City of Phoenix

Mission Statement

To improve the quality of life in Phoenix through efficient delivery of outstanding public services.

Water Services Department
Water Distribution System Maintenance

November 20, 2024

Report Highlights

Maintenance

Workorder documentation showed maintenance was performed. Procedures could be improved to include additional supporting documentation.

Key Performance Indicator (KPI) Monitoring

WSD's KPI monitoring was more robust than the monitoring performed by other survey respondents.

Materials Lab Fees

An analysis of materials lab testing using the Street Transportation department lab revealed no cost savings compared to using a subcontractor.

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#1240069

This report can be made available in alternate format upon request.

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Executive Summary

Purpose

Our purpose was to evaluate the effectiveness of the Water Services Department's (WSD) Water Distribution Division system maintenance for valves and service lines, and monitoring of performance benchmarks.

Background

WSD provides drinking water to almost 1.7 million customers Citywide. The water distribution service area for the City of Phoenix encompasses approximately 540 square miles. The City's primary sources of drinking water are surface water and groundwater.

WSD relies on a network of nearly 1,500 employees to manage its major assets, which include eight water treatment plants; nearly 300 pump, well, lift, and pressure stations; 7,000 miles of water main lines; 5,000 miles of sewer main lines; 54,000 fire hydrants; and, 94,000 manholes.

As part of the process of delivering high-quality water, WSD staff conducts repairs, inspections, and maintenance on much of the water distribution system. The repair and maintenance process can also include lab testing of materials (e.g., soil) performed by the Street Transportation Department or external contractors. These processes are queued and documented using the Oracle Utilities Work and Asset Management (WAM) application.

Results in Brief

Work order records in WAM showed maintenance was performed. Due to inconsistent maintenance policies, we could not conclude whether the maintenance satisfied WSD policies.

The work order documentation in WAM indicated maintenance was performed for leak investigation, repair, or replacement. We noted that not all the documents stipulated in the reactive workflows were attached to the work orders in WAM, and none of the work orders had the supporting documents to show an assessment was performed. When comparing the reactive workflow to the valve replacement standard operating procedure (SOP), we noted that the SOP did not reference the required documents from the workflow.

For maintenance work orders, overtime costs were incorrectly calculated, the issue was corrected in October 2022.

All work orders selected for testing recalculated regular time correctly without exception; however, the overtime calculation was incorrect for the two work orders sampled. The WAM team identified some inconsistencies in the overtime calculation of work orders in

2022, and a fix was implemented on October 6, 2022. This fix was forward-looking and not retroactive.

WSD's key performance indicator monitoring was more robust than the monitoring performed by other respondents.

We worked with WSD management to identify 15 comparable municipalities with respect to similar water distribution systems, climate, and population. We contacted each municipality to inquire about their KPIs monitored for their water distribution function. We compared Water Distribution's KPI monitoring to all survey responses received. Water Distribution KPI monitoring is more robust than all other cities that returned a response.

An analysis of materials lab testing using the Street Transportation materials lab revealed no cost savings compared to using a subcontractor.

WSD currently has a memorandum of understanding with the Street Transportation Department (Streets) to use the Streets materials lab, designed to be a money-saving arrangement. We analyzed five Water Distribution projects of similar scope that used either Street's materials lab or subcontracted Construction Administration & Inspection (CA&I) services. Our analysis revealed that using the Streets lab resulted in approximately a 5 times greater costs per linear foot for materials testing.

Department Responses to Recommendations

Rec. #1.1: Update standard operating procedures for valve and service line work orders to incorporate documentation requirements based on reactive and preventative workflows.	
***Response*:** Water Distribution will update the standard operating procedures for valve and service line work orders to incorporate documentation requirements based on reactive and preventative maintenance work flows.	***Target Date*:** January 31, 2025
Rec. #1.2: Create a plan to address a retroactive fix for overtime costs related to work orders performed prior to October 6, 2022 for future analytics that will rely on archived data.	
***Response*:** Water Services Department Asset Management Team will coordinate with staff from both ITS' Business Intelligence and Data Integration (BIDI) and WSD's Technical Support Division to create a plan to correctly calculate historical overtime labor cost associated with work orders prior to October 2022.	***Target Date*:** February 19, 2025
Rec. #3.1: Share the analysis of Streets material lab fees versus subcontracted lab fees completed with this audit with the Street Transportation Department. Collaborate with the Street Transportation Department on requirements of using the City's lab for all material testing for WSD projects in the right-of-way.	
***Response*:** Water Engineering will meet with Street Transportation Department staff who manage the materials lab and share the results from the audit including the analysis of material lab fees. Street Transportation and WSD will develop a policy for using subcontracted versus materials lab contracts for materials testing for WSD capital projects in City of Phoenix right-of-way.	***Target Date*:** February 14, 2025

1 – Valve and Service Line Maintenance

Background

To ensure that our testing included activity for the most relevant assets, we worked with WSD management and identified valve assets and service lines as the highest-risk asset categories for Water Distribution. Water mains were also classified as critical; however, maintenance work on water mains is infrequent due to the long service life and durability.

Water Distribution High-Risk Assets

Asset Type	Description	Quantity
Valves	Infrastructure that controls the flow of water through pipelines.	170,120
Service Lines	Underground pipelines connecting properties to the City's water mains.	474,536
Total		**644,656**

Valves and service lines are the highest-risk assets for Water Distribution.

WSD classifies maintenance work orders as reactive or preventative. Maintenance is considered reactive when an asset fails in service or is damaged by external factors. Preventative maintenance is scheduled maintenance determined by industry best practices or the manufacturer's suggested timelines. During calendar years (CY) and 2023, WSD performed 23,154 valve preventative work orders and 27,540 reactive/scheduled work orders. For the service line population, WSD performed 18,693 reactive/scheduled work orders. There is no preventative maintenance performed on service lines due to the materials' long service life and durability.

We selected a sample of work orders in the preceding asset categories processed during CY22 and CY23, and verified that maintenance was performed in accordance with WSD's reactive and preventative workflows and standard operating procedures (SOPs), including document retention. Additionally, we recalculated labor costs and noted whether the work order task matched the asset type and to ensure the costs were recorded correctly in WAM.

In a prior audit, we identified an exception where WSD foremen weren't approving individual work orders in WAM. As the recommendation for this exception is still in the implementation phase, we did not perform testing related to this area.

Results

Inconsistencies were noted in the standard operating procedures and maintenance workflow documentation.

We obtained SOPs for the WSD Valve and Service Line replacements, which identified the general procedures for conducting a water main valve or service line replacement. Additionally, we obtained the preventative work order workflow documents that identified the phases in the work order process (e.g., creation, approval, completion) and the reactive workflow that described the need to assess whether permits, barricades, or blue stake location services were needed. If required, these items were to be uploaded in WAM. When comparing the reactive workflow to the valve replacement SOP, we noted the SOP did not reference the required documents from the workflow and was inconsistent between the two authoritative documents. Additionally, we noted preventative maintenance criteria for valves was not documented. Having inconsistent maintenance procedure documentation or not having documented procedures increases the risk that maintenance is not performed according to standards and could result in equipment failure.

Work order records in WAM showed maintenance was performed. However, we could not conclude if the maintenance satisfied WSD policies due to the inconsistent maintenance policies.

WAM is configured with multiple fields for staff to document the work performed and to upload related attachments to support the maintenance completed. We sampled 20 reactive and preventative maintenance work orders; 10 work orders for service line maintenance and 10 work orders for valve maintenance. We tested for compliance with WSD workflow procedures.

For service line maintenance, the work order documentation in WAM indicated maintenance was for leak investigation, repair, or replacement. We noted that not all the documents stipulated in the service line reactive workflows were attached to the work order in WAM, and none of the work orders had supporting documents showing that an assessment had been performed.

Percent of Service Line Reactive Work Orders with Documentation

Permits/Barricades	Blue Stake	Photographs of Site	Materials List	Street Cut Map
20%	50%	40%	0%	40%

Determining if maintenance was consistent with procedures was inconclusive without a documented assessment.

For valve maintenance, nine work orders were for valve shut-off for reactive or preventative maintenance and one work order was for a valve replacement in an alley with no street impact. All valve maintenance work orders in our sample had appropriate documentation.

Having complete documentation in WAM showing the work performed, including the assessment, will help ensure maintenance is being performed accurately.

Sampled valve asset maintenance work order costs were calculated correctly.

For the valve asset category, the total population of work orders in CY22 and CY23 included approximately 50,000 work orders in various stages of completion, including approximately 15,000 work orders in a closed/finished status. Work orders for the scope period totaled approximately $1.4M in regular labor hours and approximately $390,000 in overtime. We selected a sample of 25 work orders comprised of $1,000 in labor hours and recalculated the labor costs using hourly pay rates obtained from the City's payroll system and hours recorded in the work orders. All work orders selected for testing were recalculated correctly without exception.

Sampled service line maintenance work orders overtime costs were not calculated correctly.

For the service line asset category, the total population of work orders in CY22 and CY23, included approximately 19,000 work orders in total in various stages of completion, including approximately 10,000 work orders that were in closed/finished status. Work orders for the scope period totaled approximately $1.5M in regular labor and approximately $430,000 in overtime. We selected a sample of 25 work orders with $8,500 and recalculated the totals using hourly pay rates obtained from the City's payroll system and hours recorded in the work orders.

All work orders selected for testing recalculated regular time correctly without exception; however, the overtime calculation was incorrect for two of the 25 (8%) work orders sampled. This only affected work order labor cost totals, not payroll. The WAM team identified inconsistencies in the overtime calculation of work orders in 2022, and a fix was implemented on October 6, 2022. This fix was forward-looking and not retroactive. In our testing, we found no exceptions for overtime calculations past the date of the fix,

which supports that the calculation error was successfully remediated. As WSD management uses work orders for historical cost analysis, this analysis is compromised without accurate costing information. A retroactive fix would eliminate this compromise.

Recommendations

1.1 Update standard operating procedures for valve and service line work orders to incorporate documentation requirements based on reactive and preventative workflows.

1.2 Create a plan to address a retroactive fix for overtime costs related to work orders performed prior to October 6, 2022 for future analytics that will rely on archived data.

2 – Key Performance Indicator Monitoring

Background

Monitoring key performance indicators (KPIs) is an essential element of continuous improvement, allowing WSD to track their performance, identify areas that can be strengthened or improved, and benchmark their results by comparing to other municipalities or data published by the American Water Works Association (AWWA).

WSD tracks 42 KPIs related to the water distribution function, including business plan metrics and goals and division performance metrics. The cumulative KPI data is published in a scorecard and made available to internal stakeholders each fiscal year.

We contacted a curated sample of similar municipalities to obtain their KPIs. We then compared the KPIs monitored/not monitored to those of WSD to determine if WSD is incorporating data elements that are effective for monitoring performance indicators. Our testing did not include validating the KPI results reported by WSD.

Results

WSD's KPI monitoring was more robust than the monitoring performed by other respondents.

We worked with WSD management to identify 15 comparable municipalities with respect to similar water distribution systems, climate, and population. We contacted each municipality to inquire about their KPIs monitored for its water distribution function. We received responses from three municipalities: San Diego, California; Austin, Texas; and Henderson, Nevada. In total, the Water Distribution division monitors 42 KPIs across the function.

Comparison of KPIs Monitored

Municipality/Organization	KPIs Monitored	KPIs in Common
San Diego, CA	13	5
Austin, TX	11	8
Henderson, NV	1	1
American Water Works Association	21	21

Water Distribution monitored more KPIs than any survey respondent.

KPIs not monitored by Water Distribution that were monitored by other municipalities included:

- Capital Improvement Spend versus Budget.
- Quantity of planned monthly meter replacements.
- Percent of drinking water samples that meet regulations.
- Percent of water quality reports submitted on time.
- Percent of local water supply.
- Customer sentiment by survey.
- First call resolution.
- Debt service coverage ratio.
- Quantity of wet taps performed.

WSD monitored more KPIs than all cities that responded. In addition, it incorporated all 21 KPIs suggested by the American Water Works Association (AWWA).

Recommendations

None

3 – Materials Testing Fee Analysis

Background

Construction work for water distribution involves many facets, one of which is materials analysis for soil. When a trench is backfilled, the City requires a compaction and moisture content test to be performed. The frequency at which this test needs to be performed varies: one test per 8" lift for 500 linear feet, per pipe run, or per day's production. WSD is not staffed to perform this test, instead it relies on the materials lab in the Street Transportation (Streets) Department, or testing subcontracted to a construction administration and inspection (CA&I) contractor. When tests are performed by Streets, an internal charge is billed to WSD.

We selected this area for testing because Water Distribution management expressed some concern with inconsistencies in costs between Streets provided services versus subcontracted services. We worked with management to identify five construction projects of similar scope where either Streets or a subcontracted CA&I performed materials testing fees. We analyzed each project to determine if costs were comparable for materials testing fees between each materials testing provider.

Results

Our analysis of materials lab testing using the Street Transportation department lab revealed mixed cost savings.

WSD has a memorandum of understanding (MOU) with Streets to use the Streets materials lab for testing. The MOU was designed to be an arrangement that would result in cost savings when compared to a CA&I and competent lab results. We analyzed five Water Distribution projects of similar scope that used either Streets' materials lab or subcontracted CA&I services to determine if the costs were comparable. Three projects used Streets' materials lab, and two used a subcontracted CA&I. The average run of pipe for the projects using Streets' lab was 21,387 linear feet, and using a CA&I was 26,571 linear feet.

The average materials lab fees for projects using the Streets' lab were $6.81 per linear foot. The average cost of materials lab fees for projects using a subcontracted CA&I was $1.39 per linear foot. This amounts to approximately 5 times greater costs per linear foot for materials testing using the Streets lab. In speaking with Streets Materials lab management, materials testing fees typically cost around 1-2% of total project costs. The WSD engineering team also agreed that this range was accurate. The materials testing fees as a percentage of project totals used for this analysis ranged between 0.08% to 6.72%. This is a wide range and, without a thorough analysis, may not result in a fair comparison of services rendered by Streets' materials lab versus subcontracted testing fees.

Materials Lab Fee Analysis

Project	Testing Provider	Total Linear Feet	Testing Fees	Cost/Linear Foot	Percent of Total Costs
WS85509122	Streets	6,825	$6,737	$0.99	0.22%
WS85509108	Streets	7,167	$43,550	$6.08	1.49%
WS85509026	Streets	22,185	$296,260	$13.35	6.72%
WS85509054	CA&I	32,700	$9,455	$0.29	0.08%
WS85509055	CA&I	20,441	$50,732	$2.48	0.58%

Using the Street Transportation department materials lab revealed mixed cost savings.

Recommendation

3.1 Share the analysis of Streets material lab fees versus subcontracted lab fees completed with this audit with the Street Transportation Department. Collaborate with the Street Transportation Department on requirements of using the City's lab for all material testing for WSD projects in the right-of-way.

Scope, Methods, and Standards

Scope

This audit encompassed water distribution maintenance activity occurring from January 1, 2022 through December 31, 2023.

The internal control components and underlying principles that are significant to the audit objectives are:

- Control Activities
    - Management should design control activities to achieve objectives and respond to risks.
    - Management should design the entity's information system and related control activities to achieve objectives and respond to risks.
- Monitoring Activities
    - Management should establish and operate monitoring activities to monitor the internal control system and evaluate the results.

Methods

We used the following methods to complete this audit:

- We interviewed WSD management and staff.
- We reviewed WSD policies, procedures, and workflows.
- We tested maintenance work orders performed on Water Distribution assets.
- We analyzed materials testing fees.
- We performed data validation procedures on WAM and SAP ledgers.

Unless otherwise stated in the report, all sampling in this audit was conducted using a judgmental methodology to maximize efficiency based on auditor knowledge of the population being tested. As such, sample results cannot be extrapolated to the entire population and are limited to a discussion of only those items reviewed.

Data Reliability

We assessed the reliability of WAM and SAP data by (1) performing electronic testing, (2) reviewing existing information about the data and the system that produced them, and (3) interviewing agency officials knowledgeable about the data. We determined that this data was sufficiently reliable for the purposes of this audit.

Standards

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Any deficiencies in internal controls deemed to be insignificant to the audit objectives but that warranted the attention of those charged with governance were delivered in a separate memo. We are independent per the generally accepted government auditing requirements for internal auditors.