

**Performance Audit:  
Department of Watershed Management  
Automated Meter Reading Program**

**December 2007**

**City Auditor's Office  
City of Atlanta**

File #07.05





## CITY OF ATLANTA

City Auditor's Office  
Leslie Ward, City Auditor  
404.330.6452

December 2007

### ***Why We Did This Audit***

Several of our past audit reports have touched on meter reading as an important part of water billing and collections. The department estimated two years ago that more than 8,000 water meters needed repair and many accounts were delinquent and disputed because bills were based on estimated water use. The billing process depends upon accurate, complete, and timely water meter reads.

The audit addressed the major challenges to successful automated meter reading implementation and how they are being addressed by the department.

### ***What We Recommended***

In order to address current operational issues for the AMR installation project, department officials should:

- Impose available contract remedies, such as a 10% withholding of payments, to ensure the contractor's compliance with the contract's installation goals.
- Determine and implement the most efficient and cost-effective approach to address outstanding "return-to-utility" and other work orders.
- Accelerate large meter repairs/replacement and AMR installation.

We also recommend the department:

- Develop a maintenance plan for small meters that includes periodic site surveys or similar ways to identify operational problems – such as leaks and broken lids – that cannot be detected with AMR technology.
- Develop comprehensive maintenance plans for large meters, and replacement plans for both large and small meters.

For more information regarding this report, please contact Stephanie Jackson at 404.330.6678 or [sjackson@atlantaga.gov](mailto:sjackson@atlantaga.gov).

## ***Performance Audit:***

### **Automated Meter Reading Program**

#### ***What We Found***

The city entered into a contract with K&V Automation, LLC on July 25, 2006 to replace or retrofit the city's existing water meter population and install a radio-based automated reading system. The \$35 million contract is for 36 months, ending in July 2009.

The Department of Watershed Management did not coordinate critical aspects of the automated meter reading project (AMR), underestimating the resources needed and potentially overestimating project benefits. Although the department is upgrading the city's water system infrastructure, the system will require immediate as well as ongoing maintenance, based on our observations of recently installed and retrofitted meters.

The level of damage to recently installed meters indicates that the department will face ongoing challenges maintaining the system and achieving the anticipated gains in billing accuracy. More than three-fourths of the 138 meters we observed (installed or retrofitted between January 1 and June 30, 2007) had at least one problem that will need to be addressed by either the department or the AMR contractor. These problems included register damage, unlocked lids, plastic or damaged meter boxes, lids that did not fit the meter box, and meter interface units (MIUs) that were not tied to the meter lids. We were unable to verify electronic reads for 13% of the sampled meters; 9% of those reads could not be verified due to broken or malfunctioning equipment. The department lacks the resources to handle the needed site repairs, some of which may impede the progress of current AMR installations and may result in higher project costs.

Implementation of the AMR system will decrease the department's knowledge of meter conditions in the field; the department should develop a proactive and cost-effective way to identify when replacement or other site repairs are needed for small meters. The department should also continue its efforts to develop meter maintenance and replacement plans.

At the end of September 2007, the AMR installations were 29% short of the installation schedule. Inventory shortages have also affected the schedule. The department has asked the contractor to provide a recovery plan to complete the project by the contract end date.

Prior to April 2007, the department paid the contractor based on a list of completed installations submitted weekly. In April 2007, department inspectors notified the department that they were unable to obtain reads on some recently installed and/or retrofitted meters. As a result, the department changed its payment process to ensure that the contractor is only paid for confirmed work.

## Management Responses to Audit Recommendations

### Summary of Watershed's Responses

|                         |  |                        |
|-------------------------|--|------------------------|
| <b>Recommendation:</b>  | 1. Department officials should work with program IT staff to assign a program code in the data collectors to identify manual meter reading entries in order to more easily identify meters that need repair by the city or contractor.   |                        |
| <b>Response:</b>        | Interfaces need to be written between Equinox and MAXIMO.  | <b>Agree</b>           |
| <b>Proposed Action:</b> | Development of Computerized Interfaces between Meter Reading/Inspection and Distribution Maintenance   |                        |
| <b>Timeframe:</b>       | Complete Interfaces no later than June 30, 2008  |                        |
| <b>Recommendation:</b>  | 2. Department officials should impose available contract remedies, such as a 10% withholding of any current and subsequent invoices, to ensure the contractor's compliance with the contract's installation goals.   |                        |
| <b>Response:</b>        | Department has understood it has the option to impose penalties under the contract.  | <b>Agree</b>           |
| <b>Proposed Action:</b> | Continue to evaluate the efficacy of imposing remedies to accelerate achievement of project goals.   |                        |
| <b>Timeframe:</b>       | Past, current and on-going.  |                        |
| <b>Recommendation:</b>  | 3. Department officials should determine and implement the most efficient and cost-effective method to address the outstanding "return-to-utility" and other work orders, so that this work does not further impede the contractor's installation progress.  |                        |
| <b>Response:</b>        | Preliminary analysis indicates the department has three options to address the issue.  | <b>Agree</b>           |
| <b>Proposed Action:</b> | Department will meet with internal stakeholders in January 2008 to select the best alternative to address outstanding "return to utility" work orders.   |                        |
| <b>Timeframe:</b>       | Implement selected alternative no later than March 31, 2008.   |                        |
| <b>Recommendation:</b>  | 4. Department officials should determine and implement the most efficient and cost-effective approach to accelerate large meter repairs/replacement and AMR installation.  |                        |
| <b>Response:</b>        | Department agrees that accelerating large meter installations is extremely important.  | <b>Agree</b>           |
| <b>Proposed Action:</b> | Department has notified the contractor that large meter activity must be increased and has assigned some large meter work to other contractors.  |                        |
| <b>Timeframe:</b>       | Immediately  |                        |
| <b>Recommendation:</b>  | 5. Department officials should develop a maintenance plan for small meters that includes periodic site surveys or similar ways to identify operational problems – such as leaks and broken lids – that cannot be detected with AMR technology.   |                        |
| <b>Response:</b>        | Department plans to follow best practices.   | <b>Agree</b>           |
| <b>Proposed Action:</b> | Complete the development of a "Small Meter Maintenance Plan".  |                        |
| <b>Timeframe:</b>       | The plan is ongoing and is scheduled to be completed by June 30, 2008.   |                        |
| <b>Recommendation:</b>  | 6. Department officials should develop a comprehensive maintenance plan for large meters that incorporates industry best practices.  |                        |
| <b>Response:</b>        | The Department is in the process of developing its large meter maintenance program.  | <b>Agree</b>           |
| <b>Proposed Action:</b> | Complete the development of a "Large Meter Maintenance Plan".  |                        |
| <b>Timeframe:</b>       | The plan is ongoing and is scheduled to be completed by June 30, 2008.   |                        |
| <b>Recommendation:</b>  | 7. Department officials should develop a comprehensive replacement plan for both small and large meters. The department should continue to evaluate and select the most appropriate alternative in order to ensure the department has a meter inventory that functions at optimal, revenue-producing levels. |                        |
| <b>Response:</b>        | See responses for recommendations #5 and #6.   | <b>Agree</b>           |
| <b>Proposed Action:</b> | The comprehensive replacement plan will be included in the large and small meter maintenance programs.   |                        |
| <b>Timeframe:</b>       | June 30, 2008  |                        |
| <b>Recommendation:</b>  | 8. Department officials should ensure the business case reflects the full scope of the planned project to identify risks and needed resources, and use it as a framework to manage the project.  |                        |
| <b>Response:</b>        | The business case was completed prior to embarking on the Project.   | <b>Partially Agree</b> |
| <b>Proposed Action:</b> | N/A  |                        |
| <b>Timeframe:</b>       | N/A  |                        |



# CITY OF ATLANTA

**LESLIE WARD**  
City Auditor  
*lward1@atlantaga.gov*

**CITY AUDITOR'S OFFICE**  
68 MITCHELL STREET SW, SUITE 12100  
ATLANTA, GEORGIA 30303-0312  
(404) 330-6452  
FAX: (404) 658-6077

**AUDIT COMMITTEE**  
Fred Williams, CPA, Chair  
Donald T. Penovi, CPA  
Cecelia Corbin Hunter  
Robert F. Ashurst, CPA  
Council President Lisa Borders

December 31, 2007

Honorable Mayor and Members of the City Council:

We included water meter reading in our 2007 audit plan because our previous audits of water and sewer billing and collections highlighted the topic's importance. The billing process depends upon accurate, complete, and timely water meter reads. The Department of Watershed Management cited broken water meters and billing disputes over estimated water use as reasons for delinquent accounts and uncollected water and sewer revenue.

The audit focused on the introduction of automated meter reading (AMR) technology – the department's major initiative for getting more accurate, timely water consumption data into its billing system – and issues relating to its implementation. Achieving the benefits of AMR technology depends not only on correctly installing the equipment, but also on assessing and managing ongoing risks to its operation.

AMR installation and accompanying meter replacement/retrofit are progressing, but the department faces challenges in completing the project on time and in achieving and maintaining its projected benefits. Our observation of a statistical sample of accepted installations calls into question the accuracy improvements to be gained from AMR: due to broken or malfunctioning equipment, we could not verify electronic reads for 9% of the meters in the sample. In contrast, the department has projected an AMR error rate of only 0.3%.

Our sample results also indicate the need for immediate maintenance and repair of recently installed meters and highlight the continuing vulnerability of the water meter system to damage and tampering. Nearly three-fourths of the 138 meters we observed had unlocked lids; other problems included register damage, plastic or damaged meter boxes, and lids that did not fit the meter box. In addition, the AMR contractor identified

as many as 2,000 meter sites the department must repair before the AMR installation can be done. Many of these issues have arisen from the department's lack of information about meter site conditions across the city. Although this is the city's first comprehensive meter replacement program since 1983, the department proceeded without gathering additional data about conditions they would encounter in the field. The cost of gathering information wasn't avoided; rather, it was delayed and must now be recognized in a realistic assessment of costs and benefits of the AMR investment.

The department agreed with seven of our eight recommendations and partially agreed with the remaining one. Their full response is included as an appendix to the report; it indicates management is already taking actions that should address the audit findings and conclusions. The appendix also includes a letter from the Commissioner of Watershed Management containing additional comments and background information. While the commissioner draws some conclusions that are different from our own, we agree on the major issues and the actions needed to address them.

The Audit Committee has reviewed this report and is releasing it in accordance with Article 2, Chapter 6 of the City Charter. We appreciate the courtesy and cooperation of the Department of Watershed Management, other city staff, and contractors throughout the project. The audit team included Ty Elliot, Melissa Davis, Dawn Williams, Stephanie Jackson, and Amanda Noble.



Leslie Ward  
City Auditor



Fred Williams  
Audit Committee Chair

---

# Automated Meter Reading Program

---

## Table of Contents

|   |    |
|---|----|
| Introduction .....  | 1  |
| Background.....   | 1  |
| Department’s Business Case Outlined Expected Benefits from New Technology ..... | 2  |
| Automation Eliminates Routine Visual Inspection of Meters.....                  | 3  |
| Automated Meter Reading Contract Established Installation Requirements .....    | 4  |
| Audit Objective.....  | 5  |
| Scope and Methodology.....  | 6  |
| Findings and Analysis.....  | 7  |
| Meter Installation is Progressing, but Operational Challenges Remain .....      | 7  |
| Planning Overlooked Implementation Issues.....                                  | 8  |
| Recently Installed Meters Need Repair or Replacement .....                      | 11 |
| Department Is Developing Meter Maintenance and Replacement Plans.....           | 18 |
| Automated Meter Reading Project Is Behind Schedule .....                        | 22 |
| The City Is Losing Revenue Due to Large Meter Installation Delays.....          | 23 |
| K&V Is Behind Schedule on Small Meter Installations .....                       | 24 |
| At Least 6,000 Installations Are Waiting on AMR Meter Lids.....                 | 27 |
| Department’s Work Order Backlog Further Impedes AMR Installation Progress ..... | 28 |
| Department Corrected Invoice Payment Control Weakness .....                     | 29 |
| Recommendations .....   | 33 |
| Appendices.....   | 35 |
| Sampling Methodology.....   | 37 |
| Management Review and Response to Audit Recommendations .....                   | 41 |

---

## List of Exhibits

|            |   |    |
|------------|---|----|
| Exhibit 1  | Meters To Be Replaced Or Retrofitted Under The Amr Contract.....        | 5  |
| Exhibit 2  | Incompatible Meters Installed After Start Of Amr Project .....          | 10 |
| Exhibit 3  | Random Sample Of Meters Installed/Retrofitted January - June 2007 ..... | 11 |
| Exhibit 4  | Number Of Sampled Meters With Problems.....                             | 12 |
| Exhibit 5  | Unverified Reads Identified In Sample .....                             | 13 |
| Exhibit 6  | Responsibility For Meter Repairs.....                                   | 17 |
| Exhibit 7  | Monthly Installation Of Small Meters.....                               | 25 |
| Exhibit 8  | Cumulative Installation Of Small Meters .....                           | 26 |
| Exhibit 9  | Percent Short Of Small Meter Installation Goal .....                    | 26 |
| Exhibit 10 | Reasons For Return-To-Utility.....                                      | 29 |
| Exhibit 11 | Pilot Sample .....  | 37 |
| Exhibit 12 | Cluster Sample .....  | 38 |
| Exhibit 13 | Sampling Error .....  | 39 |

---

## List of Figures

|           |  |    |
|-----------|--|----|
| Figure 1  | AMR Components.....                      | 3  |
| Figure 2  | Data Collectors .....                    | 4  |
| Figure 3  | Cracked Meter Register .....             | 12 |
| Figure 4  | Locking Meter Lid.....                   | 14 |
| Figure 5  | Lids That Do Not Fit Meter Pits .....    | 14 |
| Figure 6  | Plastic Meter Pits.....                  | 15 |
| Figure 7  | Broken Lid with Debris in Meter Pit..... | 15 |
| Figure 8  | Broken Meter Lid.....                    | 16 |
| Figure 9  | Meter Leak .....                         | 18 |
| Figure 10 | Old Meter Lid .....                      | 27 |
| Figure 11 | Mounting of MIU Antenna in Lid .....     | 27 |
| Figure 12 | New AMR Lid .....                        | 28 |

---

## Introduction

---

We conducted this audit of the Department of Watershed Management's (DWM) meter replacement and automated meter reading (AMR) installation pursuant to Chapter 6 of the Atlanta City Charter, which establishes the City of Atlanta Audit Committee and City Auditor's Office and outlines their primary duties.

A performance audit is an objective, systematic examination of evidence to independently assess the performance of an organization, program, activity, or function. The purpose of a performance audit is to provide information to improve public accountability and facilitate decision-making. Performance audits encompass a wide variety of objectives, including those related to assessing program effectiveness and results; economy and efficiency; internal controls; compliance with legal or other requirements; and objectives related to providing prospective analyses, guidance, or summary information<sup>1</sup>.

We proposed auditing water meter reading as part of our 2007 annual audit plan. Several of our past reports have touched on meter reading as an important part of water billing and collections. The department estimated two years ago that more than 8,000 water meters needed repair and many accounts were delinquent and disputed because bills were based on estimated water use. The billing process depends on accurate, complete, and timely water meter reads.

---

## Background

The Department of Watershed Management is responsible for over 150,000 residential and commercial water meters throughout its service area. The department's Water Distribution Division in the Bureau of Drinking Water operates and maintains the drinking water distribution system, including customer service lines and meters. The department's Bureau of Customer Service manages meter reading, billing, and collection. Information captured during meter reading provides the basis for the department's water and sewer billing and

---

<sup>1</sup> Comptroller General of the United States, *Government Auditing Standards*, Washington, DC: U.S. Government Accountability Office, 2003, p. 21.

collection. The quality of billing information affects the department's ability to take effective enforcement action and collect on bills.

The department has begun a three-year project to install about 122,000 new water meters with AMR equipment and retrofit 31,800 existing meters with the AMR equipment. According to department staff, the last large scale meter replacement was in 1983. Officials have stated that many delinquent water and sewer accounts were in dispute because bills were based on estimated water use due to broken meters. The city wrote off more than \$16 million in uncollected bills in 2005 and 2006. The department initiated the AMR installation in part because of the need to replace water meters and to obtain more accurate meter readings.

### **Department's Business Case Outlined Expected Benefits from New Technology**

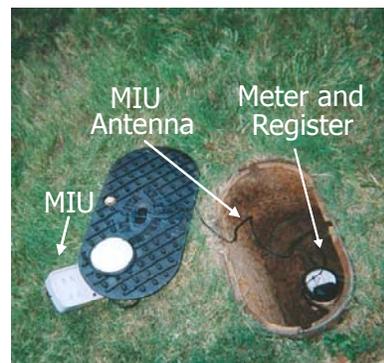
The AMR project consists of installing a radio-based system that will allow the department to read its inventory of water meters electronically. Once the AMR equipment is installed, the department will no longer have to manually read each meter on a regular basis. The department expects to reduce operating expenses associated with manual meter reading and to ensure accurate meter readings. The department identified the following expected benefits of implementing AMR technology in its December 2004 business case:

- **Labor and cost savings on meter reads.** According to the department, 26 contract staff read approximately 8,000 to 9,000 meters per day. The business case estimates that with AMR implementation, only one meter reader will be needed for regular monthly reads – amounting to annual savings of about \$1 million.
- **Fewer service calls and meter re-reads.** The city currently is required to do a large number of re-reads or off-cycle reads to verify disputed bills or to accommodate new residents or tenant changes. The business case estimates that AMR technology will improve meter reading completion rates from 92% to 99%, resulting in a drop in the number of estimated bills, higher customer confidence, and fewer meter reading staff needed for service calls – amounting to an estimated annual savings of about \$235,000.

- **Lower vehicle mileage and costs.** The business case estimates that the AMR system will require only one vehicle for meter reading resulting in estimated annual savings of about \$130,000 on vehicle and mileage costs.
- **Fewer calls to call center.** The business case states that the department’s call center handles over 4,500 calls per week, with hold times of over 10 minutes. AMR is expected to decrease the call center volume by 50%, based on AMR implementation in other jurisdictions, allowing current staff to reduce hold times.
- **Decrease in delinquent accounts.** The business case estimated that approximately 12% of the department’s accounts were delinquent – and we reported in June 2005 that 81% of the department’s accounts receivable balance was delinquent. AMR implementation is expected to result in fewer billing disputes and higher levels of customer confidence in meter reading accuracy. The business case states that this should lead to a slight decrease in delinquent accounts and improve revenue collection.
- **Faster processing of meter reading data.** The business case states that improved data flow from the meter to the billing system will allow the department to issue bills more quickly following the meter read, which could promote faster payment by customers because of increased confidence in the billing accuracy.
- **Intangible benefits.** The business case also identified other potential benefits such as improved safety, less air pollution and quicker leak detection and repair.

**Automation Eliminates Routine Visual Inspection of Meters**

The water meter measures the volume of water that customers use. That use is recorded on the attached register – a device like an odometer. A meter interface unit (MIU) is attached to the water meter and collects water use data from the register (see figure 1). Using radio frequency signals, the MIU electronically transmits the data to either a handheld or mobile data collector (see figure 2). The



**Figure 1  
AMR Components**

antenna attached to the MIU enables the data collectors to receive the radio signals. This information is then transferred to the department's billing system.



Mobile Data Collector

Handheld Data Collector

**Figure 2**  
**Data Collectors**

### **Automated Meter Reading Contract Established Installation Requirements**

The city entered into a contract with K&V Meter Automation, LLC on July 25, 2006, to replace or retrofit the city's existing water meter population and install a radio-based automated meter reading system. The contract is for 36 months, ending in July 2009, for \$35 million. Staff from the department's Bureau of Drinking Water is overseeing the AMR project. The notice-to-proceed authorizing the work to begin was also dated July 25, 2006.

According to the contract, over 153,000 meters are slated to be either replaced or retrofitted with AMR technology, as shown in Exhibit 1. Department staff stated that the number of meters to be retrofitted has increased since the contract began because additional meters have been added to the department's inventory as new customers apply for water service on new construction. Department officials stated that all new construction built since the contract began has been outfitted with either "AMR compatible" or "AMR ready" meters.

Meters older than seven years will be replaced. Functioning meters that are less than seven years old and compatible with the new technology will be retrofitted with AMR components.

Meter installation began in December 2006 with a pilot project. During the pilot project, meters were installed in northwest and west Atlanta. Full AMR implementation began in January 2007. After completing work in the pilot areas, the installers moved to the North Fulton and Sandy Springs areas. According to the department's weekly reports, by the end of September 2007, K&V had installed 23,159 small meters and 8 large meters. As of October 15, 2007, the city had paid the contractor \$3.9 million for work performed under the installation contract.

**EXHIBIT 1  
METERS TO BE REPLACED OR RETROFITTED  
UNDER THE AMR CONTRACT**

| <b>Meter Size</b>                             | <b># Meters Retrofitted</b> | <b># Meters Replaced</b> |
|---|-----------------------------|--------------------------|
| Small Meters                                  | 30,944                      | 120,088                  |
| Large Meters                                  | 856                         | 1,511                    |
| <b>Total</b>                                  | <b>31,800</b>               | <b>121,599</b>           |
| <b>Combined Total Retrofitted or Replaced</b> |                             | <b>153,399</b>           |

Source: AMR Contract

---

## Audit Objective

This report addresses the following objective:

- What are the major challenges to successful automated meter reading implementation and how are they being addressed by the department?

---

## Scope and Methodology

This audit was conducted in accordance with generally accepted government auditing standards. We conducted our audit fieldwork from June 2007 through October 2007.

The audit methods included:

- Documenting and flowcharting meter reading processes and internal controls.
- Interviewing city staff and contractors involved in the automated meter reading project.
- Reviewing automated meter reading project implementation plans, installation contracts, and performance reports.
- Observing meter installation, meter reading, and meter inspections.
- Observing equipment and site conditions at a random sample of 138 meters installed or retrofitted between January and June 2007.
- Reviewing and analyzing automated meter reading project data.
- Providing a memorandum to the Department of Law on issues related to the AMR installation contract.

---

## Findings and Analysis

---

### Meter Installation is Progressing, but Operational Challenges Remain

The automated meter reading project (AMR) is a complex, three-year, \$35 million investment to upgrade the city's water system infrastructure. A project of this magnitude warrants extensive project coordination and management. The department did not coordinate critical aspects of the project, underestimating the resources needed for successful implementation and potentially overestimating benefits.

Recently installed or retrofitted meters already need repair or replacement, indicating that the department will face ongoing challenges maintaining the system and achieving the hoped-for gains in accuracy. We observed at least one problem – such as unlocked meter box lids, poorly-fitting meter box lids, damaged meter boxes, and damaged registers – in 78% of a random sample of 138 AMR meters installed between January 1 and June 30, 2007. Most of the problems we observed related to the meter lids, but about 9% of the meters could not be read due to broken or malfunctioning equipment. The department's business plan anticipated less than 0.3% non-reads in a billing cycle.

The problems we observed could have resulted from customer tampering, accidental damage, incorrect installation, equipment malfunction, or neglect. Regardless of how they occurred, the problems indicate vulnerability in the city's water distribution system that will require ongoing effort to address. Department personnel said they do not have the staff to handle the work. The department should determine the most efficient and cost-effective method to address maintenance needs throughout the installation.

The department is developing long-term maintenance and replacement plans to ensure that its meters are functioning properly and replaced when needed once the current installation is completed. Routine maintenance and planned replacement help ensure that water service costs are fairly distributed among all rate payers. Department staff told us that they intend to develop a maintenance plan for large meters; small meters will be tested after 10 years and

replaced, if needed, rather than repaired. Because small meters are relatively inexpensive, it is reasonable to replace rather than repair them. However, the change from manual to automated meter reading reduces the department's knowledge about conditions in the field. The department should develop a proactive and cost-effective way, such as periodic site surveys, to identify when replacement or other site repairs are needed for small meters. The department is reviewing alternative strategies for a small meter replacement plan, but has not yet identified replacement options for large meters.

### **Planning Overlooked Implementation Issues**

Watershed did not adequately anticipate operational challenges and coordinate needed resources to address them before implementing the project. The department did not:

- prepare a business case for the full scope of the project to identify risks and the costs and benefits of different alternatives;
- assess field site conditions;
- coordinate work among divisions; or
- coordinate inventory requirements.

As a result of this lack of planning and coordination, the department underestimated overall project costs and may not achieve all of the project's expected benefits.

**A business case should provide a framework for project management.** The department hired a consultant to develop a business case for the AMR project in December 2004. The business case includes background information about the project, a cost benefit analysis, approximate project cost, and a projected return on investment. According to industry data, a business case provides a framework for planning and managing a business process change.

However, the business case considered only the AMR elements of the project and did not address potential project risks related to coordinating the meter and lid replacement. Further, the AMR project management team only recently became aware of the existence of the business case, and therefore could not have used it as a tool to manage the success of the project. AMR project management staff said that they measure the success of the AMR project based solely

on whether the contractor meets the installation schedule and the meters can be electronically read post-installation.

**Improved leak detection may not be achieved with current implementation.** Some of the benefits the project was intended to achieve, including increased ability to identify leaks and improve water conservation, are not possible with the meter registers currently being installed and will require an upgrade. The register model purchased by the department has leak detection on the register face but does not transmit this information to the MIU. An upgraded model transmits information about leaks, potential tampering, and backflow through the MIU into the customer information system. This register costs \$20 more per unit. A more complete business case would have presented the costs and benefits of each alternative.

**The department did not plan for needed site repairs prior to beginning AMR project.** Watershed personnel did not conduct a site survey of the conditions of small meters. While the department was aware that site conditions such as non-conforming lids (cases where new AMR lids may not fit the existing meter box), plastic meter boxes, damaged or inaccessible meter boxes, and illegal connections could hinder implementation, the department decided to address site problems on an ad hoc basis, rather than gather information to better anticipate problems and plan for needed resources. Meter readers could have collected site information before the project started. Instead, project staff is relying on K&V to notify them when site conditions require additional work.

For example, according to staff, there are four types of metal meter boxes and some plastic meter boxes installed throughout the city. The department does not have an inventory of the different types of meter boxes and where they are located. Under the contract, only one type and size of AMR meter lid is being installed. Since AMR project staff did not know, prior to installation, the sizes and locations of the various meter boxes, they did not know whether the new AMR lids would fit the meter boxes or whether some boxes would need to be replaced. Replacing the meter box after the new meter is installed increases the risk that the meter will be damaged and not covered by warranty.

**The department lacks the resources to make all of the needed site repairs, which will likely increase overall costs.** Under the contract, K&V is responsible for replacing and/or retrofitting small and large meters, and the city is responsible for work outside the contract scope, such as broken meter boxes, plastic boxes, and non-conforming lids. K&V installers refer these conditions to project staff who notify the Watershed’s distribution division staff. Distribution division management told us that the division does not have the resources, equipment, or staff to handle all site work for AMR installations.

According to distribution division management, Watershed management had originally planned to perform a complete change-out of the meter system, including meters, boxes, and lids. This approach would have addressed other site conditions concurrently with the AMR installation. In changing its approach, the department underestimated the level of resources needed to complete the project.

**The department installed incompatible meters after the AMR implementation began.** Although Watershed started planning the AMR installation in 2004 assuming that the system would use Neptune meters, it continued to install other types of meters well into the AMR contract for meter replacements on existing accounts. In July 2006, the department contracted with K&V to install or retrofit only Neptune meters with AMR components. Project staff told us that the other meters are incompatible with the AMR equipment and, as shown in Exhibit 2, they plan to replace more than 500 newly installed meters.

**EXHIBIT 2  
INCOMPATIBLE METERS INSTALLED  
AFTER START OF AMR PROJECT**

| Year         | # Installed | %           |
|--------------|-------------|-------------|
| 2006         | 206         | 41%         |
| 2007         | 300         | 59%         |
| <b>Total</b> | <b>506</b>  | <b>100%</b> |

Source: DWM Inventory Data

The department purchased \$117,000 worth of Hersey meters in 2005. Between July 2006 and August 2007, the department installed 400 Hersey meters and 106 Badger and Rockwell meters. According to

AMR project staff, the department continued to install these meters because they did not have all aspects of the AMR contract in place, although the notice-to-proceed was issued in July 2006.

**Recently Installed Meters Need Repair or Replacement**

K&V had installed 12,377 small meters as of June 2007, according to the department’s weekly reports. The majority of recently installed meters that we observed in a random sample of 138 had at least one problem that will either require some type of repair or replacement, or did not conform to contract specifications. Exhibit 3 shows the types and frequency of problems we observed at sampled meter sites in September 2007 – eight months after installations began.

**EXHIBIT 3  
RANDOM SAMPLE OF METERS INSTALLED/RETROFITTED  
JANUARY - JUNE 2007**

| <b>Problem Observed</b>            | <b>Percent of Meters</b> |
|------------------------------------|--------------------------|
| Could Not Verify Electronic Read   | 13%                      |
| Register Damage                    | 9%                       |
| Plastic Meter Box                  | 6.5%                     |
| Damaged Meter Box (Metal)          | 4.4%                     |
| Poor Fit Between Meter Box and Lid | 41%                      |
| Unlocked Lid                       | 72%                      |
| MIU Not Tied to Meter Lid          | 14%                      |

Source: Sample data collected by audit team

Most of the problems we observed were related to the meter lids, but about 9% of the meters could not be read due to broken or malfunctioning equipment, which included either cracked registers or error codes in the handhelds (see page 15 for further explanation). The department’s business plan anticipated less than 0.3% non-reads in a billing cycle. Most of the repairs are the city’s responsibility and do not appear to be covered by warranty under the contract. The department should determine the most efficient and cost-effective method to address these problems to protect the city’s assets and ensure AMR benefits are achieved.

**More than three-fourths of sampled meters had at least one problem.** We evaluated a statistical sample of 138 AMR meters installed or retrofitted between January 1 and June 30, 2007, using criteria identified in the meter installation guidelines and contract provisions. Only 30 of the 138 meters had no notable issues. We observed between one and five problems in each of the remaining 108 meters – 78% of our sample (see Exhibit 4).

**EXHIBIT 4  
NUMBER OF SAMPLED METERS WITH PROBLEMS**

| Number of Issues   | Total Meters With Issues |             |
|--------------------|--------------------------|-------------|
|                    | #                        | %           |
| None               | 30                       | 21.7%       |
| One                | 33                       | 23.9%       |
| Two                | 55                       | 39.9%       |
| Three              | 13                       | 9.4%        |
| Four               | 3                        | 2.2%        |
| Five               | 4                        | 2.9%        |
| <b>Total/Month</b> | <b>138</b>               | <b>100%</b> |

Source: Sample data collected by audit team

**Majority of meters installed in the first six months of the project are likely to have problems.** Based on the 13% sampling error, we estimate that between 65% and 91% of the meters installed or retrofitted between January and June 2007 have at least one problem<sup>2</sup>. Our sample results show no relationship between installation age and the number of observed problems. However, the most serious problems we observed were with meters installed during January through April (see Appendix A). Overall, it is reasonable to expect some level of damage to the meters or some issue that needs to be resolved, even with recently installed meters. Our sample included some meters that had been installed and accepted in each month from January to June 2007.



**Figure 3  
Cracked Meter Register**

<sup>2</sup>Sampling error describes the range of uncertainty that an estimate, based on a random sample, is applicable to the entire population from which the sample was drawn. Sampling error is calculated based on the size of the sample relative to the population and the amount of variation among the data collected.

**About 9% of meter registers were cracked; half of these were inoperable and need to be replaced.** Of the 138 meters sampled, 12 (8.7%) had damage to the meter register; in 6 of these cases the register was not operating (see figure 3). While it is not possible to identify when and how the meters were damaged, this level of damage to newly installed or retrofitted equipment suggests the department will face ongoing challenges maintaining the system.

**We could not verify reads for 13% of sampled meters.** Under the contract, the city only accepts and pays for a meter installation or retrofit after receiving a confirmed meter reading or sequence of meter readings from the meter. We were unable to verify readings for 19 of the 138 meters sampled. In 12 cases (9%), the electronic meter reading device displayed an error code or no information at all, or the MIU number on the meter differed from the number listed in the meter inventory. In 6 of these cases the meter register was cracked and not operating. These results suggest the department may not reduce missed reads as expected. We could not confirm readings for the remaining 7 meters because we could not physically access the meter box due to debris or water leakage, and one case the inspector could not locate the meter box on the property (see exhibit 5).

**EXHIBIT 5  
UNVERIFIED READS IDENTIFIED IN SAMPLE**

| Reason for Unverified Read   | Number    | Percent      |
|--|-----------|--------------|
| The number of reads where the electronic meter reading device showed the error code <b>“: : : :”</b>                           | 4         | 2.9%         |
| The number of reads where the electronic meter reading device showed the error code <b>“HHHH”</b>                              | 5         | 3.6%         |
| The number of reads where the electronic meter reading device did not provide any information about the read, termed a misread | 1         | 0.7%         |
| The number of reads the audit team could not confirm, because we could not physically access the meter box                     | 7         | 5.1%         |
| The number of reads attached to a different MIU unit # than the number listed for the location in our sample                   | 2         | 1.5%         |
| <b>TOTAL</b>   | <b>19</b> | <b>13.0%</b> |

**Source:** Sample data collected by audit team

**Notes:** According to the MIU troubleshooting guide, if an error code of “: : : :” is displayed, it indicates a problem obtaining a reading from the meter register. “HHHH” reading denotes an intermittent problem with the register that typically is self-correcting once water flows and re-aligns the odometer. If no meter reading is obtained, it indicates a problem with the MIU.

**More than 70% of the meter lids were unlocked.** K&V is contractually responsible for replacing meter box lids with locking lids that have no holes to let water into the box. Project staff told us that the meter lids should be locked to prevent public access to the equipment. Only 39 of the 138 sampled meters were locked when we arrived at the meter site; 99



(72%) were unlocked. While it is not possible to know whether a K&V installer failed to lock the lid after installation, a city inspector left the lid unlocked after inspection, or a homeowner unlocked the lid, failure to lock the lid exposes the equipment to possible tampering or damage. We observed one meter interface unit in which the wires connecting it to the register had been cut. The meter installers and inspectors should ensure that the lids are locked.

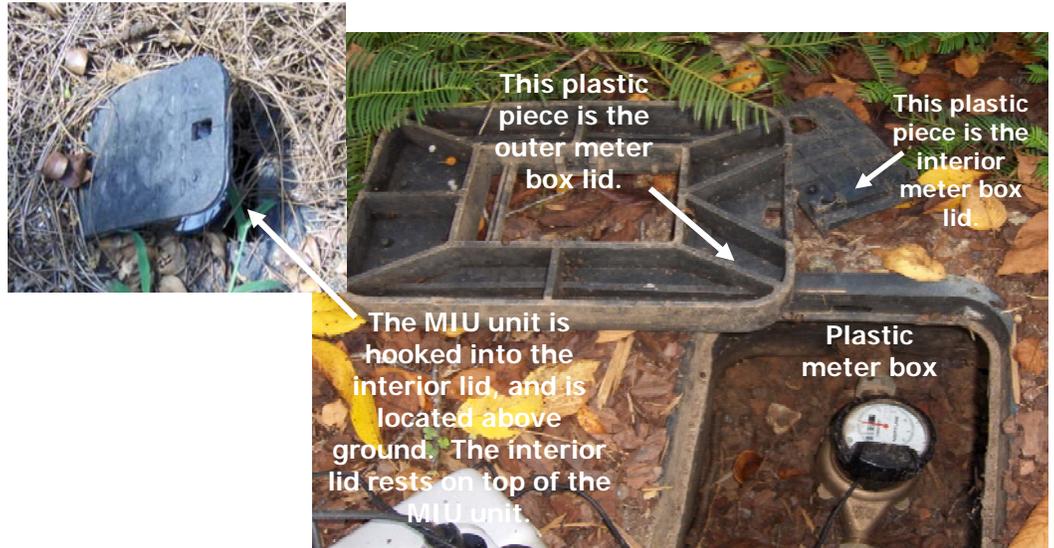
**Figure 4  
Locking Meter Lid**

**About half of the meter sites sampled need new meter boxes.** The city is responsible for replacing meter boxes when they are broken, plastic, or when the lids do not fit properly. Of the 138 meters sampled, nine (6.5%) meter boxes were plastic, six (4.4%) metal meter boxes were damaged, and an additional 53 (38.4%) had lids that did not fit the box.



**Figure 5  
Lids That Do Not Fit Meter Pits**

Because of installation placement, plastic meter boxes (see figure 6) increase the likelihood of damage to the meter reading antenna, while damaged boxes increase the likelihood of damage to the meter register itself. Many of the meter sites we observed had noticeable gaps between the meter box and lid (see figure 5).



**Figure 6**  
**Plastic Meter Pits**

Poorly-fitting lids potentially expose the equipment inside the meter box to water damage and debris, as shown in figure 7. Although the equipment is designed to function submerged in water, both circumstances could ultimately impair meter functionality.



**Figure 7**  
**Broken Lid with Debris in Meter Pit**

We also noted five instances where the new meter lid was broken, which could pose a hazard as well as expose the equipment (see figure 8) to damage. Lids are not included under warranty. Some staff suggested that forcing the lids to lock onto ill-fitting meter boxes puts the lid under stress and allows it to break more easily.



**Figure 8**  
**Broken Meter Lid**

**Electronic read failures may signal installation problems.**

According to AMR personnel, an error code or missed read alerts the department to send an inspector out to check the meter. The department notifies K&V of potential equipment problems if they cannot obtain a read. K&V is responsible for correcting equipment problems that are covered under warranty, which include manufacturing defects in material and workmanship and problems related to installation.

**Manual overrides are not detected and may mask warranty issues.** When missed reads or error codes, such as “: : : :” or “HHHH,” are recorded in the city’s customer information system, the department sends an inspector to investigate the meter malfunction. However, we observed a meter reader manually entering register reads into the system in place of the error code because he said he would have to return to collect the information anyway. Because the customer information system cannot differentiate between an electronic or manual entry, such overrides may conceal problems that should be repaired under warranty. Without an error code to alert

Watershed staff to maintenance problems, the department cannot ensure that site conditions in the field will be identified and addressed, either by the contractor under the warranty or by the department's internal maintenance staff. The department should work with program IT staff to assign a program code in the data collectors to identify manual meter reading entries in order to more easily identify meters that need repair by the city or contractor.

**The city is responsible for correcting the majority of problems identified.** The city is responsible for locking the meter lids after inspection, replacing plastic and damaged meter boxes, and repairing or replacing damaged meter registers (see exhibit 6). Replacing or repairing equipment that does not generate a read may be either the city's or K&V's responsibility. K&V is responsible for repairs covered under warranty. The city is otherwise responsible for the equipment once it is correctly installed, functioning properly, and accepted by the city. The need to repair newly installed equipment and replace meter boxes to accommodate the new lids indicates that the department underestimated the level of resources needed to install and maintain the new system to achieve project benefits.

**EXHIBIT 6  
RESPONSIBILITY FOR METER REPAIRS**

| <b>Issues Raised/Responsible Party</b>   |   |
|--|---|
| <b><u>City</u></b>   | <b><u>K&amp;V</u></b>   |
| <ul style="list-style-type: none"> <li>• Unlocked Lids</li> <li>• Fit Between Meter Box and Lid</li> <li>• Plastic Meter Boxes</li> <li>• Damaged Meter Boxes</li> <li>• Damaged Meter Registers</li> <li>• Equipment that does not read due to post-installation damage or tampering</li> </ul> | <ul style="list-style-type: none"> <li>• Equipment malfunction covered under warranty such as manufacturer's defects, or non-functioning meters due to improper installation</li> </ul> |

**Source:** Sample data collected by audit team; Review of AMR contract

## Department Is Developing Meter Maintenance and Replacement Plans

The department is developing a comprehensive testing and maintenance plan to ensure that its meters are functioning properly and accurately so that it bills for correct water use and takes advantage of warranty provisions. Department staff told us that they intend to develop a maintenance plan for large meters; small meters will be tested after 10 years and replaced, if needed, rather than repaired. Because small meters are relatively inexpensive, it is reasonable to replace rather than repair them. However, the change from manual to automated meter reading reduces the department's knowledge about conditions in the field. The department should develop a proactive and cost-effective way to identify when replacement or other site repairs are needed for small meters.

Because water meters slow over time, the department should develop a planned replacement schedule. The department is reviewing alternative methods to develop a small meter replacement plan, but has not yet identified replacement options for large meters. Routine maintenance and planned replacement help ensure that water service costs are fairly distributed among all rate payers. The department should continue its efforts to develop a long-term replacement schedule for both large and small meters.

**Reliance on error codes and customer complaints is inadequate to identify maintenance needs in small residential meters.** AMR technology enables meter readers to collect reads by driving by the meter site, rather than collecting the data manually.



**Figure 9**  
**Meter Leak**

This approach reduces operating expenses but eliminates the visual inspection of the meter site that accompanied the manual process. Thus, the department may not be aware of problems, such as broken lids (see figure 8) or leaks (see figure 9) that are wasteful or potentially hazardous but do not generate an error code in the AMR system.

Industry best practices recommend that the water utility revisit meters periodically to ensure proper operation and to protect its assets, even after automation. Department management told us that they have no plans to periodically survey meters and will rely on customers to notify them of problems with the meter.

The department's handheld data collection units used in the manual meter reading process included maintenance codes that were routed to the water distribution division to generate a maintenance work order. The new system does not have this capability. We observed a meter reader on an automated route manually noting some problems on route sheets to provide to the AMR project team, but there is not a similar automated process to generate a work order to correct ongoing operational problems.

**Small meter testing plan is a good step, but insufficient by itself to maintain the distribution system.** The department plans to test small meters to ensure that they are registering accurately. According to the department, small meters have not been tested since 1998, but staff will start testing small meters once they have been in service for 10 years, and then annually. The American Water Works Association (AWWA) identifies testing as a key element of meter maintenance. Testing ensures that meters are registering accurately and in accordance with the meter warranty so that bills are accurate and water service costs are fairly distributed among all rate payers. Given the number of problems we observed in newly installed meters, however, the department's plans to test small meters after 10 years and to otherwise rely on error codes or customer complaints to identify problems seem inadequate. We recommend the department develop a maintenance plan for small meters that includes a systematic way – such as periodic site surveys or equipment upgrade – to identify when replacement or other site repairs are needed.

**Water meters should be tested periodically, based on meter size, age, and other factors that affect accuracy, including:**

- **quality of water being measured;**
- **rates of flow and total quantity;**
- **chemical buildup; and**
- **abrasive materials carried by water.**

**Source: American Water Works Association**

The AWWA has established accuracy guidelines to assist water utilities. For example, AWWA's accuracy limits state a new  $\frac{5}{8}$ " water meter should have a minimum flow rate of  $\frac{1}{4}$  gallons per minute, the lowest flow a meter can detect, and the accuracy of that meter should be 95-101 percent, provided 10 gallons of water was used during the test.

**Replacing small meters is more cost-effective than repairing them.** Because small meters are relatively inexpensive, the department has no plans for routine small meter maintenance and will instead replace small meters when needed. Most of the city's small meters are  $\frac{5}{8}$ ", which cost about \$50 for the meter and register, and about \$34 in labor to replace. We agree that replacing small meters rather than repairing them is reasonable, but the department needs a way to determine when meters are not functioning properly and need replacement or other site repairs to mitigate revenue loss.

**The department is considering two methods for small meter replacement.** The department is developing a long-term replacement plan for small meters. A consultant has proposed alternatives that take meter age and accuracy testing into account, which is consistent with industry guidelines for replacement programs. Department management is evaluating the models to determine which is most appropriate.

Meter replacement plans are scheduled programs to change out existing meters to allow for a more efficient meter inventory and increased water revenue. AWWA recommends that utilities spread meter replacement costs over time, beginning with the oldest meters. Life expectancy and accuracy of a meter varies based on several factors, but according to AWWA, replacement schedules generally range from 5 to 15 years. Based on the department's meter inventory as of September 1, 2007, nearly 40% of small meters are 15 years old or older.

**The department should develop a large meter maintenance plan.** Department staff stated that many of the city's large meters have reached the end of their useful lives and cannot be relied on to produce accurate meter readings, which reduces revenue. The city entered into an agreement with Water Management Services (WMS) in 2004 to test the accuracy of large water meters to determine whether these meters need to be repaired or replaced. Although this contract is in place, the department has not yet established a long-term, preventative maintenance plan for large meters. Department staff told us that they are in the process of developing one that will include testing after three years of service, and annually thereafter.

The AWWA identifies the following essential elements of a meter maintenance program:

- facility records of water system parts;
- equipment records, maintenance activities, and work orders to help monitor equipment on hand, repairs and preventative maintenance activities, future maintenance schedules;
- inventory lists to record all supplies used to maintain the utility system; and
- testing in-service meters to ensure accuracy.

The department should complete its maintenance plan for large meters, incorporating the AWWA's recommended elements.

**Replacement plan alternatives do not address large meters.** While the department is evaluating replacement alternatives for small meters, management has not developed a plan to replace large meters on an ongoing basis. Large meters are currently slated to be replaced or repaired as part of the AMR installation, but the department has not developed a long-term plan to address replacement of the large meters currently being installed. Based on the department's meter inventory as of September 1, 2007, nearly 40% of large meters are 15 years or older.

**Large meters have large impact on revenue.** According to the AWWA, a portion of unaccounted for water and the lost revenue associated with it is the result of inaccurate meters that have been left in service too long. Planned meter replacement allows for maximum revenue recovery. Another large city water utility recently reduced unmetered water from about 31% to 21% through large meter management, fully accounting for city water use and reduction in theft of service. Most of the gain came from large meter

replacement; meters greater than 3" represented 1.8% of accounts and about 40% of water sales.

Meter repair may be practical for large meters, as they can be expensive to replace. However, the department should evaluate whether it is more cost-effective to repair or replace large meters based on testing results and develop an ongoing replacement plan for large meters.

---

## **Automated Meter Reading Project Is Behind Schedule**

Although K&V's weekly production has steadily increased, the number of installations has fallen short of the original installation schedule since the project began. Large meters were identified as a priority because of their impact on revenue. However, the city had only added about 553 large meters to K&V's work list for AMR installation through September 2007, and K&V has completed only 8 of these (1%). The department should ensure that its work on large meters is completed quickly to allow for timely repairs and replacement.

K&V was also about 9,600 (29%) short of the original installation goal for small meters through September 2007. The delays are compounded by inventory shortages. K&V will have to revisit approximately 6,000 previously installed meters to exchange the existing lids for AMR lids.

Despite the overall increase in monthly installations, K&V has not achieved and maintained the level of productivity required to complete the project within the 3-year contract period. The department should impose remedies available under the contract to hold the contractor accountable for its performance.

More than 2,000 "return to utility" work orders may also slow installation. These indicate site conditions that prevent installation and require the department to complete repairs before the contractor can install the new equipment. The department should determine the most efficient and cost-effective method to address the outstanding return-to-utility and other work orders, so that this work does not further impede the contractor's installation progress.

## **The City Is Losing Revenue Due to Large Meter Installation Delays**

At the end of September 2007, K&V had installed only 8 of the 553 large meters placed into their work list by the city. According to the proposed installation timetable included in the project planning documents, all of the large meters were slated for installation within the first 18 months of the project. The AMR contract requires K&V to replace or retrofit about 2,400 large meters; about 611 of those meters were divided among other contractors after the contract work began. The other contractors had completed 456 of the installations as of September 2007. However, K&V is still responsible for the majority of meter replacements and retrofits. The city is continuing to lose revenue as a result of these delays.

**Decreasing accuracy of old, large meters reduces city's revenue.** One of the reasons that the department implemented the meter replacement/AMR project was to increase revenue by replacing old, under-registering meters. Large meters were a priority because

**By September, 553 large meters had been placed in K&V's work queue; K&V completed 8.**

they had the largest revenue impact. In response to our 2006 audit work on collections, the department commissioner stated that over 2,000 large meters needed to be repaired or replaced and many of these accounts carried old, delinquent balances.

The department commissioner stated that the AMR project would enable the department to clear-up longstanding billing disputes. Each month K&V falls further behind schedule reduces the potential revenue gain from AMR installation.

**By September 2007, the department's reports show that 553 large meters had been placed into K&V's work list.** Before K&V begins work on the large meters, department staff provides them with a list of large meters that are ready to be replaced or retrofitted with the AMR components. K&V has subcontracted the large meter installations to Water Management Services (WMS), which also has a separate contract with the city to do large meter testing and analysis. Once the city provides K&V with the list of meters to be replaced and/or retrofitted, WMS determines the inventory needed to complete the installation. K&V then orders the inventory from the meter manufacturer, Neptune, and WMS then completes the installation.

Based on the department's description of how the work is performed, there does not appear to be an inherent conflict of interest in WMS's dual role in testing meters for the city and installing them for K&V. It is possible that WMS is a bottleneck for the large meter installations. However, K&V is contractually responsible for the performance of its subcontractor and the city is responsible for enforcing its contracts with WMS and K&V. The city has extended the deadline for large meter installation to July 2008, but at the current pace, the city and its contractors will have difficulty meeting the extended deadline.

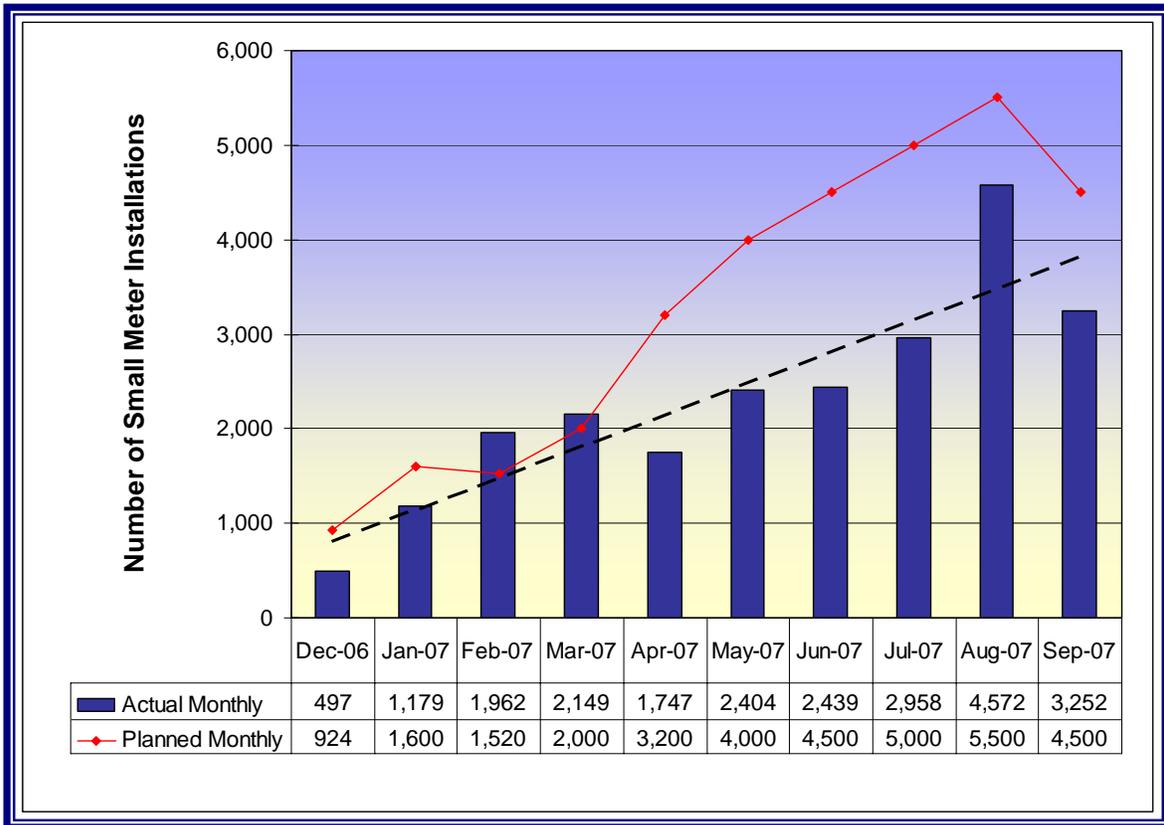
### **K&V Is Behind Schedule on Small Meter Installations**

At the end of September 2007, K&V had installed or retrofitted 23,159 small meters, about 29% short of the planned installation goal. Despite an overall increase in installations over time, K&V has not achieved and maintained a level of productivity consistent with the installation schedule.

### **The project has been behind schedule from the start.**

Although the contract with K&V was signed in July 2006, meter installations did not begin until the city's AMR pilot project began in December 2006. Full project implementation began in January 2007. As shown in Exhibit 7, K&V's small meter installation has fluctuated from month to month, but has increased over time as shown by the trend line. However, from December 2006 through September 2007, K&V met or exceeded the monthly installation goal for only two months - February and March 2007. The highest production month was in August 2007, with over 4,000 installations. But even then, the production level was still short of the installation goal of 5,500 meters for the month.

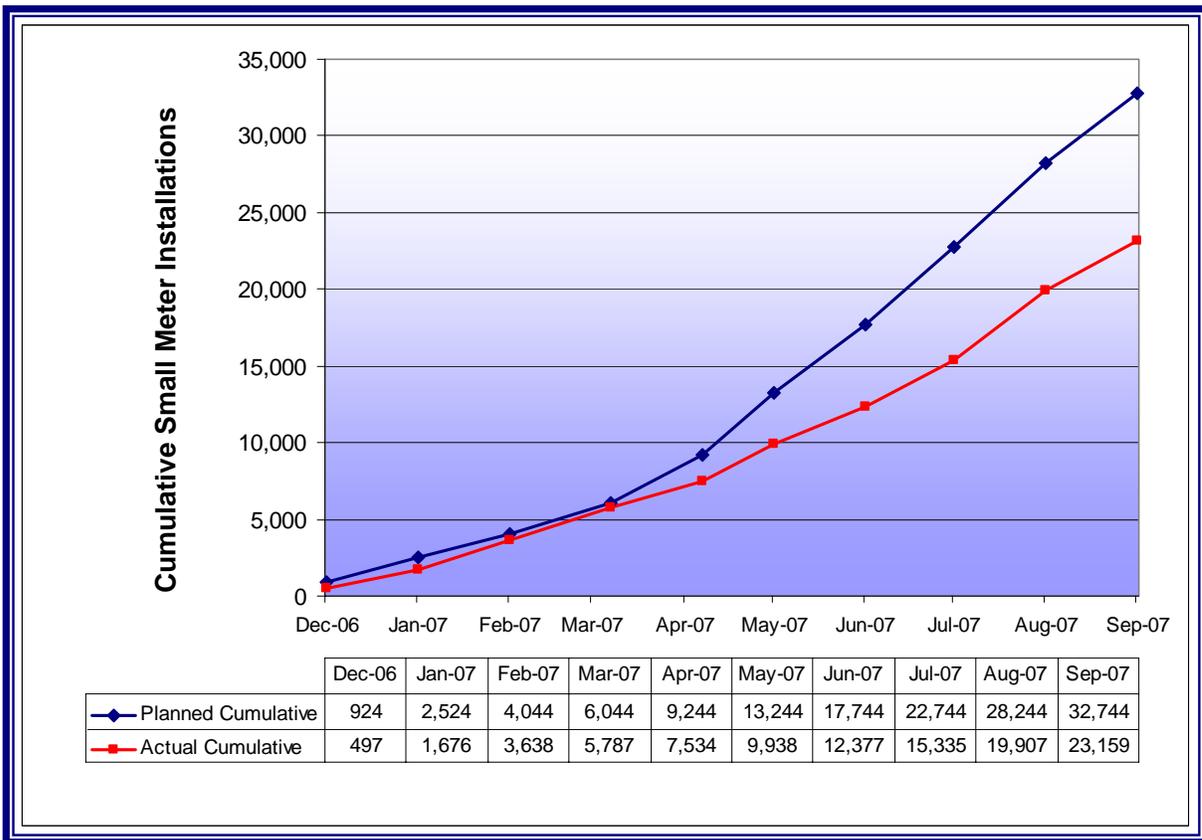
**EXHIBIT 7  
MONTHLY INSTALLATION OF SMALL METERS**



**Source:** Developed by audit staff with data from the department’s weekly reports. The planned installation figures were taken from the contractor’s original installation schedule (developed October 2006), provided by department staff.

According to the city’s weekly reports and information provided by K&V staff, K&V’s production has been limited by staff shortages and high turnover among its installers. In April, K&V sent a letter to the city’s AMR project staff stating that their (then) backlog would be caught up by the end of September, and they planned to meet that goal by increasing staff. City staff responded to K&V in June stating that the contractor’s performance was at an unacceptable level, and stated that K&V would be held to the September goal. However, during the month of September, not only did K&V fail to meet the monthly installation goal, but as shown in Exhibit 9, their productivity decreased from the previous month. By September 2007, K&V was 9,585 meters short of the planned goal, as shown in Exhibit 8.

**EXHIBIT 8  
CUMULATIVE INSTALLATION OF SMALL METERS**



**Source:** Developed by audit staff with data from the department’s weekly reports. The planned installation figures were taken from the contractor’s original installation schedule (developed October 2006), provided by department staff.

According to the AMR contract, if K&V falls behind the installation schedule by more than 10%, and the cause is attributed to non-performance by K&V, its suppliers or subcontractors, the city shall withhold 10% of any current and subsequent invoices until K&V gets the project back on schedule. K&V’s productivity has fallen short of the original installation schedule by more than 10% for eight of the ten project months shown in Exhibit 9. Watershed management told us they

**EXHIBIT 9  
PERCENT SHORT OF SMALL  
METER INSTALLATION GOAL**

| Month  | % Behind Schedule |
|--------|-------------------|
| Dec-06 | 46%               |
| Jan-07 | 34%               |
| Feb-07 | 10%               |
| Mar-07 | 4%                |
| Apr-07 | 18%               |
| May-07 | 25%               |
| Jun-07 | 30%               |
| Jul-07 | 33%               |
| Aug-07 | 30%               |
| Sep-07 | 29%               |

**Source:** AMR Weekly Reports

have requested a recovery plan from the contractor to complete the project by the contract end date.

**At Least 6,000 Installations Are Waiting on AMR Meter Lids**

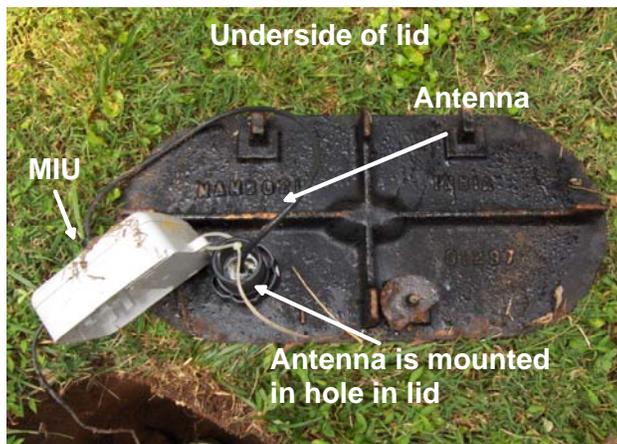
K&V ran out of AMR lid inventory in July 2007 and will need to revisit approximately 6,000 meter sites to install the AMR meter lids. The lids are designed to obtain maximum signal strength from the AMR equipment. Although K&V has since obtained additional inventory, the shortage remains an ongoing problem. K&V is working with local vendors to supplement its current supply of lids.

**K&V has been unable to provide an adequate supply of meter lids for AMR installations.** Although K&V ran short of the AMR lid inventory in July, they continued to install/retrofit meters, replacing existing meter lids (see figure 10) on the meters instead of the new AMR lids. At the beginning of September, city staff noted that there were approximately 6,000 meter installations done without the proper lids. In addition to the existing backlog of small and large meter installations, having to backtrack in order to install the AMR lids may put the contractor even further behind schedule.



**Figure 10**  
**Old Meter Lid**

**AMR lids are necessary for maximum signal reception.** The AMR contract requires the contractor to install cast iron locking lids; the lid design was approved by the city. The system is configured to



**Figure 11**  
**Mounting of MIU Antenna in Lid**

obtain the maximum signal strength from the MIUs installed in the meter pits. The basic AMR system components include a water meter, register, and meter interface unit (MIU) with attached antenna. All components are manufactured by Neptune. Electronic

meter reads are transmitted via radio frequency (RF) signals. For maximum signal strength, Neptune recommends that the MIU antenna be mounted in a hole in the pit lid (see figures 11 and 12), which is designed for this purpose. Without adequate reception, the meter reader may not be able to obtain an electronic read, defeating the purpose of AMR.



**Figure 12**  
**New AMR Lid**

### **Department's Work Order Backlog Further Impedes AMR Installation Progress**

Throughout the project, K&V's installers have encountered field site conditions that have prevented them from completing some installations. These skipped installations, categorized as "return to utility" (RTU), have generated 2,016 work orders through October 2007 that the department has yet to address. Failure to address these work orders timely could impede the contract performance; K&V cannot complete an AMR meter retrofit or replacement until the required repairs or corrections have been made to the site conditions.

**Contractor cannot install new equipment until the department completes site work.** According to contract terms, the contractor is required to inspect the existing water meter site during each AMR installation. If the installer determines that damage to the pipes or equipment would result from the installation, the contractor is to immediately contact the city's project manager and not attempt to complete the installation until the site is inspected by a city representative and further work is authorized by the project manager.

These skipped installations are categorized as RTUs. Watershed staff generates work orders from these RTUs, and the department must complete these site repairs before the contractor can complete the AMR installations.

As shown in Exhibit 10, the AMR project generated 2,016 RTU work orders through October 2007. Most RTU work orders were for meter

box problems. According to both distribution management and AMR project management staff, the department does not have the staff to complete these work orders. As a result, the city will need to determine whether it will have the AMR contractor do the repairs, have the repairs performed by city staff, or hire another contractor to complete the work. Department management told us they are negotiating with the contractor to determine whether some of these RTUs are K&V's responsibility; the final number of RTUs may be lower than the reported figures.

**EXHIBIT 10  
REASONS FOR RETURN-TO-UTILITY**

| Return-to-Utility Causes          | Number of Accounts |
|-----------------------------------|--------------------|
| Meter Box Offset                  | 1,099              |
| Possible Tamper                   | 376                |
| No Meter                          | 140                |
| Return to Utility (uncategorized) | 124                |
| Cannot Turn Off Valve             | 115                |
| Pit Too Deep                      | 99                 |
| Service Leak                      | 63                 |
| <b>Total</b>                      | <b>2,016</b>       |

Source: K&V Project Management Staff

---

## Department Corrected Invoice Payment Control Weakness

Prior to April 2007, the department paid the contractor based on a list of completed installations submitted weekly. In April 2007, department inspectors notified Watershed management that they were unable to obtain reads on some recently installed and/or retrofitted meters. As a result, the department changed its payment process to ensure that the contractor is only paid for confirmed work.

**The city is required to pay the contractor for confirmed work.** The AMR contract outlines the process by which the contractor's work is confirmed prior to invoice approval. K&V is required to electronically submit its list of newly completed installations with the

draft invoice. K&V electronically submits a list to the city on a weekly basis. The city has the opportunity to inspect an installation within seven calendar days of being notified. According to department staff and inspector's reports, the inspections are typically completed the same or following day. The city accepts installations as complete once the inspector confirms the electronic meter reading from the MIU to the meter and confirms that the meter identifying information has been correctly captured in the city's project records. The city is required to notify the contractor if the installation does not pass inspection.

If the city does not inspect the installation within seven calendar days of being notified or verify the other information, the installation is deemed to be conditionally accepted, and the city pays the contractor for the installation. However, if the city finds discrepancies up to 12 months after the notification of installation, the city will notify the contractor in writing and the contractor will fix the problem within 30 days.

**Prior to April 2007, the city paid the contractor for unconfirmed work.** While Watershed had been inspecting installations to confirm reads, it had been paying K&V based on its list of completed work rather than the confirmed work. We did not attempt to quantify how often the city paid K&V for unconfirmed work. Because the city has 12 months to identify installation problems, it is likely that any meters the city may have paid K&V for without a confirmed read would be subsequently identified during meter reading.

**Improvements in the department's inspection process ensure the contractor resolves meter malfunctions prior to payment.** City inspectors record the results of their inspection into the city's AMR software, which generates a No-Read Report that lists installations for which the inspectors could not confirm the reading. The No-Read Report is posted on a shared electronic site for K&V to review and resolve. K&V installers post their corrective action on the shared server for the city to review and accept. The items identified on the No-Read Report have to be resolved before K&V is paid for the installations.

**The department's current invoice process ensures the contractor is only paid for confirmed installations.** The department changed the invoice process in April 2007 to ensure K&V

is only paid for meters with confirmed reads. Staff now electronically tests K&V's list of completed work by comparing it to the city's list of confirmed work and to the city's No-Read Report. Staff researches and/or notifies K&V of discrepancies and awaits resolution prior to payment.



---

## Recommendations

---

In order to address current operational issues for the AMR installation project, department officials should:

1. Work with program IT staff to assign a program code in the data collectors to identify manual meter reading entries in order to more easily identify meters that need repair by the city or contractor.
2. Impose available contract remedies, such as a 10% withholding of any current and subsequent invoices, to ensure the contractor's compliance with the contract's installation goals.
3. Determine and implement the most efficient and cost-effective method to address the outstanding "return-to-utility" and other work orders, so that this work does not further impede the contractor's installation progress.
4. Determine and implement the most efficient and cost-effective approach to accelerate large meter repairs/replacement and AMR installation.

To ensure the meters are functioning properly on an ongoing basis and replaced when needed, department officials should:

5. Develop a maintenance plan for small meters that includes periodic site surveys or similar ways to identify operational problems – such as leaks and broken lids – that cannot be detected with AMR technology.
6. Develop a comprehensive maintenance plan for large meters that incorporates industry best practices.
7. Develop a comprehensive replacement plan for both small and large meters. The department should continue to evaluate and select the most appropriate alternative in order to ensure the department has a meter inventory that functions at optimal, revenue-producing levels.

When developing large-scale business process improvement projects in the future, department officials should make business decisions that ensure maximum return on investment. They should:

8. Ensure the business case reflects the full scope of the planned project to identify risks and needed resources, and use it as a framework to manage the project.

---

## **Appendices**

---



## APPENDIX A SAMPLING METHODOLOGY

We observed some problems with water meters and meter sites while accompanying meter readers on both manual and automated routes. In order to assess the magnitude of problems that could affect the AMR project, we decided to conduct a random sample of meters that had been installed or retrofitted between January and June 2007. We first conducted a pilot study to design and test data collection tools, plan the sample methodology, and ensure auditors were assessing conditions in the same way (inter-rater reliability).

The department provided us with a spreadsheet listing 11,952 AMR work orders completed between December 1, 2006, and June 30, 2007, including address, job type, acceptance date, route number, old and new meter numbers, AMR device identification number, and meter size. From this list, we randomly selected a pilot sample of 30 meters and requested a water inspector accompany the team to the meter sites. After reviewing the first 12 meters on July 27 and August 2, we revised our evaluation criteria to facilitate inter-rater reliability and more closely match contract specifications and installation guidelines. We visited another 14 meters August 16. We decided not to evaluate the final 4 meters in the pilot sample due to time constraints.

### EXHIBIT 11 PILOT SAMPLE

| Month        | Accepted Installations |
|--------------|------------------------|
| January      | 3                      |
| February     | 6                      |
| March        | 4                      |
| April        | 9                      |
| May          | 2                      |
| June         | 2                      |
| <b>Total</b> | <b>26</b>              |

**Source:** Developed by audit staff using DWM Inventory Data

Because travel time significantly increased both Department of Watershed Management and audit resources to complete the pilot sample, we decided to use a cluster sample to complete the audit. A cluster sample is a probability sample in which each sampling unit is a collection of elements. This design is appropriate when the cost of obtaining observations increases as the distance separating elements increases.

We created a pivot table to group work order information into clusters by street name and the month of the acceptance date, excluding installations from the department's pilot program in December 2006, which yielded 988 clusters with more than one accepted installation. We randomly selected 12 clusters, allocated by month proportionate to the number of accepted installations per month, for a total of 138 meters.

**EXHIBIT 12  
CLUSTER SAMPLE**

| Month        | Total Clusters | Accepted Installations | Sampled Clusters | Accepted Installations Sampled |
|--------------|----------------|------------------------|------------------|--------------------------------|
| January      | 66             | 1,065                  | 1                | 9                              |
| February     | 140            | 2,091                  | 2                | 30                             |
| March        | 161            | 1,651                  | 2                | 38                             |
| April        | 191            | 1,674                  | 2                | 24                             |
| May          | 202            | 2,257                  | 2                | 10                             |
| June         | 228            | 2,520                  | 3                | 27                             |
| <b>Total</b> | <b>988</b>     | <b>11,258</b>          | <b>12</b>        | <b>138</b>                     |

Source: Developed by audit staff using DWM Inventory Data

An auditor visited each of the sampled sites with a department employee between September 6 and September 19 and recorded observations on a standardized checklist. We then compiled the information into a master spreadsheet and analyzed the results. Our reported results exclude data we collected during the pilot because we changed the sampling design from simple random sampling to cluster sampling. Also, because we revised the evaluation criteria during the pilot sample, we did not consistently record all observations. While the pilot sample included some problems with meter boxes and lids, it did not yield any instances of misreads. We were, however, unable to verify two reads because we could not locate the meter.

**EXHIBIT 13  
SAMPLING ERROR**

| Clusters Sampled | Acceptance Date | Elements in cluster | Meters with at least 1 problem | Meters that could not be read |
|------------------|-----------------|---------------------|--------------------------------|-------------------------------|
| 1                | January         | 9                   | 9                              | 2                             |
| 2                | Feb             | 14                  | 13                             | 2                             |
| 3                | Feb             | 16                  | 8                              | 2                             |
| 4                | March           | 23                  | 22                             | 3                             |
| 5                | March           | 15                  | 8                              | 1                             |
| 6                | April           | 14                  | 11                             | 2                             |
| 7                | April           | 10                  | 8                              | 0                             |
| 8                | May             | 4                   | 2                              | 0                             |
| 9                | May             | 6                   | 2                              | 0                             |
| 10               | June            | 13                  | 12                             | 0                             |
| 11               | June            | 12                  | 11                             | 0                             |
| 12               | June            | 2                   | 2                              | 0                             |
| <b>Total</b>     |                 | <b>138</b>          | <b>108</b>                     | <b>12</b>                     |
|                  |                 | <b>Percentage</b>   | <b>78.3%</b>                   | <b>8.7%</b>                   |

Source: Sample data collected by audit team

Formula to calculate sampling error:  $2\sqrt{(N-n/Nn\bar{M}^2)*(\sum(a_i - \hat{p}m_i)^2/(n-1))}$

Where:

N = the number of clusters in the population (988)

n = the number of clusters sampled (12)

$\bar{M}$  = the average number of elements per cluster (11.4)

a = the number of elements per sampled cluster with the attribute being measured

$\hat{p}$  = the proportion of sampled elements with the attribute being measured

m = the number of elements in a cluster

Based on our sample, we estimate that 78.3% ± 12.9% of meters installed or retrofitted between January and June has at least one problem with the meter box, lid, or equipment. For meters with an equipment problem that prevents reading the meter, the sample estimate is 8.7% ± 4.5%.



**APPENDIX B**  
**MANAGEMENT REVIEW AND RESPONSE TO AUDIT RECOMMENDATIONS**

| Report # 07-04   | Report Title: Performance Audit – Automated Meter Reading Program   | Date: 12/19/07  |
|--|---|---|
| <b>Recommendation Responses</b>  |   |   |
| <b>Rec. # 1</b>  | Department officials should work with program IT staff to assign a program code in the data collectors to identify manual meter reading entries in order to more easily identify meters that need repair by the city or contractor. | DWM agrees with this recommendation.  |
| <p><b><u>Proposed Action:</u></b> Development of Computerized Interfaces between Meter Reading/Inspection and Distribution Maintenance</p> <p><b><u>Implementation Timeframe:</u></b> Complete Interfaces no later than 6/30/08</p> <p><b><u>Comments:</u></b> Presently, the list of AMR meters that can not be read by mobile readers are downloaded to Meter Reading Inspection units for field investigation. The Audit Report correctly identifies that there is no computer interface between Meter Reading Inspector’s data in the Equinox Meter Reading system and Distribution’s MAXIMO maintenance data base. Interfaces need to be written between Equinox and MAXIMO.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager</p>   |   |   |
| <b>Rec. # 2</b>  | Department officials should impose available contract remedies, such as a 10% withholding of any current and subsequent invoices, to ensure the contractor’s compliance with the contract’s installation goals.                     | DWM agrees that penalties are an option, which may be implemented if determined to be the most effective means of meeting project installation goals and timelines. |
| <p><b><u>Proposed Action:</u></b> Continue to evaluate the efficacy of imposing remedies as a means to accelerate achievement of Project goals.</p> <p><b><u>Implementation Timeframe:</u></b> Past, current and on-going.</p> <p><b><u>Comments:</u></b> The Department has understood that it has the option of imposing the 10% withholding “penalties” under the Contract. Department leadership and project staff meet weekly to evaluate status, identify potential issues and develop effective solutions. Penalties, as a means to hasten project goal achievement, have been analyzed over the last several months. A management decision was made not to impose penalties as long as there is demonstrable, measurable progress by the Contractor. Rather than impose financial penalties, the Department has demanded that the Contractor hire additional staff (well in excess of its original plan, upon which its bid was based) and increase training. That approach has worked, as evidenced by the fact that the gap between the June, 2007 planned performance and actual performance has been halved between July and November. Continued progress is expected. Should it not happen, penalties will again be explored as a means to meet the project installation goals. Finally, we will work with K&amp;V to establish an installation schedule for small and large meters that will complete the contract work within the contract time.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager</p> |   |   |

|  |  |                                      |
|--|--|--------------------------------------|
| <b>Rec. # 3</b>  | Department officials should determine the most efficient and cost-effective method to address the outstanding "return-to-utility" and other work orders, so that this work does not further impede the contractor's installation progress. | DWM agrees with this recommendation. |
| <p><b><u>Proposed Action:</u></b> Department shall undertake a problem-solving session with the internal stakeholders in January, 2008, and develop the best alternative to address the outstanding number of Return to Utility ("RTU") work orders.</p> <p><b><u>Implementation Timeframe:</u></b> Implement selected alternative no later than March 31, 2008.</p> <p><b><u>Comments:</u></b> Preliminary analysis indicates that there are three options:</p> <ol style="list-style-type: none"> <li>1. Contract out the corrective work related to RTU meters to a local contractor;</li> <li>2. Hire additional staff within the Department to address the corrective work;</li> <li>3. Contract out other work presently being undertaken by the Department, and re-assign existing, and freed-up staff to address work related to the RTU meters. A stakeholder group will evaluate these and any other alternatives, and will make a decision as to which one to adopt in January, and will implement it during the first quarter, 2008. Finally, we will work with K&amp;V to review their RTU practices and procedures to ensure that only legitimate work orders are returned.</li> </ol> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager and Eddie Roberts, Director of Distribution</p>  |  |                                      |
| <b>Rec. # 4</b>  | Department officials should determine and implement the most efficient and cost-effective approach to accelerate large meter repairs/replacement and AMR installation.   | DWM agrees with this recommendation. |
| <p><b><u>Proposed Action:</u></b> We agree that the acceleration of the large meter installation processes is extremely important. Efforts to accelerate the replacement of large meters under the AMR Contract have been underway for several months and will continue.</p> <p><b><u>Implementation Timeframe:</u></b> Immediately</p> <p><b><u>Comments:</u></b> On November 9, 2007, the Department formally notified the Contractor that the large meter installation efforts needed to be significantly increased. In response to the Department's request, the Contractor decided to, and is in the process of terminating the present large meter installation subcontractor and hiring another large meter subcontractor to complete the assignment. This decision has recently been approved by the City Office of Contract Compliance. As the AMR contract has progressed, the Department made a conscience decision to expedite the large meter portion of the work by dividing up the total number of large meters between the AMR contractor and two other contractors separately working for the Department. This strategy will ensure that the non-functioning large meters will be replaced and/or repaired in a more timely fashion.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager and Richard Parker – Large Meter Change Out Project Manager</p> |  |                                      |

|   |   |                                      |
|---|---|--------------------------------------|
| <b>Rec. # 5</b>   | Department officials should develop a maintenance plan for small meters that includes periodic site surveys or similar ways to identify operational problems – such as leaks and broken lids – that cannot be detected with AMR technology.   | DWM agrees with this recommendation. |
| <p><b><u>Proposed Action:</u></b> Complete the development of a “Small Meter Maintenance Plan”.</p> <p><b><u>Implementation Timeframe:</u></b> The plan is ongoing and is scheduled to be completed by June 30, 2008.</p> <p><b><u>Comments:</u></b> Best management practices developed nationally indicate that it is most efficient to visit AMR meters when:</p> <ol style="list-style-type: none"> <li>1. an automated meter reading was not successful;</li> <li>2. the battery needs to be replaced; and</li> <li>3. In accordance with the meter sampling for accuracy protocol, this is integral to the meter management and maintenance program.</li> </ol> <p>The Department, based on the advice of its industry-leading consultant on the AMR project, plans to follow this practice. It should be noted that service line leaks to customers included within the fixed network portion of the Contract will be identified by the “High” Demand” exception report included within the meter reading software. In the event that evidence arises that indicates that the newly installed pit lids have durability and strength problems, a periodic small meter inspection program will be implemented. As part of this strategy, the Department plans, and has budgeted for the development of an in-house meter testing shop in support of the meter maintenance plan.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager</p> |   |                                      |
| <b>Rec. # 6</b>   | Department officials should develop a comprehensive maintenance plan for large meters that incorporates industry best practices.  | DWM agrees with this recommendation. |
| <p><b><u>Proposed Action:</u></b> Complete the development of a “Large Meter Maintenance Plan”.</p> <p><b><u>Implementation Timeframe:</u></b> The plan is ongoing and is scheduled to be completed by June 30, 2008.</p> <p><b><u>Comments:</u></b> The Department is in the process of developing its large meter maintenance program. The plan will be predicated on Best Management Practices; standards published by the American Water Works Association; and manufacturers’ recommendations. As part of this strategy, the Department plans, and has budgeted for the development of an in-house meter testing shop in support of the meter maintenance plan.</p> <p><b><u>Responsible Person:</u></b> Richard Parker - Large Meter Change Out Project Manager</p>   |   |                                      |
| <b>Rec. # 7</b>   | Department officials should develop a comprehensive replacement plan for both small and large meters. The department should continue to evaluate and select the most appropriate alternative in order to ensure the department has a meter inventory that functions at optimal, revenue-producing levels. | DWM agrees with this recommendation. |
| <p><b><u>Proposed Action:</u></b> The comprehensive replacement plan will be included as an integral part of the large and small meter maintenance programs. See Recommendations No. 5 and No. 6 above.</p> <p><b><u>Implementation Timeframe:</u></b> June 30, 2008</p> <p><b><u>Comments:</u></b> See above.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover – AMR Project Manager and Richard Parker – Large Meter Change Out Project Manager</p>   |   |                                      |

|   |   |   |
|---|---|---|
| <b>Rec. # 8</b>   | Department officials should ensure the business case reflects the full scope of the planned project to identify risks and needed resources, and use the business case as a framework to manage the project. | DWM agrees with the theory behind this recommendation but we disagree with the implication that the management of the AMR project is inconsistent with the business plan. |
| <p><b><u>Proposed Action:</u></b> The business case was completed prior to embarking on the Project.</p> <p><b><u>Implementation Timeframe:</u></b></p> <p><b><u>Comments:</u></b> The Project is being managed in a manner consistent with the business case, and with the expected benefits and costs.</p> <p><b><u>Responsible Person:</u></b> Sylvia Glover - AMR Project Manager</p> |   |   |



## CITY OF ATLANTA

SHIRLEY FRANKLIN  
MAYOR

55 TRINITY AVENUE, S.W. • SUITE 5400 • SOUTH BUILDING  
ATLANTA, GEORGIA 30303-0310  
Office: (404) 330-6081 • Fax: (404) 658-7194

DEPARTMENT OF  
WATERSHED MANAGEMENT  
ROBERT J. HUNTER  
Commissioner

December 31, 2007

Ms. Leslie Ward  
City Internal Auditor  
City of Atlanta  
88 Mitchell Street, SW  
Suite 12100  
Atlanta, GA 30303

**Re: Comments - Draft Performance Audit Report – AMR Program**

Dear Ms. Ward:

Thank you for meeting with me and the opportunity to comment on the draft report of your performance audit of the Automated Meter Reading (AMR) program implementation. While our organizations have distinctly different missions, methods and constraints, both groups are striving for the improvement of effective delivery of City services. The objective of a performance audit is to investigate and document problems. The requirement for an operating department is to implement real-time solutions under field conditions. However in the final analysis, I think we agree that the AMR project will allow us to greatly improve the level of service delivered to the water and sewer customers of the Department of Watershed Management, and to the citizens of the City of Atlanta.

**BACKGROUND & CONTEXT**

The City of Atlanta and the Department of Watershed Management (the "Department" or "DWM") resumed operation of the drinking water system after a four year period of outsourced operations in April 2003. Some of the pertinent system conditions upon return included a large number of boiled water advisories and line breaks, a low number of leak repairs (approximately 750/year), the dissolution of the meter repair & testing operation and facility, a significant organizational knowledge loss due to the retirement of senior meter personnel, an inadequate billing system (e.g. Customer Information System-CIS) and unacceptable collection efforts including service disconnections. Your Office has addressed some of these issues in previous audits. In addition, the City had not conducted a large scale meter replacement program in the previous 20 years. Small water meters can begin to manifest accuracy problems in the 10-15 year age

period, while large meters are generally accurate for a longer period with proper maintenance.

Problems with inaccurate meter reading processes and an unacceptable customer billing system caused the Department to investigate ways to improve the way we manage the billing process. One of the means to a more accurate metering/billing system is the implementation of Automated Meter Reading system ("AMR system"). This type of program is complex and its full implementation within a 3 year period is an exceptional challenge. Similar programs involving approximately 150,000 meters normally require five years to implement. However, given the condition of the system and the two decade hiatus in a comprehensive small meter replacement program, I insisted on a very aggressive, 3-year meter replacement and repair program.

Fundamental to the decision to implement AMR was the fact that small meters can not be repaired cost-effectively. The industry standard for small meters is to replace rather than repair. This is not the case with large meters, which are both significantly more expensive and durable and can be rebuilt. Because of the age of the small meter inventory it was clear that the meters need to be replaced. The open question was whether to continue manual reading or improve to the industry-standard AMR technology.

Because the Department staff did not have hands-on experience in designing and implementing a meter program of this scope, the Department hired in 2004, through its Program Management Team ("PMT"), the most experienced AMR implementation consultant in the United States, Cognyst, Inc. of Kinnelon, NJ. These individuals have been actively and fundamentally involved, as representatives of the drinking water utilities, with several, large AMR projects across the United States. This team was utilized as subject matter experts during the scope development, procurement and contracting phases of the AMR project.

#### **DWM AUDIT REPORT COMMENTS**

Our response is organized in these three sections: Planning and Preparation; K&V Performance Issues; and Post-AMR Project Meter Management.

##### **I. Planning and Preparation**

By late December 2004, DWM was in the midst of its assessment and analysis of the suitability and applicability of AMR to the Department. DWM & Cognyst staff investigations considered available technology and the market-place, deployment strategies, business case components (drivers, processes, elements), ability to

enhance customer service levels, relationship of a meter reading program to a meter maintenance/management program, design of a pilot project and desired outcomes of same, procurement strategies and contract issues, organizational structure and staffing requirements, communication program needs, and implementation considerations.

Based upon analysis of these issues, and a PMT created “cost-benefit” analysis discussion, DWM moved forward with procurement and implementation. This analysis was at a level of detail appropriate in a “mature market” situation where the product has become commoditized; no longer is on the cutting-edge of development; and there is an abundance of “real life” experiential data available to inform the analysis and decision-making process.

The internal organization was created that was aligned with typical industry standard approaches: executive sponsorship, steering committee, Project Manager, internal support organization (e.g. IT, administration, project controls, field services and inspection). Project management assistance and technical AMR operational/IT assistance was provided via consultant contract with both PMT and Cognyst in support of the Project Manager. A Request for Proposal “RFP” was advertised in June, 2005, and this document was distributed to interested and qualified AMR installation contractors.

In order to obtain user verification of system benefits and problems, a multi-disciplined and multi-function project team visited other utilities where AMR was being installed or had been recently installed. The project team met with their counterparts at drinking water utilities to develop a better hands-on view of AMR systems and implementation and operation issues. Through the competitive procurement process, the joint venture K&V Automation (“K&V”) was selected as the firm most qualified and based on their experience, the firm most capable of delivering a complete, operational AMR system in the time specified. This selection was determined using comprehensive evaluative criteria combining technical capabilities, contractor experience, and cost.

In early 2006, a contract price was negotiated with K&V and the Contract was finalized. It was executed on July 25, 2006 and a Notice to Proceed was issued at that time. All RFP document creation, all evaluation techniques, all contract negotiations and all Contract Document creation were carried out as a joint effort incorporating the expertise of Department staff and consulting staff, including Cognyst.

A significant event that complicated project implementation occurred shortly after the issuance of the Notice to Proceed in July 2006. Our existing meter reading contractor, which was a member of an unsuccessful proposal team for the AMR contract, elected not to renew their meter reading contract with the City. This meant that with very short notice the City would not have anyone under contract to read the water meters. DWM did not have the available staff to perform this function

internally. Several options were evaluated including the diversion of City staff from other functions, emergency contracting and the initiation of a new procurement to obtain a new meter reading contract. The option that was implemented was the modification of the scope of the AMR contract to include meter reading. This had the additional benefit of simplifying the coordination between contractors as meters were changed from the manual to AMR system. However, to some extent, it did delay the staffing and implementation of the AMR project.

A Project Plan and Schedule (with milestones, timeframes and identified responsible parties) was first adopted by the Project Team and the Contractor in October, 2006. All systems and processes were put in place including a Communications Plan; Operating Procedures and Protocols; Project Controls; Safety Plan; QA/QC Plan; performance expectations and reporting requirements; and regular project team (DWM and contractors) meetings were scheduled and implemented.

Following a successful pilot project consisting of 500 automated meter reading installations in which all systems and protocols, including customer communication, were tested, the AMR project was launched.

Comments in response to issues raised in the Audit:

1. With regard to the Audit Report's (the "Report") finding that the Contract should have included a requirement that the Contractor change out all meter boxes and lids, the fact is that this would be an expensive and highly unusual implementation decision. The vast majority of the meter boxes are in good condition and fully acceptable for the AMR installation. Complete change out of meter boxes was never contemplated as part of the project scope, consistent with standard industry practice.
2. With regard to the statement in the Report that the Department should have undertaken an assessment of the condition of meters and meter boxes (at least a sample), this is also not standard industry practice when undertaking an AMR Project, and was not recommended by our AMR consultant. The staffing analysis undertaken by the Department was based on standard industry approach to project implementation. The primary reason for performing field surveys prior to signing a contract would be to assist the proposing contractors in determining what sizes of pit lids they would need to supply. It is standard practice that contractors are encouraged to perform their own site surveys as part of their due diligence prior to formulating their proposal. Normally a proposing contractor will survey to determine things like sizes and type of meter boxes, amount of dirt in the pits, driving times through the service territory, etc. Experienced contractors have expertise in these types of surveys.

3. With regard to addressing field issues, the Department was not in a position to add crews, and keep them on standby, in the possible event that these types of situations were encountered. As noted above, there were many other significant and critical work items related to the functionality of the drinking water system. The decision to address these field issues when they arose using either existing Department crews, or local contractors, was a conscious one: one based on financial considerations and standard practice.
4. With regard to the Report comment about adding leak detection capabilities to the metering unit, the Department analyzed this option at the time of contract negotiations, and it was determined that it was too expensive of an option to proceed with. (It would have added about \$3 million to project costs.) This is an option that will be reevaluated in future meter programs.
5. The Department agrees that the so called "Return to Utility" issue is one that deserves special attention at this time. The Department, in an effort to complete all work orders associated with this issue, will be undertaking a problem-solving session with the internal stakeholders in January, 2008, to identify alternative solutions and to recommend a solution.

#### **Planning and Preparation Summary**

The Department believes that it has done an exceptional job of researching, planning, evaluating and contracting this project. The personnel and material costs associated with meter box replacement exist whether included in the initial project scope, performed by the Department or contracted at a future date. Given the fact that a comprehensive meter replacement program had not been conducted for two decades the emphasis on rapid implementation was essential and appropriate. We believe that the ongoing measures to improve contractor performance and efficiency will be sufficient to meet project goals and reliability standards.

#### **II. K&V Performance Issues**

As in any project of this size, scope and complexity, a variety of issues do exist with respect to contractor performance. Issues which were raised within the Report included defective workmanship as determined by the Audit team's clustered field survey, a variety of meter lid issues, vandalism issues, and poor overall productivity by the Contractor. Specific responses to these Report findings are as follows:

- A. **Survey:** A variety of issues do exist with respect to K&V's performance as highlighted in the audit field survey including meter lids, vandalism, register damage, plastic meter boxes, damaged meter boxes, poor fit

between meter boxes and lids, unlocked lids, and MIUs not tied to meter lid. We note that the majority of the cited issues within the Audit report deal with meter lids, none of which will inhibit the successful reading of the meters. The AMR team is working with the Contractor to reduce the overall number of installation defects.

- B. Meter Lid Issues:** We acknowledge that correctly fitting, locked meter lids are an important factor in the success of the AMR program, and have advised the AMR contractor of the importance of having the meter lids locked and that leaving a newly installed meter lid unlocked is unacceptable.

The Department anticipates that, as a result of the meter lid change order presently awaiting approval, we will resolve the vast majority of the non-conforming meter box lid issues in the Audit Report. This change order will allow the Contractor to purchase a second (smaller) lid that will correctly fit most non-conforming meter boxes. We expect approval of this change order by the end of January 2008. Regardless of the impacts of this proposed change order, any issues that are not resolved will be addressed individually, and the entire meter box will be changed out if necessary.

- C. Vandalism:** Several of the newly installed, and accepted, AMR meter installations have been damaged by vandals. To date, Department records indicate that approximately 1% of the installations have been vandalized in some way. To deal with this issue, K&V will receive a change order to return to vandalized locations, and effect needed repairs.

- D. Schedule:** There was significant discussion within the Audit Report regarding the Contractor's progress when compared to his ***original planned schedule instead of the approved, revised, post pilot project schedule***. The original schedule was created by K&V and submitted on October 24, 2006. The date of submission was roughly 60 days prior to the beginning of the Pilot Project, before any work was initiated. Specific responses to Report findings include:

1. Issues encountered during the initial small meter installation activities that hindered the Contractor's progress included personnel (recruitment, training, and retention), site conditions (e.g. red clay difficulties), and equipment (e.g. GPS coordinate determination). All of these issues caused K&V to revise their installation schedule and to resubmit it to the Department on April 22, 2007. This revised schedule was accepted by the Department in June, 2007 and the new plan was incorporated into all reports and projections.
2. All of the statements, graphs and recommendations within the Audit report were based on the Contractor's original schedule created in

October of 2006. While the Department agrees that the Contractor is behind his original schedule, K&V has made marked progress in accelerating installation efforts.

3. It is the Department's observation that the Contractor was 30% behind their revised schedule in June of 2007, and has reduced the completion deficit to 18% by the end of September, 2007.
4. Increases in staff levels and training and the improvement of installation equipment and methods have resulted in a consistent reduction in the completion deficit. Nevertheless, the Contractor must continue to improve his monthly completion numbers if he is to meet the project deadline. K&V has been asked to submit another schedule indicating production levels necessary for the completion of all work by July, 2009.
5. To improve the completion rate of the large meter portion of his contract, K&V is in the process of terminating the present large meter subcontractor and hiring another large meter subcontractor. As the work has progressed, the Department made a conscious decision to divide up the total number of large meters between our AMR contractor and two contractors separately working for the Department as part of the large meter change out program. This will ensure that we will be able to get the large meters replaced/repared in a more timely fashion.

#### **K&V Performance Issues Summary**

I have required an extremely difficult schedule for this project. Three years is a remarkably short period for the size and scope of this project. The Department is well aware that speed is not the ultimate or sole criterion for success and we are well aware of the need for quality in addition to quantity of installations. We agree with your conclusion that the project is behind schedule. However, we maintain that with continued improvement the contractor can meet the schedule. We agree that the large meter installations and repairs are a critical issue and that is why we have three contracts addressing the problem instead of relying solely on the AMR contract. We will continue to reassign work as necessary and require modifications to the AMR contractor team as necessary to achieve a successful implementation. We also believe that the corrective measures that are already in the system to address the meter lid issues will significantly contain the problems. When the problems of unlocked lids (72%) and proper meter lid fit (41%) are resolved then the remaining issues are well within the limits of management. The Department shares your concern with the vandalism and manual override issues. We have taken Information Technology actions to establish new codes to address the override issues and have instituted an in-depth review of the vandalism problem.

**III. Post -AMR Project Meter Management**

The Department agrees with the importance of having programs in place to ensure that the AMR system continues to operate effectively for its useful life. The development of Meter Management Programs for large and small meters was envisioned to be an activity undertaken in conjunction with the AMR Project, and are scheduled to be completed by the end of June, 2008. In fact, we included both large meter and small meter testing and repair/replace programs in the Fulton County billing agreement we have been negotiating for a number of years. Atlanta City Council approved that agreement more than a year ago and it became effective on October 12, 2007 subsequent to Fulton County Board of Commissioners approval. We have not only planned for the Meter Management Programs but have legally committed to institute and conduct the programs.

The Department has determined that standard utility practice is not to perform periodic physical inspections of small meters and meter boxes. The primary purpose of the meter is to provide meter readings, and site inspections are typically only conducted in the event meter readings are not received, or batteries need to be replaced.

Should field conditions dictate, the Department will further evaluate the need to visit individual meter installations periodically.

The Department welcomed the chance to respond to the comments and recommendations of the City Auditor. As you have seen, many recommendations are in the process of being implemented. In those cases where there is a difference of opinion regarding the efficacy of a particularly recommendation or finding, it is noted.

Thank you.



Robert J. Hunter, Commissioner  
Department of Watershed Management