

AUDIT REPORT



CITY OF NEW YORK
OFFICE OF THE COMPTROLLER
BUREAU OF MANAGEMENT AUDIT
WILLIAM C. THOMPSON, JR., COMPTROLLER

Audit Report on the Oversight of the City Water Distribution System By the Department of Environmental Protection

MJ02-163A

March 3, 2003

To the Citizens of the City of New York

Ladies and Gentlemen:

In accordance with the Comptroller's responsibilities contained in Chapter 5, § 93, of the New York City Charter, my office has audited the New York City Department of Environmental Protection's efforts in maintaining up-to-date records for the City's water distribution system and implementing security measures in the water tunnel shafts. The DEP Bureau of Water and Sewer Operations is responsible for maintaining and protecting City drinking water.

Our audit resulted in the findings and recommendations that are presented in this report. The findings and recommendations were discussed with City officials; their comments were considered in the preparation of this report.

Audits such as this provide a means of ensuring that City assets are safeguarded and that its resources are used effectively, efficiently, and in the best interest of the public.

I trust that this report contains information that is of interest to you. If you have any questions concerning this report, please e-mail my audit bureau at audit@comptroller.nyc.gov or telephone my office at 212-669-8945.

Very truly yours,

William C. Thompson, Jr.

Report: MJ02-163A
Filed: March 3, 2003

Table of Contents

AUDIT REPORT IN BRIEF	1
INTRODUCTION	3
Background	3
Objectives	3
Scope and Methodology	4
Discussion of Audit Results.....	5
FINDINGS AND RECOMMENDATIONS	6
DEP Generally Maintained Up-to-Date Water Distribution Maps.....	6
DEP Has Implemented Security Measures in the Water Tunnel Shafts.....	8
Other Issues	9
ADDENDUM–DEP Response	

*The City of New York
Office of the Comptroller
Bureau of Management Audit*

**Audit Report on the Oversight of the
City Water Distribution System by the
Department of Environmental Protection**

MJ02-163A

AUDIT REPORT IN BRIEF

This audit determined whether the New York City Department of Environmental Protection (DEP) maintained up-to-date records for the City's water distribution system and implemented security measures in the water tunnel shafts. The DEP Bureau of Water and Sewer Operations (Bureau) is responsible for maintaining and protecting City drinking water.

Audit Findings and Conclusions

DEP generally maintained up-to-date records regarding the City's water distribution system. Also, DEP has implemented security measures in the water tunnel shafts. Of the 50 field cards we sampled and reviewed, all of the information contained on the cards had been entered in the new centralized computer system. However, field cards for the Jamaica water distribution system in Queens are not updated promptly. As a result, DEP workers have to rely on the manual records more when performing work in that area than in other areas of the City.

In reviewing DEP's implementation of the new computerized mapping system, we noted that the contract, slated to cost a maximum of \$6.3 million and to take five years, has been extended more than seven years beyond the original completion date at an additional cost of \$3 million. However, we reviewed documentation contained in the contract file and verified that all changes were documented and approved by DEP officials, and that the additional work identified in the change orders was not included in the original contract terms.

Audit Recommendations

We made two recommendations, both of which are listed below.

- DEP should take steps to eliminate the backlog of field cards to be entered in the Geographic Information System (GIS) for the Jamaica, Queens, area.

- If OMB should approve the project to put the City's entire water system on GIS, we suggest that the new agreement include the provision that the vendor make any future new product or upgrade to the system available to DEP at a discounted rate.

DEP Response

DEP agreed to implement the report's recommendations.

INTRODUCTION

Background

The New York City Department of Environmental Protection (DEP) oversees the collection and transport of a daily average of 1.3 billion gallons of drinking water to City residents and provides water to four upstate counties. DEP's Bureau of Water and Sewer Operations (Bureau) is responsible for maintaining and protecting City drinking water and collecting wastewater. The Bureau inspects and approves water and sewer connections performed by licensed plumbers and authorized contractors, and updates information on all water and sewer records for the City. The Bureau also responds to emergency situations such as water main breaks, leaks from water and sewer mains, inoperable fire hydrants, and failures that result in street flooding.

In Fiscal Years 1986 and 1991, our office issued two audits (MD84-013 and MC90-205, respectively) on the Bureau of Water Supply's (BWS) maintenance and repair operations and its security of City water tunnels. Those audits found that BWS did not systematically update valve maintenance cards and water distribution maps. The Fiscal Year 1991 audit found that water tunnel shafts were not equipped with intrusion alarms. The responsibilities covered by those audits are now assigned to the Bureau of Water and Sewer Operations, the subject of this audit.

Water distribution maps contain the records and information upon which DEP water operations depend; they are critical to the department's effective oversight of the City water distribution system. Prior to 1990, water distribution maps were drawn manually. In January 1990, DEP entered into a contract with URS Consultants, Inc. (URS), to create a centralized computer system for the maps using the Geographic Data System (GDS), and to update and enter maps in the new system. The contract was scheduled to be completed in March 1995. However, because of additional work added to the contract, the completion date was extended to March 2003. The water maps for Manhattan, Brooklyn, Bronx, Staten Island, and Queens (except for the Jamaica area) are on GDS.

In 1995, the City purchased the Jamaica service area from the Jamaica Water Supply Company. This area also had to be supported by a computerized mapping system. In 1998, DEP determined that the Jamaica maps would be entered on the Geographic Information System (GIS), a more versatile system. In addition, GDS had been abandoned by its manufacturer.

Currently, the City's water distribution maps are on two systems: GDS for all areas except Jamaica, Queens, and GIS for Jamaica. DEP is now seeking to enter the entire body of water distribution maps on the GIS system.

Objectives

Our objectives were to determine whether DEP (1) maintained up-to-date records for the City's water distribution system, and (2) implemented security measures in the water tunnel shafts.

Scope and Methodology

The audit period covered the period from March 1990 through October 2002.

To understand the propriety of the water maps, we obtained copies of distribution maps from the two DEP systems. To determine the accuracy of the computerized maps, we randomly selected 50 field cards covering the five boroughs. We traced the information from the cards onto the computerized system to determine whether all information on field cards was accurately entered in system. Field cards are prepared by persons who work on the water system (e.g., engineers, licensed plumbers) and are used to document all changes made to installations of new piping, valves, and hydrants.

To obtain an understanding of the contract obligations of DEP and URS with regard to computerizing the City's water maps, we obtained a copy of the contract and reviewed it.

To determine the status of the payments to the contractor, we printed a voucher report from the City's Financial Management System (FMS) and verified whether the correct object and budget codes were used. Furthermore, we ascertained that DEP was still paying the contractor as of 2002.

To determine whether DEP maintained complete and accurate records to support amounts billed to DEP, we reconciled the URS invoices against the FMS printout.

To determine the progress of the contract completion, we reviewed contract payment file against invoices and supporting documentation.

To determine the reasons for the contract extension and change orders¹ totaling \$3.3 million, we obtained and reviewed contract files related to URS contract. To determine whether DEP documented the contract extension and expansion, we obtained and reviewed the change orders related to contract, along with related invoices and documents.

To gain an understanding of the mapping process, we interviewed DEP personnel, including the chief of mapping, contract officers, and yard supervisors.

We interviewed the director of management information system to assess the internal controls implemented regarding the security measures in the water tunnel shafts. We evaluated the controls that DEP personnel provided to determine whether the access to the water tunnel shafts is limited to only approved personnel.

To determine whether the water tunnel shafts were armed with security alarms, we conducted walkthroughs of the security system implemented by DEP and observed some of the security measures in place. To ascertain the accuracy of the information we were furnished during the walkthroughs, we interviewed various DEP personnel at field sites to verify whether

¹ Section 1-01 of the City's Procurement Policy Board Rules defines a "change order" as any alteration, change, amendment, or modification to any contract or agreement approved as required by law or rule.

their experience indicated that access to water tunnel shafts is restricted to authorized personnel only.

To determine the extent to which yard personnel rely on the computerized mapping system, we visited the repair and maintenance yards and observed and interviewed personnel.

This audit was conducted in accordance with Generally Accepted Government Auditing Standards (GAGAS) and included tests of their records and other auditing procedures considered necessary. This audit was performed in accordance with the New York City Comptroller's audit responsibilities as set forth in Chapter 5, §93, of the New York City Charter.

Discussion of Audit Results

The matters covered in this report were discussed with DEP officials during and at the conclusion of this audit. A preliminary draft was sent to DEP officials and was discussed at an exit conference held January 23, 2003. On January 29, 2003, we submitted a draft report to DEP officials with a request for comments. We received written comments from DEP officials on February 19, 2003. In its response, DEP officials agreed to implement the report's recommendations.

The full text of the Department of Environmental Protection's comments is included as an addendum to this report.

FINDINGS AND RECOMMENDATIONS

DEP generally maintained up-to-date records regarding the City's water distribution system. Also, DEP has implemented security measures in the water tunnel shafts. Of the 50 field cards we sampled and reviewed, all of the information contained on the cards had been entered in the system. As a result, DEP is better able to properly maintain the water supply system and is more equipped to address water main break emergencies than it was when we last reviewed this area in 1991. However, field cards for the Jamaica system in Queens are not updated promptly. As a result, DEP workers have to rely on the manual records more when performing work in that area than in other areas of the City.

In reviewing DEP's implementation of the new computerized mapping system, we noted that the contract, slated to cost a maximum of \$6.3 million and to take five years, has been extended more than seven years beyond the original completion date at an additional cost of \$3 million. According to a DEP official, computerized mapping was a new concept for the agency, and as the contract progressed, unforeseen issues arose that necessitated change orders and additional time. We reviewed documentation contained in the contract file and verified that all changes were documented and approved by DEP officials, and that the additional work identified in the change orders was not included in the original contract terms.

DEP Generally Maintained Up-to-Date Water Distribution Maps

DEP generally maintained up-to-date mapping records. All relevant information on the 50 sampled field cards was accurately entered in the computerized system. In addition, field cards were generally entered in the system on a timely basis. However, there was a backlog in the Queens system; the information for approximately 500 field cards was not entered into the GIS system as of October 2002. As a result, workers have to rely more on manual records in this area than in other areas of the City and may be delayed in responding to emergency situations.

There are approximately 6,700 miles of water mains under the streets throughout the City. Reliable, updated water distribution maps are vital for the effective management of the system. If maintenance or repair work needs to be done in an area, workers print the detailed distribution map. If after arriving at the scene and attempting to complete the work the workers find that the map is not up-to-date, they must obtain the most recent field card.

When work is done on the system (e.g., a new water line is installed), field staff from the City's Department of Design and Construction (DDC) prepare field cards. Field cards include the following information:

- Location and size of water mains
- Type of material used for the water lines (e.g., steel)
- Types of valve
- Location and type of fire hydrants

DDC forwards the field cards to the DEP Mapping Unit, which then updates the computerized distribution maps with information from the field cards.

DEP distribution maps are maintained in two computer systems. Previously, the distribution maps were handwritten and were updated by hand. The advantage that the computerized distribution maps have over field cards and handwritten distribution maps is that they provide immediate online information to yard personnel. For instance, to obtain field cards, yard personnel have to contact the Mapping Unit, which finds the requested cards and faxes the copies.

The immediate availability of computerized distribution maps enable DEP repair crews to respond to a water main break emergency quickly. Before dispatching the crews to a street, DEP personnel print the computerized maps. These maps provide vital information needed to address emergencies effectively. A typical map shows the street location of the water pipes, their diameters, their structure (e.g., shaft or chamber), the water shut-off valves and their types (closed or boundary), the locations of the valves, the fire hydrants on the street, the type of the hydrants (e.g., standard high pressure).

We met with DEP officials who demonstrated to us the process of updating the distribution maps. We selected a sample of field cards and compared the information on the cards with the information in the system. We also evaluated whether the system maps were updated on a timely basis by determining how many field cards were outstanding (i.e., not entered in system).

The information on the sample field cards reconciled with the information recorded in both systems, GDS and GIS. We verified that:

- The pipe diameters and lengths were accurate.
- Hydrants and valves were correctly identified in the system.
- Types of valves and hydrants were also correctly identified.

We also visited the personnel in the DEP maintenance and repair yards to determine whether they were familiar with the system. We verified that yard personnel were familiar with the system and used it in performing their tasks. According to staff, they have to use the field cards on an exception basis; they rely heavily on the computerized system to identify approximate location of water mains and specifications.

We also determined whether information on the cards was entered in the system on a timely basis. When we counted the outstanding cards from June 4, 2002, through June 14, 2002, there were approximately 20 cards per borough, excluding the Jamaica, Queens, area. For this area, there was a backlog of approximately 500 cards.

We discussed the backlog with the Chief of Mapping. He stated that the Jamaica, Queens, area accounts for approximately six percent of the water lines in the City; Jamaica is on GIS. The Chief of Mapping stated that of the 18 people who work in his unit, only three of them know how to enter information in the GIS system. In addition, there are a limited number of

workstations that have both GDS and GIS. A DEP official told us they are currently seeking approval from the City Office of Management and Budget (OMB) to enter all water distribution mapping on the GIS system. As part of that endeavor, more persons will be trained in GIS, and all of the workstations will be converted to GIS so that staff can update the system on a regular basis.

When we visited personnel at the yard that covers the Jamaica area, they did not identify any significant problems due to the backlog of field cards not entered in the system. However, the risk exists that DEP may be delayed in addressing a maintenance or emergency issue because it does not have an up-to-date map on the system and must obtain a copy of the field card from another source, or has to dig up the street to find out what is causing the problem.

Recommendation

1. DEP should take steps to eliminate the backlog of field cards to be entered in the GIS system for the Jamaica, Queens, area.

DEP Response: “DEP concurs with the [recommendation] made by the audit team.”

DEP Has Implemented Security Measures in the Water Tunnel Shafts

Since our last review in 1991, DEP has implemented security measures in the water tunnel shafts; it has improved the level of security and has restricted access to the water tunnel shafts. Security measures help to safeguard the City water supply and minimize the risk of damage caused by flooding or intruders.

Because of the heightened security concerns caused by the attacks on September 11, 2001, DEP would not provide us with the specific details of the security measures they have taken. For instance, we did not visit, nor were we provided with the number of water tunnel shafts or their locations. In addition, DEP would not provide us with anything in writing that detailed the measures they have taken. However, the Deputy Director of Security, Deputy Chief of Security Operations, and Chief of Security Systems walked us through the security process and demonstrated some of the controls in place to provide us with reasonable assurance that the controls were operating. General security controls include the following:

- Access to shafts limited to specifically authorized personnel at designated times. (For instance, limited access by repair and maintenance yard personnel was borne out when they told us that they had never been to the water tunnel shafts.)
- Physical restrictions (e.g., locks).
- Surveillance measures in place, and all entries to the water tunnel shafts monitored.
- Contact maintained with local, state, and federal authorities to coordinate security response measures.

Other Issues

DEP's contract with URS to computerize the water mapping system, slated to cost a maximum of \$6.3 million and to take five years, increased to \$9.3 million and extended to at least 12 years. However, our review of the invoices and the change orders revealed that: the contractor provided documentation to support all payments and changes; the tasks cited in the change orders were not part of the original contract specifications; and all payments and changes were approved by DEP officials.

According to DEP officials, the contract increased because computerized mapping was a new concept for DEP. As the contract progressed, new issues came to light that called for additional work and that necessitated change orders as well as additional time to address these new issues.

In 1990, DEP contracted with URS to computerize the water mapping system. The contract called for specific tasks to be completed according to a schedule. For example, approximately 5,700 detailed distribution maps and 146 distribution maps were to be updated and entered on the system. The costs for services outlined in contract was \$5,998,000, with an additional \$300,000 for allotments (additional related work within the general scope of the contract that could not be anticipated or estimated at the time the contract was executed), bringing the maximum amount payable on the contract to \$6.3 million. It was expected that the completion of the contract tasks would result in the computerization of the complete water mapping system.

As of May 1995, URS attested that 95 percent of the tasks outlined in the contract were completed, and DEP had paid out \$5.7 million (95%) of the \$6 million for services outlined in the contract. However, significantly more work was still needed to accomplish the intent of computerizing the entire mapping system. When this audit commenced in March 2002, the contract had not been completed, and the total cost had increased to \$9.3 million—156 percent of the original \$6 million contract price.

We spoke with the Chief of Mapping and the Field Engineer for this contract to learn the reason for the delay and the increased cost. The Field Engineer said that the scope of work required was greater than originally anticipated. In addition, such computerization was new for them, and they had to address unforeseen issues. For example, when the City purchased the Jamaica service area, this area also had to be supported by a computerized mapping system. DEP approved three change orders to cover the additional work needed to computerize the distribution maps for the entire City.

To verify that contract payments reconciled with the percentage of work certified as completed, that payments were made only with proper authorization from DEP, and that the additional work identified in the change orders was not included in the original contract terms, we obtained and reviewed the contract file (containing the invoices and supporting documentation) and the change order documents.

Regarding the contract payments—which are based on the percentage of work completed—all requests for payments were accompanied by invoices and other relevant documentation, such as payment schedules. The invoices included a schedule indicating the percentage of work completed and the corresponding payment requested. We verified that the computations were correct and that the payments requested reconciled with the percentage of work certified as completed by the contractor.

Regarding authorization of payments, DEP prepares a contract payment approval and tracking sheet to accompany each invoice. The tracking sheets are signed by various DEP persons, including the field engineer, section engineer, Chief, project manager, and contract accounting office, certifying that the materials were delivered as stated in the invoice, and authorizing release of the funds. We verified that tracking sheets were completed and authorizations were given prior to releasing funds to the contractor.

Regarding the change orders, we found that three of them were submitted for this contract. The contractor provided DEP with justifications for each task in the change orders. We verified that the tasks cited in the change orders were not part of the original contract specifications, and that all of the change orders were approved by DEP officials.

In July 1995, the first change order was authorized, calling for the contractor to perform additional research, drafting, and updating tasks. The change order included the following: update and reconfigure maps for the Bronx and Staten Island, draft additional maps for Queens, and research additional field cards to update maps in Manhattan, Staten Island, and Queens.

In June 1996, the second change order was authorized, calling for the contractor to compile 6,000 additional field cards in the five boroughs, enter them on the system, and perform other additional tasks, not included in the original contract.

In September 1998, the third change order was authorized, calling for the contractor to update and computerize the distribution maps for the Jamaica system. The computerized maps for this area would be on the GIS rather than GDS. According to DEP, the Convergent Group, the company that manufactured the GDS system, stopped its research and development sometime in 1995 and abandoned its GDS operations in 1997.

GDS is a software drawing tool; GIS is a computer application capable of assembling, storing, manipulating, and displaying geographically referenced information. GIS stores maps and other data as layers of information, making it possible to perform complex analyses. For example, by “turning off” certain layers, GIS can display specific, narrowly focused information. According to DEP, GIS is a better system than GDS in that it provides more detailed information on the exact location of water mains, valves, and other assets. For example, maps on GIS indicate the distance of the water pipe from the curb and provide maintenance and repair histories, but maps on GDS lack this detailed information. GIS maps would help increase the security and availability of water-related information. GIS also has the capability to provide information continuously to interested parties (DEP and private contractors), and to provide data for investigation of water quality issues.

DEP is in the process of putting its entire water system on GIS.² DEP developed a capital project request to OMB in 2002, with an estimated cost of \$10 million, to convert the water mapping system from GDS to GIS. As part of its argument, DEP officials stated that “GDS was developed over a decade ago and resides on a propriety software mapping platform that is no longer viable since it has been discontinued and is no longer supported. Additionally, GDS is not a GIS product and, as such, is unable to support GIS applications and to secure sensitive maps and data pertaining to the water supply system.”

OMB is evaluating DEP’s request concerning the possible savings and efficiency that the conversion to GIS might provide.

Under these circumstances, we make the following recommendation:

Recommendation

2. If OMB should approve this project, we suggest that the new agreement include the provision that the vendor make any future new product or upgrade to the system available to DEP at a discounted rate.

DEP Response: “DEP concurs with the [recommendation] made by the audit team.”

² The catch basin system managed by DEP and gas pipelines managed by Con Edison are already on the New York City GIS base map.



**Department of
Environmental
Protection**

59-17 Junction Boulevard
Flushing, New York
11373-5108

**Christopher O. Ward
Commissioner**

**Douglas S. Greeley, P.E.
Deputy Commissioner**

**Bureau of Water and
Sewer Operations**

Tel (718) 595-5330
Fax (718) 595-5342
DGreeley@dep.nyc.gov



www.nyc.gov/dep

(718) DEP-HELP

February 13, 2003

Mr. Greg Brooks
Deputy Comptroller
Office of the Comptroller
1 Centre Street
New York, New York 10007-2341

Dear Mr. Brooks:

On behalf of Commissioner Ward, I am responding to your letter of January 29, 2003, which requested our review and comment upon the draft findings of Audit MJ02-163A. This audit concerned the oversight of the New York City Water Distribution System by the Bureau of Water and Sewer Operations.

Please be advised that we have provided comments to the audit team at the exit conference and these comments were incorporated in the draft audit report. There is one additional comment which we wish to incorporate at this time. On page seven of the draft report, we are recommending that the first paragraph on the page be replaced by the following:

“Field cards are completed by the City’s Department of Design and Construction (DDC) field staff. DDC reviews and forwards the approved field cards to the DEP Mapping Unit, which then updates the computerized distribution maps with information from the field cards.”

DEP concurs with the two recommendations made by the audit team. The two recommendations, to eliminate the backlog of field cards to be entered into the GIS system and to solicit vendor discounts for software upgrades have been incorporated into our plans for the next phase of DEP’s GIS project. Since the scope of work and funding for the next phase of this project is presently under review at the Office of Management and Budget, we are not able to provide an implementation schedule to you at this time.

Very truly yours,

Douglas S. Greeley, P.E.
Deputy Commissioner

LOG #2002-1396