Audit Report

AUSTIN WATER UTILITY
CIP: CHANGE ORDERS

October 23, 2007

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City of Austin

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Date: October 23, 2007

To: Mayor and Council

From: Stephen L. Morgan, City Auditor

Subject: Austin Water Utility CIP: Change Orders audit report

I am pleased to present this audit report on change order management for Austin Water Utility (AWU) capital construction. For this audit, we contracted with JCV Engineering (JCV), an engineering firm based in Houston, Texas, that is independent of City of Austin construction. JCV examined a total of 2,961 change orders associated with 67 AWU projects that were completed from 2004 through 2006 to determine if cost and time growth were generally in line with industry standards.

These construction projects are managed by two different groups. One group manages those projects that are within the Austin Clean Water Program (ACWP). Those projects are dedicated to eliminating sanitary sewer overflows within a timeline set by an agreement with the U.S. Environmental Protection Agency. A private firm, Earth Tech, manages the program for the city and oversees the management of all contracts in the ACWP. AWU construction projects that are not within the ACWP are managed by City of Austin employees in the Department of Public Works and in the Utility itself.

We found that both project groups have cost growth slightly above the industry standard and that cost growth containment for both has improved significantly over the last three years.

Average time growth is relevant for internal comparisons within the two respective project groups. However, due to outliers in the data, median time growth is a better indicator of AWU's overall situation. We also found time growth on ACWP projects to be well within the range of the industry standard and that this parameter has also shown significant improvement over the period in review. However, those projects managed outside of the ACWP have time growth significantly outside of the expected industry range and time growth management for this group has become less effective since 2004.

We have issued one recommendation aimed at improving project management on AWU construction projects outside of the ACWP.

We appreciate the cooperation and assistance we received from staff in the Austin Water Utility, the Austin Clean Water Program and the Department of Public Works during this audit.

Stephen L. Morgan, CIA, CGAP, CFE, CGFM
City Auditor

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COUNCIL SUMMARY

This report provides an analysis of change orders in the capital construction program of the Austin Water Utility. This analysis required specific expertise in engineering and construction project management for municipal utilities. The Office of the City Auditor contracted with an engineering firm with such expertise that has not performed engineering or construction project management for any project in the City's Capital Improvements Program (CIP) and does not plan to seek such work in the future. The firm that conducted the analysis is JCV Engineering (JCV), a consulting firm based in Houston, Texas.

The purpose of JCV's analysis was to determine if cost and time growth on the Utility's capital construction projects was within industry standards. Cost and time growth are both managed through the change order process. In the great majority of construction contracts some change orders are necessary. Most agencies and contracting entities try to limit the number and the size of change orders because they actually represent a non-competitive sole source procurement in which the owner is negotiating at a distinct disadvantage.

The industry standard and target adopted by the City of Austin for cost growth is 5% of the original contract value. By analyzing change orders for utility projects completed from 2004 through 2006, we found that the average cost growth on these projects is slightly above the industry standard – 6.64 percent after closeout for projects managed within the Austin Clean Water Program (ACWP), and 6.77 percent after closeout for projects managed through the City's regular project management groups. Additionally, both project management groups show significant improvement at controlling cost growth over the time period examined.

In order to analyze the reasons for change orders, they must be properly classified. Both ACWP and non-ACWP projects were found to properly classify change orders by type of change (i.e. errors/omissions in plans or specifications, unforeseen conditions, value engineering suggestions, or owner requested changes). Analysis of major drivers of cost growth in both project groups can be categorized as actions taken or decisions made by the City rather than the contractor.

While the ACWP project management has improved in controlling time growth over the period under review, the project management for Utility capital construction outside of the ACWP has actually become less effective. The industry standard average range is 10 to 20 percent. Because of some outliers in the data, we opted to use the median time growth for our review in order to have a more accurate picture. The median time growth for all ACWP projects is 9.4 percent, and the median growth for the AWU projects outside of the ACWP is 23.7 percent, which is considerably above industry standard average range.

We have issued one recommendation aimed at standardizing and improving project management outside of the ACWP. Management has concurred with this recommendation.

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ACTION SUMMARY
AUSTIN WATER UTILITY CIP: CHANGE ORDERS

Rec. #	Recommendation Text	Management Concurrence	Proposed Implementation Date
1	In order to improve the time growth on projects managed by the City's project managers, the Assistant City Manager for CIP Management Services should direct the Director of Public Works and the Austin Water Utility Director to establish and appoint appropriate employees to a Project Management Improvement Task Force within the next six months for the purpose of making needed improvements to the internal controls of project management.	Concur	April 2008 (date added by OCA per Assistant City Manager Rudy Garza)

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BACKGROUND

As part of City Auditor's annual service plan for FY 2006-2007, the City Council Audit and Finance Committee approved an initiative to establish an on-going audit presence at the Austin Water Utility (AWU or the Utility). The initial work on this initiative was to begin assessing risk associated with the Utility's various programs and functions. One of the first high risk areas selected for audit was the management of change orders in the Utility's capital construction program.

Because this audit required expertise that the Office of the City Auditor (OCA) does not have on staff, we contracted with the consulting firm JCV Engineering (JCV) to provide expertise in capital project engineering and construction project management, including change order management. JCV is based in Houston, Texas, and is in all ways independent of any ties to any City of Austin CIP engineering or construction project management. The firm also has access to and is knowledgeable of pertinent industry standards.

In the great majority of construction contracts some change orders are necessary. Most agencies and contracting entities try to limit the number and the size of change orders because they actually represent a non-competitive sole source procurement in which the owner is negotiating at a distinct disadvantage. Once a contract has been entered into, changes can represent either cost reductions or increases. What is ultimately desirable is a contract so well prepared that the most cost effective project is constructed without the need for any changes. While this is the ideal, its achievement is, in most cases, a practical impossibility.

Austin's history of sewage overflows has triggered action by the U.S. Environmental Protection Agency. This action, in the form of an Administrative Order issued in 1999, calls for Austin to eliminate overflows by the end of 2007. In November, 2001, the Austin Clean Water Program (ACWP) was created to manage the City's effort to comply with the EPA Administrative Order. Construction on the first ACWP projects began in 2004. From that time to the present, 35 have been completed to a degree sufficient for the analysis used in this audit.

Three different groups manage the projects under review in this audit. A private project management firm manages those projects that fall within the Austin Clean Water Program. The majority of the of the Utility's capital construction projects outside of the ACWP are managed by City of Austin employees in the Department of Public Works (DPW), and a few are managed by City employees within AWU.

Austin has a "true-up" process that affects the statistics. Close out change orders normally are a final adjustment of the actual quantities of work accomplished with those estimated, and upon which the contractor's bid was based. If we assume unbiased accurate estimates of quantities, we would, in the absence of any contract changes, finish with no close out changes. While close out changes reduce the final value of the contracts, they do not really represent a savings. They merely indicate that the amount of items accomplished by the contractor in completing the work was less than had been estimated in the original contract. In other words, it corrects an error in estimating by the design engineer.

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OBJECTIVES, SCOPE, AND METHODOLOGY

Objectives

Our objectives for this analysis were to:

1. Determine if the number and dollar amounts of change orders are within reasonable boundaries compared to industry standards;
2. Determine if there are excessive time delays when compared to industry standards.

Scope

The analysis of ACWP managed change orders includes all projects completed in 2004 through 2006 except those that were not completed to the degree needed for the analysis to be valid. This resulted in the analysis of 601 changes to 35 projects.

The analysis of projects managed from within DPW and AWU includes all change orders on all projects completed in 2005 and 2006 except those that were not completed to the degree needed for the analysis to be valid. Also excluded was one emergency excavation project with an unusually large change in the work that would have improperly skewed the analysis. Five projects completed between April and December of 2004 were also included. This resulted in the analysis of 2,360 changes to 32 projects.

The start date, rather than the completion date is used for ACWP projects, while the completion date is used to group the AWU-CC projects because that was the data available. This would be a problem if we were comparing the groups to each other. However, for internal comparison within each group to its own previous performance, the analysis is valid.

Methodology

JCV used the methodologies described below to meet the project objectives.

JCV interviewed representatives from ACWP project management, Austin Water Utility, and the Public Works Department to gain an understanding of the information available, where it is located and how project documentation is managed. Copies of the procedures dealing with change orders and a small judgmental sample of project files were examined for the purpose of determining what information was available in project files. For the change order analysis, JCV used copies of the Pending Change Order Log for the ACWP projects and the original change order documents for the projects managed by DPW and AWU.

The ACWP projects were analyzed separately from those managed by City employees in DPW and AWU. The decision to segregate the ACWP projects was made because ACWP project management, procedures, and records are somewhat different in nature from those of “normal” city construction projects. The projects managed by DPW and AWU were analyzed as one group and will be referred to in this report as AWU capital construction projects (AWU-CC) projects.

Time growth for each contract was determined by dividing the number of days added to the contract by the number of days allowed in the original contract to reach substantial completion.

A percentage time growth was calculated for each project for which there was data. That data was available for 33 of the 35 ACWP projects and 28 of the 32 AWU-CC projects.
A common system for the coding of changes was used in both The ACWP and the AWU-CC programs. Change orders were grouped for analysis by code designation into three categories: Engineer Error, Unforeseen Conditions, and Owner Responsibility. Close Out changes were analyzed separately.

Spreadsheets were used to describe the plus or minus effect of each change order on the time and cost of each project. Close out changes were used in determining cost before and after close out for each project. Further summations were performed by change category.

Summations from the various columns on those spreadsheets combined with calculations based on those summations provide one basis for the findings in this report. The other basis is the consultant's knowledge of industry standards, as published by the Construction Industry Institute (CII), and the comparison of AWU data to those standards.

Internal controls were examined in-so-far as they related to the reliability of the information used in the analysis. This included determining if change orders were properly classified by type (i.e. errors/omissions in plans or specifications, unforeseen conditions, value engineering suggestions, or owner requested changes), as well as whether data from the actual change orders was properly transferred and summarized in spreadsheets. No control deficiencies were detected that would cause the data used in this analysis to be unreliable. The consultant did note some deficiencies related to records management practices which are outside of the scope of this audit. OCA will issue a management letter that communicates those observations to the appropriate parties along with this report.

The inherent risk of fraud, waste, and abuse in the area of capital construction is high. For both of our audit objectives, we designed and performed tests that provided us with a reasonable basis for detecting fraud, waste, and abuse on the projects examined. These tests were not designed to either detect or assess the risk of fraud, waste, and abuse throughout the entire City of Austin capital improvements program. As a result of these tests, additional concerns have come to our attention that potentially may involve abuse. Further work is needed to determine if these concerns are valid. We are currently assessing the options for follow-up on these concerns.

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.

Those standards also speak to the reliance on work performed by consultants with specialized training and experience (specialists). The standards require that we perform procedures regarding the specific work to be relied on that provide a sufficient basis for that reliance. We have followed this requirement and have determined that we can rely on the work of JCV as the basis for the findings and conclusions in this report.

AUDIT RESULTS

Our audit of the change orders to the Austin Water Utility's capital construction projects over the period from 2004 through 2006 indicates that the average cost growth on these projects is slightly above the industry average irrespective of whether the project was managed within the Austin Clean Water Program or through the City's regular project management groups. Most of the cost drivers leading to change orders are within the City's control. Both the ACWP and AWU-CC project management show significant improvement at controlling cost growth over the time period examined.

Median time growth for the ACWP projects is well within industry standards and time growth management for this group has also improved over the three years studied. However, median time growth for the AWU-CC projects is well above the high end for industry standards and time growth management has become less effective over the time period under review.

Although the average cost increases on the projects examined somewhat exceed the industry standard, AWU shows improvement in cost containment over the time period under review.

While both ACWP and AWU-CC projects show significant improvement in controlling cost growth over the period under review, the average cost increase on both groups is slightly higher than the industry standard. An analysis of change order classifications shows that the biggest cost drivers are within the City's control. Close out costs present a departure from the industry norm in that they are largely negative for both project groups.

Results of change order analysis show that the average cost increase on both ACWP and AWU-CC projects is slightly higher than the industry standard. Industry standards are available for cost increases on capital construction projects. As an upper limit, state law limits contract cost growth to no more than 25 percent. The industry standard is 5 percent. Austin and some other Texas cities use 5 percent (after closeout) as a desirable target requiring special notifications and/or actions when contracts exceed this cost growth.

A common system for the coding of changes is used in both the ACWP and the AWU-CC programs. If we group change orders by code designation into the following three categories, we get a clearer picture of what is driving the cost.

- Engineer Error – changes that resulted from an error, omission, or failure to anticipate a condition or situation that could reasonably have been foreseen on the part of any member of the design team.

- Unforeseen Conditions – changes caused by conditions discovered after contract execution that could not have been reasonably foreseen by any of the parties and which require a change in the contract in order to complete the work as designed.

- Owner Responsibility – changes that do not fall into the unforeseen category and that are not necessary to accomplish the original contract as executed. One of the codes with in this category

is User Request. User Request change orders frequently increase or decrease the contract scope and are typically made at the unsolicited request of the City or its agents.

Exhibits 1 and 2 below show the breakdown of increases and decreases in cost for each of those three categories for the ACWP and AWU-CC projects respectively.

For the ACWP projects, the average net percentage change after closeout is 6.64 percent with a median net change of 8.3 percent. This means that the average change is above the 5 percent target and that more than half of the projects are well above the 5 percent target.

EXHIBIT 1
Average Cost Increase in ACWP Projects by Category

Category	Average % Change	Net % change
Owner Responsible + Owner Responsible -	6.20 2.90	+3.30
Unforeseen Condition + Unforeseen Condition -	3.78 0.11	+3.67
Engineer Error + Engineer Error -	2.72 0.04	+2.68
Close Out + Close Out -	0.30 3.31	-3.01
TOTAL	Absolute Value 19.36%	Net After Close Out 6.64%

SOURCE: JCV Engineering and OCA analysis

For AWU-CC projects, the average net percentage change after closeout is 6.77 percent with a median net change of 6.75 percent. The proximity of the average change to the median indicates that the cost increases by project are evenly distributed around the average, i.e. close to one half of the projects are completed with a net change after close out above the 6.77 average and about one half are completed below the average.

EXHIBIT 2
Average Cost Increase in AWU-CC Projects by Category

Category	Average % Change	Net % change
Owner Responsible + Owner Responsible -	12.08 7.06	+5.02
Unforeseen Condition + Unforeseen Condition -	6.47 3.26	+3.21
Engineer Error + Engineer Error -	1.33 0.04	+1.29
Close Out + Close Out -	1.16 3.91	-2.75
TOTAL	Absolute Value 35.31%	Net After Close Out 6.77%

SOURCE: JCV Engineering and OCA analysis

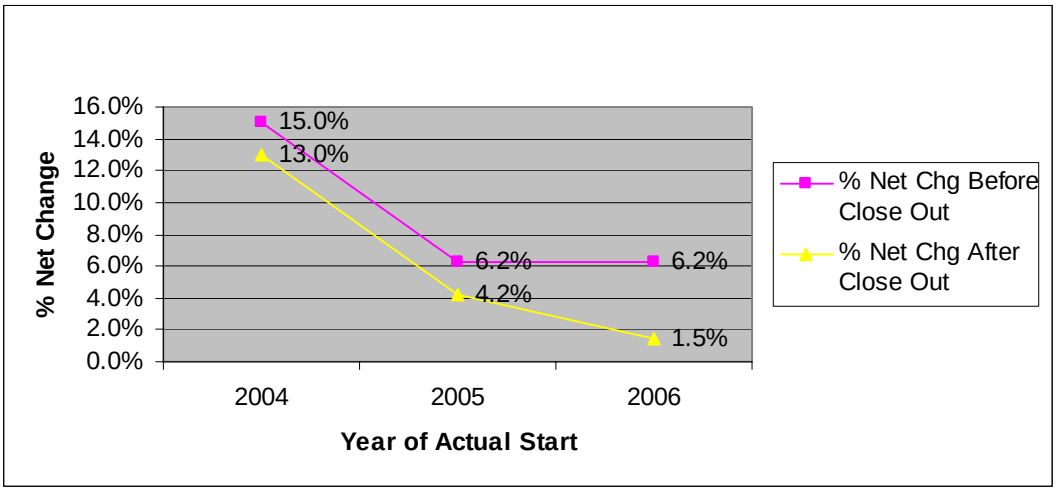
The absolute value of all changes to the work lends perspective to the actual amount of changes made to the projects. While the ACWP projects had absolute change of about 19 percent, the total change required to complete the AWU-CC projects was about 35 percent, or a little over one-third of the original contract amounts.

Further analysis shows that the biggest cost drivers in both groups are within the City's control. The single category of change causing the largest amount of cost increase in both groups is "Owner Responsibility," which are those changes within control of the owner. The code within this category causing the most change in AWU-CC projects and the second most change in AWCP projects is User Request. User Request changes frequently increase or decrease the contract scope and are typically made at the unsolicited request of the City or its agents. In the case of the AWU-CC projects, the Owner Request category makes up the entire 5 percent growth that is the industry standard.

Both groups show significant improvement in controlling cost growth over the period under review. Our analysis of the percentage net changes due to change orders over the time periods reviewed shows that those percentages were reduced over time.

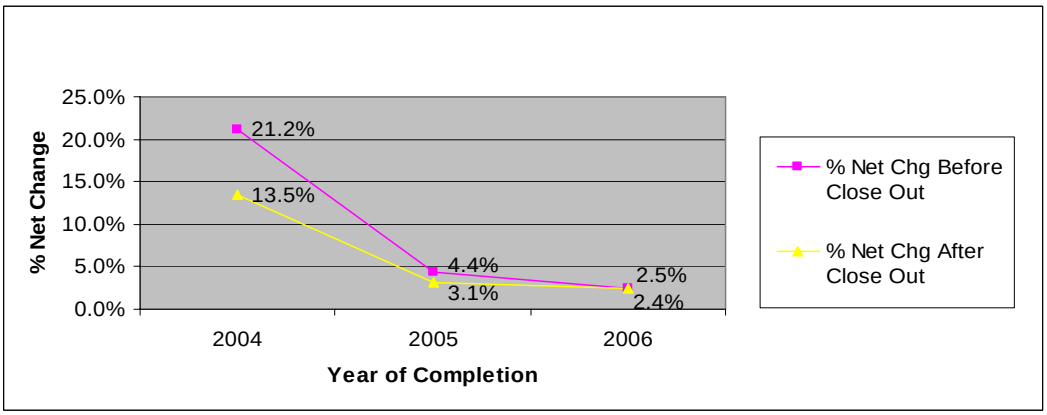
Exhibits 3 and 4 below demonstrate the improvement that each management group has made at controlling cost growth.

EXHIBIT 3
Percent Net Cost Increase in ACWP Projects by Year



SOURCE: OCA graphing of JCV Engineering analysis

EXHIBIT 4
Percent Net Cost Increase in AWU-CC Projects by Year



SOURCE: OCA graphing of JCV Engineering analysis

Close Out costs present a departure from the industry norm in that they are largely negative for both project groups. Close Out is a final 'true-up' of the actual quantities of labor and materials used in the project compared to those that were estimated in the engineering designs upon which the construction contractor's bid was based. If we assumed unbiased accurate estimates of quantities, we would, in the absence of any other contract changes, finish with no close out items to either add or subtract. Lacking perfect estimates, we would expect a normal scatter of the estimates of quantities for the pay items, that is, there would be as many overruns as under runs.

This is not the case with either group of projects under review. In 25 of the 35 ACWP contracts, the Close Out changes resulted in a reduction of the contract cost. For all 35 contracts, we find an average net increase in value of 9.65 percent before close out and average net close out changes of -3.01 percent, resulting in final reported net cost growth after close out of 6.64 percent as shown in Exhibit 5 below.

EXHIBIT 5
Average Cost Increase before/after Close Out in ACWP Projects

Category	Average % Change	Net % change
Total + Change Orders Total – Change Orders	12.70 3.05	+9.65
Close Out + Close Out -	0.30 3.31	-3.01
TOTAL	Absolute Value 19.36%	Net After Close Out 6.64%

SOURCE: JCV Engineering and OCA analysis

For the 32 projects in the AWU-CC group, we find an average net increase in value of 9.52 percent before close out and average net close out changes of -2.75 percent, resulting in final reported net cost growth after close out of 6.77 percent as shown in Exhibit 6 below.

EXHIBIT 6
Average Cost Increase before/after Close Out in AWU-CC Projects

Category	Average % Change	Net % change
Total + Change Orders Total – Change Orders	19.88 10.36	+9.52
Close Out + Close Out -	1.16 3.91	-2.75
TOTAL	Absolute Value 35.31%	Net After Close Out 6.77%

SOURCE: JCV Engineering and OCA analysis

This issue of negative close out values does not appear to cost the City money or time. However, it masks the true effect of changes and is not consistent with random errors or occasional mistakes in estimating. Our analysis attempts to differentiate between the effect of change orders both prior to and after close out wherever possible.

Change orders are properly categorized by type of change. A small sample of projects was chosen at random for a detailed examination of the selected source documents to ensure that our understanding of the coding system for change was aligned with that used by the individual entering the data into the records. Change orders were reviewed for completeness and proper

placement of work changes in change order categories according the DPW Procedure manual. We found no major deviations.

Median time growth for the ACWP projects falls at the lower end of the industry standard; this parameter is significantly higher than industry standard for the AWU-CC group.

Average time growth is relevant for internal comparisons within the two respective project groups. However, due to outliers in the data, median time growth is a better indicator of AWU's overall situation. While time growth has both indirect and direct costs associated with change orders, it is difficult to determine the exact cost of time growth for AWU's projects because the recordkeeping is not specific enough.

Industry Standards are available for time growth on capital construction projects. When changes to the work occur in a construction project, one result can be that additional time is needed to achieve completion as specified in the contract. Time extensions can also be caused by weather or other factors beyond the owner or contractor's control. Recent research[1] has identified the industry average for projects that are accomplished with project delivery methods and processes similar to those used by the City to be within the range from 10 to 20 percent.

Average time growth is relevant for internal comparisons within the two respective project groups. When grouping the projects by year we used the contract start date for ACWP projects and the year of completion for the AWU-CC projects because this is the information that was available to us. Inconsistent grouping would be inappropriate if we were comparing the two groups to each other. However, it is appropriate for trending within each respective group. This parameter shows that while the ACWP project management has improved at controlling time growth over the period under review, the AWU-CC management has not.

Exhibits 7 and 8 below show time growth trends for ACWP and AWU-CC projects respectively.

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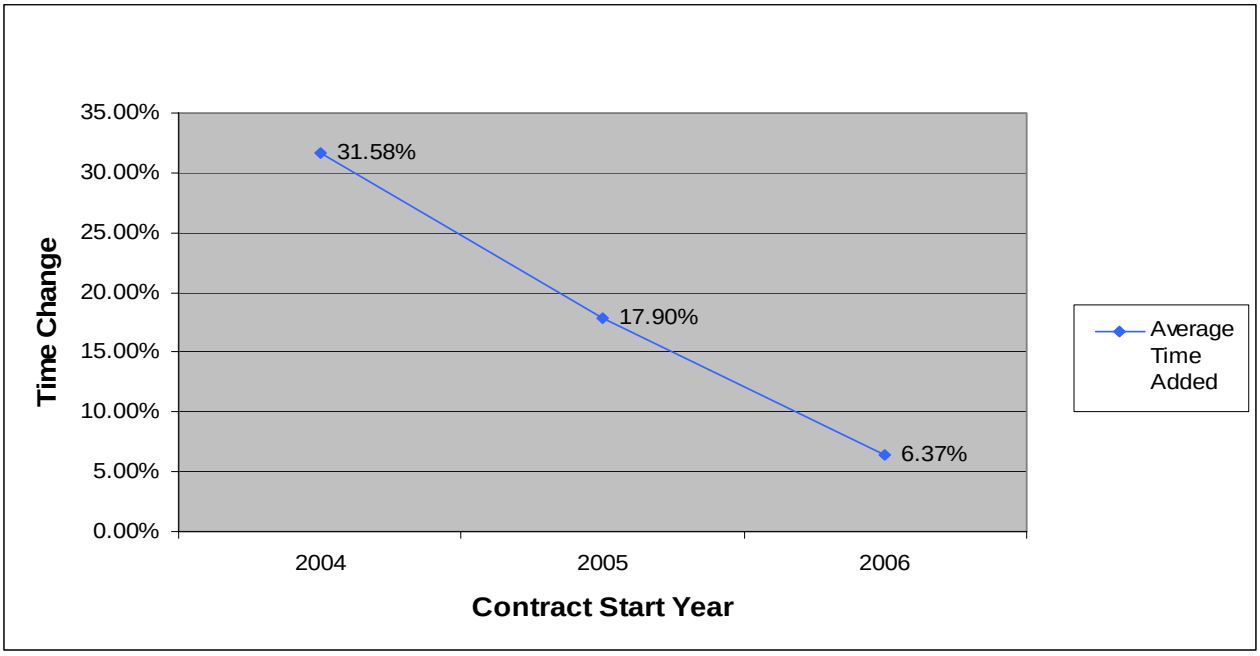
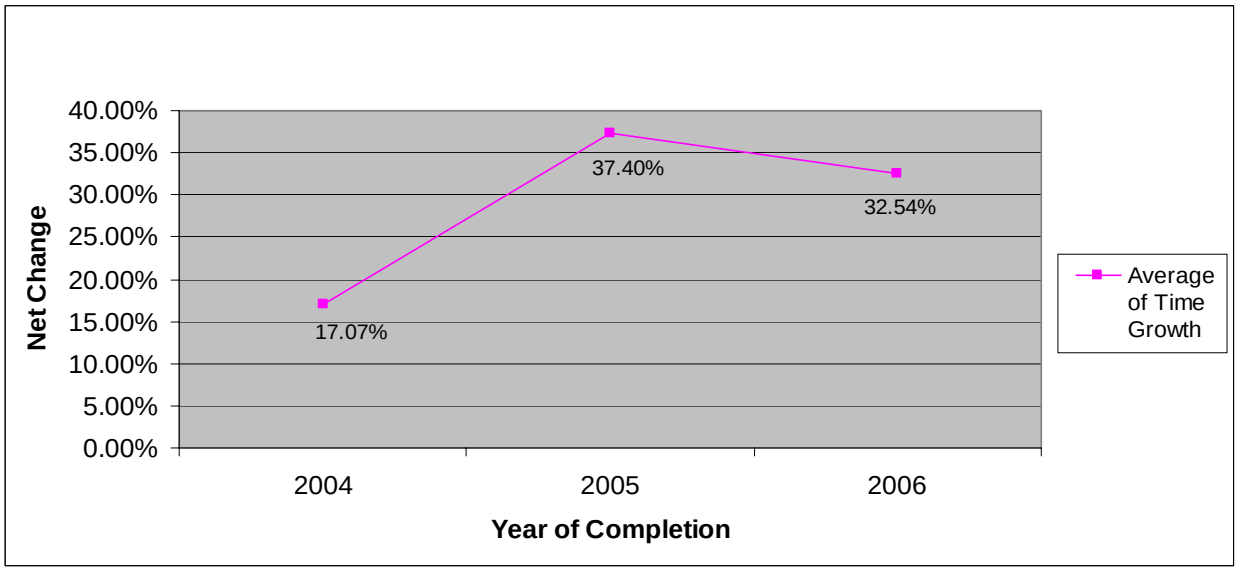
[1] *Construction Change Orders* , James J O'Brien, McGraw-Hill-Copyrigh 1998; and *Early Warning Signs of Project Changes*, Alaa A. Zeitoun and Garold D. Oberlander under the guidance of the Change Order Impacts Task Force of the Construction Industry Institute (CII) study in conjuction with Oklahoma State University – April 1993.

EXHIBIT 7
Average Time Growth in ACWP Projects by Year



SOURCE: OCA graphing of JCV Engineering analysis

EXHIBIT 8
Average Time Growth in AWU-CC Projects by Year



SOURCE: OCA graphing of JCV Engineering analysis

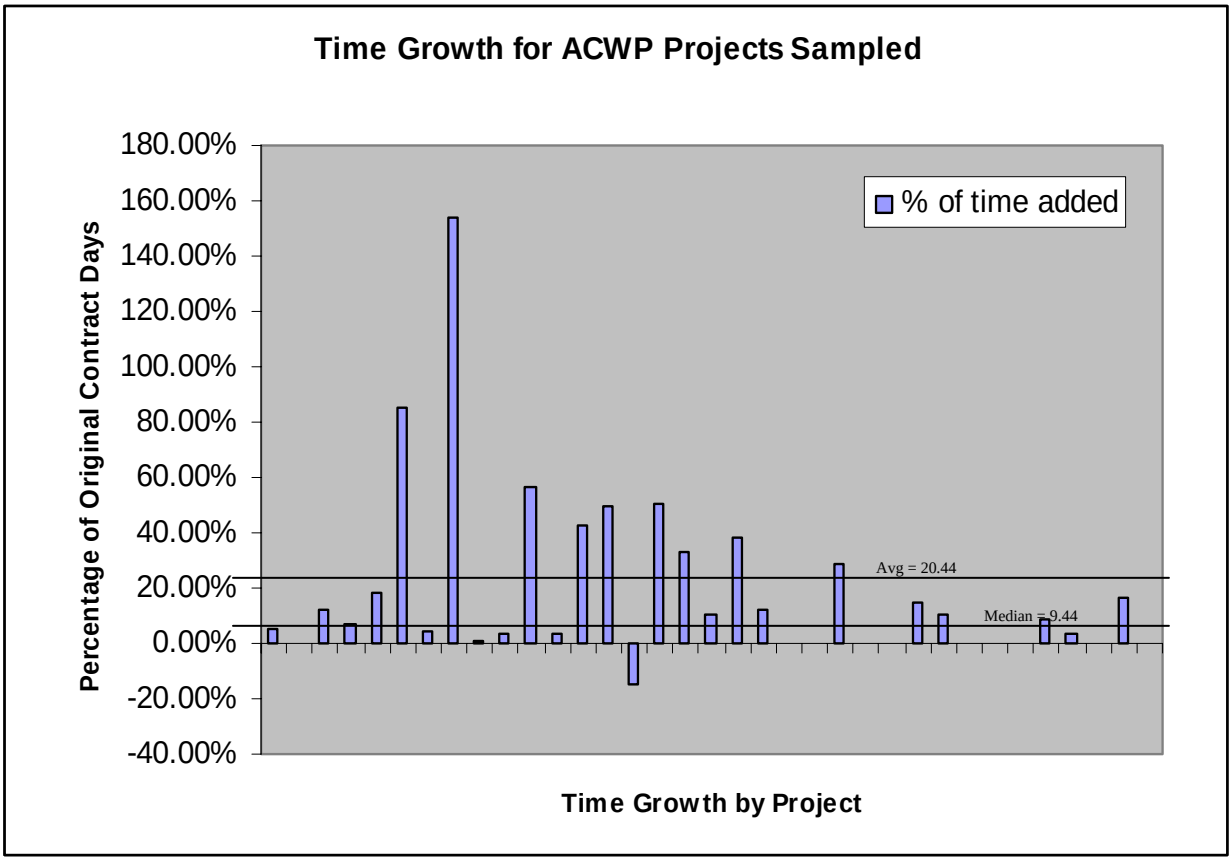
Due to outliers in the data, median time growth is a better indicator of AWU's overall situation. Although the average time growth for the ACWP and AWU-CC projects are both above industry average, a closer examination of the data shows that time growth average for

both groups is unduly affected by a relatively limited number of extremely large or very small values. These outliers in the data skew the average and suggest that the median is a better indication of central tendency for this analysis.

The median time growth for all ACWP projects is 9.44 percent (See Exhibit 9 below). The median growth for the AWU-CC projects is 23.7 percent (See Exhibit 10 below), considerably higher than the ACWP project group and also above the expected 10 to 20 percent that is the industry standard.

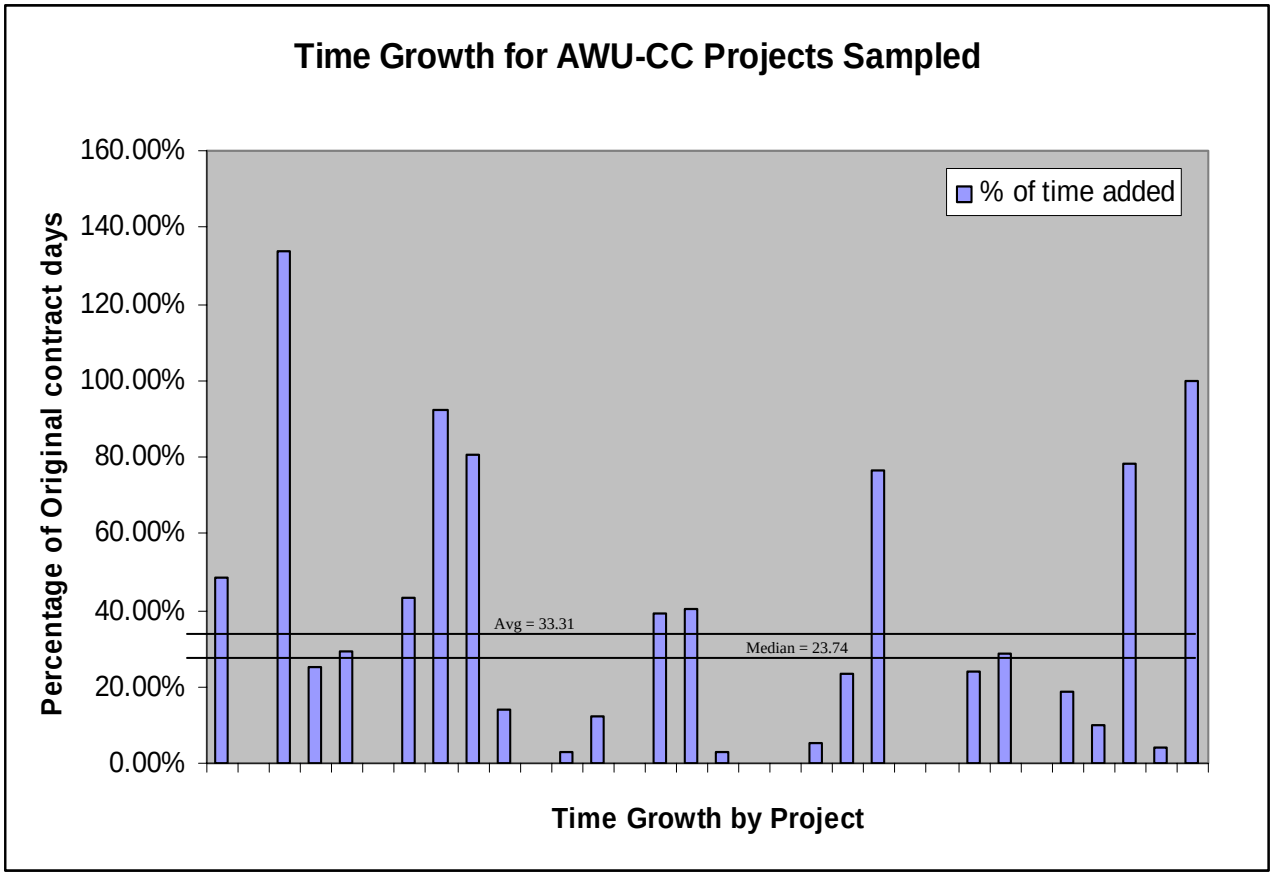
Exhibits 9 & 10 below show the percentage of time growth by project for both ACWP and ACWU-CC projects.

Exhibit 9
Time Growth by Project – ACWP



SOURCE: OCA graphing of JCV Engineering analysis

Exhibit 10
Time Growth by Project – AWU-CC



SOURCE: OCA graphing of JCV Engineering analysis

It is difficult to determine the exact cost of time growth for AWU's projects because of the recordkeeping process. As previously noted, there are many reasons for change orders that result in additional time to complete the changed work. Irrespective of the reasons for change orders, there are usually both direct and indirect costs associated with adding time for project completion. However, without specifically accounting for added costs within the change order process, those costs cannot be identified.

Recommendations (draft)

01. In order to improve the time growth on projects managed by the City's project managers, the Assistant City Manager for CIP Management Services should direct the Director of Public Works and the Austin Water Utility Director to establish and appoint appropriate employees to a Project Management Improvement Task Force within the next six months for the purpose of making needed improvements to the internal controls of project management.

MANAGEMENT RESPONSE:

MEMORANDUM

TO: Steve Morgan, City Auditor

FROM: Rudy Garza, Assistant City Manager

DATE: October 18, 2007

SUBJECT: Response to Audit Recommendations

I have reviewed and approved the Austin Water Utility's and the Public Works Department's responses to the audit recommendations in OCA's draft report on CIP change orders. Attached is management's response to the audit recommendations.

Devon Madrigal for
Rudy Garza
Assistant City Manager

Attachments

cc: Greg Meszaros, Director, Austin Water Utility
Perwez Moheet, CPA, Deputy Director
Gopal Guthikonda, P.E., Assistant Director, Engineering Services
Joe Ramos, Acting Director, Public Works
Sam Angoori, Acting Assistant Director

MANAGEMENT RESPONSE:

Concurrence – Prior to the audit, Management implemented new procedures to provide for oversight of contract compliance, accounts payable and accounts receivable. Both the Austin Water Utility and Public Works Department recently added positions to their internal audit functions to perform compliance audits, financial analysis, and payment and budget verifications. In 2007, the Program Management Office (PMO) was created within Public Works to support the Project Management Division in its goal of effectively delivering Capital Improvement Projects. The PMO will assist with tracking, monitoring and controlling project schedules and budgets, including change orders. The PMO includes a position for a Quality Assurance/Quality Control (QA\QC) engineer to focus on quality issues related to capital improvement (CIP) projects. Also in 2007, a Change Control Process was developed and implemented. Project managers are now required to submit a Change Request to the Change Control Board for any changes which affect the overall project schedule or budget. This will increase the level of management control over the change order process.

In addition, Management will also need to further analyze the data provided in the audit to better understand the factors that contribute to time growth; stakeholder participation, weather, etc, on the projects managed by the City's Project Managers.

Although both departments have already taken steps to improve contract management, especially as it pertains to change orders, Management does concur that there is some need for improvement to the internal controls of project management.

Responsible Individual – Within the Austin Water Utility, the Assistant Director of Engineering Services, Gopal Guthikonda, is responsible for implementing the recommendations. Sam Angoori, P.E., Acting Assistant Director of Public Works will ensure that these actions are taken and the recommendation is implemented.

ACTION PLAN
Austin Water Utility
CIP change Orders Audit

Rec. #	Recommendation Text	Proposed Strategies for Implementation	Status of Strategies	Responsible Person/Phone Number	Proposed Implementation Date
1	In order to improve the time growth on projects managed by the City's project managers, the Assistant City Manager for CIP Management Services should direct the Director of Public Works and the Austin Water Utility Director to establish and appoint appropriate employees to a Project Management Improvement Task Force within the next six months for the purpose of making needed improvements to the internal controls of project management.	Management will continue with the already implemented contract management programs. Regular reporting and meetings will ensure stronger coordination between Austin Water Utility and the Public Works Department.	Planned	Austin Water Utility's Assistant Director of Engineering Services, Gopal Guthikonda, 972-0240 Sam Angoori, P.E., Acting Assistant Director of Public Works; 974-9753	April 2008 (date added by OCA per Assistant City Manager Rudy Garza)