Performance Audit of the Public Utilities Department's Valve Maintenance Program

SEVERAL OPPORTUNITIES EXIST TO IMPROVE PROGRAM EFFICIENCY AND PRODUCTIVITY

DECEMBER 2012

Audit Report

Office of the City Auditor

City of San Diego

OCA

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THE CITY OF SAN DIEGO

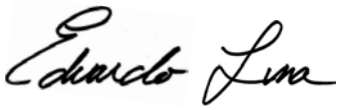
December 31, 2012

Honorable Mayor, City Council, and Audit Committee Members
City of San Diego, California

Transmitted herewith is an audit report on the Public Utilities Department's Valve Maintenance Program. This report was conducted in accordance with the City Auditor's Fiscal Year 2012 Audit Work Plan, and the report is presented in accordance with City Charter Section 39.2. The Results in Brief is presented on page 1. The Administration's response to our audit recommendations can be found after page 42 of the report.

We would like to thank staff from the Public Utilities Department, as well as representatives from other City departments for their assistance and cooperation during this audit. All of their valuable time and efforts spent on providing us information is greatly appreciated. The audit staff responsible for this audit report are Claudia Orsi, Andy Hanau, Shoshana Raskas, Sonja Howe, and Chris Constantin.

Respectfully submitted,



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Results in Brief

We conducted a performance audit of the Water Operations Branch (water department) valve maintenance program within the Public Utilities Department (PUD) in accordance with the Service Level Agreement between PUD and the Office of the City Auditor. The objectives of the audit were to determine:

- The extent to which the water department's valve maintenance program operates in accordance with industry standards and practices, as well as internal policies and goals; and
- The extent to which the valve maintenance program management monitors valve maintenance reports and applicable data to ensure that maintenance scheduling appropriately reflects the areas of the City that experience the highest number of water main breaks, and/or present the highest risk.

Opportunities Exist to Improve the Valve Maintenance Program

During our audit, we found that several opportunities exist for the valve maintenance program to improve efficiency and reduce risk. PUD has not maintained hydrants and valves in accordance with PUD guidelines, or widely accepted industry standards, leading to reduced maintenance rates. In addition, some valves and hydrants are unnecessarily maintained repeatedly while others go unmaintained, and there are significant geographic differences between maintenance completion rates. These inefficiencies and coordination problems were due to a lack of oversight and training, as well as inadequate policies and procedures governing the preventive maintenance process. We also found that improved performance metrics would more accurately measure program performance, increasing management oversight and accountability of the valve maintenance program.

If PUD had ensured that Valve Maintenance Supervisors scheduled and coordinated maintenance more effectively, 15,000 additional valves and hydrants could potentially have been maintained over the last five years. Overall, PUD Valve Maintenance Supervisors did not receive adequate training, and in addition, insufficient information in the appurtenance database resulted in inefficient maintenance assignments, reducing the number of hydrants and valves receiving preventive maintenance within each five-year maintenance cycle.

Furthermore, the City could do more to prevent the paving over of gate valve caps and to collect information to recover potential costs. Finally, the City can improve the accuracy of cost recovery for water lost during a hydrant knock over by changing how it tracks water loss.

PUD Can Improve the Valve Maintenance Program by Implementing 12 Recommendations

We recommend that PUD management prioritize oversight of the valve maintenance program and develop policies and procedures to ensure that the program operates efficiently and that effective oversight of the program occurs. We made 12 recommendations, of which the department agreed with all 12. We would like to thank the PUD staff, as well as representatives from other City departments for their assistance and cooperation during this audit. All of their valuable time and efforts spent on providing us information is greatly appreciated.

Background

PUD Maintains 78,000 Valves and Fire Hydrants with a Budget of $1.54 million

The Public Utilities Department (PUD) in the City of San Diego (City) provides drinking water to 1.3 million City residents. Within PUD, the Construction and Maintenance Division of the Water Operations Branch maintains approximately 78,000 water appurtenances,[1] including more than 25,000 fire hydrants and 45,000 isolation valves.

Fire hydrants are critical to fire suppression efforts and are also used to flush out the water system to clear pipes of rust and sediment. In contrast, isolation valves serve to turn off water in the case of a water main break or for construction projects.[2] The most common type of isolation valve in the distribution system is a gate valve, which shuts off water by lowering a metal disk that blocks water from flowing through a pipe. PUD's valve maintenance program also maintains air valves and blow-off valves. Air valves are float-operated valves that are used at the higher elevation points in the distribution system to let air escape. Blow-off valves are controlled outlets used to discharge water. They consist of a gate valve as part of a blow-off assembly used at low points in the distribution system to flush mains and at pipe end points such as cul-de-sacs. **Exhibit 1** shows diagrams of three primary appurtenance types in the distribution system. In addition, **Exhibit 2** shows the quantities of each appurtenance type in the system. In this audit, we reviewed the valve maintenance program for all fire hydrants, as well as those valves between six and twelve inches in diameter.

[1] 'Appurtenance' is an industry term that collectively refers to water valves and fire hydrants.
[2] A main is one type of pipe used for conveying water.

Exhibit 1

Diagrams of Water System Appurtenances

Fire Hydrant

Gate Valve

Air Valve

Source: Public Utilities Department

Exhibit 2

Appurtenance Inventory

Appurtenance Type	Isolation Valves	Fire Hydrants	Blow-off Valves	Air Valves	TOTALS
Number in City Inventory	45,217	25,100	4,696	2,573	**77,586**

Source: OCA analysis based on data provided by the Public Utilities Department

Preventive Maintenance Extends Valve and Hydrant Life and Provides Valuable Asset Information

PUD has a preventive maintenance program that performs maintenance on fire hydrants and system valves to ensure the water distribution system operates safely, reliably and efficiently. Preventive maintenance aids systems or components to continue to perform their intended functions throughout their service life. In addition to performing physical maintenance on the valves and hydrants, work crews inspect the appurtenance, collecting valuable information about valve and hydrant condition.

Preventive maintenance techniques vary by appurtenance type. Conducting preventive maintenance on a gate valve entails accessing the top of the valve at street level by removing the cap and then exercising the valve by lowering and raising the gate. Crews will replace the gate cap and paint it to complete maintenance. Occasionally, PUD crews encounter gate valves that are covered

under asphalt, in which case they will locate the valve and uncover it before conducting routine maintenance. Crews maintain blow-off valves by locating the gate cap and ensuring the valve and blow-off cap are accessible. Air valves can be maintained by testing the shut off function. For hydrants, crews remove the gate cap for the associated hydrant isolation valve , shut the hydrant off, open the ports to ensure the gate is working, grease and lubricate the fire hydrant stem if needed, turn the hydrant on, take a pressure reading, and paint the hydrant and gate cap. For all appurtenance types, preventive maintenance includes a visual inspection of the components that are above ground to check for leaks and wear.

The preventive maintenance program currently has fifteen staff (15 FTE) who conduct preventive maintenance activities. There are three vacant crew positions. In addition to conducting preventive maintenance, the crews repair broken valves and fire hydrants[3], assist contractors to shut off water mains during construction and assist in isolating mains during water main breaks. The Fiscal Year 2012 budget for the valve maintenance program was $1.54 million.[4]

PUD has Established a Five-Year Maintenance Cycle for All Hydrants and Valves

PUD has set a goal of maintaining all valves and hydrants on a five-year cycle,[5] and PUD's valve maintenance section uses two software applications, SPLASH[6] and SWIM,[7] to plan and track maintenance. Information on each valve and hydrant, including type, size, location, and maintenance history, is contained in a master database that is accessed by these systems.

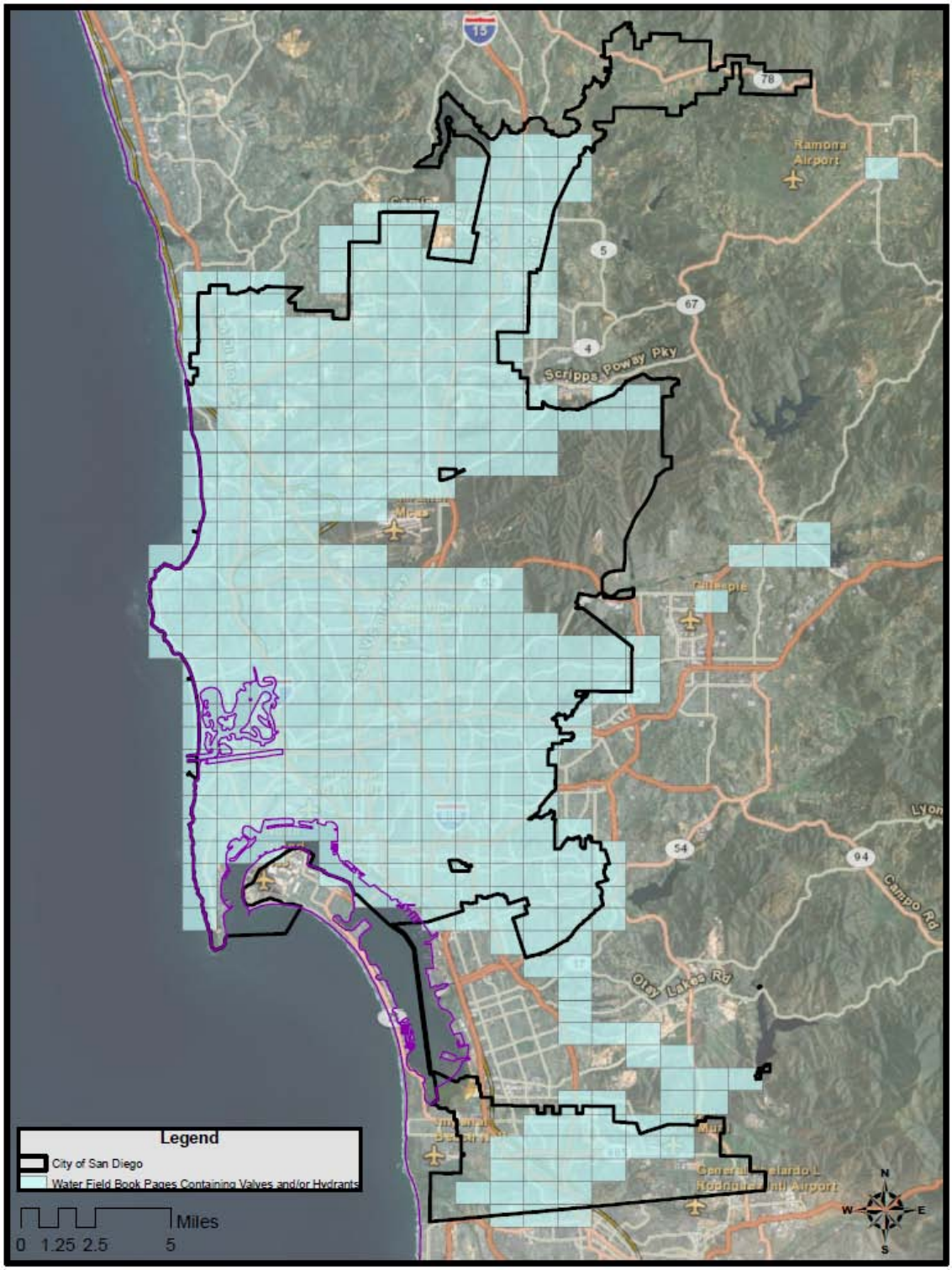
PUD also uses the Water Field Book to plan and coordinate preventive maintenance efforts. The Water Field Book divides the City's water infrastructure into a grid, with each area on the grid representing a page in the Field Book ('Field Book Page'). PUD supervisors told us that standard practice should be for crews to perform preventive maintenance on all valves and hydrants in each area before moving to the next, with the goal of reaching each area every five years.

Exhibit 3 shows the 384 areas that contain fire hydrants or water valves owned and maintained by the City.

[3] Occasionally, vehicles will collide with fire hydrants, knocking them over and causing hydrant damage and water loss.
[4] This quantity includes other activities that are not considered preventive maintenance such as contract assists and hydrant repairs.
[5] PUD had planned to change the cycle for hydrants and air valves to four years, but they have not implemented that change and the cycle is currently every five years for all valve types.
[6] The System Planning and Locator Application for Sewer and Hydrographics (SPLASH) application is a Geographic Information System that displays infrastructure graphically.
[7] The Sewer/Water Infrastructure Management (SWIM) system is used to generate and track work orders for sewer and water infrastructure.

Exhibit 3

384 Areas Contain City Water Appurtenances



Source: OCA analysis based on data from ESRI, SANDAG, SanGIS, and the Public Utilities Department

Note: The City owns and maintains water infrastructure outside of the City's jurisdiction, and so some areas shown lie partially or fully outside of the City limits.

Chapter 1

Opportunities Exist for the Valve Maintenance Program to Improve Efficiency and Reduce Risk

We found that the Public Utilities Department's (PUD) valve maintenance resources have been used inefficiently and the department has not met its goal of performing preventive maintenance on all fire hydrants and water valves[8] every five years. We found that of the City's approximately 78,000 valves and hydrants, more than 21,000 (27 percent)[9] did not receive preventive maintenance during the recent five-year cycle we studied, from May 1, 2007, to April 30, 2012.[10] At the same time, more than 13,000 of the City's appurtenances[11] received preventive maintenance multiple times – with some receiving preventive maintenance up to eight times. If those resources had been directed to performing preventive maintenance on appurtenances that were due for maintenance, nearly 15,000 additional valves and hydrants could have received preventive maintenance within the five-year cycle.

In addition, we found that crews have been dispatched to maintain valves and hydrants in some areas repeatedly, while crews were not sent to some areas at all during the five-year cycle we reviewed.

As a result of these maintenance practices, the City lacks complete information on the condition of valves and hydrants. In addition, many of the City's valves and hydrants may have a higher risk of failure during emergency situations such as main breaks or fires, increasing the risk of property damage and public safety impacts.

[8] 'Water valves' refers collectively to several types of water valves, including isolation valves, blow-off valves, and air valves.
[9] Data provided by PUD indicates that approximately 4,000 (5 percent) of the total inventory of appurtenances were installed during the five-year period we reviewed; however, we found that the install date field was not reliable and that some of these appurtenances were installed prior to the five year review period. Therefore, in order to ensure that our review captured all appurtenances that required preventive maintenance during the review period we did not remove appurtenances that were identified as being recently installed from the population we reviewed. All other fields were found to be reliable in our testing, as noted in Appendix B (Objectives, Scope and Methodology).
[10] We selected this timeframe to capture the most recent data PUD had at the time of our data request.
[11] 'Appurtenance' is an industry term that refers collectively to water valves and hydrants.

More than 21,000 Hydrants and Valves Were Not Maintained in the Last 5 Years

We found that maintenance rates varied by type of appurtenance, and that rates fell below department goals for all appurtenance types. While fire hydrants were maintained at a higher rate than other water appurtenances, nearly 6,000 (24 percent) were not maintained or tested in the last five years. Air valves were maintained at the lowest rate; approximately 56 percent of air valves were not maintained during the five-year period we studied. **Exhibit 4** summarizes preventive maintenance by appurtenance type during the study period.

Exhibit 4

Preventive Maintenance Completion Rates by Appurtenance Type

Appurtenance Type	Isolation Valves	Fire Hydrants	Blow-off Valves	Air Valves	TOTALS
Number in City Inventory	45,217	25,100	4,696	2,573	**77,586**
Number Receiving Preventive Maintenance May 1 2007 - Apr. 30 2012	33,837	19,103	2,390	1,126	**56,456**
Percent Not Maintained	**25%**	**24%**	**49%**	**56%**	**27%**

Source: OCA analysis based on data provided by the Public Utilities Department

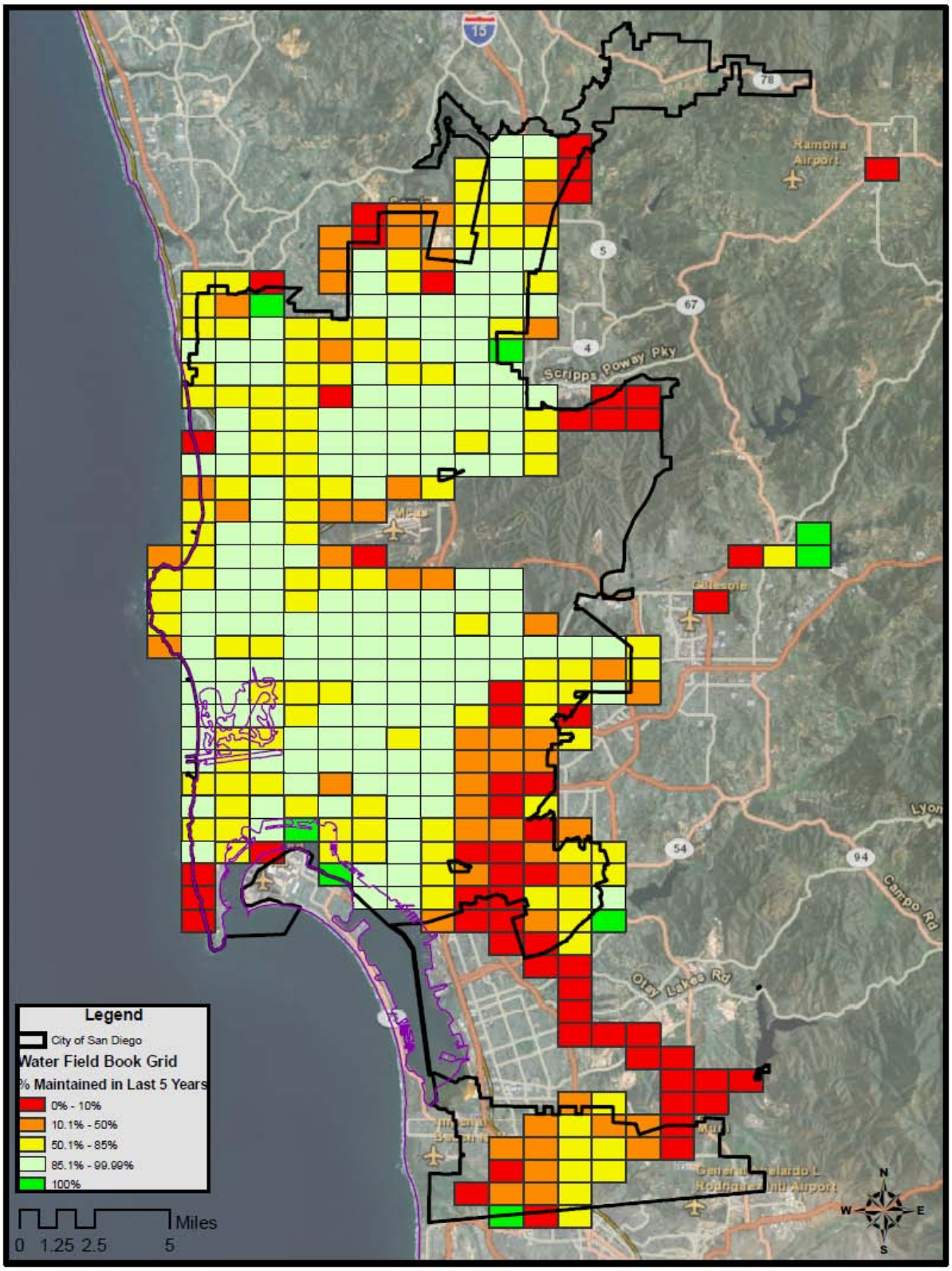
Preventive Maintenance Completion Rates Vary Significantly by Area

In addition, **Exhibit 5** shows preventive maintenance completion rates by area.[12] Areas shown in shades of green had higher completion rates, while those shown in shades of red had lower completion rates. The exhibit demonstrates that maintenance rates varied significantly in different areas. According to PUD, differences in maintenance rates were not due to any purposeful maintenance strategy used by PUD. Rather, our analysis indicates that differences in maintenance rates were caused by a lack of oversight and training as well as inadequate policies and procedures, as discussed in more detail below.

[12] As described in the Background section, PUD uses the Water Field Book to plan preventive maintenance activity. Each area shown in the exhibit represents one area of the Water Field Book, known as a Field Book Page.

Exhibit 5

Preventive Maintenance Completion Rates by Area



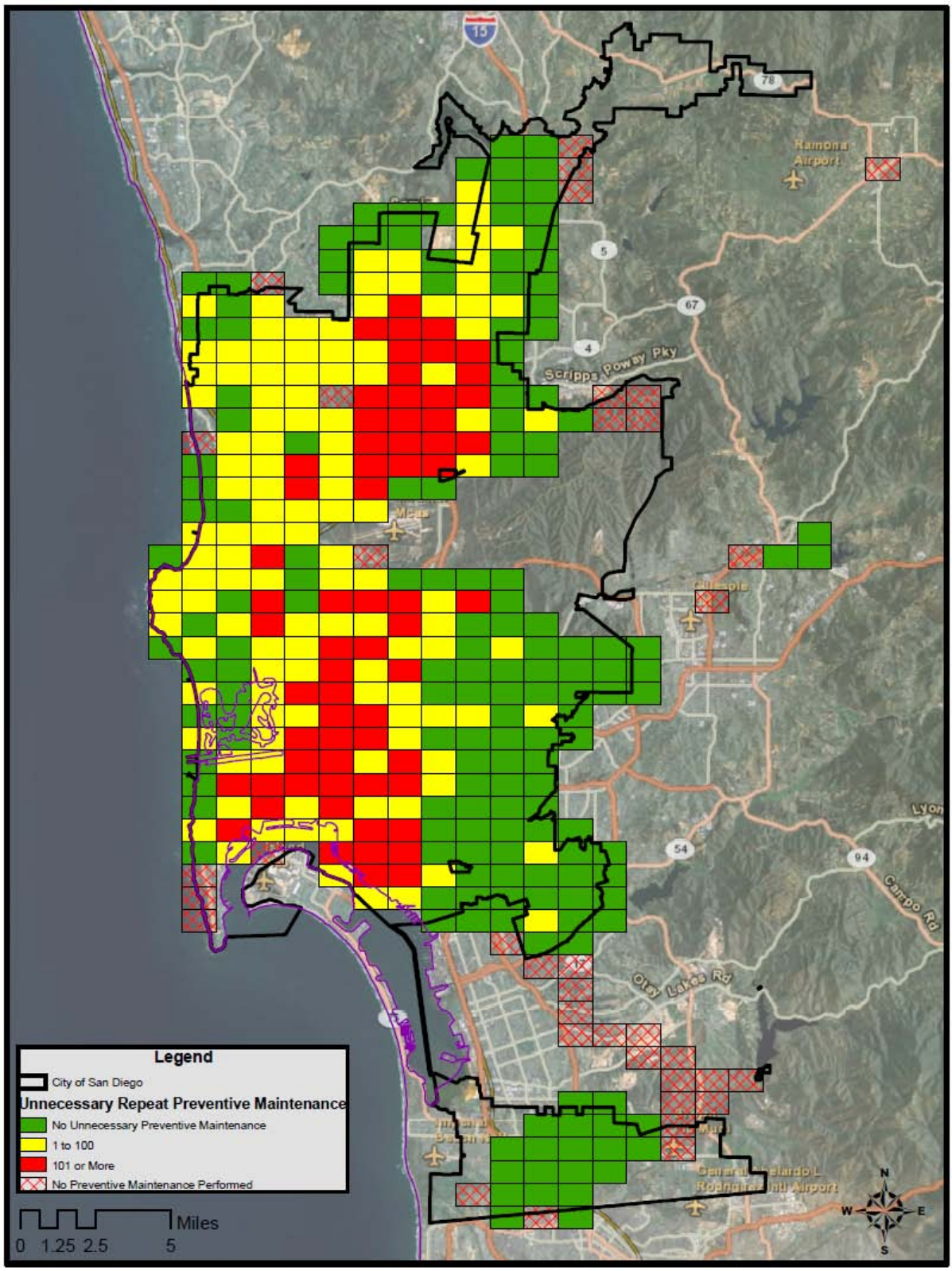
Source: OCA analysis based on data from ESRI, SANDAG, SanGIS, and the Public Utilities Department

Some Valves and Hydrants are Unnecessarily Maintained Repeatedly While Others Go Unmaintained

We found that crews maintained many hydrants and valves unnecessarily in some areas of the City during the five-year study period. At the same time, many other appurtenances were not maintained at all. Approximately 13,600 hydrants and valves received preventive maintenance more than once, with some receiving preventive maintenance as many as eight times. Exhibit 6 shows the number of unnecessary preventive maintenance work orders completed in each area during the five-year period we reviewed. Areas shown in red and yellow had higher incidences of unnecessary preventive maintenance.

Exhibit 6

Unnecessary Preventive Maintenance Work Orders by Area



Source: OCA analysis based on data from ESRI, SANDAG, SanGIS, and the Public Utilities Department

Overall, of the 71,123 preventive maintenance work orders completed in the last five years, 14,667 (21 percent)[13] were for appurtenances that had already received maintenance during the five-year cycle. At the same time, more than 21,000 of the City's valves and hydrants went unmaintained. PUD management told us that there was no operational reason why these valves and hydrants received preventive maintenance more than once. If PUD had provided more effective oversight and training and developed policies and procedures to ensure that Valve Maintenance Supervisors assigned work orders only to those appurtenances that were due for maintenance, nearly 15,000 additional valves and hydrants could have received preventive maintenance during the five-year cycle.

Crews Are Not Assigned to Complete All Required Preventive Maintenance in Each Area Before Moving On

In addition, we found that crews moved from one area to the next without completing all required preventive maintenance in each area. PUD management told us that crews should perform preventive maintenance on all appurtenances in each area before moving on, with the goal of cycling through all areas every five years. Adhering to this system would ensure that all appurtenances receive preventive maintenance during each five-year cycle.

Instead, we found that in some cases Valve Maintenance Supervisors appeared to assign preventive maintenance only to valves and hydrants that were already overdue for maintenance – thereby not assigning preventive maintenance to some appurtenances that would be due in the next five years. Because crews should not return to that area for approximately five years, this means that many valves and hydrants that are due for preventive maintenance do not receive it.

For example, there are 456 appurtenances in one area we reviewed, which is primarily located in the City's Paradise Hills neighborhood. We found that between February and November 2009, crews performed preventive maintenance on 219 valves in the area. Crews then ceased performing preventive maintenance in that area and moved on, leaving 238 (52 percent) of the valves in that area unmaintained.

Furthermore, we found that crews were assigned to some areas multiple times during the five year cycle we reviewed, while crews

[13] While 13,633 valves and hydrants received preventive maintenance more than once during the study period, some of these appurtenances received preventive maintenance up to eight times. In total, 14,667 preventive maintenance work orders were completed for appurtenances that were not due for maintenance.[14] Exercising an appurtenance typically involves partially or fully closing and opening the valve or hydrant.

did not cycle through some areas at all. Of the 384 areas containing water valves and hydrants, we found that crews cycled through 42 areas three or more times during the five-year period we reviewed, while appurtenances in 37 areas we reviewed did not receive any preventive maintenance at all. We recommend that PUD revise policies and procedures, and improve training and oversight to ensure that preventive maintenance is cycled through all areas of the City and to ensure that Valve Maintenance Supervisors coordinate maintenance more effectively by assigning crews to complete all preventive maintenance work orders in each area before moving on

Preventive Maintenance of Hydrants and Valves is Essential for Safety and Operational Effectiveness

According to the American Water Works Association (AWWA), performing preventive maintenance on hydrants and valves allows the utility operator to assess the condition of the valve or hydrant and determine the need for repair or replacement. In addition, valve and hydrant manufacturers recommend that these appurtenances be exercised[14] on a regular basis to test appurtenance performance and break up sediments and deposits that can impair proper functioning. Exercising valves and hydrants on a regular basis thereby helps ensure that these appurtenances will operate as intended in an emergency – limiting property damage and public safety impacts from fires and flooding and minimizing the number of customers impacted by water shut-offs.

Lack of Oversight and Formal Maintenance Procedures Has Led to Reduced Maintenance Rates

All of the above issues were perpetuated because PUD did not appropriately prioritize and oversee the valve maintenance program. Managers were not aware of inefficiencies and coordination problems that reduced valve and hydrant maintenance rates and caused geographic differences in maintenance rates. Furthermore, according to PUD Valve Maintenance Supervisors did not receive adequate training to enable them to assign work orders appropriately.

In addition, PUD's existing policies and procedures are not sufficient to ensure that maintenance is scheduled and performed appropriately. The lack of adequate policies and procedures and lack of oversight and training has allowed inefficiencies in the valve maintenance program to occur and has reduced the overall effectiveness of the program. For example, PUD does not have a formal policy requiring supervisors to ensure that preventive maintenance is not repeatedly scheduled unnecessarily. PUD management told us that Valve Maintenance Supervisors may not have known to use the date of last preventive maintenance to

[14] Exercising an appurtenance typically involves partially or fully closing and opening the valve or hydrant.

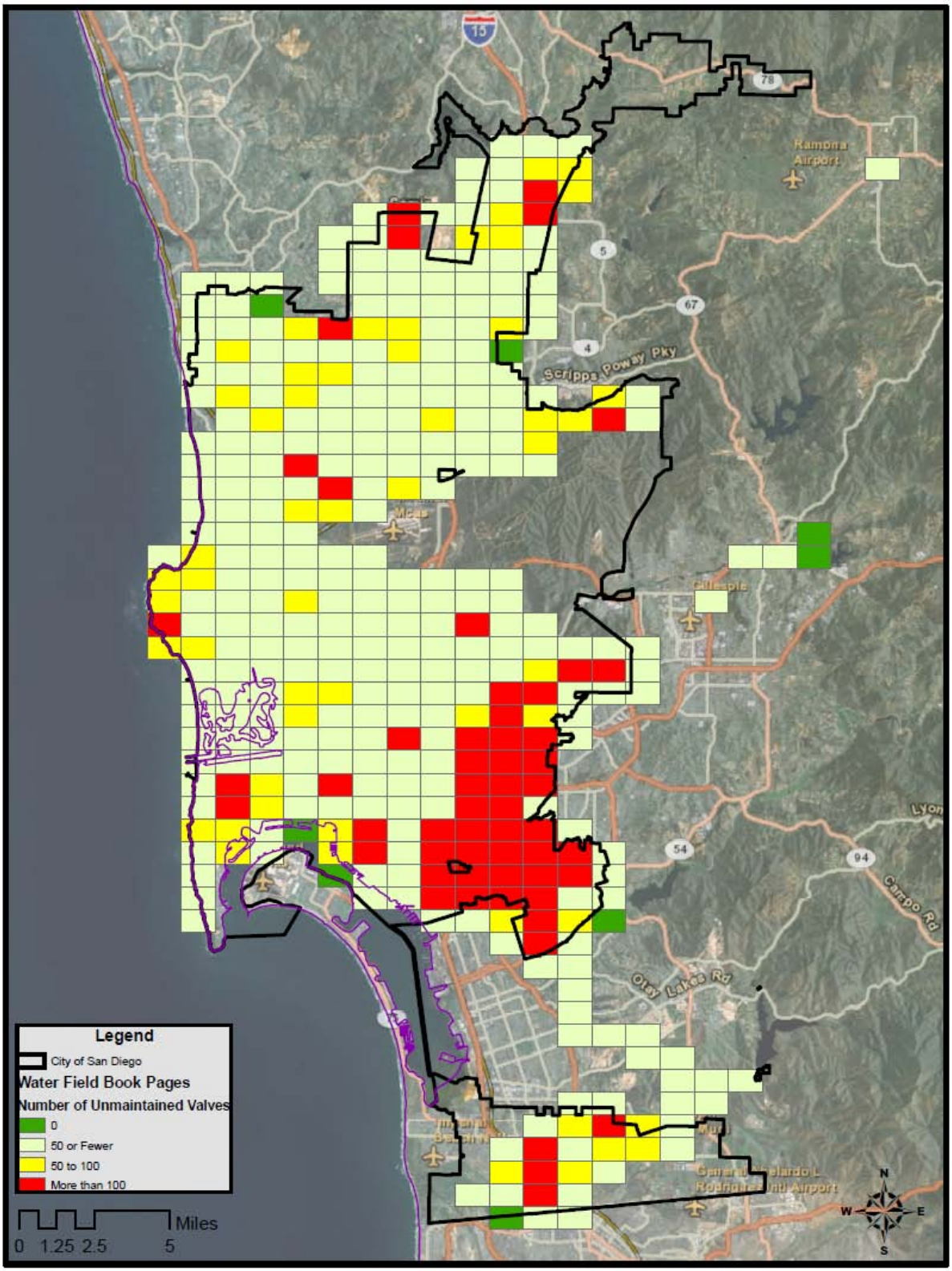
determine if maintenance is needed for the valve or hydrant. In addition, while PUD does have a procedure stating that all appurtenances in each area should be maintained before moving on, our analysis indicates that oversight was not sufficient to ensure that this procedure was adhered to. In addition, the procedure does not define how each five-year cycle should be planned and coordinated, which would help ensure that maintenance is cycled through all areas of the City.

Some Valves and Hydrants Have an Unnecessarily High Chance of Failure in an Emergency – and Some Areas are at Higher Risk Than Others

Because PUD has not ensured that all valves and hydrants receive preventive maintenance, the Department does not have complete and up-to-date information on the condition of water system appurtenances. In addition, because preventive maintenance extends the useful life of these appurtenances, some valves and hydrants that have not been maintained may have an unnecessarily high risk of failure during emergency situations such as main breaks or fires. Finally, because maintenance has not been effectively planned and coordinated to ensure that appurtenances in all areas of the City receive maintenance, unmaintained valves and hydrants are more heavily concentrated in some areas of the City. **Exhibit 7** shows the number of unmaintained fire hydrants and water valves in each area. Areas shown in red and yellow have higher numbers of unmaintained appurtenances, while areas shown in shades of green have lower numbers of unmaintained fire hydrants and water valves. As noted above, differences in maintenance rates were cause by a lack of training and oversight in addition to inadequate policies and procedures, and according to PUD there is no purposeful strategy to maintain appurtenances in some areas more frequently.

Exhibit 7

Unmaintained Valves and Hydrants by Area



Source: OCA analysis based on data from ESRI, SANDAG, SanGIS, and the Public Utilities Department

In order to increase the efficiency of the valve maintenance program, reduce the risk of valve or hydrant failure during emergencies, and ensure that preventive maintenance resources are distributed equitably across all areas of the City, we make the following recommendation:

Recommendation #1

Public Utilities Department management should prioritize oversight and training of the valve preventive maintenance scheduler program to ensure that the program is executed effectively. Policies and procedures should be revised to designate responsibility for management-level review of completed work orders on a regular basis to ensure compliance with policy.

In addition, the Public Utilities Department should revise existing policies and procedures to ensure that:

a) **Appurtenances are not scheduled for unnecessary preventive maintenance;**

b) **All appurtenances requiring preventive maintenance in each grid/area receive it before crews move to another area of the City; and**

c) **Preventive maintenance activities are cycled through all areas of the City. (Priority 2)**

Chapter 2

Improved Performance Metrics Would More Accurately Measure Program Performance, Increasing Management Oversight and Accountability of the Valve Maintenance Program

During our review of the Public Utilities Department's (PUD) valve maintenance program, we found that PUD's Preventive Maintenance Completed report, the primary performance measure used to monitor program performance, does not accurately reflect annual progress made towards the program goal of maintaining all appurtenances every five years. In fact, while the fiscal year 2011 report stated that 15,493 preventive maintenance work orders[15] for valves and hydrants were completed, we found that only 6,448 valves and hydrants due for maintenance were actually maintained – meaning that actual progress towards the five-year goal of maintaining all appurtenances was 58 percent lower than reflected in the report. PUD's fiscal year 2011 Preventive Maintenance Completed report is located in **Appendix C**.

Also, we found that the Preventive Maintenance Completed report does not break down preventive maintenance performed by geographic area. As noted in Chapter 1, we identified significant differences in preventive maintenance completion rates across geographic areas, and appurtenances in many areas received preventive maintenance repeatedly while in other areas no maintenance was performed at all.

Tracking and Monitoring Performance Measures is Essential to Ensure Program Effectiveness and Accountability

According to the United States Government Accountability Office, tracking and monitoring program performance towards established goals and objectives is essential to ensure program efficiency and effectiveness.[16] In addition, reporting accurate and meaningful performance measures increases accountability with decision makers and the public.

[15] PUD valve maintenance supervisors assign crews work orders for valve and hydrant maintenance. Typically, one valve or hydrant is maintained per work order.
[16] U.S. Government Accountability Office. *Standards for Internal Control in the Federal Government*. GAO/AIMD-00-21.3.1 (Washington, D.C.: November 1999).

However, we found that the performance measure used by PUD - the number of preventive maintenance work orders completed during the fiscal year, instead of the number of unique valves and hydrants that received preventive maintenance during the five-year cycle – is not an effective measure because it does not provide an assessment of the actual annual progress PUD has made towards its goal of performing preventive maintenance on all appurtenances every five years. As noted above, many valves and hydrants received preventive maintenance multiple times unnecessarily during the five-year reporting period we reviewed. By tracking only the number of work orders completed during the fiscal year, without taking into account whether each appurtenance maintained was actually due for maintenance, the report does not allow supervisors and managers to identify unnecessary repetitive maintenance issues which reduce overall maintenance rates.

We should also note that in some cases, PUD staff may log preventive maintenance work orders as 'complete' in the database, even when crews sent to maintain the valve or hydrant were not able to complete the preventive maintenance request because the valve could not be located, was paved over, or the team sent did not have enough crew members to maintain that particular appurtenance.[17] Although PUD management told us that it is somewhat rare for crews to be unable to perform preventive maintenance upon arriving at the valve or hydrant location, logging these work orders as 'complete' when maintenance was not actually performed also causes performance results to be overstated in the Preventive Maintenance Completed report. We were not able to quantify the overall impact of counting these work orders as complete on overstating performance results because adequate data is not captured in the Sewer/Water Infrastructure Management (SWIM) database for us to analyze.

Lack of Adequate Performance Measures and Reporting Reduces Management Oversight and Accountability of the Valve Maintenance Program

Because PUD only tracks, monitors, and reports the number of preventive maintenance work orders completed, PUD management is not able to ensure that the valve maintenance program is making adequate progress towards its goal of maintaining all valves and hydrants across the City every five years.

[17] As noted in Chapter 4, some appurtenances require three or more crew members to maintain due to location and traffic conditions.

In order to increase PUD management's ability to track and monitor the performance of the valve maintenance program, we recommend that:

Recommendation #2 **The Public Utilities Department should develop performance measurement reports to facilitate effective oversight of and accountability the valve maintenance program and ensure compliance with the five year maintenance cycle policy. Performance measures to be included in these reports should include:**

a) **The number of unique valves and hydrants that have received preventive maintenance during the current maintenance cycle.**

b) **The number and percentage of unique valves and hydrants that have been maintained in each geographic area (for example, each Field Book Page) during the reporting period. (Priority 2)**

Recommendation #3 **The Public Utilities Department should develop a procedure to record in the Sewer/Water Infrastructure Management (SWIM) system when crews in the field discover that preventive maintenance could not be performed on an appurtenance. This procedure should ensure that work orders are not recorded as 'complete' in the SWIM system when maintenance work is not actually performed. (Priority 2)**

Chapter 3

PUD Should Develop a Valve and Hydrant Maintenance Prioritization Plan

As reported in Chapter 2, we found that the Public Utilities Department (PUD) has the goal of maintaining all appurtenances over a five year cycle. This approach can be categorized as a cyclic one with the goal of maintaining all valves and hydrants in the system with the same frequency. PUD does not maintain data on which appurtenances might be higher priority due to their location, purpose, or risk of failure.

An Appurtenance Prioritization System Helps Utilities Best Manage Assets to Prevent Failure

According to the American Water Works Association (AWWA), valve maintenance programs are important to prevent asset failure. For hydrants and other valves, the Water Research Foundation found in a survey of utilities across North America and the United Kingdom[18] that of eight primary factors influencing appurtenance lifespan, maintenance procedures is the second most influential factor. Preventive maintenance does more than lengthen the appurtenance lifespan; it allows utilities to collect information on the condition of the valves and hydrants in their inventory. One Water Research Foundation report explains that for hydrants and isolation valves in particular, poor asset condition may remain unknown until an appurtenance is needed. Without preventive maintenance that determines the asset state, the system is compromised.[19] According to San Diego Fire-Rescue Department, malfunctioning hydrants has not been a problem in the City. Nevertheless, preventive maintenance should be performed appropriately in order to ensure that hydrants continue to operate as intended and allow the City to collect information on hydrant condition.

Our research indicates that it is an industry best practice to use a risk-based approach to prioritize assets for maintenance. This allows a utility to concentrate scarce resources on the most critical valves and hydrants, maintaining those on a shorter time cycle than lower-priority assets. Those assets that have a high consequence of failure should be prioritized for maintenance proactively while those assets with a low likelihood of failure and a low consequence of failure

[18] 25 utilities answered the survey with responses from Australia, New Zealand, the United States, Canada, and the United Kingdom.
[19] Marlow, David R. and David J. Beale. *Condition Assessment of Water Main Appurtenances.* Water Research Foundation. 2012.

should be maintained less frequently and with a more reactive strategy in a resource-tight maintenance environment. **Exhibit 8** demonstrates this concept using examples of criteria some utilities have used to prioritize maintenance of appurtenances.

Exhibit 8

Appurtenance Prioritization Example

	Priority		
Type	Low	Medium	High
VALVE	Small-diameter valves in a high valve redundancy area	Valves that are oldest, but may not be in a high risk location	Valves where flooding or large water shut-off area would occur if valve fails, or high probability of main failure
HYDRANT	Hydrants that are newer and in a high hydrant redundancy area	Mid-age hydrants with no prior maintenance problems	Hydrants near medical facilities

Source: OCA analysis based on industry assessments and selected utilities' practices.

Industry Best Practice Supports a Risk-Based Approach to Preventive Maintenance Using Prioritization

The type of appurtenance determines the consequence of failure. The failure of air valves could affect both water pressure and water quality; the failure of an isolation valve could increase the consequences of a main break, including flooding; and the failure of a hydrant could exacerbate fire damage. A recent study published in the AWWA journal recommends a risk-based approach to appurtenance prioritization that focuses preventive maintenance on critical valves.[20] Factors that could determine the criticality of a hydrant or valve include location, the potential damage from fire or flooding, and in the case of isolation valves, the size of a water shut-off area. The AWWA standard for metal-seated gate valves supports this approach, stating that maintenance of critical metal-seated gate valves should be more frequent than for non-critical valves.

In addition to the AWWA research and standards, a third party assessment of the City's valve maintenance program indicates that

[20] Marlow, David R. and David J. Beale. *Condition Assessment of Appurtenances: A Water Sector Perspective.* American Water Works Association Journal. Vol. 104 Iss. 1, January 2012, E26-E35.

best-in-class utilities are moving to a risk-based prioritization of preventive maintenance activities. The assessment recommended that PUD reset goal achievement metrics with a goal of maintaining high priority appurtenances on a yearly basis.[21] The assessment identifies other utilities with risk-based maintenance programs in place including the East Bay Municipal Utility District and Seattle Public Utilities. A review of the fire hydrant maintenance program for the nearby Sweetwater Authority, which maintains hydrants in National City, Chula Vista, and parts of San Diego County, found that the Authority also considers the criticality of hydrants when assigning hydrant maintenance work orders.

PUD Has Not Implemented a Third-Party Recommendation to Identify Critical Appurtenances for Prioritized Maintenance

PUD does not have a process in place to identify critical valves and hydrants in their database and to file service requests for those appurtenances on a more frequent cycle. The third party assessment of PUD recommended using a risk-based approach to preventive maintenance instead of a cyclical one. PUD has not implemented this recommendation and continues to maintain all valves and hydrants on the same cyclical basis.

Many High-Risk Valves and Hydrants May Be Maintained Less Often than they Should Be

Some valves and hydrants have a higher probability and/or consequence of failure than others due to such factors as the type and age of the appurtenance, type of area served, and potential for the main to break. If these valves and hydrants do not function properly during an emergency, the risk to public safety in the case of fire hydrants and to the environment and public access to water in the case of valves is magnified. According to the San Diego Fire-Rescue Department, malfunctioning hydrants have not been a problem. Nevertheless, valves and hydrants which are deemed critical should be maintained more frequently because preventive maintenance is essential to extend the life of appurtenances.

Because PUD does not use a risk-based approach when performing valve and hydrant maintenance, low-risk appurtenances are maintained at the same frequency as high-risk ones. Furthermore, because PUD does not currently complete enough preventive maintenance to maintain all valves and hydrants on a 5-year cycle,[22] many high-risk appurtenances are maintained less often than may be prudent – and some have not been maintained at all. Under a risk-

[21] In 2009, PUD retained a third-party firm to evaluate various aspects of PUD programs, including the valve maintenance program. The final report was submitted to PUD on Sept. 1, 2010.

[22] PUD reported that the number of preventive maintenance work orders completed declined from 15,493 in fiscal year 2011 to 6,795 in fiscal year 2012 – a decrease of 56 percent. After reviewing workload reports and consulting with PUD management, we determined that this reduction in preventive maintenance performed was primarily the result of staffing issues, such as turnover and crew injuries. In addition, there was a significant increase in non-preventive maintenance work, such as hydrant knock over repairs.

based system, critical valves and hydrants would be prioritized for maintenance, and reductions in resources available for maintenance would usually only impact maintenance schedules for appurtenances deemed non-critical.

In order to ensure that PUD follows industry best practices, we recommend that:

Recommendation #4 **The Public Utilities Department should implement a risk-based approach to valve and hydrant maintenance. This implementation should entail:**

- **The development of criteria to determine which valves and hydrants are the most critical. Criteria to be considered should include type of area served, potential for the associated main to break, potential for damage and injury resulting from appurtenance failure, and the water shut-off area if the valve fails to operate.**
- **The recording of this information in the Sewer and Water Infrastructure Management (SWIM) and System Planning and Locator Application for Sewer and Hydrographics (SPLASH) systems so it is easily accessible to PUD's valve maintenance group when scheduling maintenance activities.**
- **The development of policies and procedures to schedule maintenance according to the criticality tiers developed. These policies and procedures should be developed in conjunction with other audit recommendations.**
- **An analysis to determine if the valve maintenance section is properly staffed to meet requirements of the risk based approach. (Priority 3)**

Recommendation #5 **Upon implementation of a risk-based approach to valve and hydrant maintenance, the Public Utilities Department should work with the City's Information Technology provider to produce reports for each maintenance priority cycle. For example, one report should identify maintenance progress made for valves and hydrants on a one-year high priority maintenance cycle, while another report would identify progress made for valves and hydrants on a ten-year low priority maintenance cycle.**

These reports should include the number of unique valves and hydrants maintained during the reporting period and should detail maintenance progress made by geographic area, consistent with Recommendation #2, above. (Priority 3)

Chapter 4

PUD Crews Can Be Deployed for Hydrant and Valve Maintenance More Efficiently Resulting in an Increase in Appurtenances Maintained

During our review, we found that the Public Utilities Department (PUD) could better utilize personnel resources to ensure valves and hydrants are maintained as efficiently as possible. The current valve maintenance crew structure of three two-person crews and three three-person crews may not be the most efficient use of crew resources. For example, three-person crews are sometimes deployed when a two-person crew would be sufficient. We reviewed a judgmental sample of three weeks where we found that in at least 40 percent of daily deployments a three-person crew was used unnecessarily.[23] While it appears that the supervisor does attempt to group work orders in nearby vicinity, there is no policy to support this practice. In addition, PUD has not established a policy to determine consistently whether a valve or hydrant requires three people, and the infrastructure database contains insufficient information on which appurtenances have required three people in the past.

Resources Should be Used Effectively to Maximize the Impact of the Valve Maintenance Program

Resources should be used in the most efficient way possible to maximize the impact of the valve maintenance program. One of PUD's primary goals is to operate the water system efficiently and effectively.[24] The Independent Rates Oversight Committee articulates the importance of this goal with their vision that, "a high level of public confidence in the City of San Diego's utility services is maintained because the services are provided in the most cost effective and environmentally sensitive way."[25] It is essential to maintain a high level of public confidence in the City's utility services. Accordingly, efficient personnel management may be a key component to effective service delivery.

[23] Our three week sample included the weeks of July 11, 2011, January 23, 2012, and April 23, 2012.
[24] *The City of San Diego Fiscal Year 2013 Adopted Budget: Public Utilities.* 479-480.
[25] *San Diego Municipal Code §26.2001.*

PUD Supervisors Do Not Have the Policies and Information they Need to Plan Work Efficiently

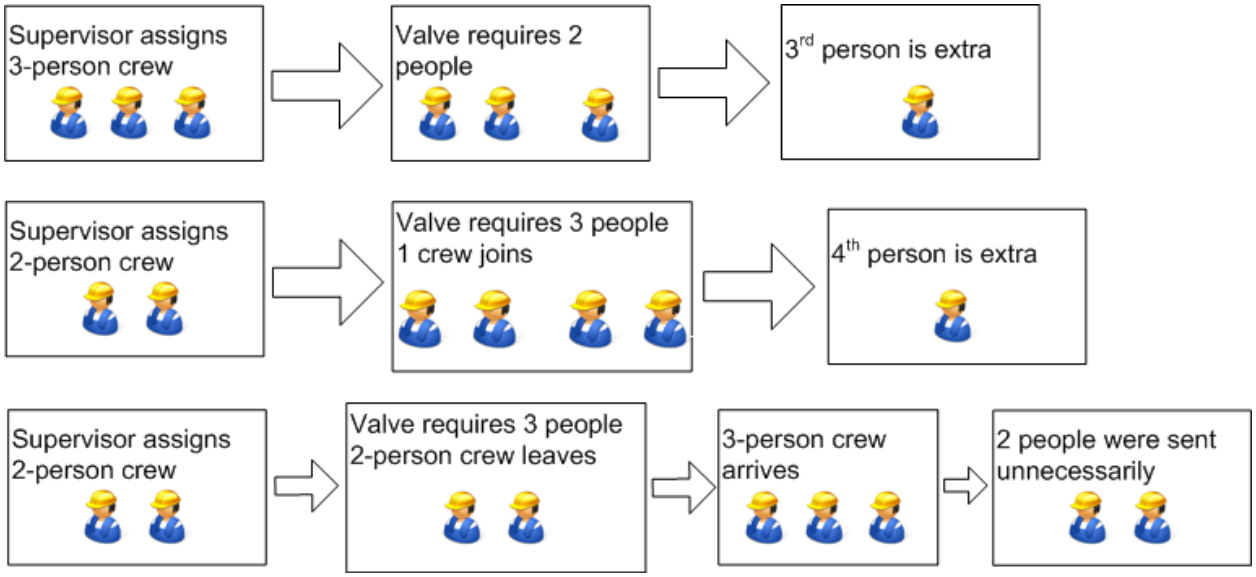
Since supervisors do not have needed information, they lack the ability to quickly and efficiently determine which valves and hydrants require a three-person maintenance crew. According to PUD, three-person crews are only required if the valve is in a vault or on a busy street. Three person crews are also necessary for some hydrant repairs. The database does not indicate when a valve is located on a busy street and there is no formal policy or procedure to determine which valves are located on streets warranting a three-person crew. According to PUD, only 10-15 percent of valves are located on busy streets. Instead of developing a written policy and using the PUD database resourcefully, PUD relies on the judgment of the Valve Maintenance Supervisors. When PUD relies on supervisor judgment rather than a more systematized approach, there is a risk that criteria may not be applied consistently. Without a consistent and objective procedure, crews may be deployed inefficiently, as we saw in our judgmental sample.

There is also no information in the database on whether valves require two or three people. Without this data, PUD cannot effectively deploy appropriately-sized crews to each appurtenance.

While the formal staffing structure is currently six three-person crews, PUD is holding three positions vacant. In practice then, the current structure includes three two-person crews and three three-person crews. Most preventive maintenance activities only require two crew members. PUD has stated that they believe they likely have too many three-person crews, but a formal study of this issue has not been undertaken and a proposal for meet and confer has not been developed. PUD reported to us that they plan to bring a proposal for a new staffing structure to the Labor Relations Office for meet and confer, but there is no documentation of a proposal yet. **Exhibit 9** illustrates three different scenarios that occur under the current staff assignment process.

Exhibit 9

Current Staff Assignment Process is Inefficient



Source: OCA analysis based on information provided by the Public Utilities Department

A Lack of Policies and Procedures as well as Insufficient Information in the Appurtenance Database Results in a Reduced Number of Valves and Hydrants Receiving Preventive Maintenance Within Each Five-year Maintenance Cycle

When an extra person is sent to an appurtenance, resources are wasted. In addition, when two crew members are assigned to a task that requires three people, two crews are often combined to complete the work, when three people should have been deployed from the beginning. The inefficient use of crew members can reduce the number of valves and hydrants that receive preventive maintenance within each five-year cycle.

Resources are also wasted when not planning maintenance activities in close proximity to each other. At present, PUD cannot easily assign three-person activities all to one crew and all in the same part of the City. Without formal policies and procedures, it is difficult for PUD to ensure that maintenance activities will be assigned in close proximity to each other in the future. Failure to take location into consideration results in a waste of appurtenance maintenance resources and reduces the number of valves and hydrants that receive preventive maintenance within each 5-year cycle.

In order to ensure that PUD resources are deployed in the most efficient way possible, we recommend that:

Recommendation #6 **The Public Utilities Department should conduct a formal study to determine the most efficient organizational structure and deployment of valve and hydrant maintenance crews. This study should consider whether operational efficiency would be**

	increased by reducing the number of three-person crews. The study should also consider the total number of crews needed to complete all maintenance tasks within the timeframe established by the department. The results of this study should be documented in formal policies and procedures to provide guidelines for appropriate crew size and to ensure that appurtenance maintenance activities are completed in the most efficient and effective manner. (Priority 3)
Recommendation #7	**Upon completion of the study in Recommendation #7, the Public Utilities Department should work with the Labor Relations Office to present a formal proposal for the restructuring of valve and hydrant maintenance activities to the affected labor unions should reductions in FTE occur as a result. (Priority 3)**

Chapter 5

The City Can Do More to Prevent Valves from Being Covered by Asphalt During Street Resurfacing

During our audit, we found that valve maintenance crews occasionally encounter valves that are covered by asphalt, which can delay preventive maintenance. The Public Utilities Department (PUD) identified 182 valves as having been found covered over a four year period. PUD work crews spend time locating covered valves through a combination of consulting the Water Field Book that shows valve locations on a map, using a metal detector, and digging or using a jackhammer where a valve may be covered. Once the valve is located, crews uncover the valve. After maintenance, crews devote time to repaving around the valve and adjusting the cap up to street level with metal risers. PUD does not currently track the number of buried valves encountered by crews. In addition, PUD does not update the valve and hydrant database when they find a covered valve and uncover it. According to PUD, there is no procedure in place to document when a crew identifies a discrepancy between the location of a valve in the field and its listing in the Water Field Book. Exhibit 10 illustrates a crew member attempting to locate a valve with a metal detector and how gate valve caps appear under normal conditions.

Exhibit 10

Metal Detector Being Used to Locate a Valve (left) & Gate Valve Caps (right)

Source: OCA photograph (left) & Public Utilities Department (right)

When Streets are Repaved, Gate Valve Caps Should be Protected and Adjusted Up to Street Level

The City has a requirement in place to protect gate valve caps during street paving. The City contract for asphalt overlay requires that the contractor protect gate valve covers when paving a street, including those that may have been covered previously.[26] For contract work, Public Works inspectors within the Engineering and Capital Projects (E&CP) division are responsible for assuring that valves are not covered in asphalt as part of their inspection process.[27] Inspectors are required to review contractor work on a daily basis and conduct a final walk-through before approving a project as completed. Contractor work is under warranty for one year, during which the contractor is responsible for correcting any work flaws that are discovered at their own cost.[28] PUD will pay $14,556 to adjust valve covers for the Fiscal Year 2012 asphalt overlay group projects. The cost to PUD varies from year to year depending on the amount of asphalt overlay to be completed.

[26] The Contract requires that contractors comply with the Whitebook, which delineates the valve cap requirements. *The City of San Diego Standard Specifications for Public Works Construction: "Whitebook"*, 191-195. 2010 Edition.
[27] The City Municipal Code provides for the right to conduct random inspections. *San Diego Municipal Code §62.1108.*
[28] *The City of San Diego Standard Specifications for Public Works Construction: "Whitebook"*, 83. 2010 Edition.

Complete and Timely Information on the Condition of Infrastructure is Key to Good Asset Management

While criteria is in place to protect gate valve caps during street paving, government agencies should maintain information on the condition of their infrastructure, such as which caps are found covered, as part of comprehensive asset management. Asset management provides information that managers can use to identify an organization's needs and to make decisions.[29] For more comprehensive asset management, PUD should note when a valve is found covered.

Without an Up-To-Date Copy of the Water Field Book, Inspectors and Contractors Do Not Have All the Information they Need to Protect Gate Valve Caps

During our research period, we found that E&CP inspectors do not have an up-to-date copy of the Water Field Book to identify the location of valves during inspections. Contractors do not have a copy of the Water Field Book at all, and thus may find it difficult to fulfill their contractual obligation to locate covered valves and uncover them. According to PUD, a small subset of covered valves may be on private property or in an unpaved area.[30]

According to E&CP, some valves may have been covered before the division was inspecting as rigorously as they do now. Our November 2010 Street Maintenance Audit found that for inspection of contractor work, "the City lacks the requirements to ensure compliance to acceptable standards."[31] Since that audit, E&CP has implemented a recommendation to put inspection procedures in writing;[32] however, the procedures adopted by the Field Division do not apply to contract work for street resurfacing.

When PUD Staff Spend Time Locating and Uncovering Valves, they are Delayed in Completing Other Valve and Hydrant Maintenance Activities

PUD staff spend valuable time locating, uncovering, and adjusting covered valves. This work takes away from time that could be spent conducting other maintenance activities. Since PUD does not maintain information on covered valves, it is currently unfeasible to quantify and attempt to recover the associated loss. Additionally, because contractors and inspectors do not have in their possession up-to-date Water Field Books, it is difficult for them to ensure that they locate and uncover all valves. Covered valves may not be usable in the event of an emergency.

In order to ensure that PUD uses its staff resources as efficiently as possible, we recommend that:

[29] U.S. Government Accountability Office. Water Infrastructure: *Comprehensive Asset Management Has Potential to Help Utilities Better Identify Needs and Plan Future Investments*. GAO-04-461 (Washington, D.C.: March 19, 2004), 4.
[30] PUD does not currently track this kind of location information in their database, so it is difficult to quantify the extent of this issue.
[31] Office of the City Auditor, *Performance Audit of the City's Street Maintenance: City Needs to Improve Planning, Coordination, and Oversight to Effectively Manage Transportation Assets* (San Diego, CA: Nov. 29, 2010).
[32] Office of the City Auditor, *Audit Recommendation Follow-up Report* (San Diego, CA: Sept. 6, 2011).

Recommendation #8 The Public Utilities Department should develop a procedure for crews to note when they encounter a covered valve, and to use the SWIM database to maintain information on valves found covered so that appropriate action can be taken. (Priority 3)

Recommendation #9 To prevent future valves from being covered, the Public Utilities Department should provide an up-to-date copy of the Water Field Book to inspectors and to contractors. The Field Engineering Division of Engineering and Capital Projects should ensure that inspectors have access to the Water Field Books and use them effectively when conducting inspections of contractor work to ensure that gate caps remain uncovered. (Priority 3)

Recommendation #10 The Field Engineering Division of Engineering and Capital Projects should formalize the current guidelines for the inspection of capital improvement projects for asphalt overlay by transforming the guidelines into a Standard Operating Procedure. (Priority 3)

Chapter 6

The City Can Improve Cost Recovery for Hydrant Knock Overs Through Better Data Collection

We found that the Public Utilities Department (PUD) can ensure full and accurate cost-recovery for hydrant knock overs by improving how it tracks hydrant water loss. PUD and the City have estimated that, on average, 150 City hydrants are knocked over by motorists each year, and in cases where a responsible party is identified in the police report the City's Risk Management Department (Risk Management) is responsible for seeking loss recovery. We found that Risk Management charged a flat rate for water loss, currently about $700, which may result in over or under charging drivers for hydrant knock overs. In one instance we reviewed, a driver was undercharged by approximately $660, while in another case a driver was overcharged by about $220. **Exhibit 11** shows a water geyser caused by a collision with a fire hydrant.

Administrative Regulation 45.80 Requires that the City Document All Losses and Seek Cost Recovery for Losses Resulting from Crimes or Negligence

When City property is lost or damaged due to crimes or negligence, the City is required to seek cost recovery.[33] In doing so, the City must document the loss and provide an estimate of repair costs. The Municipal Code confirms that loss recovery may include the unauthorized use of City water or damage to the City water system.[34] City regulations do not specify whether to recover for estimated or actual water loss. Actual water loss can be calculated easily based on hydrant size and the duration of the water flow.

[33] *City of San Diego Administrative Regulation 45.80: Management of Loss to City Property Due to Crimes or Negligence.*
[34] *San Diego Municipal Code §62.0105.*

Exhibit 11

Hydrant Knock Over Resulting in Water Loss

Source: Public Utilities Department

PUD Does Not Track Specific Water Loss Amounts for Each Hydrant Knock Over Incident

Currently, PUD does not track the water flow time when a vehicle hits a hydrant. PUD work orders do not have a field to note when water flow starts or stops. We reviewed a sample of hydrant knock over police reports from 2010 and 2011. While many of the police reports noted that the officer witnessed either the San Diego Fire-Rescue Department or PUD shut off the water, they rarely noted the amount of time that water flowed. Reports varied with one noting a geyser lasting 90 minutes and another where the driver who collided with the hydrant turned the water off himself before police or fire personnel arrived on the scene. Most reports do not indicate the amount of water flow time.

Risk Management Lacks Information to Charge for Water Losses on a Case By Case Basis and Instead Relies on a Flat Rate for Water Loss

Given that PUD does not track water loss time or calculate water loss amounts, Risk Management lacks sufficient information to charge for loss on a case by case basis and so charges for a fixed amount of water. There is also currently no established calculation tool which Risk Management staff could use to calculate water loss based on

water flow time and the size of the associated pipe. Risk Management uses a fixed charge based on the water that would be lost on average from a four to six inch pipe over forty-five minutes. Though the quantity of water charged remains constant at 437 units (43,700 cubic feet), Risk Management staff adjusts the final charge depending on the current cost of water. In most cases in our sample, there was no dispute, and the driver paid the full amount for hydrant repair, including the water charge.

Charging a Flat Rate for Water Loss Does Not Ensure Full and Accurate Recovery of Losses

Since all drivers are charged for the same amount of water, some may be overcharged or undercharged depending on the amount of water that is actually lost. We reviewed a judgmental sample of 22 hydrant knock over cases that were referred to Risk Management for loss recovery and found that Risk Management sought recovery for water loss in all 16 of the cases where the hydrant emitted water. We found that the City overcharged for water in at least one case and undercharged in another; however, without available data on the length of time water flows, it was impossible to determine the accuracy of many of the water charges in our sample. Without adequately documenting water losses for each hydrant knock over case in accordance with City regulations, the City risks over collecting revenue, which could lead to payment disputes. When the City undercharges, it may not be fulfilling its obligation to seek cost recovery, and a loss is incurred.

In order to ensure that the City collects full and accurate dollar amounts for water losses resulting from fire hydrant knock overs, we recommend that:

Recommendation #11 **The Public Utilities Department should develop a procedure to track water loss time and calculate the amount of water loss from hydrant knock overs on a case by case basis. (Priority 3)**

Recommendation #12 **The Public Utilities Department should work with the Risk Management Department to develop policies and procedures that ensure water loss cost recovery is based on the current cost of water and the actual amount of water lost. (Priority 3)**

Conclusion

The Public Utilities Department (PUD) operates a preventive maintenance program to ensure that the water distribution system operates safely, reliably and efficiently. Preventive maintenance aids systems or components to continue to perform their intended functions throughout their service life. In its FY 11 Annual Report the Independent Rates Oversight Committee (IROC) expressed some concerns that the distribution system valves and hydrants were not the focus of the preventive maintenance program, and that their potential inoperability could exacerbate the impacts of water main breaks and could significantly delay repairs and restoration of services. To address IROC concerns, the Office of the City Auditor conducted a performance audit of the PUD valve maintenance program.

We found that several opportunities exist to improve the efficiency and effectiveness of the valve maintenance program. Amongst our key findings, we noted that if PUD had used its resources more efficiently nearly 15,000 additional valves and hydrants could have received preventive maintenance during the five-year cycle we reviewed. We also noted that PUD does not have a valve and hydrants maintenance prioritization system and thus, valves and hydrants in critical areas of the City receive maintenance at the same rate as appurtenances in low risk areas. Further, we noted that some areas of the City received preventive maintenance repeatedly, while other areas of the City did not receive maintenance during the five-year cycle. We also noted that PUD has inadequate performance metrics to monitor compliance with its five-year maintenance cycle.

To address these issues and others discussed in the report, we made a total of 12 recommendations geared at improving departmental oversight, and efficiency and effectiveness of the valve maintenance program. We believe that if PUD implements the recommendations made in the report, the valve maintenance program would achieve greater efficiencies.

Recommendations

In order to increase the efficiency of the valve maintenance program, reduce the risk of valve or hydrant failure during emergencies, and ensure that preventive maintenance resources are distributed equitably across all areas of the City, we make the following recommendations:

Recommendation #1 Public Utilities Department management should prioritize oversight and training of the valve preventive maintenance scheduler program to ensure that the program is executed effectively. Policies and procedures should be revised to designate responsibility for management-level review of completed work orders on a regular basis to ensure compliance with policy.

In addition, the Public Utilities Department should revise existing policies and procedures to ensure that:

a) Appurtenances are not scheduled for unnecessary preventive maintenance;

b) All appurtenances requiring preventive maintenance in each grid/area receive it before crews move to another area of the City; and

c) Preventive maintenance activities are cycled through all areas of the City. (Priority 2)

In order to increase PUD management's ability to track and monitor the performance of the valve maintenance program, we recommend that:

Recommendation #2 The Public Utilities Department should develop performance measurement reports to facilitate effective oversight of and accountability of the valve maintenance program and ensure compliance with the five year maintenance policy. Performance measures to be included in these reports should include:

a) The number of unique valves and hydrants that have received preventive maintenance during the current maintenance cycle.

b) The number and percentage of unique valves and hydrants that have been maintained in each geographic area (for example, each Field Book Page) during the reporting period. (Priority 2)

Recommendation #3 The Public Utilities Department should develop a procedure to record in the Sewer/Water Infrastructure Management (SWIM) system when crews in the field discover that preventive maintenance could not be performed on an appurtenance. This procedure should ensure that work orders are not recorded as 'complete' in the SWIM system when maintenance work is not actually performed. (Priority 2)

In order to ensure that PUD follows industry best practices, we recommend that:

Recommendation #4 The Public Utilities Department should implement a risk-based approach to valve and hydrant maintenance. This implementation should entail:

- The development of criteria to determine which valves and hydrants are the most critical. Criteria to be considered should include type of area served, potential for the associated main to break, potential for damage and injury resulting from appurtenance failure, and the water shut-off area if the valve fails to operate.
- The recording of this information in the Sewer and Water Infrastructure Management (SWIM) and System Planning and Locator Application for Sewer and Hydrographics (SPLASH) systems so it is easily accessible to PUD's valve maintenance group when scheduling maintenance activities.
- The development of policies and procedures to schedule maintenance according to the criticality tiers developed. These policies and procedures should be developed in conjunction with other audit recommendations.
- An analysis to determine if the valve maintenance section is properly staffed to meet requirements of the risk based approach. (Priority 3)

Recommendation #5 Upon implementation of a risk-based approach to valve and hydrant maintenance, the Public Utilities Department should work with the City's Information Technology provider to produce reports for each maintenance priority cycle. For example, one report should identify maintenance progress made for valves and hydrants on a one-year high priority maintenance cycle, while another report would identify progress made for valves and hydrants on a ten-year low priority maintenance cycle.

These reports should include the number of unique valves and hydrants maintained during the reporting period and should detail maintenance progress made by geographic area, consistent with Recommendation #2, above. (Priority 3)

In order to ensure that PUD resources are deployed in the most efficient way possible, we recommend that:

Recommendation #6 The Public Utilities Department should conduct a formal study to determine the most efficient organizational structure and deployment of valve and hydrant maintenance crews. This study should consider whether operational efficiency would be increased by reducing the number of three-person crews. The study should also consider the total number of crews needed to complete all maintenance tasks within the timeframe established by the department. The results of this study should be documented in formal policies and procedures to provide guidelines for appropriate crew size and to ensure that appurtenance maintenance activities are completed in the most efficient and effective manner. (Priority 3)

Recommendation #7 Upon completion of the study in Recommendation #7, the Public Utilities Department should work with the Labor Relations Office to present a formal proposal for the restructuring of valve and hydrant maintenance activities to the affected labor unions should reductions in FTE occur as a result. (Priority 3)

In order to ensure that PUD uses its staff resources as efficiently as possible, we recommend that:

Recommendation #8 The Public Utilities Department should develop a procedure for crews to note when they encounter a covered valve, and to use the SWIM database to maintain information on valves found covered so that appropriate action can be taken. (Priority 3)

Recommendation #9 To prevent future valves from being covered, the Public Utilities Department should provide an up-to-date copy of the Water Field Book to inspectors and to contractors. The Field Engineering Division of Engineering and Capital Projects should ensure that inspectors have access to the Water Field Books and use them effectively when conducting inspections of contractor work to ensure that gate caps remain uncovered. (Priority 3)

Recommendation #10 The Field Engineering Division of Engineering and Capital Projects should formalize the current guidelines for the inspection of capital improvement projects for asphalt overlay by transforming the guidelines into a Standard Operating Procedure. (Priority 3)

In order to ensure that the City collects full and accurate dollar amounts for water losses resulting from fire hydrant knock overs, we recommend that:

Recommendation #11 The Public Utilities Department develop a procedure to track water loss time and calculate the amount of water loss from hydrant knock overs on a case by case basis. (Priority 3)

Recommendation #12 The Public Utilities Department should work with the Risk Management Department to develop policies and procedures that ensure water loss cost recovery is based on the current cost of water and the actual amount of water lost. (Priority 3)

Appendix A: Definition of Audit Recommendation Priorities

DEFINITIONS OF PRIORITY 1, 2, AND 3
AUDIT RECOMMENDATIONS

The Office of the City Auditor maintains a classification scheme applicable to audit recommendations and the appropriate corrective actions as follows:

Priority Class[35]	Description[36]	Implementation Action[37]
1	Fraud or serious violations are being committed, significant fiscal or equivalent non-fiscal losses are occurring.	Immediate
2	A potential for incurring significant or equivalent fiscal and/or non-fiscal losses exist.	Six months
3	Operation or administrative process will be improved.	Six months to one year

[35] The City Auditor is responsible for assigning audit recommendation priority class numbers. A recommendation which clearly fits the description for more than one priority class shall be assigned the higher number.

[36] For an audit recommendation to be considered related to a significant fiscal loss, it will usually be necessary for an actual loss of $50,000 or more to be involved or for a potential loss (including unrealized revenue increases) of $100,000 to be involved. Equivalent non-fiscal losses would include, but not be limited to, omission or commission of acts by or on behalf of the City which would be likely to expose the City to adverse criticism in the eyes of its residents.

[37] The implementation time frame indicated for each priority class is intended as a guideline for establishing implementation target dates. While prioritizing recommendations is the responsibility of the City Auditor, determining implementation dates is the responsibility of the City Administration.

Appendix B: Objectives, Scope, and Methodology

In accordance with the City Auditor's fiscal year 2012 Audit Work Plan and in response to a request from the Independent Rates Oversight Committee (IROC), we conducted a performance audit of the Water Operations Branch valve maintenance program. The objectives of the audit were to determine: the extent to which the water department's valve maintenance program operated in line with industry standards and practices, as well as internal policies and goals; and the extent to which the valve maintenance program management monitor valve maintenance reports and applicable data to ensure that maintenance scheduling appropriately reflects the areas of the City that experience the highest number of water main breaks and/or present the highest risk. To accomplish our objectives, we performed the following audit procedures:

- Reviewed pertinent laws, policies and procedures, regulations, and agreements related to valve maintenance;
- Interviewed relevant management and staff to obtain an understanding of the valve maintenance program including conducting ride-alongs with valve maintenance crews;
- Analyzed valve and hydrant maintenance data and other asset data as well as GIS data for fiscal years 2007-2012;
- Obtained and analyzed information on industry guidelines and best practices for valve and hydrant maintenance;
- Reviewed a third-party assessment of the City's valve maintenance program,[38] industry standards, research studies and interviewed officials from several major utilities to understand best practices for appurtenance prioritization.

We also assessed the reliability of Public Utilities Department (PUD) data by tracing data to source documents and vice versa as well as reviewing related documentation. We interviewed department officials knowledgeable about the data. While we found that PUD's data on the installation date of each appurtenance contained errors, we determined that the data were sufficiently reliable for the purposes of our report.

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. Our conclusions on the effectiveness of the valve maintenance program our detailed within the report.

[38] This assessment was prepared for PUD in 2010 and includes analysis of valve maintenance activities.

Appendix C: FY 2011 Preventive Maintenance Completed Report

FY 2011
PUBLIC UTILITIES DEPARTMENT
WATER OPERATIONS BRANCH
Goal # 3
Pipelines Citywide
Perform 17,514 PMs on Air Valves, Blow Offs, Hydrants, Valves 6" And Larger)

For the Period of: 7/1/2010 to 6/30/2011

Facility Type	Total Number of Facility Type	FY Goal	# of PMs Completed For Period:	% of Annual Goal	# of PMs Completed For FY:
AIR VALVES (AIRV)	2,689	672	123	18%	123
HYDRANT (HYD)	24,864	6,216	5,896	95%	5,896
BLOWOFF (BLOF)	4,955	991	3	0%	3
VALVE (VALV)	48,176	9,635	9,471	98%	9,471

COMBINED FY TOTALS: (from 7/1/2010 through 6/30/2011)

Total Number for Air Valves, Blow Offs, Hydants, Valves 6" and Larger	Number of PMs To Be Completed During FY:	Number of PMs Completed For The Period:	Number of PMs Completed For The FY	Percent of PMs Completed For The FY:	FY GOAL
80,684	17,514	15,493	15,493	88.46%	100%

Target Schedule

	High Priority (65% of Target)		Low Priority (35% of Target)	
	Fire Hyd	Air Valv	Blow Offs	Gate Valv
100%	6216	672	991	9635
75%	6061	655	966	9394
50%	5905	638	941	9153

Not on target for any achievement

FY Beg = 7/1/2010, FY End = 6/30/2011, FY Elap Days = 364.00, FY Days % = 1.00

Print date: 08/30/2012 2:57:49PM, Data Refresh Date: 08/30/2012 2:56:52PM, Program Start date: 07/01/2010
N:\WaterOperations\FY2011 B2G Gainsharing Reports\FY2011 Goal 3 OPEN AND CLOSED PMS FOR AIRV BLOF HYD VALVES 6 AND LARGER 111910.rpt

THE CITY OF SAN DIEGO

M E M O R A N D U M

DATE: December 28, 2012

TO: Eduardo Luna, City Auditor

FROM: Roger Bailey, Director of Public Utilities

SUBJECT: Management Response to Public Utilities Valve Maintenance Program Audit

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Attached is Management's Response to the Performance Audit of the Public Utilities Department's Valve Maintenance Program. This response has been coordinated with the Public Works and Risk Management Departments and is forwarded for inclusion in the subject audit report.

Roger S. Bailey

Attachment: Management Response

cc: Jay Goldstone, Chief Operating Officer
Wally Hill, Assistant Chief Operating Officer
Tony Heinrichs, Director – Public Works
Greg Bych, Director – Risk Management

Management's Response to Report Recommendations

The City acknowledges the Office of the City Auditor review of the Public Utilities Department Valve Maintenance Program performed in response to a request from the Independent Rates Oversight Committee (IROC). The following summarizes the audit findings and recommendations contained in this report and the City's responses to these recommendations.

Recommendation 1: Public Utilities Department Management should prioritize oversight and training of the valve preventive maintenance scheduler program to ensure that the program is executed effectively. This will provide for management-level review of completed work orders on a regular basis to ensure compliance with policy.

In addition, the Public Utilities Department should revise existing policies and procedures to ensure that:

a. Appurtenances are not scheduled for unnecessary preventive maintenance;
b. All appurtenances requiring preventive maintenance in each grid/area receive it before crews move to another area of the City; and
c. Preventive maintenance activities are cycled through all areas of the City. (Priority 2)

Management Response: Agree with recommendation.

Public Utilities will prioritize oversight and training of the valve maintenance scheduler program to ensure proper execution. Additionally, existing policies and procedures will be revised (inclusive of items a-c above) to designate responsibility for management review of completed work orders.

Date to be completed: June 30, 2013.

Recommendation 2: The Public Utilities Department should revise performance measurement reports to facilitate effective oversight and accountability of the valve maintenance program and ensure compliance with the five year maintenance policy. Performance measures to be included in these reports should include:

a. The number of unique valves and hydrants that have received preventive maintenance during the current maintenance cycle;
b. The number and percentage of unique valves and hydrants that have been maintained in each geographic area (for example, each Field Book Page) during the reporting period. (Priority 2)

Management Response: Agree with recommendation and will follow until Recommendation 4 has been fully implemented.

Public Utilities staff currently produces a department-wide "matrix report" once every three months. The report identifies the number of valves and hydrants that have received maintenance. A report does not currently exist, but will be created, to track hydrant and valve maintenance in geographic areas. The Department will add this process to its existing SOPP.

Date to be completed: June 30, 2013.

Recommendation 3: The Public Utilities Department should develop a procedure to record in the Sewer/Water Infrastructure Management (SWIM) system when crews in the field discover that preventive maintenance could not be performed on an appurtenance. This procedure should ensure that work orders are not recorded as "complete" in the SWIM system. (Priority 2)

Management Response: Agree with recommendation.

Public Utilities staff has now been trained and directed not to close any work order that has not been fully completed. Incomplete work orders will be referred for additional investigation and additional work to ensure preventive maintenance has been fully accomplished. The department will add this process to its existing SOPP.

Date to be completed: June 30, 2013.

Recommendation 4: The Public Utilities Department should implement a risk-based approach to valve and hydrant maintenance. This implementation should entail:

- The development of criteria to determine which valves and hydrants are most critical. Criteria to be considered should include type of area served, potential for the associated main to break, potential for damage and injury resulting from appurtenance failure, and the water shut-off area if the valve fails to operate.
- The recording of this information in the SWIM and System Planning and Locator Application for Sewer and Hydrographics (SPLASH) systems so it is easily accessible to the Public Utilities Department's valve maintenance group when scheduling maintenance activities.
- The development of policies and procedures to schedule maintenance according to the criticality tiers developed. These policies and procedures should be developed in conjunction with other audit recommendations.
- An analysis to determine if the valve maintenance section is properly staffed to meet requirements of the risk based approach. (Priority 3)

Management Response: Agree with recommendation.

The Public Utilities Department will research other utilities for best management practices consistent with the elements of the above recommendation and implement a risk-based approach to valve and hydrant maintenance.

Date to be completed: December 31, 2013.

Recommendation 5: Upon implementation of a risk-based approach to valve and hydrant maintenance, the Public Utilities Department should work with the City's Information Technology provider to produce reports for each maintenance priority cycle. For example, one report should identify maintenance progress made for valves and hydrants on a one-year high priority maintenance cycle, while another report would identify progress made for valves and hydrants on a ten-year low priority maintenance cycle.

These reports should include the number of unique valves and hydrants maintained during the reporting period and should detail maintenance progress made by geographic area, consistent with Recommendation #3, above. (Priority 3)

Management Response: Agree with recommendation.

The Public Utilities Department will work with IT as it implements recommendation 4 above, to leverage available technology to produce reports showing maintenance progress by geographic area and maintenance priority cycle.

Date to be completed: December 31, 2013.

Recommendation 6: The Public Utilities Department should conduct a formal study to determine the most efficient organizational structure and deployment of valve and hydrant maintenance crews. This study should consider whether operational efficiency would be increased by reducing the number of three-person crews. The study should also consider the total number of crews needed to complete all maintenance tasks within the timeframe established by the department. The results of this study should be documented in formal policies and procedures to provide guidelines for appropriate crew size and to ensure that appurtenance maintenance activities are completed in the most efficient and effective manner. (Priority 3)

Management Response: Agree with recommendation.

Public Utilities Department staff will conduct a formal study to determine the most efficient organizational structure for valve and hydrant maintenance and crew structuring. The results will be documented in policies and procedures and will be utilized as guidelines for newly developed SOPP's.

Date to be completed: September 30, 2013.

Recommendation 7: Upon completion of the study in Recommendation 6, the Public Utilities Department should work with Labor Relations Office to present a formal proposal for the restructuring of valve and hydrant maintenance activities to the affected labor unions should reductions in FTE occur as a result. (Priority 3)

Management Response: Agree with recommendation.

The Public Utilities will coordinate with the Labor Relations Department to present formal proposals concerning the restructure of valve and hydrant maintenance activities to the respective labor unions.

Date to be completed: December 31, 2013.

Recommendation 8: The Public Utilities Department should develop a procedure for crews to note when they encounter a covered valve, and to use the SWIM database to maintain information on valves found covered so that appropriate action can be taken.

Management Response: Agree with recommendation.

The Public Utilities Department will develop a new action code within the SWIM database that, when used, will automatically refer valves found covered for appropriate remedial action. The department will add this process to the SOPP.

Date to be completed: December 31, 2013.

Recommendation 9: To prevent future valves from being covered, the Public Utilities Department should provide an up-to-date copy of the Water Field Book to inspectors and to contractors. The Field Engineering Division of Engineering and Capital Projects should ensure that inspectors have access to the Water Field Books and use them effectively when conducting investigations of contractor work to ensure that gate caps remain uncovered. (Priority 3)

Management Response: Agree with recommendation.

The Public Utilities Department's Asset Management Program is preparing to release the 2012 fieldbooks. This year, fieldbooks will be available in hard copy as well as electronically. PDF versions will also be posted on the Public Utilities website. Going forward, the department now has the ability to generate the fieldbooks automatically and will be updating the electronic version every six months from which hard copies can be printed as needed. Field Division will ensure that the inspectors use these books effectively when conducting inspections of contractor work to ensure that gate caps remain uncovered.

Date to be completed: April 30, 2013.

Recommendation 10: The Field Engineering Division of Engineering and Capital Projects should formalize the current guidelines for the inspection of capital improvement projects for asphalt overly by transforming the guidelines into Standard Operating Procedures.

Management Response: Agree with recommendation.

The Engineering and Capital Projects Department has prepared a draft SOP for the inspection of CIP overlay and slurry project inspections. This draft SOP is in the approval process.

Date to be completed: April 30, 2013.

Recommendation 11: The Public Utilities Department should develop a procedure to track water loss time and calculate the amount of water loss from hydrant knock-overs on a case by case basis. (Priority 3)

Management Response: Agree with recommendation.

The Public Utilities Department will review and revise as appropriate its current procedure to ensure that water loss resulting from hydrant knock-overs is more precisely calculated.

Date to be completed: June 15, 2013.

Recommendation 12: The Public Utilities Department should work with the Risk Management Department to develop policies and procedures that ensure water loss recovery is based on the current cost of water and the actual amount of water lost. (Priority 3)

Management Response: Agree with recommendation.

Public Utilities Department staff met with Risk Management staff and both departments agreed that the Public Utilities Department will provide more precise cost recovery data for water loss resulting from hydrant knock-overs. The department will also add this process to its SOPP's.

Date to be completed: June 15, 2013.