3 of this Guidance Document. This form must be completed no later than January 31st of every year and summarize the program activities and results for the previous 12-month period. The completed forms must be available for review during EPD inspections and sanitary surveys, and copies submitted when requested by EPD.

Additional resources for developing a leak detection and repair program can be found in the International Water Association (http://www.iwahq.org) October 2000 Reference Paper "**Losses from Water Supply Systems**", and the American Water Works Association (www.awwa.org) Manuals of Water Supply Practices, especially "Water Audits and Leak Detection (M36)".

PART 3: LEAK DETECTION AND REPAIR REPORT FORM

Unaccounted-for Water Use:

> ***Unaccounted-for water** is the difference between water pumped or purchased and water that is metered or confidently estimated. Unaccounted-for water should include master meter inaccuracies, domestic and non-domestic meter under registration, errors in estimating for stopped meters, over registration revenue meters, unauthorized hydrant openings, unavoidable leakage, recoverable leakage, illegal connections, water storage tank overflows, data processing errors.*

Calculation of unaccounted-for water use should be based upon the volumes reported on your monthly or semiannual reports filed with the Environmental Protection Division.

I. *GENERAL SYSTEM INFORMATION*

Reporting Period (Year)	
Water System Permit #	
Water System Name	
Water System Address	
Contact Person Name	
Contact Person Phone #	
Description of Water Use	

II. *SOURCES OF WATER SUPPLY*

Please give amounts in gallons per minute **(gpm)**, per day **(gpd)** or million gallons per day **(mgd)**.

Source Type: **SW** = Surface supply, **GW** = Ground supply, **P** = Purchased supply
Source Status: **R** = Regular use, **S** = Standby use, **E** = Emergency use

Name of Source	Source Type	Pumping Capacity

III. *WATER USAGE AND METERING*

Are all sources of supply (including major interconnections) equipped with master meters? Yes No			
What percentage of your system is metered? %		How often are they read?	
How many meters are recalibrated and/or replaced each year?			
Water Production for calendar year		**Water Consumption for calendar year**	
Total Water Production: (metered pumped or purchased		Total Water Consumption: (metered use)	

IV. *WATER SUPPLY AUDIT FOR CALENDAR YEAR* _____

Total metered water production (from previous section)		Total		% of Total
Total metered water consumed (from previous section)		Subtract		
Authorized unmetered usage		Subtract		
e.g. firefighting, flushing, cleaning, etc..		Subtract		
		Subtract		
		Subtract		
Water lost to breaks that have since been repaired		Subtract		
TOTAL UNACCOUNTED-FOR WATER (Distribution System Leakage (DSL))		Sub-Total		

Formula: Unaccounted-for water (%) = (Production - metered & authorized use) / (Production) x 100% (DSL)

V. LEAK DETECTION AND REPAIR

Do you regularly survey your system for leaks with listening equipment? yes no

Total miles of distribution pipe	Percent of system surveyed each year	Length of pipe surveyed each year	Listening equipment used	Year of Last survey	Number of leaks found	Number of leaks repaired

Do you have a regular water system rehabilitation program? _____yes _____no
If yes, give details:

On a separate page, please describe your future plans for water system leak detection and repair.

Recommendations:
* Check at least one third of your water distribution system for leaks each year.
* Fix every detectable leak as soon as possible.
* Have an on-going system rehabilitation program.

VI. CERTIFICATION OF WATER LEAK DETECTION AND REPAIR PROGRAM:

To be signed by the owner or official of the water system operating this water system.

I hereby certify that the information provided on this form is true and accurate to the best of my knowledge and belief.

Date:_____ Signature:_____ Title:_____

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
PUBLIC UTILITIES COMMISSION

IN RE: PAWTUCKET WATER SUPPLY :
BOARD GENERAL RATE FILING : DOCKET NO. 3945

DIVISION OF PUBLIC UTILITIES AND CARRIERS RESPONSES TO THE COMMISSION'S FIRST SET OF DATA REQUESTS

2. How is Mr. Woodcock's approach to the calculation of lost and unaccounted for water supported by the articles cited in Mr. Woodcock's testimony?

Response

Under Mr. Woodcock's proposal, LUFW is allocated based on miles of transmission and distribution mains and service lines unweighted for diameter. The articles identified in the footnotes on page 20 suggest that LUFW is a function of main and service line length and the number of service line connections. The articles also indicate that most water leaks occur on customer service piping, not water mains.

Respondent: Jerome D. Mierzwa

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
PUBLIC UTILITIES COMMISSION

IN RE: PAWTUCKET WATER SUPPLY :
BOARD GENERAL RATE FILING : DOCKET NO. 3945

DIVISION OF PUBLIC UTILITIES AND CARRIERS RESPONSES TO THE COMMISSION'S FIRST SET OF DATA REQUESTS

3. Should PWSB be required to construct an annual water audit as was performed by the City of Philadelphia in the International Water Association format to support its calculation in this case?

Response

Whether PWSB should be required to construct an annual water audit in the IWA format depends on whether the additional revenues which would realized exceed the cost of the audit over a reasonable period of time. Mr. Mierzwa has no estimate of the cost of such an audit or the potential additional revenues which may be realized.

Respondent: Jerome D. Mierzwa