Final Report

INDEPENDENT REVIEW OF THE WATER SYSTEM IMPROVEMENT PROJECT (WSIP) CONSTRUCTION MANAGEMENT PROGRAM

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Prepared for:

San Francisco Public Utilities
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EXECUTIVE SUMMARY

An Independent Review of the San Francisco Public Utility Commission (SFPUC) Water System Improvement Program (WSIP) was conducted during the week of October 3, 2011. The review was specifically focused on the Construction Management (CM) Program and addressed three specific areas of interest to the San Francisco Public Utilities Revenue Bond Oversight Committee (RBOC). The areas studied were Change Management, Risk Management and Project Cost, Schedule and Contingencies. A list of questions was developed to help define the specific issues to be addressed and was used in undertaking the review.

The review was conducted by an Independent Review Panel (IRP) that was initially retained by the SFPUC to perform periodic reviews of the construction management program. However, this review was commissioned by the RBOC, an oversight committee representing regional and city ratepayers. The IRP consists of the following construction industry professionals: Gary Griggs, Stanford University, who served as Panel Chair; Glenn Singley, Los Angeles Department of Water and Power; Don Russell, Independent Consultant; and Galyn Rippentrop, Independent Consultant. Bill Ibbs of the University of California at Berkeley participated in the review as an Independent Observer on behalf of the RBOC.

The review consisted of interviews with CM Team staff, site visits to a number of on-going construction projects, attendance at various project meetings and review of relevant project reports and documents. The review was specifically focused on the performance of the construction management team in handling change management, risk management, and project cost schedule, contingencies for the on-going construction program. The specific construction projects reviewed were the Bay Division Pipeline (BDPL) – East Bay, the Sunol Valley Water Treatment Plant (SVWTP), the New Irvington Tunnel (NIT) and the Crystal Springs/San Andreas (CSSA) Transmission Upgrade. These projects were chosen based on their status of construction and identified issues relevant to the review.

This is the second review performed by the IRP with the previous one being conducted in November 2010 and a report issued in January 2011. The first review focused on specific organization, procedures and performance aspects of the CM program.

The IRP members were selected to serve on the Panel based on their extensive construction industry experience, which would permit assessments to be made based on relatively quick reviews of the CM Program. For this second review the IRP was asked to perform more detailed analysis and provide benchmarking data to support their findings and recommendations. The primary source of benchmarking was the Multi-Project CIP Benchmarking Program Phase 4 Final Report dated 2009 that was sponsored by the Metropolitan District of Southern California and prepared by MWH. It includes a comprehensive study of best management practices based on surveys of eleven water related agencies. In particular, it addresses key performance indicators related to project delivery. One of the IRP members, Mr. Singley, represented his agency which participated in the study.

The findings of the IRP for this second review are as follows:

General: The IRP continues to be impressed by the very comprehensive and highly qualified CM Team, the CM Plan and Procedures that have been put in place, and the overall management of the program. The WSIP is a massive program consisting of 86 separate local and regional construction contracts taking place over more than a decade. As such, there are tremendous challenges in managing cost and schedule performance which is a focus of this review. The IRP feels that the SFPUC has in place a CM

Program which greatly enhances the possibility of achieving a successful project and meeting cost and schedule goals.

Change Management: ***The change management procedures are excellent and meet or exceed industry standards.***
There appears to be a clear understanding of the procedures and they are generally being successfully implemented. Change orders related to cost appear to be effectively managed on a project-by-project basis tracking them through the actual, potential, and pending stages, including trends and risk components, and measuring performance against allocated contingencies. The BDPL- East Bay and the SVWTP both have large numbers of cost-related change orders attributable primarily to design errors and omissions, differing site conditions and other causes. In the case of the BDPL-East Bay, there has been a problem in managing the changed conditions. In particular, there was an excessive use of force account work in lieu of change orders. Management actions have been taken to address this problem including staffing changes, adding additional resources, strengthening procedures, and providing additional oversight. However, it does indicate a potential weakness in implementation and oversight of change management that could be problematic for the WSIP if it reoccurs on other projects and therefore warrants close attention by WSIP CM management. It appears that the change orders on the SVWTP are being effectively handled. In aggregate, cost-related change orders for currently active or completed Regional construction projects appear to be within acceptable industry ranges as a percent of total construction contract award value.

There are also well-defined procedures in place for schedule-related change management. Time impact analyses are conducted for any proposed change to assess the effect on the overall program. The critical path for the program appears to be based, in large part, on the shutdown schedules. The tracking and reporting of schedule-related changes was not as clear to the IRP as the reporting for cost-related changes both at a project level and for the program as a whole. This is most likely the result of the more complex nature of schedule tracking and management on a multi-project basis. Some of the current program reports, such as the Contract Summary report, do not by themselves provide a complete picture of program schedule performance.

Risk Management: ***There is a very effective risk management program in place that, in the opinion of the IRP, is one of the best examples being used for a construction program.***
The risk management procedures are excellent and the entire team, including at the program level, regional level and project level, appear to be complying based on the projects reviewed, interviews conducted and documents reviewed. Thorough risk assessments are conducted at the beginning of each project and involve all key staff including the contractor. The risk registers resulting from these assessments are used for management purposes over the course of the project construction. It doesn't appear that there have been many surprises if any resulting from unidentified risks and there were examples of avoidance and effective mitigation when identified risks were encountered. The cost-related risks are very effectively incorporated into the cost management process by including them in project contingency assessments. It was not as clear to the IRP how the time-related contingencies were being used for schedule management and reporting.

Project Cost, Schedule and Contingencies: ***The cost, schedule and contingency management procedures are excellent and meet or exceed industry standards.***
Project cost management appears to be very effective and depends on the change management procedures. The Construction Management Information System (CMIS) provides timely information and regular forecasting. Two of the projects studied, the BDPL-East Bay and SVWTP are both experiencing

significant cost increases over the original construction contract award amount due to the large number of change orders for each project. Lessons learned from these projects should be applied to future work to help avoid such overruns on other projects and on the overall program. A review was conducted of the reported status of all Regional projects that are completed or currently under construction and it appears that they are tracking within budget. There is also an additional management reserve due to the construction award amounts being under the construction project budgeted amounts.

Project schedule management also appears to be very effective based on strong procedures and construction contract requirements. Reporting is based on a Primavera Version 6 (P6) construction contract schedule platform. Given the more complex nature of schedule analysis, it was not clear to the IRP how the individual project construction schedules relate to the original award contract schedules or to the overall WSIP performance. It is recommended that schedule change management reporting systems be further developed to allow for better reporting of actual and forecast schedule performance compared to the original contract schedules and to the overall WSIP performance. Two of the projects studied have significant schedule overruns. However, it is not clear what the impact of those schedule delays will be on the overall program.

Contingencies are assigned to each construction contract at ten percent of the award amount. Contingency management is used very effectively for managing cost growth. Contingency assessments are performed on a monthly basis for each project and include change orders (actual, pending and potential), trends and risk components. If the cost increases exceed the original ten percent contingency allowed, management must get approval from the Commission for increases. The ten percent contingencies related to project schedules are used for early warning purposes and reporting to the Commission. However, the aggregation of these individual project contingencies does not provide an accurate assessment of schedule performance at a program level because of the more complex nature of the schedule interrelationships of individual projects on a multi-project program.

Recommendations:
Following are the major IRP recommendations:

1. ***Perform an audit of the latest Earned-Value Analysis or, alternatively, perform a Cost- and Schedule-to-Complete Analysis, in order to check the forecast of overall WSIP cost and schedule performance.***

2. ***Revise the current Contract Summary reporting to better reflect the actual program schedule change management process being used and establish a policy for what change orders and trends are to be considered for identifying program performance problems for both cost and schedule.***

3. ***Verify that there are system-wide Emergency Procedures in place including evacuation, notification, regular drills and training at all construction field offices.***

4. ***Assess the earthquake provisions related to construction ways and means.***

BACKGROUND

The San Francisco Public Utilities Commission (SFPUC) received a report on the Water System Improvement Program (WISP) from a five-person Independent Peer Review Panel on January 19, 2010. One of the Panel's recommendations was to:

"Conduct an independent test/audit of the Construction Management (CM) organization mid-to-late 2010 to verify performance. Because the CM organization is at the beginning of a steep ramp of work, it would be prudent for the SFPUC to commit to evaluate it shortly after the large projects have begun. At that time the organization can be adjusted to address any problems that have become evident once the organization has been put to the test."

With respect to that recommendation, the SFPUC authorized the WSIP Program Manager, Parsons, to contract with four senior-level construction management industry professionals, the Independent Review Panel (IRP), to conduct an independent review of the WSIP's current Construction Management Program. Parsons originally contracted with the IRP members is October/November of 2010. It was anticipated that the IRP would be asked to perform three CM reviews. The IRP conducted its first on-site review in October/November of 2010 and prepared a Report for submittal to the Commission prior to the end of December 2010. That review included a fairly broad look at the CM organization, procedure, reporting and performance.

The IRP was commissioned again in September 2011 by the RBOC to conduct the second review in October/November of 2011 including a one week on-site visit during the week of October 3, 2011. This review primarily addressed three recently identified areas of interest to the RBOC. Questions were identified to help define the specific issues to be addressed and were used in undertaking the review.

The IRP consists of the following construction industry professionals: Gary Griggs, Stanford University, who served as Panel Chair; Glenn Singley, Los Angeles Department of Water and Power; Don Russell, Independent Consultant; and Galyn Rippentrop, Independent Consultant. Bill Ibbs of the University of California at Berkeley participated in the review as an Independent Observer on behalf of the RBOC. Brief bios of the panel members are provided in the Appendix.

SCOPE OF THE REPORT

A scope of services and work plan was developed before the start of the review covering the three areas requested by the RBOC. The specific scope was developed jointly by Bill Ibbs and Gary Griggs, and reviewed and approved by the RBOC. The scope included a brief review of relevant project documents and reports, a one week on-site visit to the WSIP headquarters office in San Francisco including visits to four construction project sites, attendance at various meetings, interviews with key staff and a debriefing with senior RBOC and SFPUC management. The list of people interviewed, projects visited and review itinerary are included in the Appendix. In accordance with the charter of the IRP, the review was specifically focused on the performance of the WSIP CM Team during the current construction phase of the program. The IRP was also asked to make recommendations regarding areas of concern for future review and oversight. It should be cautioned that the findings and recommendations of the IRP for this report are based on a very limited review, and, as a result, they are not intended to reflect the overall WSIP performance and should not be generalized without more detailed review and analysis. However, they should be helpful in addressing issues that could be beneficial to the overall program success.

FINDINGS AND RECOMMENDATIONS

The findings of the IRP CM Review are presented as responses to, and discussion of, the specific questions making up the scope of services. Recommendations and Next Steps are also provided.

A. Change Management

Changes over the course of construction of any infrastructure project or program are one of the most significant factors in cost and schedule growth. While it is difficult to avoid changes, it is important to limit them to those that are essential and to have a formal and controlled change order process to manage them. The WSIP Change Management Procedure sets out a very well defined and controlled process for managing project changes. Cost-related change orders for the WSIP are characterized as potential, pending and approved depending upon their stage of development, review and approval. Trends are used for early identification of possible future cost-related changed conditions well in advance of the formal change order process. Cost contingencies are provided to allow for additional costs within which the changes are managed. For schedule-related change orders a time impact analysis is performed prior to accepting or rejecting the change. The WSIP procedures are set forth in Construction Management Procedure 016, Construction Change Management. Specially developed project control and construction management software (Oracle's P6 and Contract Manager) are being used to manage changes and control their impacts on cost and schedule. The CM review addressed the following specific questions:

1. **Are the change orders in excess of the cost and schedule contingencies provided?** ***In total, the cost-related change orders appear to be within the specified contingencies and schedule-related change orders appear to exceed the contingencies as reported.***

   Of the individual projects reviewed, the Bay Division Pipeline (BDPL) No.5 – East Bay and the Sunol Valley Water Treatment Plant (SVWTP) have exceeded their contingency allowances for cost. The contingency allowance has subsequently been increased for Sunol Valley WTP as indicated on the WSIP Active Construction Contracts Report, Approved Pending, Potential CCs, Trends & Risks vs. Contingency as of September 30, 2011 (see Figure 1). The New Irvington Tunnel (NIT) has incurred 118 days of schedule extension and the Sunol Valley WTP is trending a delay of approximately three months. For all Regional projects currently under construction, and including all cost-related change orders, trends and risks, some are within their original 10% cost contingency and some have required contingency increases. A number of projects are experiencing significant schedule delays and need attention.

   As of August 31, 2011 (see Table 1) there has been $46.6 million worth of cost-related change orders approved within the WSIP program, which represents a 2.6% increase in costs based on the original construction contract award values or 21% of the revised 12% contingency and 26% of the original 10% contingency. When pending and potential change orders plus trends are added, the increase in costs adds up to 6.2% in excess of the original contract award values or 51% of the 12% contingency and 62% of the original 10% contingency. As noted in the report, the cost increase including all change orders and trends needs attention because it exceeds the 41% contract completion status. However, it should be pointed out that this analysis includes some trend-related costs that will occur at a future time beyond the 41% completion stage and also includes Local WSIP projects which are not part of the review. The inclusion of potential

change orders and trends in the forecasting may result in an overly conservative, meaning worse than actual, assessment of summary level performance.

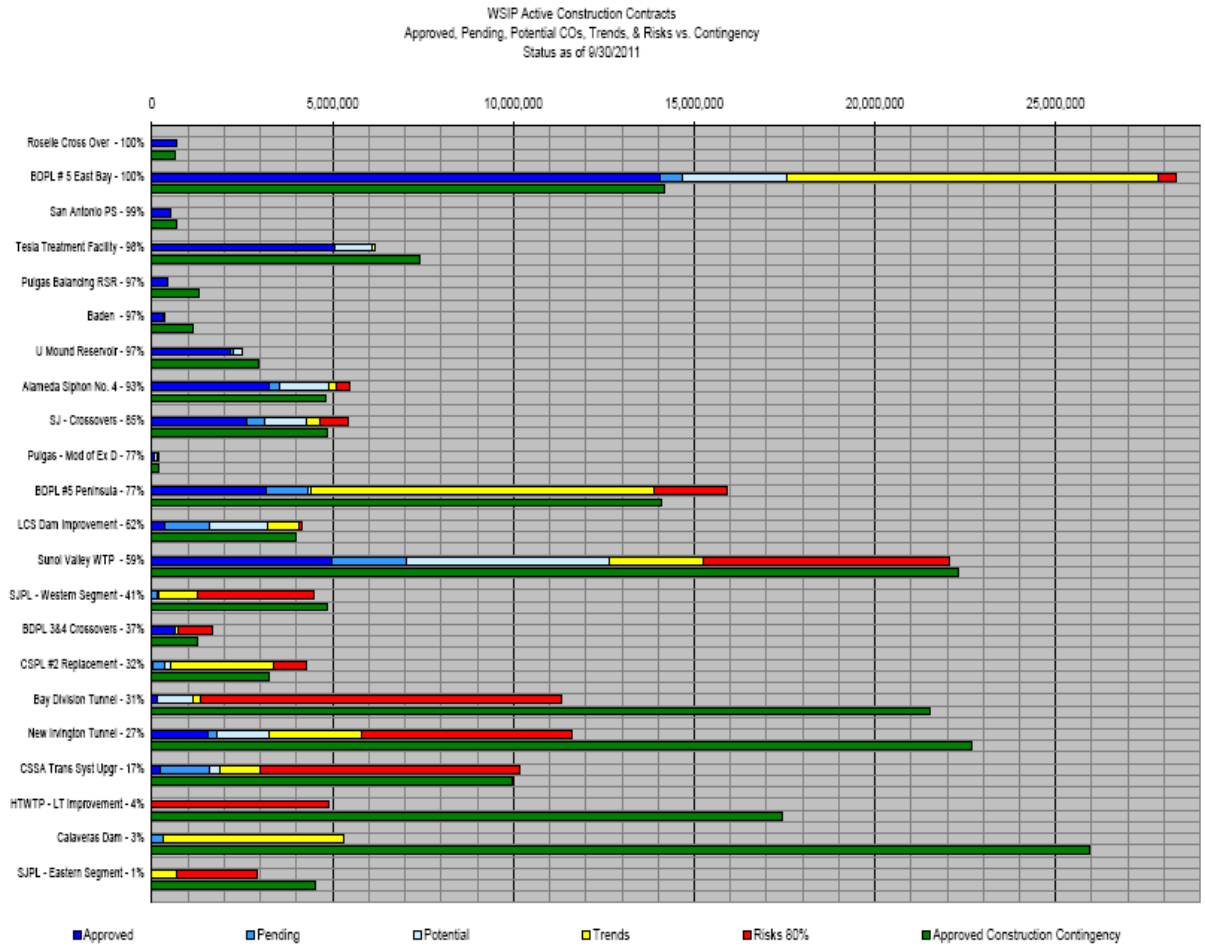

Figure 1 – COs, Trends, Risks vs. Contingency

For the Regional projects classified as current or in the process of closeout, a total of 1,203 approved, pending and potential change orders have been identified. The total estimated value of those changes was approximately $66.2 million as reported in the Multi-Project Change Reasons Report dated October 3, 2011 (MPCR Report) which represents 4% of the construction contract award value or 40% of the original 10% contingency for the Regional projects. Therefore the Regional projects appear to be within their contingency based on a 41% completion status. Note that it is assumed that the 41% completion applies to the Regional projects net of the Local projects.

Table 2 provides a contract summary for the Regional projects as of September 25, 2011. If only approved and pending change orders are included, the cost increase is 3.1% of the original construction contract award value or 16% of the original 10% contingency. While it can be argued that including potential change orders and trends may result in an overly conservative assessment of cost performance, the IRP feels that they should continue to be tracked as is done

in Table 1 as early indicators of potential overruns. In addition, there should be a clear and consistent policy as to what assessment should be used as an indicator of problem performance

A similar contingency approach is used for reporting schedule performance. The original time contingency for all projects awarded through August 31, 2011, was 3,545 days (see Table 1) of which 2,453 days of extended time had been approved. That represented 63% of the contingency time that had been used versus 41% of construction work that had been completed. When potential and pending change orders, along with trends, are included, 96% of the contingency time had been used. Accordingly, the additional time is highlighted as "Exceeds Limit" on the Contract Summary report. As of September 25,2011 (see Table 2), Regional projects had an original 10% contingency of 2,168 days with 1,213 days of approved and pending change orders. Therefore, approved and pending change order time extensions for Regional projects represented 56% of the original 10% contingency time that had been used versus 44% of the construction work that had been completed. It should be noted that there have been large time extensions for smaller Regional projects that have reached or are about to reach construction completion (e.g. SJPL Crossovers, Lawrence Livermore, Baden/San Pedro Valve Lots) but are not on the critical path and will not affect the overall WSIP schedule. However, as discussed above for cost-related change orders, there must be a clear policy as to whether potential change orders and trends should be included in the reporting and which should reflect performance problems.

The schedule contingency approach discussed above is only being used to provide early warning of each construction project schedule performance and for obtaining Commission approval if construction contract durations exceed 10%. In particular, the program summary schedule contingency does not relate directly to the individual project schedule performance because individual project schedules are not additive and overlap one another. The number of days cited in the Contract Summary report are based on a gross analysis of the numeric data which aggregates all identified time extensions in a simple arithmetic fashion and does not account for concurrency or relate to total program float based on the program critical path analysis. As such, care should be taken before drawing any conclusions from such gross data.

Program level schedules changes are more accurately tracked on the basis of time impact analysis updates to the P6 construction contract schedules and analyzed together with the other projects based on the critical path for the combined projects and impacts on the shutdown schedule and overall WSIP schedule. The Contract Summary reporting should be revised to more accurately reflect the impact to the overall program critical path schedule.

Contract Summary Date: 9/27/2011

Water System Improvement Program

WSIP Program Summary

Construction Start:	1/25/04
Construction Completion:	8/14/15

CHANGE ORDER	COST	TIME (Days)
Sum Original Contract Values	$1,806,460,619.00	35446
Revised Sum Contract Value *	$1,853,031,027.13	37899
Original Contingency (10%)	$179,901,171.70	3545
Revised Contingency (12%)	$218,713,774.90	3870
Approved & Pending Change Orders		
A. Approved Change Orders	$46,570,408.13	2453
Approved Change Orders % of Contingency **	21%	63%
Current Contract Value ***	$1,853,031,027.13	08/14/2015
B. Pending Change Orders	$9,565,764.84	415
Pending Change Orders % of Contingency **	4%	11%
Pending Contract Value ***	$1,862,596,791.97	08/14/2015
Potential Change Orders & Trends		
C. Potential Change Orders	$16,524,610.86	343
Potential Change Orders % of Contingency **	8%	9%
Potential Contract Value ***	$1,879,121,402.83	08/14/2015
D. Trends	$39,412,495.12	509
Trends % of Contingency **	18%	13%
Potential Contract Value incl. Trends ***	$1,918,533,897.95	12/12/2015
Contracts Summary		
Total FAC Change Orders (A + B + C)	$72,660,783.83	3211
Total FAC Change Orders % of Contingency **	33%	83%
Total FAC Contract Value ***	$1,879,121,402.83	08/14/2015
Total FAC Change Orders incl. Trends (A + B + C + D)	$112,073,278.95	3720
Total FAC Change Orders % of Contingency incl. Trends **	51%	96%
Total FAC Contract Value incl. Trends ***	$1,918,533,897.95	12/12/2015
Forecast Remaining Contingency	$106,640,495.95	150

Expenditures

Earned	Total Retention	Total Earned Minus Retention	Contract Balance	Contract %
$751,663,551.38	$54,296,509.36	$697,367,042.02	$1,153,779,594.97	41%

* Sum of original contracts plus approved changes.
** Percent of total current contingency.
*** Contract Values are additive. Dates are latest contract end dates.

Legend: Meets Requirements | Needs Attention | Exceeds Limit

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Table 1 – Contract Summary for All Completed and Ongoing Projects

Contract Summary for WSIP Regional Ongoing Projects (without SF Local projects)	
Cost	
Original construction Contract value for the 22 Regional Projects	$ 1,600,025,627.00
Revised construction Contract value for the 22 Regional Projects	$ 1,641,536,850.13
Original Contingency @ 10% + Program Contingency	$ 305,702,562.70
Revised Contingency after Commission approval to increase various projects	$ 344,515,165.90
Approved Change Orders as of 25 September 2011	$ 41,511,223.13
Pending Change Orders as of 25 September 2011	$ 8,055,480.50
Approved + Pending Change Orders as of 25 September 2011	$ 49,566,703.63
% of revised cost contingency (approved + Pending Cos) used	**14%**
Schedule	
Original construction Contract duration for the 22 Regional Projects	21679
Revised/modified construction Contract duration for the 22 Regional Projects after Commission approval to	22715
duration (Contingency)@ 10% of total 22 project duration	2168
Revised duration (Contingency) after Commission approval to increase various projects	2492
Approved Change Orders as of 25 September 2011	1036
Pending Change Orders as of 25 September 2011	177
Approved + Pending Change Orders as of 25 September 2011	1213
% of revised construction contract duration contingency (approved + Pending Cos) used	**48%**
Total Earned as of 25 September 2011	$ 720,947,591.60
Percentage of construction progress as of 25 September 2011	**44%**

Table 2 - Contract Summary for Completed and Ongoing Regional Projects

2. **Among projects with significant change orders, what have been the major reasons for the changes (differing site conditions, owner-requested, contractor-requested, design changes, design errors, etc.)? *Differing site conditions appear to be the major reason for change orders.*** As is fairly standard in the industry, the WSIP categorizes change orders based on six causes: Design Errors, Design Omissions, Differing Site Conditions, Owner Requests, Regulatory Requirements, and Other. According to the August 2011 PCM Report, 754 change orders have been approved for a value of $37.6 million for all Regional projects to date. The major reason for the change orders was differing site conditions, which is also fairly typical of the industry for projects with significant amounts of underground construction.

   Both the quantity and value of approved change orders were examined for five projects from the MPCR Report with the highest volume of change orders among active projects (See Table 3). The five projects that were reviewed for change management performance included 383 change

orders (51% of all approved change orders). The value of these change orders was approximately $26 million, or 69% of all change orders that were recorded in the August 2011 PCM Report.

Project Description	Design Errors	Design Omissions	Differing Site Conditions	Owner Requests	Regulation Requests	Other
BDPL-East Bay	57 (1)	0	5,351 (29)	586 (10)	819 (5)	3,759 (19)
TESLA	444 (5)	1,358 (14)	39 (5)	1,444 (36)	667 (8)	1,084 (12)
SVWTP	1,057 (13)	310 (13)	794 (33)	2,140 (19)	38 (3)	243 (18)
Alameda Siphon	462 (17)	392 (9)	969 (26)	1,265 (25)	169 (6)	3 (8)
SJPL Crossovers	209 (5)	230 (10)	516 (7)	845 (14)	42 (2)	780 (11)
Total	**2,229 (41)**	**2,290 (46)**	**7,669 (100)**	**6,280 (104)**	**1,735 (24)**	**5,869 (68)**

Table 3 - Major Approved Change Orders by Project & Reason
Note 1: Top 5 Projects that have the most Change Orders by Volume
Note 2: $1,000s (Number of Change Orders)

The percentage breakdown of change order causes for the five projects were very similar to the percentage breakdown for the entire WSIP program. The three major reasons for issuing change orders related to these five projects included Differing Site Conditions, Owner Requests and Other. It should be pointed out that change orders often do not fit perfectly into one category and involve judgment by those identifying them. Following is a discussion of the change orders for the five projects:

The need to correct Design Errors and Design Omissions generated 17% of the total cost of the change orders representing approximately $4.5 million in costs. Additional peer or independent design reviews during the design phase, as well as constructability reviews by construction professionals, could reduce future expenditures for these types of change orders.

Costs of change orders to compensate for Differing Site Conditions amounted to nearly 30% of the $26.1 million change order total cost. Recognizing that much of the WISP work is underground, including pipelines and tunnels, this percentage is not surprising. However, this category has resulted in over $7.7 million in change orders. Had all of these differing site conditions been recognized during design, it could be expected that the original contract bid prices would have increased to provide for this work. Therefore, it should not be construed that all of this $7.7 million represents “additional costs” of the Program. However, work done under change order conditions does typically carry a premium cost when compared to work done under the basic contract. Additional geotechnical investigation during design could result in some future cost avoidances, and would certainly increase the reliability of the cost and schedule forecasting during the construction period of each of the projects.

Owner-requested Changes has resulted in $6.3 million of change orders and accounted for approximately 24% of the change order costs. This category is typically the category where examples of growth in scope of the project will be found. This type of change will also typically be used to accommodate changes in the scope that will improve operational capabilities of the

completed project. A Change Control Board has been created to review all owner initiated change requests that exceed $50,000 in value.

Change orders that were Regulatory-driven amounted to $1.7 million or 7% of the total cost.

The Other category of change orders has been created, and to date has accounted for $5.9 million or approximately 23% of the total committed for change orders. These are changes required for all other reasons, including emergency work, adjustment of bid quantities, force majeure events, incentive payments, accepted substitutions, and value engineering change proposals

3. **Are change orders being managed effectively and efficiently including documentation and causes, and are they in compliance with the authorizing legislation?** ***Yes.***

   The program has established excellent procedures for change management (CM Procedure No. 016, Construction Change Management) that meet or exceed the guidelines established by the Construction Management Association of America (CMAA). The change management process is well defined with clear descriptions of responsibilities and approval authority.

   The Construction Management Information System (CMIS) appears to be effective in helping the CM Team track and manage change orders and is being used to effectively manage and document the change order process. However, based on discussions with the contractors interviewed, there is some concern as to how efficiently the process is being managed. For various reasons, several projects, such as those identified above, have large backlogs of change orders to be processed. Where this has occurred, a recovery plan has been put in place and additional administrative and estimating resources have been employed. In addition, staff members have been replaced when it was determined necessary. Follow up internal audits have been performed by the management team to ensure that all projects are complying with the procedures in the CM Plan and that change orders are being effectively and efficiently managed. Regular audits are performed by the Program Construction Management (PCM) Team.

   During discussions with the program managers, we were also informed that change orders are checked to be sure that they are in compliance with the authorizing legislation. This seems to be understood at the project level as well. For example, the Sunol Valley WTP includes upgrades that are being specifically funded by the Water Enterprise as opposed to the program bond funds.

4. **How are trends identified and cost and schedule estimates assigned to them?** ***Trends appear to be readily identified and cost and schedule estimates are being assigned.***

   Trends include any potential deviation from the approved schedule or contract amount that is not yet a proposed change order but that the Project CM believes has a significant potential of becoming a change to the contract amount or schedule. They are usually identified by communications with the contractor, weekly progress meetings, Requests for Information (RFIs), Submittals, input from the design team, information provided in the CMIS Issues Report or review of the project's Risk Register. Costs and schedule estimates for trends are usually done as a rough order of magnitude based on experience and/or previous costs. For significant issues

the Project CM can prepare an independent estimate that is reviewed by upper management. Monthly meetings are also held to review the trends.

In discussions that were held at various jobsites and with members of the Program Construction Management (PCM) Team, everyone is very aware of the importance of establishing trends and they are included in the Forecasts-at-Completion (FACs) estimates. Because of the WSIP philosophy of "No Surprises", it appears that most project personnel are not at all reluctant to identify them. In general, the review team found that Project CMs believe that it is better to list a trend and delete it later than to miss an issue that comes as a surprise to management later in the project.

5. **Is there an understanding of the difference between risks, trends and change orders (potential, pending and approved)?** ***Yes.***

   The CMIS Program Team has done a good job of educating the CM team staff on the importance of accurately developing risks, trends and change orders. Based on our interviews and site visits everyone seems to have a full understanding of the differences between each category. Procedures are in place and well defined for reference by the field staff. The PCM Team has been very active in reviewing each category. Meetings are held monthly to review the CM Top Issues Report and discuss risks, trends and change orders. Field audits are also conducted to insure that costs and time are not duplicated and that issues are being updated and recorded accurately.

6. **How do the project change order percentages (cost and schedule) compare to industry norms?** ***The overall project change order percentages appear to be within industry norms.***

   Some projects within the WSIP Program have higher than normal cost and schedule change orders as a percentage of awarded contract amounts that appear to relate to an unusually high amount of Differing Site Conditions, Design Issues, and Owner Requests. However, even with these instances the performance compares favorably to industry norms and in the opinion of the IRP are not out of line with what would be expected of a project of this magnitude and complexity.

   Each type of project has different conditions, unknowns and risks associated with the work. For example, underground work usually has a considerably higher probability of experiencing changed conditions or potential risks (especially in urban areas) than aboveground work. For large projects, 5% is considered a moderate amount of change orders (from Chapter on Change Orders in "Megaprojects-Challenges and Recommended Practices" by Hatem and Corkum, ACEC, 2010). For Regional projects with construction activities underway (see the August 2011 PCM Report), approved cost-related change orders for the WSIP Program are 2.6% and schedule-related change orders are 4.5% both within the moderate industry norm. If pending and potential change orders are also included, the percentages increase to 3.8 and 6.3%, respectively. For this more conservative assessment, the cost-related change orders still appear to be within the moderate industry norm with the schedule-related change orders higher than the moderate industry norm.

   Comparisons were also made with the results the Multi-Agency CIP Benchmarking Program Phase 4 that was sponsored by the Metropolitan Water District of Southern California with eleven participating water agencies (MWH Final Report dated 2009). This study determined that

change order costs as a percentage of construction bid awards ranged from 0.9% for water storage projects to 20.9% for water treatment facilities. The study was based on 142 projects of differing types and developed linear curves as a function of cost with an initial base cost that varied for each type of project. Depending upon the size of the project to which the curve is applied the percentages could change slightly. The WSIP cost and schedule related change order percentages are well within this range.

The City and County of San Francisco recently released a Legislative Analyst Report, "Evaluation of Contract Change Orders for Large Construction and Professional Services Contracts", dated October 17, 2011. The analysis indicated that the average percentage cost increases compared to the average original contract award amounts for public utilities projects ranged between 5.5% and 10.1% depending upon the size of the projects. Although these percentage increases appear to be somewhat consistent with the WSIP construction contract performance it should be noted that the Analyst's Report also contains professional services contracts which should be removed from the analysis before making any such comparisons.

7. **Is there any indication that the favorable bidding climate is constraining profit margins and resulting in greater use of change orders?** ***There is no question that the program has benefited by the favorable bidding climate with bids significantly under the budgeted amounts and this may be resulting in the large number of change orders for some of the projects.***
   In a review of the bid results for 21 projects (see Table 4) all but one project had at least three bidders. Although all the contract awards were below the Engineer's Estimate, the next lowest bids for each project were generally within a few percentage points of the low bid indicating that the contractors were looking at the work in the same way.

   During our site visits and interviews, staff members had various opinions concerning the contractor's use of change orders. Some felt that the contractors were submitting excessive numbers of change order/claim-related letters in an effort to recapture lost profit margins or establish a position for a future claim. Others said they had no indication that this was happening based on verbal discussions with the contractors or impressions left by the contractors during partnering sessions or quarterly DRB (Dispute Review Board) meetings. However, when the bid results are reviewed and compared to the Engineer's Estimate, it appears the contractors "sharpened" their pencils in an effort to secure the work. In turn, it would only be natural that the contractors would be less likely to absorb small change orders as indicated by the large quantity of Change Order Requests being submitted at some projects.

8. **Is the SFPUC paying to avoid claims or, conversely, is the resolution of change orders being delayed to avoid impacts on the project, and, if so, how pervasive is it?** ***There is no indication that SFPUC is paying to avoid claims or delaying the resolution of change orders to avoid impacts on a project.***
   The CM Plan and Procedures include provisions for Partnering and a DRB/DRA (Dispute Resolution Advisor). The fact that there has been only one DRB hearing and no claims filed is testimony to the success the WSIP team is having in their relationship with the contractors. A Project Issue Resolution Ladder has been developed is also being used successfully to settle issues before they reach the DRB level or are submitted as a claim.

Region/Project Name	No. Bids	Engineer's Est.	Low Bid	Next Lowest Bid
San Joaquin Region	Ea	$ Millions	$ Millions	$ Millions
San Joaquin Pipeline Crossovers	7	21.0	11.7	11.8
SJPL System Western Segment	11	63.0 – 70.0	48.4	50.7
SJPL System Eastern Segment	9	52.0 – 57.0	45.2	46.6
Roselle	5	3.05	2.8	2.9
Tesla (Design/Build)	3	Not Available	81.4	93.2
Sunol Valley Region				
New Irvington Tunnel	4	253.2	226.6	275.1
Alameda Siphon No. 4	4	38.0 – 43.0	30.9	31.9
Calaveras Dam	5	250.0 – 300.0	259.6	284.1
Sunol Valley Water Treatment Plant	9	109.0	83.1	84.2
San Antonio Pump Station Upgrade	8	8.5 – 9.5	7.0	7.1
Bay Division Region				
Bay Tunnel	4	235.0 – 260.0	215.3	215.4
BDPL No. 5 - East Bay	8	88.0 – 98.0	61.6	64.4
BDPL No. 5 – Peninsula	6	62.0 – 69.0	52.2	53.5
BDPL Nos. 3 & 4 Crossovers	9	21.5	12.7	12.8
Peninsula Region				
Lower Crystal Springs Dam	2	18.0 – 22.0	17.4	18.7
Pulgas Balancing Roof Replacement	6	14.0 – 18.0	12.7	12.9
Pulgas Balancing Dechloramination	3	1.8 – 2.2	1.5	1.6
Harry Tracy Water Treatment Plant LT	5	220.0 – 245.0	174.0	183.0
CSSA Transmission Upgrade	4	100.0 – 120.0	99.8	100.9
Crystal Springs Pipeline No. 2	8	43.0 – 48.0	32.5	38.3
Baden & San Pedro Valve Lot	9	15.0 – 18.0	11.5	11.6

Table 4 – WSIP Project Bid Analysis

Note: Does not include the San Francisco Region and some completed projects.

Although the timing for settling and processing change orders has been slow for a few cases, management has taken action to rectify that problem. There is no indication that the resolution of change orders is intentionally being delayed to defer impacts on the projects. In fact, during site visit discussions, project staff members generally indicated a desire to resolve the change orders as quickly as possible and have no problem requesting help from the RCM or upper management, if necessary. The BDPL-East Bay project was an exception where the CM Team avoided using change orders resulting in a large backlog. This appeared to be due to lack of appropriate resources and the large number of changed conditions being experienced in the field resulting in the excessive use of force account work.

9. **Evaluate the project change order management process based on the Construction Industry Institute's Change Management Process.** ***The change order management process meets or exceeds the Construction Industry Institute's (CII's) process.***

   The CII report emphasizes preparing good baseline documents, recognizing changes early in the project life, being open in communication, documenting baselines and change processes and being prompt in executing changes. The processes and practices established in the WSIP for change management align very well with the principles described in the report. The modest levels of changes documented for most WSIP projects attest to a strong, well thought-out program.

   The CII prepared Special Publication 43-1, Project Change Management, to find solutions to, or means of, avoiding changes that interrupt the flow of work, create delays, cause schedules to slip and inflate costs, which in turn may generate claims or costly litigation. The report provides a set of recommended best practices for the effective management of change and offers a prototype change management system. The principles of effective change management covered in the CII publication are to promote a balanced change culture, recognize change when it occurs, evaluate change, implement change, and continuously improve from lessons learned.

   Change should be controlled early. Feedback should be obtained from owners and operators throughout the Planning and Design stages. Necessary changes caught in early stages are much less costly than changes during construction. Changes handled early in the construction phase produce better results than changes that are put off. A few WSIP projects have experienced significant owner-requested design changes after the start of construction, increasing total construction costs. For example, the Sunol Valley Water Treatment Plant had eight major design changes during the bid period as addenda to the contract bid documents. However, the majority of projects have experienced changes well within acceptable levels.

   Project teams must have a disposition to manage change. Teams need experience in managing change and must have the right temperament. The SFPUC has brought in a number of experienced CM professionals who understand change management and keep on top of changes from the beginning of the project. Effective management of change requires work execution methods that include specific, integrated and systematic steps to recognize, evaluate and implement change. Project controls include budget controls, schedule controls, trend analyses, status reports and progress reports as reported though the CMIS. The SFPUC has a rigorous set of uniform processes and procedures that are well enforced throughout the WSIP. Project controls are top notch and continued training helps to promote consistency from project to project.

   It is necessary to promote a balanced change culture that encourages beneficial changes and prevent/discourages detrimental changes. The later the change occurs, the less efficient is its implementation. WSIP CMs are required to analyze risks, move risks to trends as issues become more defined, and process trends into specific changes orders as needed. This system promotes early detection of changes and reduces likelihood of major disputes.

   Change must be recognized, evaluated and implemented. Team members must have open communication with each other. Original agreements must be recognized as baselines. Required or elective changes must be evaluated and implemented in a way that minimizes impacts to cost and schedule. SFPUC project personnel and contractors are meeting regularly and are working through project issues. Rigorous schedules and cost breakdowns help set baselines from which changes can be evaluated. For the most part, changes are being

implemented in a timely way. Of the specific projects visited, Sunol Valley WTP appeared to have a large number of change orders due to owner requested changes and design errors, and the BDPL – East Bay projects had a large backlog of change orders related to differing site conditions and others.

10. **What do contactors have to say about the change management process (timeliness, reasonableness, reconciliation and getting paid)?** ***The three contractors interviewed appeared somewhat frustrated by the handling of change orders, which is not unusual for construction projects.***

    There appears to be a feeling that the owner's staff on site may not have the authority to negotiate change orders or did not want to take the responsibility to do so. It was also expressed that it is not always clear who had the authority to make a final settlement. One of the contractors felt they should have the right to negotiate directly with that individual. They also felt like the approval process for the owner takes too long and creates a backlog of issues which, in turn, produces slow payment for additional work that has been performed. There was a feeling that the City certification process may also be delaying approvals.

    The contractors interviewed were also consistent in their answer that more help was needed for the CM contract administration on site to produce more timely answers concerning contractual issues. Usually, there is only one Field Contract Administrator (FCA) on each project which may not be sufficient on projects with large numbers of change orders. Also, the FCA on the BDPL - East Bay had to be replaced for performance reasons which may indicate the need to be more selective in filling the positions and provide additional training. In general, the contractors did not complain about a lack of reasonableness in the negotiations of the change orders. As is always the case, there are change orders that have been denied and may eventually become an issue, although the contractors did not indicate that they planned to pursue them further. However, once a contractor has agreed to a change order they are apparently prohibited from reserving their right to later action.

    It should be noted that the projects visited were chosen in part because there were change management issues and may not be representative of all projects. Also, it appears that a few of the contractors are submitting change orders in large batches and in some cases just as placeholders.

    Regarding payments, the Construction Management Procedures require that the Project CM review the Contractor's Monthly Application for Payment in a timely manner. Review of the Document Turn-Around Report shows that Applications for Payment are being paid on an average of just over 20 days, which is superior performance when compared to industry norms on large, public projects. During the site visits, contractors were asked about their payments. They agreed that their monthly pay applications were getting paid in a timely and reasonable manner. There was one instance that a contractor pointed out that $1 million was withheld from the monthly pay application for non-conformance issues that were valued far less than the amount withheld. And the contractor on the Crystal Springs/San Andreas Transmission Upgrade (CSSA) Project was very concerned about the delay in getting paid for changes orders as a result of the delay in processing change orders as discussed above. However, it should be noted that some of the delay has been a result of the inability of the contractor to submit acceptable documentation on which action could be taken.

11. **To what extent are there unresolved change orders (e.g. unilateral, force account and denied) that could have cost, schedule and legal implications at a later date and are they being satisfactory accounted for?** ***The number of unresolved change orders varies by project.***
    A review of the Turn-Around Report shows the majority of open change orders within the WSIP Program fall into the "Greater than 21 Days" category. Several reasons were given as to why change orders were ending up in this category. Some contractors have been slow to submit Change Orders and Force Account records and then eventually submit a large number of requests at one time. Other change orders require input from the subcontractors or additional time to estimate which adds time to the process.

    Cost and schedule impacts are being acknowledged, as unresolved change orders are negotiated and processed. There is a renewed effort at the project and regional levels, with oversight from upper management, to insure that all issues are being properly included in the appropriate Risks, Issues, Trends and Change Order reports. Upper management has also done an excellent job of negotiating settlements with representatives from the contractor for outstanding issues that have gone unresolved at the project level, thus avoiding potential legal action in the future. Because of these efforts there has only been one DRB Hearing and two DRB Advisory Opinions to date.

    Of the projects visited, one Unilateral Change Order was identified on SVWTP. Unilateral Change Orders are issued when the CM Team and the contractor cannot come to agreement on the change order and the work must proceed to avoid unacceptable delays. There have, however, been many change orders denied, especially on the SVWTP and the BDPL – East Bay Project. These could arise as contentious issues needing to be elevated for resolution, including the potential of litigation at a later date. Thus far the CM Team do not feel that there are an unusually high number of denied change orders and those that may involve unresolved issues are included in project trends which allow for their potential impacts on cost and schedule to be accounted for in the forecasts. There has been a very limited use of dispute resolution indicating that issues are being resolved.

12. **Is there some consistency in the management of change orders on a project-by-project basis, or are the results significantly varied among projects?** ***Yes.***
    The Change Management Procedure provides very clear and concise procedures for the management of change orders. CMIS is an excellent tool for tracking and providing information to allow management to handle change orders. All Project CMs attend the same orientation and training on proper use of CMIS. Based on site visits and the review of various reports, the majority of projects are consistent on how they handle change orders. One project, the BDPL – East Bay Project, appeared to have improperly followed the procedures for force account and unit price work, but measures have been taken to ensure these procedures are adhered to by all projects in the future.

13. **Are lessons learned from change orders being applied to future projects?** ***Yes.***
    At the completion of each project the CM staff conducts a lessons learned debriefing meeting and then submits a lessons learned report that is available for use on future projects. Lessons learned are also verbally presented and discussed at various meetings that are held with the CM

staff. In the case of the BDPL - East Bay Project, where procedures for force account and unit price work were not followed, a directive was issued by senior management reinforcing the procedures to be used and the requirement to strictly comply with all of the applicable procedures. Stricter controls were implemented to ensure that payments do not go beyond the approved levels. All project teams were notified of the new procedure and consequences of not complying.

B. Risk Management

Risk management is essential to successful execution of the construction. The review focused on the risk management process including construction interface management, public safety, and cost and schedule performance. Parsons concluded in 2007 that there was a significant risk that the WSIP could exceed $4.6B and that the SFPUC should consider conducting more detailed risk analyses on the most critical projects. Since then, the SFPUC has strengthened this aspect of the WSIP program. The WSIP Construction Management Procedure (No. 34, Risk Management Plan Preparation, Approval and Implementation) is very comprehensive outlining the plan objectives and execution. At the beginning of each project, key project participants are required to attend a Risk Assessment Workshop. A Risk Register is developed that is "used to identify, analyze, and clarify ownership of risks and define how risks are to be strategized, controlled, mitigated and managed". Risks are evaluated and scored based on the probability of occurrence and potential impact to cost and schedule (see Tables 5 through 9). Probability-based confidence levels are determined using Monte-Carlo analyses to assess the combinations of the various risks occurring together. The Risk Register is used as a management tool during the construction phase. Active Risk Management (ARM) software from Strategic Thoughts in the UK is being used.

RISK IDENTITY & CAUSE									
A	B	C	D	E	F	G	H	I	J
Risk ID	Risk Category	Risk Description	Location	Cause	Effect	Risk Plan Owner	Status	Trigger Date	Expiration Date

CURRENT ASSESSMENT				MITIGATION							
K	L	M	N	O	P	Q	R	S	T	U	V
Severity of Impact (S)						Mitigation Action Items					
Probability Of Occurrence (P)	Impact To Cost ($)	Impact To Schedule (Days)	Risk Score (R)	Strategy	Risk Plan	Action Items	Action Owner	Action Start	Action End	Action Status	Contingency Plan

Table 5 – Risk Register Template (CMP034)

Probability (P)	
Scale	Range
5	>80%
4	60%-80%
3	40%-60%
2	20%-40%
1	<20%

Table 6 – Probability Scale (CMP034)

Severity of Impact to Cost ($_{cost}$)	
Scale	Range
5	>1% of total Project Cost
4	.8%-1% of total Project Cost
3	.6%-.8% of total Project Cost
2	.4%-.6% of total Project Cost
1	<.4% of total Project Cost

Table 7 – Severity of Impact to Cost (CMP034)

Severity of Impact to Schedule ($_{schedule}$)	
Scale	Range
5	>10% of total Project Schedule
4	8%-10% of total Project Schedule
3	6%-8% of total Project Schedule
2	4%-6% of total Project Schedule
1	<4% of total Project Schedule

Table 8 – Severity of Impact to Schedule (CMP034)

Probability						
	5	8	16	18	23	25
	4	7	10	17	20	24
	3	3	9	12	19	22
	2	2	5	11	14	21
	1	1	4	6	13	15
		1	2	3	4	5
		Severity of Impact (Cost)				

Table 9 – Risk Score Matrix (CMP034)

The following specific questions were addressed in the CM review:

1. **Have actual risks incurred to date been previously identified in the Risk Management Plan and were the impacts accurately forecast?** ***Yes.***
   There have been cases where risks actually incurred were identified in advance and the impacts were accurately forecasted in the risk assessments prepared at the program and project levels. One example is the New Irvington Tunnel. Early in the project, the Risk Register identified a 50% chance that there would be a change in California Occupational Safety and Health Administration (Cal OSHA) tunnel classification due to excessive levels of methane gas. The risk plan is to rigorously follow the OSHA standards to avoid problems. This risk was closed in July 2011 after the tunnel was reclassified by Cal OSHA as a result of a gas emission event.

2. **What are the capabilities for analyzing and forecasting risk and have they been tested and proven effective?** ***The risk assessment process appears to be very effective in identifying risks.***
   The risk management procedure (CMP No. 034) clearly addresses plan development, implementation, approval and reporting processes. Risk assessment workshops are conducted at the beginning of a project with input from all major participants. The categorization of the probability and severity of the risks is straightforward and nicely summarized in risk registers for each project. The overall summary of risks is presented in the form of a Risk Score Matrix (also referred to as a "heat map", see Table 8) that provides management with easy recognition of risk related issues. There is evidence that the process has been tested and proven effective as discussed in the question preceding and following this one.

3. **How efficiently are risks being mitigated and progress tracked?** ***It appears that risks have been identified and efficiently mitigated.***
   The following two cases were reported as examples:
   - **New Crystal Springs Bypass Tunnel**. Delay in the completion of Shutdown #2 was identified as a major risk for the project as the delivery of water to the customers would be impacted. In January 2011, the risk was closed without occurring as the team was

very proactive in mitigating the risk by extending the work hours to accelerate the schedule as well as obtaining all the environmental clearance prior to the start of work.

- **Baden and San Pedro Valve Lot**. Delay in the demolition and installation of pump and motor #3 was a major identified risk for the project as any delay would impact the installation of the remaining pumps and motors #2 and #1. In August, 2010, the risk expired without occurring due to proactive actions by the CM team in coordination with the contractor, the City, and PG&E to avoid delay in delivery of the City's and contractor's furnished materials, as well as the PG&E power services, respectively.

Risks are being tracked in various CMIS reports and reviewed during regularly scheduled meetings at the program and projects levels. All projects visited confirmed that they were conducting monthly risk management meetings during which the risk register was reviewed, updates made to it and additional mitigation measures established. Key project staff participates in the meetings along with a representative from the program-level risk management group.

4. **How does the Risk Management program compare with other utilities of similar size and complexity?** ***Based upon the experience of the CM IRP members this appears to be one of the more sophisticated risk management procedures being used.***

   It certainly meets or exceeds the guidelines established by the CMAA. For comparison, the Los Angeles Department of Water and Power does not have as sophisticated a risk process but is in the process of developing one. The Federal Highway Administration utilizes a probability-based, risk assessment process on its large federally-funded projects, as does the Federal Transit Administration (FTA). The FTA process also relies heavily on actual project performance on previous federally funded transit projects.

5. **Is the Risk Management program being effectively used by the entire project team?** ***Yes.***

   In general, the risk management program appears to be effectively used by the entire team. It is taken very seriously at the program level where regular risk management meetings are conducted. All projects visited reported that they were conducting monthly risk management meetings. At each of the meetings we had with on-site project staff there was a representative from the program level risk group who apparently regularly assists the project teams in the development, maintenance and execution of the risk management plan.

6. **Is there a sufficient construction interface management plan in place to ensure that all 81 projects will fit together?** ***While there is not a specific interface management plan in place, measures appear to have been taken to help ensure that the system interfaces are being managed.***

   Of prime importance is the fact that the program has been geographically organized into regions based on combining the projects together in a way that will help minimize interface issues. It is felt that the major interface issues are contained within the regions allowing for effective management, oversight and control by the regional management staff. There are also configuration management control measures in place to ensure that the various projects will fit together. Also, it is felt that the shutdown procedures allow for incremental testing and confirmation of the interoperability of the system. Some consideration should be given to establishing a more formal interface management plan for future programs whereby the

interfaces are specifically identified, responsibilities defined and regular interface meetings conducted.

7. **How are the risks associated with system shutdowns being addressed?**
The system shutdowns conducted thus far have been reported to have proceeded well.
Thus far approximately 80 of the anticipated 140 shutdowns have been completed. Monthly shutdown coordination meetings are being conducted. Representatives of the CM IRP attended one of the meetings. These meetings include WSIP management, consultants, and City Operations staff. Every upcoming shutdown is reviewed, issues are raised if appropriate, follow-on actions are committed to, and schedules are adjusted, as necessary. The meeting attended involved more than two dozen people and was viewed as being extremely efficient and effective. The management staff overseeing the shutdown activity appears to be doing an excellent job and the meetings appear to be contributing very much to the shutdown success.

   The CSSA Transmission Upgrade Project indicated concerns about impacts at the project level from delays in scheduled shutdowns but it did not appear that such delays would affect the overall system activity.

8. **Have the risks to the public during construction been adequately addressed and mitigated?**
Yes.
In accordance with the Occupational Safety and Health Administration (OSHA), construction safety is measured by recordable injuries and lost time incidents and the associated rates based on total hours worked. The overall WSIP safety performance is excellent with 18 total recordable injuries, four lost time incidents, and 59 total lost work days reported over the 2.1 million hours of work performed. This results in a Total Recordable Injury Incident Rate of 1.7 and a Total Lost Time Incidence Rate of 0.4 against the 2009 national average rates of 4.3 and 1.6, respectively based on the Bureau of Labor Statistics.

   Regarding public safety, it appears that satisfactory measures have been put in place to protect the public from potential hazards during construction and only minor complaints have been reported. Additional law enforcement personnel are being used in areas of close proximity and access to roadways, such as the New Irvington Tunnel and Sunol Valley WTP projects. There are particularly sensitive risks associated with pedestrian and bicycle traffic in the CSSA Transmission Upgrade Project area because of the Sawyer Trails running along the reservoirs and heavily used by the public for recreation purposes.

9. **Has the risk of an earthquake during construction been addressed with mitigation?** ***The risk of an earthquake during construction appears to have been addressed to some extent.***
The types of projects being designed and built for WSIP design often do not allow for minimizing impacts to the facilities during construction if an earthquake occurs as this would be very difficult and costly to do, if even possible. However, it may be good to evaluate this further as to what if any measures have been, or could be, implemented during the construction phase. Several projects did report that they had emergency procedures in place for evacuation and other measures necessary for the safety and welfare of the on-site personnel following earthquakes and other incidents. It is recommended that emergency procedures, training and drills be verified on a program-wide basis.

10. **How effectively is the SFPUC mitigating and predicting risk in order to control costs and complete projects in a timely manner?** ***Very effectively.***
    Risk has very effectively been incorporated into project control especially in managing cost contingency by including an 80% confidence level risk related cost. The risk-associated cost increases are not included in the CMIS reporting of forecast-at-completion cost and schedule which is in accordance with industry standards. However, they are included in contingency management. This inconsistency is not a problem as long as it is clearly understood and results in a more conservative contingency management. How risk is included in schedule forecasting is not as clear.

11. **Is the SFPUC effectively including the contractors in risk discussions and analysis?** ***Yes.***
    Several projects reported that they included the contractor in the development of the risk register at the beginning of the project, which is a requirement of the Risk Management Procedure, but felt it was inappropriate to involve them in the follow-on regular risk meetings. Most of the CM team members interviewed felt that including the contractor could help them to identify potential project claims. One project reported that the contractor had been included in their regular project risk meetings but the contractor eventually stopped attending because the contractor felt the meetings were not useful and were merely repeating the same discussion from previous meetings. In talking to the contractors they did not appear particularly interested in the risk management procedures. They felt that they fully understood the risks associated with the construction. The Risk Management Procedure also requires in Section 4.2, Contractor, that "The Contactor is responsible to deliver the project as specified in his contract. The Contractor executes his assigned risk mitigation measures to reduce or eliminate potential Risks." It is recommended that program-level management establish a clear policy of how the contractor should be involved in the on-going risk management program.

12. **Is there some consistency in the identification, tracking and mitigation of risks on a project-by-project basis, or does the approach and level of efforts vary among projects?** ***Yes.***
    There does appear to be good consistency in the risk management procedures among the projects. Standard risk reports have been developed and the reporting is consistent. The program level risk staff in helping to enforce and manage the process overall and working with the project level staff in maintaining the risk register and updating assessments.

C. Project Cost, Schedule and Contingencies

Cost growth and schedule delays are always a concern over the course of construction. It is essential to closely track cost and schedule performance and provide timely information to the project staff. This includes accurate forecasting of cost at completion and completion dates. This is not easily done given the uncertainties of predicting what will happen in the future. Soft costs associated with agency and consultant program and project management costs including construction management, engineering support during construction and environmental monitoring and mitigation must also be closely managed. WSIP has very well developed Cost and Schedule Procedures which are in line with the industry standard and meet or exceed the requirements of the CMAA. Oracle's Program Manager (CMIS) and P6 software is being used. The following specific questions were addressed in the CM review:

1. **Have there been major increases in cost and schedule and, if so, what are the reasons?** ***There have been major cost increases and schedule extensions for some of the projects reviewed primarily resulting from change orders.***
   The primary reasons are due to change orders as discussed in Section A, Change Management. Based on the August 2011 PCM Monthly Report, the performance of the four projects reviewed is summarized in Table 10.

Project Description	Original Contract Budget Amount	Original Contract Award Amount	COs Approved Pending Potential	Trends	Total COs + Trends	% Original Contract Amount
BDPL-East Bay	67,746,809	61,588,008	17,429,259	9,464,035	26,893,294	44
SVWTP	91,412,376	83,102,160	11,824,689	3,803,001	15,627,690	19
NIT	249,323,470	226,657,700	2,884,948	2,564,500	5,449,448	2
CSSA Trans. Upgrd.	109,739,300	99,763,000	1,761,650	3,870,000	5,631,650	6

Table 10 – Construction Contract Cost Performance

The BDPL-East Bay and SVWTP projects are forecasting significant cost increases. The SVWTP and NIT projects are also experiencing schedule delays of approximately 93 days and 142 days, respectively. However, it should be pointed out that the projects reviewed were selected, in part, because there were performance issues. Based on the initially allocated 10% contingency, these increases to cost are tracking high. However, as noted in Table 10, the original contract award amounts are significantly below the original construction contract budgeted amounts for each project providing an additional project reserve which should cover any additional contingency required. The schedule variances are a concern and it is not entirely clear to the IRP how the individual project delays impact the overall delivery schedule of the program.

As reported in the August 2011 PCM Monthly Report, there were 22 Regional projects under construction. Three of the projects are currently scheduled to be completed after the approved completion dates. More specifically, one project is expected to be completed 60 days late, one may be 21 days late, and one may be 62 days late. None of these delays is expected to have negative impacts on any scheduled shutdowns or startups.

The total of the original construction contract amounts for the 22 projects is $1.519 billion, with $532 million invoiced as of September 1, 2011. The total contingency amount for the 22 projects is $173 million. The current forecast of costs for change orders, trends and risks is $142 million. Therefore, it appears that the projects currently under construction will be completed within the approved budget amounts.

The cost performance on completed construction projects has been excellent. As reported in the July 21, 2011 BAWSCA Report on SFPUC Contract Awards, final construction costs for completed projects averaged about 4% higher than the bid amount but were 12% less than the construction phase budget. However, 53% of the completed Regional construction projects did not meet their planned substantial completion dates. The performance level of the WSIP cost

control function is very good and well within industry norms but further work may be needed to address schedule performance.

The primary reasons for the cost and schedule variances are change orders as discussed in Section A of this report. Based on the experience of the IRP members, this performance meets what would be expected of a program of this magnitude and complexity.

2. **How is cost and schedule performance being tracked and is the reporting timely and forward looking?** ***Cost and schedule are being tracked very well and the reporting is timely and forward looking.***

   The development and maintenance of current and accurate construction cost and schedule information is rigorously managed by the CM Team. Management's procedures for tracking performance are clear and comprehensive. The value of this tracking is reflected in the successful completion of projects to date.

   Cost and schedule information is entered into the CMIS at the project level. Contractors are required to submit cost information and updated completion schedules on a monthly basis, reporting current status of the work and future projections. The project level CM teams review the costs and schedules and prepare Monthly Progress Reports that reflect the current status of the work. Changes in project costs and schedules are handled and input to the CMIS at the local project level by the Field Contract Administrator (FCA). The information is tracked and reported by the CMIS at the project, regional, and the program levels. It is this same information that forms the basis for the reports that are available for upper management and the Commission.

   A Primavera Version 6 (P6), Construction Contract Schedule/Progress Management system is used to effectively create, track and monitor construction project progress, budgets, and expenditures at the project, regional, and program levels; as well as, evaluates project schedule trends. Schedules are also used to assist with shutdown coordination, time impact analysis, delays and claims, and the ability to create what-if-scenarios for each project to evaluate alternative schedule recovery/acceleration strategies. Additionally, equipment and materials purchases may be tracked to ensure timely delivery for on-time construction completion. Monthly Program, Regional, and Project Progress curves are regularly prepared from the system which provides management with timely forecasts of the status of each Program component against the latest approved baselines. These curves are all prepared directly from the status information provided by contractors in their monthly CPM updated schedules by updating each activity with the progress as measured in the field. In cases where the contractor's monthly schedule update is rejected for non-conformance to contract specifications, the system allows the CM to prepare a modified version of the schedule to maintain management informed of actual progress.

   This provides the SFPUC with a comparison of the current physical progress versus the current baseline planned Early and Late Planned progress. By including the Late Planned Progress curve in the standard S-Curve, management has a clear indication of the available float in the schedule and how the construction progress is tracking against this float. These curves effectively marry the cost and schedule information into a one-page summary (see Figure 2).

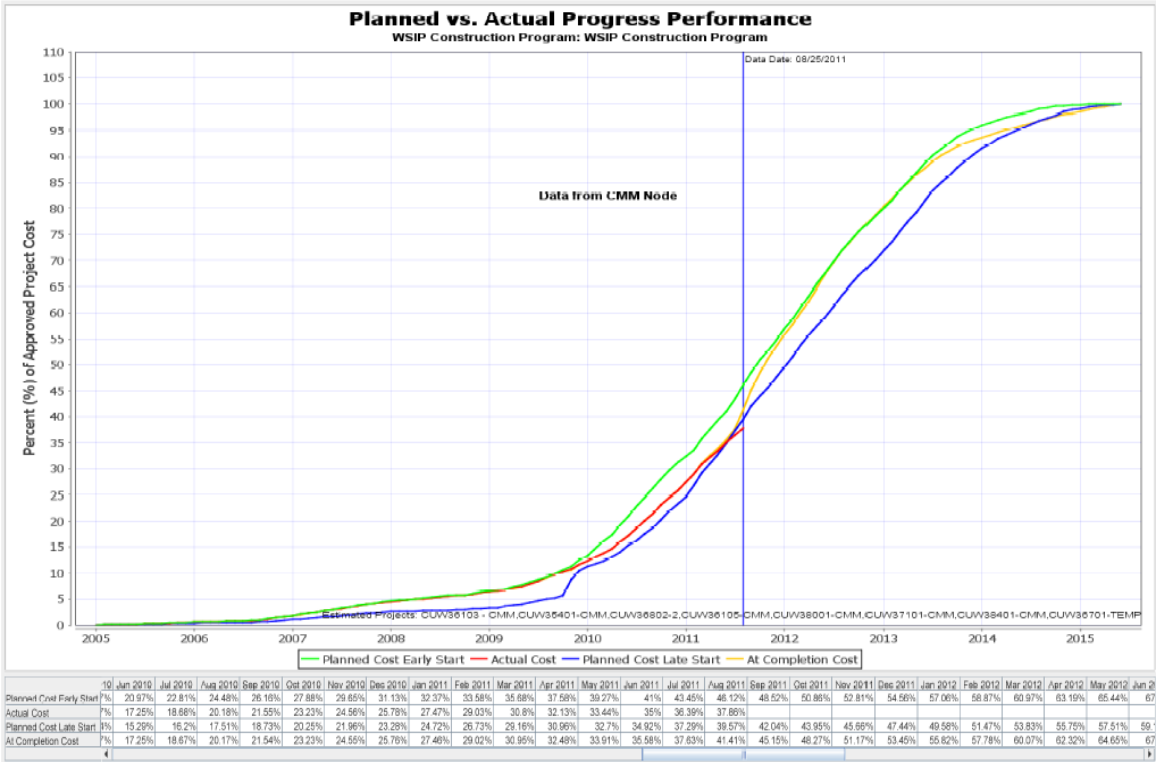

Figure 2 – WSIP "S" Curves

It should be noted that the information tracking and reporting system serves as a fundamental and powerful management tool. For example, earlier this year the change order problems on the BDPL - East Bay Project discussed in Section A of this report were revealed by the management information system and allowed upper management to focus on the causative factors. Remedial actions that will correct the situation are currently underway at the project level, adjustments in personnel have been made, and procedures have been tightened up. This occurrence can be cited as a clear demonstration of how the CMIS serves as a strong management tool, as well as a reporting mechanism.

3. **Is there a mitigation process in place to address cost and schedule growth, and, if so, what is it and how effective is it?** ***Yes, there is an effective mitigation process in place.***

There are a number of processes in place to mitigate undesired growth in cost and schedule, and scope. These three elements of any project are related and interdependent. If the scope of a project is increased, one can typically expect that the cost will increase, and quite frequently the time required to complete the work will also increase. A manager can frequently reduce the time or schedule to complete the work by spending additional money (e.g. paying for overtime work). At the beginning of a construction effort, the balance of these three factors is reflected in the original contract documents. Virtually all changes to one of these three factors will require a change in the contract, in the form of a change order.

Any proposed change in the scope of a WSIP project is carefully reviewed in the field and at the Regional level to determine if the change in the work is necessary, if the expected cost of the change is reasonable, and if the change will impact the project completion schedule. Routine

changes are developed at the project level by the Construction Management staff. The Change is then reviewed by the appropriate Project Manager, and then sent on for further review and approval at the Regional level of management. If the cost of the requested Change is above a pre-set dollar amount, or if there is any question that the requested work can legally be accomplished using WSIP bond funding, the requested Change Order is sent to senior management for review. A Change Control Board (CCB), composed of senior WSIP management personnel, is maintained to review significant Owner Requested Changes in the work for a project (i.e. more than a $50,000 increase in cost, or more than a 10% increase in the time allotted to complete construction). The CCB was originally formed to review significant pre-construction scope, cost and schedule changes greater than a specific threshold. Since the CM Change Management Procedures clearly outline the approvals required during the Construction Phase, CCB review during the Construction Phase is only required for "owner" requested changes greater than or equal to $50k. All other changes initiated in the Construction Phase are handled via the CM Change Management procedure and do not require separate review by the CCB.

Changes in project scope are being reviewed carefully by the WSIP management team. The program has been underway during a time when the country's construction industry is severely depressed. Consequently, bid prices and resulting contract values have been established that are significantly below the construction cost estimates developed during the planning and design phases of the Program. These "bid savings" provide the opportunity to add enhancements to the construction that could improve the capabilities of the operations department, but may not be absolutely necessary for the specific project being constructed. This aspect of the review has become an important function of the Change Control Board to guard against scope and cost growth that could result from non-essential work.

Growth in schedules, or time to complete the individual projects and the overall program, is also carefully managed. Contractors are required to notify the CM Team when costs have reached 80% of the approved contract value and confirm cost-at-completion. The contractors are also required to provide three week look-ahead schedules on a weekly basis and if the project is more than two weeks behind the planned schedule a corrective action plan is required.

Based on the performance to date, and with the exception of a few projects discussed herein, the mitigation measures appear to be working well.

4. **What is the basis of the projected costs and schedules at completion and are they realistic?**
In general, there appears to be a sound basis for realistic cost and schedule projections.
Current projections of costs and schedules to complete projects that have not yet started construction are primarily the responsibility of the Project Managers, who are assisted by the SFPUC Engineering Management Bureau. Projects currently under construction are the direct responsibility of the CM Team. Current estimates of cost to complete projects in construction are based upon current contract values, plus estimates or forecasts of costs of changed or additional work that will need to be accomplished under the current contracts. There is a hierarchical system to identify and track potential changes to the work and their cost and schedule impacts.

Anytime an item is identified that has the potential to cause increased cost and/or schedule delays and it appears it has a reasonable chance of occurrence, the project CM team with the approval of the PCM will identify a trend including an estimate of the associated cost and schedule impacts. Projected forecast-at-completion (FAC) costs are then based on combining the actual costs to-date, change orders (potential, pending or approved) and trends. In addition, costs associated with risks (80% confidence level) are included in the contingency reporting; however, they are not included in the FAC cost reporting.

Schedule delays are more difficult to forecast given the interrelationship of the individual construction activities that may have inter-dependant relationships with other activities, but they are clearly accounted for by WSIP management. All Requests for Change Orders that have potential schedule impacts must include the contractor's detailed analysis of the potential delay. Upon review and acceptance of these time impact analyses by the WSIP project managers, the potential time impacts are included under the category of "Trends" when completion forecasts are next made. Time extensions associated with all change orders (Approved, Pending or Proposed), and all Trends, are included in each update of each completion schedule forecast.

5. **What is the basis of establishing contingencies and how are they being managed at a project and program level?** ***Cost and schedule contingencies are initially established as ten percent of the construction award amount and duration and managed closely at the project and program management levels.***

Contingency accounts are typically established for construction projects to provide funding for accomplishment of work that is required for the beneficial completion of the project, but was unforeseen at the time the contract was awarded. Inclusion of these work items are generally done under "Change Orders" to the construction contract. In accordance with Commission policy, construction contingency amounts for each construction contract are currently established, at the time of contract award, at 10% of the awarded contract value and 10% of the contract duration. Any request by WSIP management to increase the contingency amount above 10% of the contract value must be submitted to the Commission and justified by WSIP senior management. Approvals are granted on a contract by contract basis, by the Commission.

At a project-level, amounts of contingency funds spent to date and the amount remaining in the project contingency account are examined by WSIP management on a monthly basis, as well as each time a Change Order is to be executed. The established, written procedures do not permit additional contract work to be executed if sufficient funds are not remaining in the project contingency account or contract schedules are to be exceeded.

As discussed under Section A, Change Management, the 10% schedule-related contingency is used primarily for early warning purposes and for Commission reporting and approvals. While it is a good management tool for individual projects, it does not necessarily reflect program level performance because of the interrelationship of the individual projects. Project and program level management use specific schedule management processes as described in Section A.

6. **Are sufficient contingencies being carried to cover increases in cost and schedule, and are the contingencies consistent with industry practice?** ***Yes.***

The WSIP program involves a number of projects that include a significant amount of underground work, such as pipelines and tunnels, which by its nature is fraught with unforeseen conditions. Given the nature, scope and complexity of the WSIP projects, it is considered highly unlikely that every project will be completed within the policy-based 10% contingency amount. However, if an across-the-board standard contingency amount is to be used, then the 10% level is a reasonably acceptable target, program-wide. That level is certainly within "industry-standard". In addition, the Commission has established a procedure for increasing the contingency level, on a project-by-project basis, and based upon detailed justification. That procedure has worked satisfactorily to date, according to WISP's senior management. Consideration could be given to returning to the practice of basing the initial project contingencies on the initial risk assessments, assigning higher than 10% contingencies to higher risk projects and lower contingency amounts to lower risk projects. This may create more realistic goals for those managing the higher risk projects and reduce the need to go to the Commission for increases. The overall program contingency could still be held at 10%.

In addition, the WSIP senior management is currently proposing an amendment to the Commission's procedure that would consolidate all project savings into a Program Management Reserve that could later be accessed to provide additional project funds during times of critical needs, while still providing total transparency and accountability of the use of those funds. In simple terms the amendment would permit the reservation of any "bid savings" (i.e. difference between the budgeted construction contract value before bidding, and the actual contract award value after bidding) as an augmentation for the actual number of dollars allocated in the contingency account (10%). Funds from this reserve account would only be accessible after formal approval by the Commission for additional project contingency. It is recommended that serious consideration be given to this adjustment in the Commission's procedures to help ensure that funds would be available for changes in the work that are time-critical.

Given the type of projects involved, the complexity of the WSIP program, and the Commission's procurement requirements, the performance rating of the team's ability to control the expenditure of cost-related contingency funds to date appears to be quite good. For the 22 current projects under construction, all of which are at varying stages of construction, 15 of the projects have used 10% or less of their contingency to date, 14% have used between 10% and 100% of their contingency, and three have exceeded their original 10% contingency. For this same group of 22 current projects, upon completion, two projects are projected to use less than 10% of their contingency account, 10 are projected to use between 10% and 100%, and 10 projects are expected to exceed their original 10% contingency allowances.

Overall, the 22 current projects are expected to have used approximately 81% of the original cost-related contingency amounts upon completion, equating to an 8.1% increase in the original contract award amounts for this group of projects. Given the owner-advantaged bidding climate during the period when these contracts were bid and awarded, such cost increases should not be surprising and should be considered within industry "norms".

Schedule-related contingency management is supplemented by other more applicable processes in place to manage schedule. In aggregate, it appears that schedule-related

contingency usage is projected to be in excess of 10% of construction award durations as shown in Tables 1 and 2 of Section A, Change Management. However, as discussed before, this is not necessarily an indication of schedule delays at a program level.

7. **How do the project soft costs compare with other similar programs?** ***As a percentage of construction cost, the soft costs appear to be at the high end of the range for other similar programs.***

   The term "Project Soft Costs" is typically used to refer to all costs attributable to a construction project that are not part of the physical construction work (labor, material, equipment and related direct markups such as overhead and profit). The WSIP has established the following categories of soft costs: Program and Project Management, Pre-Design Planning, Environmental Permitting & Compliance, Engineering Design, Construction Management Engineering Support & Contract Administration, Legal Right-of-Way, Project and Operations Support.

   In accordance with its scope, the CM Review Team specifically assessed the soft costs associated with Construction Management during the construction phase of the WSIP. All cost figures are based on June 2011 reporting data (Attachment C: June 2011 Revised WSIP – Cost Breakdown, Harlan L. Kelly Jr., AGM).

   The Construction Management and Contract Administration costs cover all required CM services, including management of project field office, field inspection, administrative support, schedule review and analysis, cost estimating, claims analysis, safety monitoring, project closeout, administration support, and Supplier Quality Surveillance cost during equipment fabrications. In addition, these costs cover testing services and special inspections, contract administration/management and labor relations (including administration of Project Labor Agreement). The total forecast of $271.9 million for this critical function is approximately 11.6% of total construction cost. The estimated cost of these services is $271.9 million which is 11.6% of the total construction cost.

   There are also Engineering Support costs necessary to support the construction management program during the construction phase of the projects. This includes overall design support during construction including activities such as technical review and approval of submittals, handling of field change orders, and design clarifications. The estimated cost of these services is $67.6 million which is 2.9% of the total construction cost.

   In addition, there is a component of the overall WSIP Program Management costs directly attributable to CM during the construction phase of the program. Program management costs include all expenditures associated with program-level development and implementation. These costs cover the following functions/activities: general oversight and coordination between the various SFPUC/City organizations and consultants involved in the WSIP; program controls and reporting; risk management; program communication and public outreach; legal services at the program level; cost estimating at the program level; document control/management; program-level CM functions such as programmatic contract administration, schedule and cost controls, field safety, quality management, dispute resolution; labor relations; programmatic effort related to system engineering; programmatic ROW support; interagency permitting; and administrative functions such as reports to oversight bodies, response to various oversight bodies and audits, formal requests to Commission and Board of Supervisors (for approval of

policies, changes to City Charter, supplemental appropriations, and changes to the program). Additionally, these funds cover all consulting services for program support, the administration of program contracts, and the resources appointed to the WSIP Director's Office. Assuming an allocation of these costs in proportion to the combined cost of the CM and Contract Administration and Engineering Support to the total overall WSIP soft costs, it is estimated that the cost of these services will be $25.1 million or 1.1% of the total construction cost.

There is also a component of the overall WSIP Project Management cost that is directly attributable to the construction phase CM. Project Management costs include oversight and management functions that are specific to a project. These functions, which extend from project initiation to construction completion and start up of new facilities, include: project-specific controls, cost estimating (including 35% design check cost estimate and 95% design independent cost estimate) and scheduling, value engineering, general oversight and coordination between the various SFPUC and City organizations and consultants involved in the project. Project management costs include the costs associated with labor hours of the Project Manager (PM), Regional Project Manager (RPM), and Regional Client/Operations Representative (a.k.a. Operations Liaisons) assigned to the project. Also Project Management costs include record management, communication costs and other project-specific administrative costs. Assuming the same percentage allocation as for Program Management costs, it is estimated that the cost of these services would be $41.8 million or 1.8% of the total construction cost.

Combining the above estimated soft costs, the total associated with the construction phase CM would be $406.3 million or 17.3%.

Based on a review of several benchmarking analyses conducted by similar agencies (see Table 11) and used for benchmarking with the Multi-Agency Study, it was determined that the soft costs as a percentage of total construction cost ranged from 10.8% to 20.8%. The WSIP is at the higher end of the industry range as would be expected for a complex program of 81 publicly-funded regional projects being constructed over a period of greater than ten years. Such large multi-project programs have management requirements over and above stand-alone projects. Also, City staffing requirements may result in some unavoidable overlap of City and consultant staff as noted in the previous IRP review.

Phase	Los Angeles Hyperion Full Secondary Phase I	Los Angeles Hyperion Solids Handling Projects	Seattle Metro West Point Project	Milwaukee Water Pollution Abatement Program	Boston Harbor Clean-up Deer Island Treatment Plant
Project Management	1.1	2.3	0.6	2.2	0.4
Construction Management	7.6	10.7	5.2	3.6	2.4
Project Controls	2.6	2.7	2.0	1.8	1.7
Engineering Support/Survey	4.6	6.4	5.5	3.3	2.0
Start-up and Training	0.1	4.7	1.8	1.3	1.0
Inspection	4.8	4.3	2.5	6.0	3.3
TOTAL	20.8	31.1	17.6	18.2	10.8

Table 11 – Comparison of Costs during Construction as a % of Construction Costs
Source: Multi-Agency Study (David M. Griffith & Associates, 1995)

8. **Are the soft costs, specifically program or project management consultant help, contributing to the ability to maintain more control over the program, thereby assuring timely program completion that might not otherwise happen?** ***Yes.***

The soft cost funding is required to assemble and maintain the quality and quantity of staff that are in place today. Unquestionably, the WSIP would not have achieved the successes it has already realized on completed projects (on schedule, under budget, exemplary safety record, minimal public complaints, zero claims to date, etc.) without the quality and quantity of the management staffs. The current, on-going projects are showing similar success.

During this current year there have been a few projects that have had performance problems, especially regarding cost and schedule issues. Some personnel needed to be changed and they were. Some procedures needed to be tightened and they were. And all levels of management were reminded that constant vigilance by qualified professionals is what it takes to successfully complete complex construction programs. That is what Program and Project Management consultants do and that is what the WISP team did.

In the opinion of the reviewers, the costs of CM Team are within industry norms and are justified as evidenced by the overall successful performance of the program to date.

D. Recommendations and Next Steps

Following are a prioritized list of recommendations and next steps:

a. Short term

1. ***Perform an audit of the latest Earned-Value Analysis or, alternatively, perform a Cost- and Schedule-to-Complete Analysis, in order to check the forecast of overall WSIP cost and schedule performance.***

   The RBOC has expressed a desire to obtain an independent review of whether the overall WSIP program will be completed within the current budget and scheduled completion date. WSIP management is preparing earned-value analyses on a regular basis for that purpose. An independent assessment could be undertaken by either a detailed audit of the latest earned-value analysis or performing a cost- and schedule-to-complete analysis. This should include a detailed analysis of the Critical Path Method (CPM) WSIP Program Completion Schedule.

2. ***Revise the current Contract Summary reporting to better reflect the actual program schedule change management process being used and establish a policy for what change orders and trends are to be considered for identifying program performance problems for both cost and schedule.***

   The current schedule performance reported on the Contract Summary utilizes an aggregation of individual project contingencies as a basis of measuring program schedule performance. A more accurate means of reporting should be developed consistent with the overall program critical path and shutdown schedule requirements. In addition, it is not clear whether potential change orders and trends should be included in the determination of whether corrective measures are required as reported in the Contract Summary reports. There should be an agreed policy regarding this.

3. ***Verify that there are system-wide Emergency Procedures in place including evacuation, notification, regular drills and training at all construction field offices.***
   It is essential that there be standard procedures and training in place for handling emergencies, such as earthquakes, accidents and terrorist activities. This should include procedures specifying communications, notification, roles and responsibilities, practice drills and training of all staff. It was not clear from the IRP's limited review that such procedures are in place.

4. ***Assess the earthquake provisions related to construction ways and means.***
   One of the principle reasons the WSIP is being undertaken is to address seismic deficiencies in the existing system. Given the probability of an earthquake occurring before completion of the program, a determination should be made of what measures have been taken in the design of the system and the construction means and methods being used to provide protection of the system during the construction phase.

b. Long Term

1. ***Consider other delivery approaches such as design/build, CM at risk and CM/GC for future projects.***
   The WSIP has used the design-bid-build approach to project delivery for most of the program. While there are many benefits to this delivery approach, there are others such as design/build, construction management at risk and construction manager/general contractor that may benefit future SFPUC programs from the standpoint of management, quality, cost and schedule performance.

2. ***Contract for Constructability Reviews to be provided by construction contractors, on a consulting or fee-for-service basis, for projects prior to the completion of design, with particular attention paid to geotechnical issues.***
   The SFPUC utilizes independent design reviews during the design phase of projects to help reduce design errors and omissions. Constructability reviews are also currently undertaken early in the construction phase. It may be helpful to also include construction contractors during the design phase to help develop designs that are more constructible.

3. ***Apply procedures and lessons learned to future programs such as the SSIP.***
   There have been many very valuable lessons learned during the course of the WSIP construction. It is strongly recommended that these lessons be compiled and used by other SFPUC projects, such as the upcoming Sewer System Improvement Program, as well as other agencies implementing such programs.

4. ***Implement a formal Integration Management Plan for future programs.***
   For large complex multi-project programs like WSIP, it is essential to make sure that the many interfaces between the separate projects are managed closely to ensure overall system performance. This is apparently being addressed on WSIP by the way the program is organized and through the shutdown management process. However, a more formal integration management process may have benefit on future programs whereby the interfaces are specifically defined, responsibilities defined and regular interface meetings conducted.

Appendix

A. BIOS OF PANEL MEMBER

Gary Griggs, Panel Chair
Gary is a Consulting Professor and Director of the Construction Institute at Stanford University. He teaches a series of courses on infrastructure project development and delivery covering the planning, environmental, design, and construction of major infrastructure project. He is also an Adjunct Professor at the Asian Institute of Technology where he teaches project and construction management. His over 30 years of industry experience includes managing major infrastructure projects around the world and he has held senior level positions at several global firms including President of Parsons Brinckerhoff's Infrastructure Company where he was responsible for all operations and projects. He is a registered professional engineer in several states including California and a member of the American Society of Civil Engineers.

Glenn Singley, Panel Member
Glenn is Director of the Water Engineering and Technical Services Division of the City of Los Angeles Department of Water and Power (LADWP). He is responsible of all major Water System Capital projects, with a current-year budget of $500 million. The Division provides planning, design, project management, construction management, survey, geotechnical, and Geographical Information System (GIS) mapping services for the Water System. Prior to his current position, he was the Northern District Engineer responsible maintaining and operating the Los Angeles Aqueduct. He has over 30 years of experience and is a registered professional engineer in California, a member of the American Water Works Association, and a Director on the Board of the Western Council of Construction Consumers.

Don Russell, Panel Member
Don is currently an independent consultant providing services to the construction industry. He was the co-founder of Vanir Construction Management where he served as President and Chief Executive Officer for many years and continues to serve on the company's Board of Directors. He is a 40-year veteran of the construction management industry and has worked domestically and internationally for both public and private sector clients. He has also been President of startup companies that became recognized developers/owners/operators of underground natural gas storage facilities. He has been active in the Construction Management Association of America for more than 25 years where he served as Chairman of the Standards of Practice and Ethics Committees, as a member of the Association's Board of Directors and Executive Committee, and as President from 1994 to 1995.

Galyn (Rip) Rippentrop, Panel Member
Rip is currently an independent consultant providing services to the construction industry. He was President and Chief Executive Officer of Frontier-Kemper Constructors for over eight years responsible for all operations and projects and successfully led the expansion and diversification of services and products offered by the company and its subsidiaries. He has over 35 years of domestic and international heavy construction experience consisting of underground construction associated with major transportation, water and energy, and mine development projects. Some of his major projects include Rio Piedras Project in San Juan, Puerto Rico; Congress Heights and New Hampshire Avenue Tunnels in Washington, DC; and, eight kilometers of twin-bore rail tunnels under the Storebelt Straits in Denmark. He is a member of the Beavers and Moles underground construction associations.

B. SITE VISITS

Project	Comments/Issues
Bay Division Pipeline 5 – East Bay (CUW36802)	Bay Division Region. Met with key staff. Major change order backlog resulting from design issues and differing site conditions. Used force accounts for much of the work. Exceeding contingency.
Bay Division Pipeline – Tunnel (CUW36801)	Peninsula Region. Attended DRB Meeting and visited construction site. Issues with OSHA regarding hyperbaric pressure during interventions and ventilation. Use of vertical conveyor system somewhat new. Concerns about availability of TBM extraction pit and connections in the East Bay if advance rates are very good.
SVWTP Expansion & Treated Water Reservoir (CUW38101)	Sunol Region. Met with key staff and visited construction site. Many owner-directed change orders during bidding. A large number of change orders currently being processed.
New Irvington Tunnel (CUW35901)	Sunol Region. Met with key staff and visited construction site. Gassy conditions being addressed with OSHA.
Crystal Springs/San Andreas Transmission Upgrade (CUW37101)	Peninsula Region. Met with key staff. Difficulty in resolving change orders. Contractor not providing construction schedule.

C. LIST OF INDIVIDUALS INTERVIEWED

Program Level:

Julie Labonte, Program Director
Harvey Elwin, Deputy Director of Construction
John Kinneen, Program Construction Manager
Emad Mansour, CM Operations Manager
Jess Yoder, Program Advisor
Doug Stovall, Program Construction Contracts Manager
Richard Bridge, Program CMIS Manager
Gustavo Soto-Rosa, Project Controls
Susan Hou, Program Risk Manager
Todd Bjornsen, Program Safety Manager

Bay Division Pipeline No. 5 – East Bay

Joanna Wong, Regional Project Manager
Ben Leung, Regional Construction Manager
Joe Ortiz, SFPUC Project Manager
Roger Hatton, Regional Consultant Construction Manager
Jack Santos, Project Construction Manager

Margaret Berg, Field Contracts Administrator
Ajay Singh, Scheduler/Cost Control Specialist
Steve Martin, SFPUC QA Inspector – Pipeline/Structural
Myesha Henderson, Administrative/Document Control Specialist
Fadie Nasri, Program Risk Analyst
Peter Cuddihy, Construction Contractor Operations Manager (Ranger Pipeline Inc.)

Bay Division Pipeline No. 5 – Tunnel

Harvey Elwin, Deputy Director of Construction
Emad Mansour, CM Operations Manager
Joanna Wong, Regional Project Manager
Ben Leung, Regional Construction Manager
Bob Mues, Project Construction Manager
Nick Coluccio, Contractor Executive – Coluccio
Ray Post, Contractor Executive - Michels
Jim Stevens, Construction Contractor Project Manager
Jessica Romm. DRB Coordinator
DRB Panel Members:
Don Deere
Fred Dunham
Russell Clough

Sunol Valley Water Treatment Plant

Dan Wade, Regional Project Manager
Ravi Krishnaya, Assistant Project Manager
Kevin Costello, Regional Construction Manager
John Barsky, Regional Consultant Construction Manager
Rizal Villareal, Project Construction Manager
Steve Higgs, Field Contracts Administrator
Fadie Nasri, Program Risk Analyst
Marcus Jefferson, Risk Analyst
Chris Bessa, Shutdown Coordinator
Chris Wilkins, Construction Contractor Deputy Manager (Schimmick)

New Irvington Tunnel

Dan Wade, Regional Project Manager
David Tzstoo, Assistant Project Manager
Dan McMaster, Project Consultant Construction Manager
John Snitzmier, Field Contracts Administrator
Fadie Nasri, Program Risk Analyst
Manny Diaz, Construction Contractor Project Manager (Kiewit)

Crystal Springs/San Andreas Transmission System Upgrade

Husam Masri, Regional Project Manager
Alan Johanson, Regional Construction Manager
Dave Conover, Regional Consultant Construction Manager
Tony Gilmore, Project Construction Manager
Mark Smith, Project Consultant Construction Manager
Mike Astin, Field Contracts Administrator
Rudy Geronimo, Cost Estimator
Mark Spumer, Project Controls
Fadie Nasri, Program Risk analyst

C. ITINERARY

Sunday, October 2

06:00 pm – 08:00 pm	Working Dinner (Millbrae)

Monday, October 3

07:30 am – 08:00 am	Meet with Program Advisor (Jess Yoder) (1145 Market Street, 3rd Floor)
08:00 am – 09:00 am	Meet with Deputy Director of Construction (Harvey Elwin)
09:00 am - 10:00 am	Meet with Program Director (Julie Labonte)
10:00 am – 11:00 am	Meet with Program Construction Manager (John Kinneen)
11:00 am - 12:00 pm	CM Operations Manager (Emad Mansour)
12:00 pm - 01:00 pm	Lunch/Travel to Site Visit
01:00 pm – 05:00 pm	Bay Division Pipeline 5 – East Bay Site Visit
05:00 pm – 07:00 pm	Working Dinner

Tuesday, October 4

08:00 am - 11:00 am	Bay Division Pipeline – Bay Tunnel DRB Meeting and Site Visit
11:00 am – 1:00 pm	Shutdown Meeting in Millbrae
12:00 pm - 01:00 pm	Working Lunch
01:00 pm - 02:00 pm	Review and Analysis of Project Documents in Project Home Office
02:00 pm – 02:45 pm	Meet with Program Construction Contracts Manager (Doug Stovall)
02:45 pm – 03:30 pm	Meet with Program CMIS Manager/Project Controls (Richard Bridge/Gustavo Soto-Rosa)

03:30 pm – 04:15 pm	Meet with Risk Manager (Susan Hou)
04:15 pm – 05:00 pm	Meet with Safety Manager (Todd Bjornsen)
06:00 pm – 08:00 pm	Working Dinner

Wednesday, October 5

08:00 am - 12:00 pm	SVWTP Expansion and Treated Water Reservoir Site Visit
12:00 pm - 01:00 pm	Working Lunch
01:00 pm – 05:00 pm	New Irvington Tunnel Site Visit

Thursday, October 6

08:00 am - 12:00 pm	Review and Analysis of Project Documents in Project Home Office
12:00 pm - 01:00 pm	Working Lunch
01:00 pm – 02:00 pm	Review and Analysis of Project Documents in Project Home Office
02:00 pm - 05:00 pm	Crystal Springs/San Andreas Transmission Upgrade Site Visit
05:00 pm – 07:00 pm	Working Dinner

Friday, October 7

08:00 am - 11:30 am	Review Team Working Session
11:30 am - 2:30 pm	Team Debriefs SFPUC Management on Findings
12:30 pm - 02:00 pm	Lunch with SFPUC Management
02:00 pm - 04:00 pm	Review Team Working Session – Summarize Findings and Recommendations