

FINAL REPORT

CALTRANS WORKLOAD DEVELOPMENT PEER REVIEW

Prepared for: CALTRANS

and

THE STATE LEGISLATIVE ANALYST'S OFFICE

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INTRODUCTION and EXECUTIVE SUMMARY

The Capital Outlay Support Peer Review Committee (PRC) was requested to evaluate the new mandated program for determining the Capital Outlay Support Workload and Budget Requirements of the California Department of Transportation (Caltrans) as directed in Business, Transportation, and Housing Supplemental Report of the 1996 Budget Act, Item 1660-001-0042 - Department of Transportation. The evaluation was undertaken between July and September 1996. This report presents the results of our review of the proposed process and practices and recommends specific actions to improve the department's efficiency and effectiveness in forecasting the Capital Outlay Support Workload and Budget.

The charge given the PRC consisted of two parts. Part one was set forth in Item 2660-001-9942 - Department of Transportation, as part of the supplemental Report of the 1996 Budget Act, Paragraph Ia as follows:

1. *Capital Outlay Support Budget Model.* The Department of Transportation (Caltrans) shall develop its proposed 1997-98 Capital Outlay Support budget using a project development workload model that estimates resources at the project level. The estimating process shall be based upon the efficient resource level requirement to perform identified work, rather than upon historical averages and unsubstantiated adjustments. Caltrans shall have its approach validated by engineering and management practitioners from the private and public sectors. The validation shall include at least the following:
 - a. A peer review evaluation, consisting of representatives of large, comparable private and public engineering enterprises. This peer review shall, at minimum:
 - i. Review Caltrans' proposed approach for developing capital outlay support workload and budget.
 - ii. Compare Caltrans' proposed approach against industry best practices.
 - iii. Recommend needed modifications.
 - iv. Provide to Caltrans and the Legislature, not later than September 30, 1996, a Report of Findings and Recommendations.

Part two is contained in the California Department of Transportation (Caltrans) Capital Outlay Support Peer Review Team memo as follows:

I. Objectives

Review and provide written evaluation of the proposed new approach to determine Capital Outlay Support workload and budget requirements. The written evaluation should consider objectives as defined by the Project Management Improvement Plan, staff perspectives gained through personal interviews, appropriate legislation, and a comparison against industry best practices .

II. Scope of Work

A. Review the following documents

1. Stanford Research Institute (SRI) recommendations
2. Project Management Program Business Plan
3. Project Management Improvement Plan workplan (portions)
4. Project Management using PYPSCAN , PYPSCANer's Guide , and other relevant documents concerning PYPSCAN (Person Year and Project Scheduling and Cost ANalysis) system
5. Guide to the Caltrans Work Breakdown Structure (WBS) and Resource Breakdown Structure (RBS)
6. Relevant legislation (to be provided by Caltrans)
7. Capital Outlay Support Performance Measures
8. Project Management Handbook

B. Interview corporate, district and service center staff to document Capital Outlay Support budget proposal objectives. Include:

1. Approach to transition from PYPSCAN to Project Support Budgets to detailed Project Workplans
2. Interim estimating process, including Project Support Budgets
3. Person-hour estimating standards plan
4. Progress to date
5. Current obstacles

C. Produce Draft and Final Report of Findings. Report to include an evaluation of the proposed Capital Outlay Support Budget proposal against industry best practices. Evaluation of progress to date. Recommend changes in priorities or methods to accelerate progress. Identify obstacles or roadblocks, potential solutions, and internal or external resources which could enhance success.

For easy future reference we have organized our report into eight sections as follows:

1. Introduction and Executive Summary
2. Findings

3. Shortcomings
4. Recommendations
5. Arizona Department of Transportation
6. Private Consultant Practices
7. Responses to SRI Report Review
8. Appendix

The PRC approached its assignments with three basic focal points:

1. Comparisons of Caltrans Project Management and Budgeting practice with those of Private Practice.
2. Present status of the effectiveness of the Caltrans bottoms-up Project Management program, and the present level of expertise of its Project Managers.
3. Implementation status of the XPM project management tool as a replacement for PYPSCAN.

Under previous Caltrans leadership and political administrations, Caltrans was perceived to have a poor record of delivering product. There seemed to have been a lack of focus and commitment to the client. The result has been a legislature that has been extremely critical of Caltrans leadership and their programs. In California, the Legislative Analysts Office (LAO) is tasked with measuring performance as mandated by legislation. The LAO has also been critical of Caltrans and its ability to deliver on its program.

The product/deliverable definition has varied. For a long time the emphasis by Caltrans was on how many Federal dollars were captured and spent in a fiscal year. Recently, the product has been how many budgeted (programmed) dollars were spent and how many programmed projects were delivered in the programmed year. The new focus will include managing the support cost for delivering the annual program.

During our review, we interviewed the staff of the Office of Workload Development at Headquarters, as well as the North Region Districts 1, 2 and 3, and Districts 4, 7 & 12. At Headquarters we reviewed both the existing program based workload forecasting program (PYPSCAN), as well as the proposed project management program (XPM) in great depth. We also held telephone interviews with Dana Curry and Mark Cunningham of the Legislative Analysts Office and John Dietrich of XPM, Inc. At the regional Districts we reviewed the operational implementation of both the old and the new workload forecasting programs. It became obvious, almost immediately, that although the proposed XPM program promised greatly enhanced project level information system control, it is not yet operational to the point where it becomes a project management tool or even a scheduling tool. District 3 (which is the mother district for Districts 1 and 2) was a trial district for the implementation of the new XPM program, and has fully implemented the present limited capacity of XPM. However, in order to adhere to the new cultural directive for Caltrans budget forecasting and management that is termed a bottoms-up approach (in reality it is a product driven zero based budgeting

program implemented through project level control) that estimates resources at the project level, District 3 has augmented XPM with other ancillary software and applied a reality check through the old standby PYPSCAN. In varying degrees this same improvising Band-aid approach was occurring in each of the four Districts which the committee visited.

The Caltrans approach for determining the Capital Outlay Support workload and budget, as it relates to industry practices, has been reviewed considering state budget requirements. The Capital Outlay Support Budget is based on the projects in the various programmed documents such as the State Transportation Improvement Program (STIP), the State Highway Operation and Protection Plan (SHOPP), and the Traffic Systems Management (TSM), along with projects funded by county sales tax measures and privately funded projects. Historically, there have been wide variations in work load requirements due to funding changes and natural disasters, such as earthquakes and floods. The normal budget process requires that the agency workload be determined from 12 to 18 months before the beginning of the budget year. This long lead time underlines the need to accurately predict future workloads and to have resource flexibility in the event unscheduled budget changes such as earthquakes, floods and other emergencies occur, or new funding is available.

The determination of workload is a key element of the budget process. It must be accurate, credible and acceptable to the Project Manager, the District Director, the Department, the Agency and the Legislature. It is a complex process, as it must predict both the funding received from multiple sources as well as the work that must be completed each year on projects in various stages of development. The stages extend from the conception of a project through environmental clearance, design and completion of construction which usually covers a period of 2 to 4 years and can extend much longer on complex projects.

In the past, Caltrans has used PYPSCAN to determine program workloads. PYPSCAN estimates are made on historical project data considering a number of factors such as project size and type, location and cost. It was designed to focus on the schedules for groups of projects, or programs. Periodically the PYPSCAN formulae were updated; however, the updates depended on program-wide historical data which was slow to reflect changes, as well as project delivery conditions that increased workloads such as environmental requirements or, on the other hand, those which reduced workload such as improved procedures and technology that increased productivity. PYPSCAN was not designed to be used to determine project task workloads or to manage individual projects.

Historically, Caltrans has emphasized management of programs instead of individual projects. PYPSCAN reflected a program emphasis as well as program performance measures. The performance of project development and delivery was measured by the percentage achieved in obligating all available annual federal funds, as well as being in a position to immediately build projects to compete for any federal discretionary funding that became available. Over the years, Caltrans has been very effective in not losing any federal funding and in attracting significant amounts of discretionary funding.

Project Managers operate against a finite set of projects . Functional Managers operate against all projects within the program . Program Management is a continuous process which considers project/task resource requirements and priorities in the establishment of schedule commitments.

In the current Caltrans environment of relatively inflexible resources, program management is very important in establishing project schedule commitment and must be considered in the Project Manager/Function Manager work agreement process. Projects and their individual task timelines and resource requirements are the building blocks for the program budget. In the environment of constrained, inflexible resources, project priorities must be established and program-wide leveling of workload across all resources must be performed before Functional Managers can be expected to commit to delivery dates for their products. Constant evaluation of project changes, actual accomplishments and expenditures must be performed and factored into functional manager commitments.

The approach Caltrans is now pursuing for developing the capital outlay support workload is a Product Driven Zero Based Budgeting Project Management Program. This is a significant cultural change from what has been done in the past, but given the necessary time for the change to take root and grow strong as a new accepted culture in the Agency, it should offer opportunities to more effectively budget and manage the overall project delivery program. The term bottoms-up has been used to describe the budget process. Although this term provides a word picture of the basic intent of the program, a more appropriate description of the new budget process is product driven and zero based.

Workload determination, budget preparation, and performance measurements are an integral part of the mandated management process. It emphasizes project management rather than program management under the control of a single Project Manager with workload determined by specific functional tasks on a project-by-project basis. The old days of throwing the project over the fence to the next function once a specific task is complete are over. Performance measurements for deliverables are being investigated, defined and instituted to reflect project accomplishments related to quality, schedule, cost and customer satisfaction.

The PRC reviewed the approach that Caltrans has taken to develop the 1997-98 budget. Caltrans had adopted basic changes for determining workload that are consistent with project management and the procedure used in private industry. These consist of a Work Breakdown Structure, a Resource Breakdown Structure, and a Project Work Plan. The WBS identifies tasks as building blocks for determining workload and for objectively measuring progress and performance. The RBS is used to assign resources to the tasks in the WBS. The Project Work Plan identifies the scope, cost and schedule and includes WBS tasks and RBS resources along with commitments for completion.

We found that while Caltrans had adopted these basic changes, these changes are only in the process of being implemented and were used to a very limited degree in developing the 1997-98 budget. In the past Caltrans has not determined resource needs by task; therefore, managers do not have that experience and there is no data base for reference. As a result, managers have used PYPSCAN as a start for estimating individual project resources and then as a reality check for total resource needs. Caltrans has established a number of functional task forces to determine work norms for the tasks and intends to collect information by task to build a data base for reference in the future. As the functional units gain experience in determining the work for accomplishing the tasks, they will be able to more accurately determine the workload.

Caltrans has adopted XPM as the primary project management tool; however, the PRC found there is no coherent implementation of XPM at this time, and in varying degrees, districts have improvised and used a Band-aid approach to augment it.

An essential part of the project management concept is to have monitoring reports that are accurate and timely. The PRC found that these reports are not yet available from XPM and the districts are improvising and are using various methods for data basing information and preparing reports, but they are not timely and they are sometimes inaccurate.

The procedure that Caltrans has adopted is similar to that used by industry where tasks are used to identify workload, but managers in industry have gained the expertise for determining workload by task.

The project management process at the Arizona Department of Transportation (ADOT) is similar to that of Caltrans. ADOT implemented a project scheduling system (Primavera) a year ago and is now implementing the resource features of that system. ADOT has, however, had the resource planning and staffing modules of the Artemis system in place for several years and found it is successful in measuring construction cost and schedule commitments. The Artemis system imports time sheet and accounting information from other ADOT systems.

The detailed results of this review are presented in eight parts. After the Introduction and Executive Summary, the next three sections provide a summary of findings, perceived shortcomings, and recommendations. Sections 5 and 6 provides the details of some of the relevant project management and budgeting practice of the Arizona Department of Transportation and private practice firms. Section 7 contains our comments on the progress that appears to have been made by Caltrans towards the recommendations in the Project Management process contained in the SRI Report.

This report attempts to identify recommendations that address a variety of specific issues with the overall thrust of the recommendations being to provide possible activities that could improve Caltrans' project management and budgeting operating efficiency and effectiveness. The recommended actions attempt to accomplish this through enhancements in performance

measurement procedures, management, and accountability at all staffing levels. The PRC report seeks to identify potential improvement in project management practices by enhancing the already prescribed set of integrated performance measures and tools that will apply to senior managers, division managers, district directors, functional managers, project managers, and supporting staff, and by fostering a managed partnership with private-sector firms for contracting-out. Inefficiencies in administrative, operational, and maintenance activities reduce the amount of funds available for capital expenditures, because these are programmed off-the-top, thereby reducing funds available for programming capital projects. Improved accountability is accomplished by providing project managers with management tools and the authority to exercise budget, resource and schedule control so they can really be responsible for meeting their performance goals. By giving them the necessary tools and the flexibility and authority in using them, they can take the actions necessary to meet the schedule deadline and budget requirements. Almost every Project Manager interviewed indicated that they needed the opportunity to use outside contract resources whenever appropriate in order to meet their performance goals in the most efficient way.

This report has generated 39 Findings and 12 Shortcomings from which 60 Recommendations have been drawn. These are fully described, categorized, and prioritized in this report and since they are already in bullet format, are hereby made a part of this executive summary. The two major objectives guiding the selection of these priorities were the expeditious and complete implementation of a Product Driven Zero Based Budget process combined with a fully functional Project Management Program with user friendly and operational data bank tools.

The PRC has concluded that the major barriers to the success of the Product Driven Zero Based Budgeting Project Management system confronting Caltrans leadership are as follows:

The unavailability of a data based project management reporting system anchored by XPM.

The lack of the use of flexible resources within the purview of the Project Manager.

The significant culture change required from Functional Managers in determining resource needs by project, and in accepting the Project Managers' leadership role.

The ingrained bureaucratic cultural resistance to a flattened organizational culture centered on project delivery by Project Managers.

The culture change necessary at Caltrans to eliminate micro management of individual projects by Headquarters.

The PRC would like to express its deepest appreciation to Director van Loben Sels for his constant and complete support, to Tony Harris and his Headquarters staff, to Irene Itamura and the District 1, 2 and 3 staff, to Joe Browne and the District 4 staff, to Ken Steele and the District 7 staff, and to Brent Felker and the District 12 staff. Without the outstanding level of their

enthusiasm, interest, preparation, participation, cooperation, and the written information readily supplied, our task would have been impossible. The leadership of Caltrans can be justifiably proud of the department team members with whom we met for their obvious commitment and dedication to the culture changes required and mandated by a Zero Based Budgeting and Product Driven bottoms-up programing with Project Manager control.

FINDINGS, SHORTCOMINGS AND RECOMMENDATIONS

This assessment of Caltrans' project management and budgeting performance entailed many steps: analysis of data; a literature search, including a review of prior reports, and selected studies and extensive interviews. During the course of the study, the project team interviewed nearly 100 persons inside and outside of Caltrans to develop our perspectives on the problems and issues that the department faces in fully implementing the Project Management and Product Driven Zero Based Budgeting Program, and how specific recommendations might be addressed. We obtained data to support points that allow quantification, and in generating findings, shortcomings, and recommendations we have incorporated the team's experience with similar management consulting assignments and analyses for government and corporate entities.

FINDINGS

Generally the PRC found that Caltrans has adopted and is implementing the concept of a Product Driven Zero Base budget approach, and used this approach in building the 1997-98 budget. However, since Caltrans does not have historical information for workload requirements by task and has limited experience in estimating such workload, the resources requested for the 1997-98 budget appeared to be a best estimate with a reality check by PYPSCAN for overall resources.

The PRC does not believe that Caltrans will be ready to conduct an automated analysis with XPM and report the results during the 1997-98 budget hearings in April 1997.

The following is a list of the major findings identified by the PRC:

1. The Caltrans Plan for replacing PYPSCAN with a fully operational XPM program as a tool for an effective project management information system is good (more detail, better control) and is underway.
2. The Caltrans Plan for Product Driven Zero Based Budgeting (bottoms-up) is good and is well underway.
3. The Caltrans Plan for life cycle control of a project including authority and responsibility for project delivery by Project Managers is good and is underway.
4. The Caltrans Plan for having the Function Managers as technical resources to the Project Manager is good and is beginning to take hold.
5. Signed Project Partnering Agreements between Single Focal Point, Program Manager, Project Manager, Function Managers, and Resident Engineer are good (in fact essential) and are underway.

6. Functional task groups at the headquarters level are currently developing resource work standards and norms to be used by project managers and functional managers as reality checks when they develop their Project Work Plans and budgets.
7. PYPSCAN has been in existence since 1980. PYPSCAN has been the only tool for assessing budget issues (PYs) at the program level. This approach has been updated over the years and has provided to date, a good check on the gross maximum resource needs of a program. However, it is inadequate to address project level resource requirements and status. The system cannot identify resource needs or status at the (sub) functional level.
8. Implementation of project management concepts is underway at Caltrans. A structure of functional managers exists that controls the resource matrix organization. Through project work plans and work agreements, the project team reaches agreement on project delivery issues, such as schedule and resources as requested by the Function Managers.
9. XPM is perceived by Caltrans Project Managers to be a comprehensive program/product management database and support system while, in fact, it is designed to be a project management schedule and control system with roll-up capabilities to perform program-wide analysis. XPM is currently NOT meeting the design requirements, however, even when it does, it will never fulfill the current expectations. XPM (or a replacement project scheduling tool must be integrated with a suite of applications through an open database structure to meet the needs of scope, schedule, cost and resource management envisioned by the PRT and many of the individuals interviewed in Caltrans. Unfortunately, until the system is accurately presented, is user-friendly , operational and its integration with Caltrans' Transportation Accounting and Management System (TRAMS), Caltrans Time Recording System (TRS), etc. has been accomplished, full resource allocation and monitoring capabilities at the project level will continue to be inadequate. Consequently, program level budgeting will continue to be perceived as suspect by Project Managers, Functional Managers, and information reviewers.
10. Each of the interviewed Districts are using resources that had been allocated to future projects in order to address the need for unbudgeted current critical project need. This practice will eventually cause the future projects to also become critical from a delivery standpoint.
11. Due to interpretation of current state law, consultant resources can only be utilized on unique seismic or emergency projects, thereby inhibiting resource flexibility. Caltrans Project Managers feel a frustration in the lack of resource options available for the delivery of projects. They would like to be able to contract out with On-Call contracts for 1) peak work, 2) storm related work, 3)work beyond their PY allocations, and 4) work to

keep their program on schedule. Caltrans has proposed in the 1997-98 budget the establishment of a Transportation Disaster Fund (TDF) that would provide funding flexibility for both support services and capital outlay to promptly respond to emergencies without taking resources from ongoing projects. When on-call contracts are in place, Caltrans would like the \$500k limit removed. They would like the ability to work with reliable Consultants, even though the work involved may exceed the \$500k limit.

12. Ability to utilize students, interns, etc. is also sharply curtailed. Again, resource flexibility is sharply curtailed.
13. Although quantifiable data was not presented, nor seemed to be readily available, it appears to be the general consensus among Caltrans staff that inadequate resources are being provided for Capital Outlay Support of mandated programs. Consequently, a project prioritization approach is established in each District on a program basis to assist functional managers in allocating limited resources.
14. Caltrans has undergone organizational changes over the past few years. Employee levels have been reduced from approximately 20,000 to approximately 16,000. During fiscal 95-'96 Caltrans delivered 96% of the raw number of STIP, SHOPP, and TSM projects. From a dollar perspective, Caltrans delivered 100% of the funds available for these same programs.
15. In the competitive marketplace of private practice, accurate resource requirements estimating is a matter of survival. Award of a contract because the resources needed have been estimated at too low a level will result in a financial loss on the project. Or, after being chosen as the most qualified consultant, resources required to complete the project are estimated at too high a level, you will not be awarded the contract. In contrast, within Caltrans, there are no punitive impacts to Project Managers, Function Managers, Single Focal Points, Program Managers and District Directors for inaccurate estimating of resource requirements.
16. The model written work programs and handbooks prepared by Headquarters and Districts are excellent guides and tutorials to help Program Managers, Function Managers, Project Managers, and Single Focal Points to clearly understand their role. However, it is impossible to implement them as presented because a basic management tool (XPM) to be used in administering the program is not yet on line.
17. The 1995 Allocation Plan, STIP, SHOPP and TSM Delivery performance indicates that 96% of the projects and 118% of the program dollars were delivered. The 96% of projects delivered amounts to \$1,062.3 million which is also 96% of the program amount. The 118% of the program amount includes an additional 60 projects that were advanced amounting to \$143.7 million, bringing the total delivery of 740 projects to \$1,026.3 million. Using a performance measure for number of projects delivered and another performance measure for program dollars that is not directly related to the number of

projects delivered is misleading. This leads to misunderstandings about the actual project delivery and may divert attention from the causes of project attrition that need to be addressed.

18. The Project Manager and Function Manager level of Caltrans do not believe they have been allocated sufficient resources in the past and there is some doubt on their part that sufficient resources will be assigned under the new Zero Based Budgeting Program based on their estimates in the future to complete the STIP projects being assigned to them. At any time, Caltrans Project, Functional and Program Managers have a series of projects scheduled over a period of a minimum of three years that they are working on.
19. Headquarters has mandated lowering total overhead allowances for project delivery from 25% to 12-1/2%. Although the concept is good and the percentage reasonable, it appears that a major culture change within Caltrans is required before it will be an accurate cost accounting figure for all types of overhead expenses. Headquarters receives fixed annual resources to perform specific overhead functions. Headquarters administration accounts for approximately 5% of the total capital support overhead allowance.
20. The Engineering Service Center (ESC) is responsible for structure design, structure construction, geotechnical investigations, finalization of plans, specifications and estimates, preparation of bid packages and advertising and award of contracts. Although they play a role in almost every project, it does not appear that the ESC staff is a signator to the signed work agreements for projects that are currently being developed at each of the Districts.
21. Caltrans presently uses PYPSCAN as a reality check on project work plans and District 3 backs this up with a 20% maximum rule of thumb reality check. 20% is a very high percentage for capital outlay support within the private consultant community.
22. Some District Project Managers indicated that not all of the necessary hardware for utilizing XPM had been installed as yet.
23. Each of the Districts visited has, to some degree, jury-rigged a band-aid tool for providing data to the Project Managers.
24. The following Caltrans programs were identified as typical sources of assignments for District 7 Project Managers:

STIP
SHOPP
Minor Projects
Locally Funded

Major Joint Projects (Alameda Corridor)
Toll Bridges
Toll Roads

25. District 7 has introduced another entity into the Project Work Plan in the form of the Project Engineer who is identified as the technical resource who will have total responsibility for technical decisions.
26. It was noted that in District 7 approximately 1.5% of the total Capital Outlay Support resources are allocated to project management.
27. The PRC found the Report to the Legislature of the proposed project management and budgeting programs thorough, complete and comprehensive, although not fully implemented at this time.
28. Projects are still schedule driven rather than resource driven even though resources have been constrained to the point where they are the critical path for project delivery.
29. The proposed TRS information link into XPM deals only with State Employee hours. The Contract Administration and Tracking System (CATS) does not provide a similar feed into the XPM system for consultant hours and there is currently no plan to create this link. Currently staff has to rekey consultant invoices into CATS. Investigations of the existing CATS systems indicate that it is a long way from providing information necessary to meet the same data requirements such as the current TRS for staff hours. In addition, many (or most) contract provisions do not require consultant invoices and billings to be related to the Caltrans Work Breakdown Structure. This is a necessary requirement to integrate consultant hours into WBS based workplans.
30. It was reported that the XPM database system is having difficulty assimilating the data for the 3,000 projects that are under design annually in a timely manner and then being able to roll the data up and down through the various levels of detailed tasks. It was also reported that the XPM database system was having difficulty providing security for input data from indiscriminate changes by anyone on the network.
31. It was agreed by the PRC and the headquarters staff assigned to this task force that the major issue facing the Department is that the LAO has lost confidence in Caltrans' ability to budget and perform California's Capital Outlay program in a timely and cost effective manner. The LAO's loss of confidence affects Caltrans ability to work with the Legislature in the appropriation of sufficient budget to perform the needed program.
32. District 7 must deal with over 100 cities and answer to 84 Legislators in delivering its products and projects.

33. A department-wide task force, Work Estimating Norms (WEN), led by the Project Management Program Office is developing norms for all WBS level 5 activities by basically using selected projects from within the two most frequently used design project types to develop the templates for Estimating Norms. These are Construct Freeway (FC) and Widen Freeway - with Structure Dollars (QE). They will also use and verify historical data from TRAMNS. Consideration of levels 6 and 7 activities will also be included. Efforts will be made to find similar estimating systems in use in the private sector.
34. The PRC did not find evidence that would indicate Caltrans will be ready to conduct an automated analysis with XPM and report the results during the 1997-98 budget hearings in April 1997.
35. Caltrans has established and continues to implement award programs in recognition of outstanding performances in project delivery and design. However, none of these award programs include monetary rewards. These award programs include:

THE DIRECTOR'S AWARD FOR PROJECT DELIVERY

Director James W. van Loben Sels initiated these awards to recognize outstanding performance in Project Delivery. There are four categories: 1. Director's Award for Excellence in Transportation Project Delivery which is awarded to the district with the best record of delivery for the fiscal year. 2. The Director's Award for Innovative Ways to Keep a Project on Schedule, 3. The Director's Award for Innovative Ways to Keep a Project within Budget, and 4. The Director's Award for Excellence in Project Delivery by a Consultant Caltrans' team.

CALTRANS EXCELLENCE IN TRANSPORTATION AWARDS

This competition is conducted by Caltrans annually to recognize excellence in transportation throughout California. There are 10 categories. Each category allows an entry from Caltrans and an entry from local agencies and private companies. There are 90 to 130 entries each year. Framed awards are given to the winning organization and certificates to individuals.

THE CHARLES H. PARCEL AND KARL MASCOTS AWARDS FOR OUTSTANDING MANAGEMENT AND ENGINEERING IN TRANSPORTATION

The Charles H. Parcel Award is given annually to recognize valued contributions by Caltrans engineering managers to the field of transportation engineering and

California's transportation program management. The Karl Mascots Award is given annually to recognize outstanding contributions by Caltrans registered engineers to the field of transportation engineering. The winners are honored at the annual TRANNY awards banquet hosted by the California Transportation Foundation.

THE DIRECTOR'S WATER CONSERVATION HONORS

Caltrans' commitment to protect and enhance the State's natural resources is embodied in the Department's Environmental Policy. Because water is a valuable resource, Caltrans will again present this award for the 1994-95 fiscal year for a project in Landscape Design and Water Management.

CALIFORNIA TRANSPORTATION FOUNDATION TRANNY AWARDS

The California Transportation Foundation, a non-profit, public benefit organization, was founded in 1988 to Promote and Recognize Excellence in California Transportation . The foundation accomplishes one of its purposes through an annual program, recognizing outstanding transportation achievements. All Caltrans winners of the Excellence in Transportation Awards are automatically entered into this competition.

FHWA EXCELLENCE IN HIGHWAY DESIGN AWARDS

This program is conducted biennially by the Federal Highway Administration (FHWA), U.S. Department of Transportation, to encourage excellence in the design of highway-related facilities and to recognize projects that contribute effectively to a more pleasing highway experience. Winners of the Caltrans Excellence in Transportation Awards are automatically entered in this competition if they fit the FHWA criteria. We are also limited, as an organization, to three entries per category.

THE FEDERAL HIGHWAY ADMINISTRATION ENVIRONMENTAL EXCELLENCE AWARDS

This biennial awards program was developed by the FHWA to honor those partners, projects, and processes that excel in meeting growing transportation demands while protecting and enhancing the environment. This award is handled by the Environmental Program at headquarters.

36. The Department has not adequately informed all proposed users of the project management system of the differentiation between project resourcing and data warehousing and recovery, related to computer usage, i.e. how to use Product Driven

Zero Based Budgeting and management which is built from project and task estimates, rather than expecting to rely on the output of an automated scheduling tool.

37. The term XPM has become synonymous with the comprehensive Program / Project Management Plan information system proposed by the Department. The Program Project Management Plan is envisioned to be a suite of applications supporting project management and delivery functions linked to each other and to other Departmental applications through Oracle database technology. XPM is only one component of the overall system, specifically, the project schedule and control tool (also referred to as the project scheduling tool). XPM is not designed to be a comprehensive application with the full requirements of cost, scope, schedule, and risk management. XPM is limited to schedule and support cost management with elements of risk management.

38. Project Management Program staff indicated that the anticipated date that all required data would be on a common platform is March 1998 at the earliest. It was qualified that this date is based on several assumptions:

Common database platform would be achieved through data warehousing, not replacement of all existing project applications.

Resources (Project Management Program staff, consultant dollars, district participation and ISSC participation) must be provided in an adequate manner. The current funding mechanism for ISSC development at Caltrans is inadequate to address the complexity and rapid changes in information technology.

The report findings and shortcomings related to the cultural changes required to implement project management must first be overcome. The square peg in a round hole analogy used by the PRC will apply regardless of the computer system until systemic, cultural issues are addressed.

39. It is the opinion of some within Caltrans that much value is gained by schedule management, a function easily supported by XPM. That resource management can be accomplished outside XPM, in fact, several districts, most notably District 11, feel this is the best solution, even if the TRS interface to XPM was operational. However, the PRC does not believe this is in line with the Director's policy of one consistent program throughout the Department.

SHORTCOMINGS

Evaluation of our findings resulted in 12 Shortcomings that reflect the absence of operational and user friendly tools, the lack of flexibility and unclear accountability, as well as other issues.

1. There does not exist an on-going external measurement program (regularly scheduled peer review) for quality, schedule and budget results.
2. There does not exist an on-going internal measurement program for quality, schedule and budget results for all levels of staff.
3. XPM is not up and running and there is no other system presently available that provides up-to-date reports, therefore, project management is suffering from inconsistent, late and sometimes erroneous data.
4. It appears that Project Managers are being assigned more projects than they can adequately and effectively manage, particularly in light of reduced resources and the inoperational status of the XPM tool.
5. Project data such as budget expended versus milestone reached is not available to Project Managers on a minimum of a monthly basis.
6. The portions of the XPM program presently utilized are not user friendly on a Project Manager level or on a district program basis, in fact, not even at the Headquarters program level as yet, and it does not appear that it will be fully operational for many months.
7. There does not appear to be a meaningful monetary incentive program to reward high performing managers or other employees.
8. The implementation of the interface between XPM and TRS (Oracle output) is far behind schedule since it was to be completed by August 1, 1996.
9. Project Managers are becoming disillusioned and frustrated trying to apply the XPM management program before it is fully operational to the level necessary for providing project management data.
10. The XPM system is losing credibility which may severely damage its acceptance potential in the future because it is behind schedule and has not been able to deliver as advertised.
11. Caltrans lacks graphic trend reports to quickly and easily monitor and manage projects.

12. Caltrans lacks simple logic reports appropriate for the Corporate and District levels to quickly assess the Capital Outlay Program.

RECOMMENDATIONS

After identifying the Findings and Shortcomings, we developed 60 Recommendations to address the perceived problems contained in these Shortcomings. In order to more easily follow the major thrusts of the recommendations they have been placed into these five major categories.

- A. XPM Anchored Database Development and Implementation
- B. Project Management Program Implementation
- C. Project Delivery Efficiencies
- D. Allocation of Resources
- E. Performance Measures and Incentives

A. XPM Anchored Database Development and Implementation.

1. A realistic date should be set for implementing a fully operational Department-wide database XPM system, as well as the coordinated and fully functional total Program/Project Management reporting system of which XPM is only one part.
2. The complete program should be clearly defined for output, fully operational and user friendly before mandating its use by Project Managers.
3. Establish one District as the trial District to work with Headquarters until the entire project management database and reporting system is working. Although District 3 has been the assigned District to date, it may be advantageous to consider either District 7 or District 12 as a future pilot to provide fresh ideas.
4. Continue to use PYPSCAN as a reality check until XPM works.
5. As a 1st phase, concentrate on getting XPM up and running to level 5, then expand its use to lower levels. However, continue to check detailed logic so that it can be expanded to lower levels at a future date.
6. Ultimately, for levels below level 5, the XPM program must readily accept ongoing adjustments for variable or changed conditions such as revised time cards, cash overtime, leave balance, and 9/80 schedules for shortened, more finite tasks with resource assignments by named individuals.
7. The ultimate data warehousing technology system of which XPM is only a part must be able to provide the data to allow for a final comparison of the original budget for a project, the record of the changes to the project, and the final total cost of the project including all overhead and ancillary costs for the project debriefing of the Project Manager, Function Manager, and Program Manager, then store this data in a systematic data base to use as a budgeting guide for future

projects.

8. The implementation of the XPM resource management interface with Oracle needs to be expedited since the total project management process, as a complete tool, hinges on the information system data output report and its effective use by Project Managers. Without this timely and user- friendly complete data reporting system, the Project Manager is forced to improvise for much of the ongoing data needed to fully understand the status of a project.
9. It is recommended that the following data sources be tracked and placed in the Project Managers Database as measurable goals for project evaluation and future budgeting as a part of the Program/Project Management Plan system.
 - a) Significant milestones and projects completion data compared with original schedule.
 - b) Final cost of project compared with original budget.
 - c) Receipt of External permits.
 - i) Date received vs. original schedule.
 - ii) Additional costs to project to receive permit.
 - d) Number and complexity of bid documents addendums during bidding process.
 - e) Comparison of bid cost with original programmed budget, fund request, engineers estimate, and final award amount.
 - f) Number and additional cost of construction change orders.
 - g) Number and settlement cost of post construction claims.
 - h) Accident rate during construction.
 - i) Ongoing tracking of accident rate after project completion.
 - j) Comparison of actual maintenance costs compared to anticipated programmed maintenance.
 - k) Success of congestion management program.
10. It is recommended that the XPM Administrator's Advisory Council (XAAC) task force be expanded to include the technical experts from each District or Region which are presently implementing XPM under the Band-aid concept in order to bring together the most knowledgeable practitioners with the charge of developing the fully operational user friendly system that meets the Project Managers needs. This basic system should be implemented in the trial district before it is expanded throughout all districts. (Note the excellent Operational Band-aid systems detailed by the Northern Region and District 7.)
11. It is recommended that the XPM system be fine tuned so that it can be rolled up or down from a base level 5 on a function level, a project level, and a program level.

12. All costs affecting the project need to be entered into the database on a regular basis if the overall status of the various projects are to be evaluated by the Project Manager to make timely changes as part of the Program Project Management Plan.
13. There should be a link between XPM and CATS for tracking consultant hours and costs, and consultants should use the same WBS elements as State Employees for reporting their time and costs. It would improve accounting efficiency if CATS were modified to permit direct entry of consultant invoices.
14. It is imperative that a reality check be run on XPM, and an achievable accomplishment list including the linkage data of this system with ancillary output programs such as CATS, ORACLE, etc. This should provide Project Managers with the actual data deliverables including dates when delivery will take place. It should be prepared as soon as possible to restore credibility of the basic tool.
15. The PRC recommends that Caltrans train all staff members to use the term XPM appropriately as only one of the elements of the Program / Project Management Plan that is limited to providing scheduling and support cost management data with elements of risk management.

B. Project Management Program Implementation

1. Although Single Focal Points may have the responsibility and flexibility in deciding whether to go below level 5 for project management data collection at this time, sometimes Corporate may have special requirements on certain projects to collect data below level 5, and therefore, a formal policy on these projects should be established for guidance of the Project Manager.
2. The Project Manager should finalize project budgets in dollars including the cost of other project costs, the dollar value of PY's, as well as consultant costs when applicable.
3. In order to be sure that the Function Manager will equitably allocate resources to projects, the general rule should be that all Projects Managers should be one hat.
4. However, some small (less than one million dollars in capital outlay) single function projects may lend themselves to the two hat management concept at the discretion of the District Program Manager.

5. Project data pertaining to earned value such as budget and schedule expended compared to milestone reached and tasks accomplished must be available to Project Managers on a minimum of a monthly basis. Graphic trend reports must be available to the Project Managers so they can quickly and easily recognize project status.
6. Function Managers must have the ability to reallocate resources based on changing project demands and priorities subject to Project Manager concurrence and Single Focal Point arbitration of differing opinions of the team members.
7. It is recommended that the Project Manager for a project that shares function resources between Districts (Brokering), be from the District where the project is located, and that brokering of portions of discreet project functions be used sparingly due to the inefficiency of split project functional teams.
8. It is recommended that a formal project management training program be established for all new Project Managers and Functional Managers.
9. It is recommended that in implementing contracting-out for Professional Services under the Flexible Resource Plan or when negotiating internal work plan project agreements, that Project Managers and Function Managers be trained in negotiating and administering lump sum contracts in a manner consistent with Quality Based Selection procedures.
10. It is recommended that in implementing contracting out for professional services under the Flexible Resource Plan that Project Managers and Function Managers be trained in the negotiating and administrating of Design/Build contracts based on the Quality Based Selection two-phase procedures.
11. Any functional unit of Caltrans whether at the District level or Headquarters Staff that will use any of the resources assigned to a Project Manager must be a party to the signed work agreement.
12. Although Resident Engineers have a history of working as independent Project Managers during construction, it is important that in the future, the Project Manager maintains control of the project schedule and budget through the completion of construction because it is this phase where the most can be learned through accountability for measurable results.
13. Where a Project Engineer is assigned to the project management team, this person must be a signator and supporter of the final project resource agreement.
14. The PRC recommends that an oversight task force be created at the Headquarters

level, staffed by the most experienced Functional Managers, to monitor the Product Driven Zero Based Budget and schedule requests submitted by Project Managers. This recommendation is made because, although project budgets are easier to monitor than program budgets, they are only as accurate as the experience and talents of the Project Manager and his team. Since this is a new program for most Project Managers and there is little, if any, historical or norm data presently available. Strong oversight on a project level should be implemented until these two major shortcomings are eliminated.

15. On page 24, Chapter VII - Project Management Activities, the role of the Project Manager should be expanded through the construction phase and the Resident Engineer should be part of the work plan. (See revised matrix above.)
16. The Project Management Activities data recording is designed for large and complex projects. It would be helpful to Project Managers if a flexible system of reducing data reporting requirements for single function or small projects be provided for guidance.
17. The role of the Project Engineer needs to be more thoroughly defined to prevent overlap or omissions in responsibility with the Project Manager.
18. Open to traffic should become the most important milestone, and the date of one year after this milestone should be the final milestone for the Project Manager.
19. Function Managers are as critical to the Product Driven Zero Based Budgeting Project Management Program as the Project Manager and should receive training as to their role on the project team.
20. It is recommended that it be standard procedure for the Project Manager to interview the Customer at the start of the project to determine scope, and upon completion of the project to prepare a standardized report on customer satisfaction.
21. It is recommended that depending on the difficulty of the project that up to 10% of the Capital Outlay Support Resources be allocated to Project Management to allow the Project Manager sufficient resources to guarantee budget, schedule and quality of the project.

C. Project Delivery Efficiencies

1. All levels of the Caltrans project team need a better understanding of who the

customer is so they can become customer oriented.

2. Caltrans needs to establish a program for client/customer debriefing to determine the project satisfaction level of the customer.
3. It is recommended that requests for additional funding from the California Transportation Commission (CTC) contingency fund for projects and legislature finance letters for programs be used as often as required to request additional funds for projects and programs that experience significant unforeseen changes that require funding that is above the approved budget, rather than borrowing resources from the early stage of future projects. The approval process for these additional funding mechanisms must be expedited by both the CTC, and Legislature so as not to impact product delivery.
4. It is recommended that borrowing resources from projects scheduled to be completed in future years be discouraged since this only tends to delay and cause budgeting problems for the future project.
5. It is recommended that a plan be developed for project management of Caltrans oversight on locally managed projects.
6. It is recommended that Caltrans submit an updated implementation plan and schedule to the Legislature when the use of a completely functional product driven zero based budgeting and project management program will be ready for user-friendly use. Since it is a total culture change, as well as a technical data base change it must have time to work itself into the work habits of the staff and leaderships within Caltrans.
7. It is recommended that Caltrans report its record of project deliveries in two categories -
 - a) Continue to report on the number and percent of the original STIP projects proposed to be delivered during the year, versus the actual percentage completed of the original projects, and the reason for non-completion on those that were not completed.

- b) Expand the report to include the number of new projects that were added to that year's STIP from the future STIP because of project efficiencies or additional available resources (such as new funding from bond issues, etc. or reallocated funding from delayed or canceled projects) and their percent complete and time saved by moving them ahead.
- 8. Caltrans should enhance the effectiveness of its Environmental Specialist resources so it can respond statewide, such as the District 12 Right-of-Way Service Center in an effort to expedite environmental clearance.
 - 9. Project completion schedules are established in programming documents adopted by the CTC on a different timeline than the state budgeting process. PRC recommends that Caltrans carefully evaluate its resource needs under the new project based program before committing to a project completion schedule and staff resource requirement, since otherwise it will continue to be a program based budget. Also, the Legislature will be carefully watching the completion results for the proposed full program with the current staff level thinking it is project based, when it is not.
 - 10. PRC recommends that all future program resource requests include contingency plans which provide for the opportunity to use flexible resources, such as contracting-out, when unforeseen changes are required to prevent the reallocation of resources on a crisis basis.
 - 11. PRC recommends that Caltrans determine their interpretation of the requirements of SB1505 (devolution) and SB160 (flexible resources) and the impact of a favorable decision on the part of the Supreme Court for contracting-out, so the major changes can be incorporated into the project management and budget programs as soon as possible without creating another frustrating cultural shift for staff.
 - 12. A project should not be scheduled in the STIP for design and construction until it has environmental clearance.
- D. Allocation of Resources
- 1. It is recommended that the resource allocation to the Districts provide a flexible system of all types of District resources, such as the use of cash overtime, temporary employees, student interns, the reassignment of resources between Districts and the substitution of staff resources for professional services contracting-out dollars be established so that projects can move ahead on schedule. This ability to change resource allocation would eliminate the inefficiencies and additional costs caused by not being able to correct for

the lack of needed resources or the over abundance of fixed resources.

2. Rather than arbitrarily allocating some standard percentage of each Capital Outlay Support budget to the ESC, ESC should estimate its real needs on a project-by-project basis, and sign the work plan agreement.
3. Corporate decisions on a program level need to take into account the resource estimates recommended by Project Managers and based on the individual project Product Driven Zero Based Budgeting Program. This first step of product driven zero based budgeting is essential and must be an integral part of the Capital Outlay support programs budgeting process and is a must if Caltrans is to ever be successful in project delivery under the new project management culture.

E. Performance Measures and Incentives

1. Establish an annual external measurement tool (peer review) for quality, schedule and budget results. Not necessarily a standing committee with field membership.
2. Implement the proposed on-going internal performance measurement program for quality, schedule, and budget results.
3. Caltrans needs an enhanced incentive program to reward high performing staff members.
4. There should be a system set up so the Program Manager and Project Manager can continually monitor the adopted performance measures to assure they remain current and credible.
5. A simplified performance measuring program needs to be established that measures resource use compared to productivity with simple logical reports on a project and program level for review by the Program Manager, District, Director, Corporate and the Legislature.
6. It is recommended that all funds allocated to Caltrans for every program they are assigned be allocated to a product or service recognizable to the public so that the Legislature can evaluate cost benefit for each product or service. This would make it possible to evaluate the true cost of Capital Outlay Support for the project delivery program.
7. After reviewing the Report to the Legislature on Capital Support Performance Measures, the PRC recommends an expansion of the number of proposed measures as shown below:

		Major Projects			
	Capital Support in Context	Project Development	Construction	Post Construction Performance	Total
Quality		1*	1	1	3
Time Growth		2	1		3
Capital Cost Growth		1	2	1	4
Capital Delivery		1			1
Support Cost	2	1	1	1	5
Total	2	6	5	3	16

* 1 - added performance measure.

8. Earned Value should become a byword of the project management program and should be applied in the following three basic accountability areas:
 - a) Resources Expended Compared to Resources Budgeted for the Project
 - b) Products Delivered Compared to Program Milestones
 - c) Actual Schedule Compared to Planned Schedule

9. In depth training at all levels of staff must be implemented as soon as the complete system is operational so that they clearly understand their role in Capital Outlay Support and know they must be accountable and motivated to contribute to project delivery in the most cost effective manner on each individual project through the implementation of the Product Driven Zero Based Budgeting and project management system.

ARIZONA DEPARTMENT OF TRANSPORTATION PRACTICES

During June 1996, the Arizona Department of Transportation (ADOT) was asked to participate in Caltrans' peer review evaluation. Victor M. Mendez (P.E.), the Assistant State Engineer - Statewide Project Management, was selected by ADOT as the appropriate participant for the peer review. Victor was selected due to his extensive knowledge and experience in the program and project management arena. His recent academic studies have also prepared him to assess current business and technology issues that confront the private and public sectors.

Over the past 3 years, ADOT has embarked on a quality-oriented project management process for project delivery. ADOT's project development process begins with the scoping phase and continues one year into maintenance. At the present time, ADOT is still in the process of

implementing project management.

It is interesting to note that Caltrans and ADOT are undergoing very similar experiences not only with program and project management issues, but also with external factors that affect agency functions. For example, within the program and project management arena, project delivery is affected by; (1) limited resources, (2) lack of comprehensive project management systems and tools, and (3) increasingly complex environmental protection rules and regulations. Some external factors that affect how agencies structure their business processes are; (1) increasing customer (taxpayer) demands and expectations, (2) more involvement by other public agencies, and (3) heightened legislative oversight and demand for accountability.

In contrast to Caltrans, however, ADOT has a smaller program commitment. The current ADOT 5-Year Highway Construction Program allocates approximately \$710 million for the implementation of a freeway in the Phoenix metropolitan and \$1.8 billion for statewide highway needs. This program represents approximately 450 projects.

All direct project delivery activities occur within the department's Intermodal Transportation Division (ITD). Support services, such as accounting and information systems support, reside in other divisions. The approximate workforce within ITD consists of the following: (1) 474 in planning and engineering, (2) 722 in construction, (3) 1,041 in highway maintenance, (4) 186 in operations, and (5) 30 in administration.

The project management process at ADOT is very similar to that of Caltrans. Some project Managers have functional responsibilities along with project manager responsibilities (similar to two-hat). Others have only project manager responsibilities. Significant emphasis has been placed on teamwork. Cross functional project teams are formed from the various functional units. The functional managers are responsible for; (1) assigning resources to the individual projects, (2) the quality assurance and quality control of their technical product, and (3) are involved in escalation and resolution of technical issues.

Due to previous organizational structure, a project scheduling system (Primavera) was implemented in August 1995 for project development activities. A different system (Artemis) was implemented for construction activities several years ago. The resource features of Primavera are still in the implementation stage. However, the resource planning and staffing modules of the Artemis system have been in place for several years. Artemis is successful in measuring construction costs and schedule commitments. It is important to note that Artemis imports time sheet and accounting information from other ADOT systems.

The implementation of project management has changed the way ADOT does business. It is cultural change that has impacted many people. Consequently, an extensive project management team training program was implemented in September 1995. To date, more than 400 people have been trained. The training sessions address people skills (e.g. communication, teamwork, negotiation, stress management), the project development process, and provide a hands-on project simulation.

ADOT BUDGETING BACKGROUND

For purposes of the peer review evaluation, this document will describe ADOT's budgeting processes with regard to the Intermodal Transportation Division's administration and construction budgets. The discussion on the administration budget will be further constrained to the planning and engineering activities.

On an annual basis, the Arizona Department of Transportation (ADOT) is allocated a lump sum operating budget by the state legislature. This budget is used to fund several Divisions within ADOT. Among these divisions, the Intermodal Transportation Division's (ITD) administration budget is used to fund the planning and engineering functions.

Within ADOT, the Intermodal Transportation Division is responsible for the planning, design, construction, and maintenance of highways and freeways in the State of Arizona. ITD's primary budget components are the administration, maintenance, and construction budgets. These annual lump sum operating allocations are funded primarily from the State Highway Fund. A minor amount is funded from the State General Fund.

The annual budgeting process normally begins in April, continues into the January legislative sessions in the following year, and ultimately results in a final approved budget by April or May. Throughout this process, ADOT works in concert with the Joint Legislative Budget Committee (JLBC) and the Office of Strategic Planning and Budgeting (OSPB). These two entities represent the legislative and executive branches of state government, respectively.

ITD ADMINISTRATION BUDGET

ITD manages the Department's highway planning and engineering functions in Arizona. The activities performed within these functions include but are not limited to the following:

- Project management.
- Roadway pre-design and design.
- Structural engineering.
- Traffic engineering.
- Right-of-way activities. Planning studies.
- Project programming.

The Department contracts with consulting engineering firms and hires temporary and seasonal personnel to augment in-house staff. Additionally, ADOT transfers some quality assurance and quality control responsibilities to the consultants. However, the planning and engineering

activities remain the responsibility of full-time ADOT personnel.

ITD carries out its planning and engineering responsibilities primarily through staff at its central office with input and support from the nine engineering districts. Staff is organized into functional areas encompassing several units. These units typically include registered professional engineers, engineering technicians, and administrative support staff.

Planning and engineering staff are funded from the annual operating budget that is approved by the Legislature. These funds are derived from ADOT's portion of the Highway User Revenue Fund (HURF), which is a component of the State Highway Fund. HURF consists of revenues from the gasoline tax and other transportation-related fees.

A base funding level for planning and engineering operations was established by the Legislature several years ago. During the annual budgeting process, ITD makes recommendations with regard to adjustments to the base level. These budget adjustments are identified from new responsibilities, new laws, new growth factors, and efficiency factors that evolve and impact the department's resources and its ability to meet the program commitments.

ITD CONSTRUCTION BUDGET

ITD manages the Department's highway construction in Arizona. Private contractors are selected through a competitive process to perform the actual highway construction. The activities performed within ITD, called construction engineering, include but are not limited to the following:

- Inspection and materials testing of roadway construction to ensure procedures and materials meet plans and specifications.
- Surveying.
- Reviewing roadway design drawings.
- Approving all payments to contractors.
- Monitoring force accounts.
- Processing contractor claims.
- Reviewing and approving change orders.

The Department contracts with private engineering firms and hires temporary and seasonal personnel to augment in-house staff. Additionally, ADOT transfers some quality control and surveying responsibilities to the contractors. However, the construction engineering activities remain the responsibility of full-time ADOT personnel.

ITD carries out its construction responsibilities through staff in nine engineering districts and its central office. Staff, organized into areas encompassing several units, oversee construction activities, provide on-site inspections, and provide non-direct support to the construction process. Construction units typically include resident engineers, engineering specialists, quality control

technicians, survey personnel, materials testing staff, and records clerks.

Construction staff are funded primarily from the ADOT construction program established each year by the State Transportation Board. Construction funds are derived from HURF which consists of revenues from the gasoline tax and other transportation-related fees. Construction funded staff positions are not appropriated by the Legislature; they are determined by the Department, based upon total construction activity. However, the Legislature does impose a ceiling on the number of construction positions. Normally, ADOT staffs at levels that are significantly below the established ceiling.

ITD establishes a program level construction staffing plan using 1.3 direct FTEs and 0.3 indirect FTEs per million dollars of contractor payments as a basis. In addition, ITD uses interim staffing such as seasonal and contracted temporary personnel. Direct staff are defined as those personnel that are directly involved in project contract administration activities. Indirect staff are defined as support personnel involved in the construction process, but are not directly involved in contract administration. Through the use of the Artemis-based Construction Management Program (CMP), the Department determines the projected resources needed to deliver the program based upon construction that is planned and construction that is already in process. Further detail from CMP provides the staffing team the necessary information to allocate the necessary resources to the individual engineering districts.

On a periodic basis, CMP planning values, durations, productivity factors, and hourly salary rates are analyzed and, if necessary, adjusted to account for productivity improvements and changes in market conditions. These adjustments have a direct impact on the resource information that is provided and the resource allocation decisions that are made.

Project Management with Primavera Project Planner (P3) - Introduction

In 1995, the Arizona Department of Transportation began the implementation of Primavera Project Planner (P3) as the primary project management tool for its design/engineering activities.

At the inception, P3 was implemented as a time-driven system with the intent to expand its resource capabilities and eventually evolve into a true resource-driven environment.

At the present time, P3 is used as a project scheduling tool to track schedules for the design projects that are in the 5 Year Highway Construction Program. The projects are updated throughout the month by the project managers and technical leaders involved with each of the individual design projects. The Critical Path Method (CPM) is used to plan, schedule, and monitor the design projects. Some of the basic information collected reflects the scheduled dates and progress for each activity, the float on each project, and brief project status comments. The Program and Project Management Section (PPMS) is responsible for providing P3 system support, development, and training.

ADOT design projects are contained in a P3 database residing on a dedicated local area network server. Project team members, technical managers, and management can access the system via the local area network through micro computers. Data entry, network analysis, scheduling, report writing, and graphics generation are accomplished using a combination of P3, database software, report writing software, and PC Anywhere communications software. A brief description of the software involved follows:

Primavera Project Planner

A multi-user project management and scheduling tool. The system is intended to help project teams plan, control, and manage projects. In its current state, P3 is designed around a Btrieve database which can be partially customized to fit unique corporate needs. The system includes report writing and graphic generation capabilities. ADOT uses the Windows version of P3.

Microsoft FoxPro

FoxPro is a relational database that is used by PPMS to merge additional project information stored in DBF files with data stored within P3. It is also used to manipulate the data in P3 into a format that can be utilized for reporting purposes.

Crystal Reports

Crystal Reports is a Windows report writer selected by PPMS because of its capability to read different databases, ability to design reports in a wide variety of formats, and its ability to handle large quantities of data. All of the monthly reports published by PPMS are produced using Crystal Reports.

PC Anywhere

PC Anywhere is a communications package that is used to allow user access to P3 from remote locations.

ADOT is currently in the process of implementing the resource component of P3. The resource component will be implemented through the Resource Analysis and Management Plan (RAMP) efforts.

Resource Analysis and Management Plan - Introduction

Primavera Project Planner (P3) is the nucleus of the Arizona Department of Transportation's future Resource Analysis and Management Plan (RAMP).

RAMP is a project information management strategy that will help optimize the use of available in-house and consultant resources in completing ADOT's highway development projects as programmed. Additionally, RAMP will help customize the 5 Year Program to make the best use of available resources.

RAMP is being designed to facilitate the development of resource driven project and program schedules. It will also help measure ADOT's performance at activity, project and program levels. The intent is to facilitate continuous improvement in providing the best highway system to the public with the available resources.

RAMP is necessary to help ADOT continuously improve its effectiveness in serving its customers' needs and for producing more with less; it is necessary to optimize the use of available resources. With RAMP, ADOT's efficiency will be measured in terms of resource utilization and timeliness of promised deliverables and trends thereof. RAMP will facilitate comparison of ADOT's performance to that of consultants. It will also help determine the adequacy of current resources and develop future budgets based on projected program needs.

RAMP will facilitate development of resource driven schedules. It will provide resource estimates for a given program as well as help estimate the amount of work that can be accomplished for given resources.

RAMP GOALS

The RAMP goal is to make the best use of available resources in preparing high quality construction plans. It was decided to use resource driven schedules for planning and monitoring progress of the programmed projects. Initially, two objectives were established for RAMP:

Development of appropriate Division level performance measures that reflect on effectiveness of the resource management.

Development of a turnkey RAMP system (on paper) and an appropriate feasible implementation plan (strategy and time-line).

Once the above objectives are met, the RAMP should be implemented. The plan outlined here will be fine-tuned to meet the changing needs of the RAMP customers.

RAMP Customers

There are two types of customers to be served: internal and external customers.

Internal customers include, but may not be limited to:

- Project managers
- Technical leaders (team leaders)
- Org. supervisors (within each technical function)
- Technical managers
- Intermodal Transportation Division (ITD) management
- Program and Project Management Section (PPMS)
- Transportation Planning Group
- Administrative Services Division

External customers include, but may not be limited to:

- Consultants
- Legislature (How well ADOT is using the available resources.)
- Other partners (e.g., Local Government, FHWA, BIA, etc.) in construction of highways
- Other state DOTs and research organizations (e.g., ASU, TRB, NCHRP, etc.)

The issues that may be of concern to these and other customers have been anticipated and are listed under Issues later in this document.

Additional issues may emerge as progress is made on the RAMP process. These will be included in the list as they are identified.

Information Needs of the Customers

Even though customers may need a broad range of information from RAMP, an attempt has been made to anticipate their most frequent needs in the following table.

INFORMATION	P M	TL	OM	T M	EM	CNSL	CNST	EC
ADOT PERSON-HOURS								
EARNED	J	J	JG	JG				*

ACTUAL	J	J	JG	JG				*
ADOT COST								
EARNED	J	J	JG	JG	G			*
ACTUAL	J	J	JG	JG	G			*
TECHNICAL FIELD								
EARNED PERSON-HOURS	A	A	AT	AT				*
ACTUAL PERSON-HOURS	A	A	AT	AT				*
EARNED COST	A	A	AT	AT	T			*
ACTUAL COST	A	A	AT	AT	T			*
FTEs			OG	TG	TG			*
CONSULTANT COST								
EARNED	J	J	JG	JG	G	JG		*
ACTUAL	J	J	JG	JG	G	JG		*
TOTAL (ADOT + CONSULTANT) COST								
EARNED	J	J	JG	JG	G			*
ACTUAL	J	J	JG	JG	G			*
PROJECTIONS								
ADOT PERSON-HOURS	J	J	JG	TG				*
ADOT COST	J	J	JG	TG	G			*
CONSULTANT COST	J	J	JG	TG	G	JG		*
ADOT FTEs			OG	TG	G			*
PRODUCTIVITY PERFORMANCE								
ADOT PERSON-HOURS PRODUCTIVITY	JG	JG	JG	JG				*
ADOT ECONOMIC PRODUCTIVITY	JG	JG	JG	JG	JG			*
CONSULTANT ECONOMIC PRODUCTIVITY	JG	JG	JG	JG	JG	JG		*
TOTAL ECONOMIC PRODUCTIVITY	JG	JG	JG	JG	JG	JG		*
TIMELINESS PERFORMANCE								
TARGET BID DATE	J	J	J	J	J	J	J	*
PROJECTED BID DATE	J	J	J	J	J	J	J	*
LATEST COMPLETED PHASE OR MILESTONE	J	J	J	J		J	J	*

KEY: Information needed by PM - Project Manager, TL - Technical Leader, OM - Org. Manager, TM - Technical Manager, EM - Executive Management, CNSL - Consultant, CNST - Construction Contractor, EC - Other External Customers, such as SLIM, auditors, etc.

Information level J - Project, G - Program, T - Technical field or function, A - Activity, O - Org. Code

(*) PPMS will customize reports for these customers on request.

Potential Use of the RAMP Information

Each user may have a different objective for the information, but they all desire to make timely facts-based decisions. RAMP will fill some of the gaps left unfilled by time-driven schedules in this regard. The succeeding discussion addresses the anticipated use of the RAMP information at each decision making level. One use is common to all; it will result in better program and project management at all levels, if the information is used strategically to improve communication.

Utility to Project Managers: The project manager coordinates the project team effort per given scope, budget and schedule. RAMP is the missing piece in ADOT's project management process. Its inclusion will make a difference in process structure. It will result in logical and realistic schedules. The purpose of RAMP information will be to help the project manager in the following areas:

Assess the project needs at the start.

Conduct risk analysis and plan for contingency.

Document assignment and commitment at the start.

Verification of charges in the Transportation Accounting System (TRACS). More effective budget and schedule monitoring.

Early detection of activities and technical functions with potential cost over-runs and/or delays.

Progressive cost analysis that compares the earned versus actual, and budgeted (or planned) versus projected costs. This includes productivity measures.

Assess the utilization of the current resources and estimating the need of resources in the future.

Consolidation of project management information.

Information sharing to assure better communication within the team and with the customers. The quality of information from the resource driven schedule should improve.

Increase confidence in ADOT's project management process due to easy access to reliable and timely information.

Timely resolution of issues.

Enhance ability to complete the project as promised.

Utility to Technical Leaders: The technical leaders serve on the project team. They are responsible for producing and delivering the desired technical product for the team per assigned scope, budget and schedule. RAMP will help provide a better assessment of the current and projected workload. RAMP information can help them self-appraise as to how are they doing with the budget and schedule in delivering the promised products. It will give them more confidence in ADOT's project management process.

Utility to Technical Manager: These managers coordinate the technical aspects of the projects for which their staff is responsible. A technical manager assigns the staff to do what is necessary or hires one or more consultants to do the technical design. The purpose of RAMP information would be to help these managers in the following areas:

Assess the project and program needs at the start.

Conduct risk analysis and plan for contingency.

Verification of charges in the TRACS system. More effective budget and schedule monitoring.

Early detection of activities, technical leaders and consultants with potential cost over-runs and/or delays.

Progressive cost analysis.

Better coordination of consultant and in-house ADOT staff work assignments.

Ensure the optimal use of available resources.

Assessing the need for current and projected level of resources. Advance warning of coming resource crunch and plan for hiring consultants.

Verification of unit's ability to deliver its assignments.

Ability to conduct performance analysis of ADOT staff versus consultants.

More effective information sharing with the unit staff, project managers, management, and consultants.

Increase confidence in ADOT's project management process due to easy access to reliable and timely information.

Timely resolution of issues.

Enhance ability to complete their portion of the project as promised.

Utility to Management: RAMP adds significantly to the value of the information generated by time-driven schedules. However, RAMP information may have to be packaged in summary form focused on the issues for deliberation and decisions to be made. Most of the information should be in tabular and graphical forms. The purpose of RAMP information would be to help management in the following areas:

Assess the current and projected staffing and budget levels.

Assess operating productivity and perform trend analysis.

Internal policy decisions and guidelines. Assess what is doing well and what is not doing well.

Communication with employees.

Communication with the Governor, legislature and auditors.

Communication with ADOT customers and suppliers.

Assumptions and Constraints

RAMP needs to be developed and implemented immediately.

It is assumed that the system will be fine tuned as it is implemented and used by the project managers.

Resources for this effort are to be mostly drawn from the existing PPMS staff.

The project managers, team leaders and technical managers will customize Primavera schedule and resource allocation based on project scope. They will also keep this information (i.e. scope, budget and schedule) current so that reliable project and program management reports can be produced in a timely manner.

We need to be able to extract information about actual cost and person hours by activity for each project from the TRACS system on timely basis. Like the Construction Management Program, it should be feasible to develop interface mechanism for design phase information from TRACS to Primavera Project Planner (P3) or something (like DB2 main frame database).

Assume a flat rate of 84 percent (as used in construction) as availability rate. To be more realistic, additional data collection and analysis may have to be conducted. Additional 20% time may have to set aside for ADOT related non-project activities by each team member.

Decision Maker Inundated with Information

RAMP, like any other decision model, has a potential of generating an immense amount of information, all of which may be interesting. However, reporting unnecessary information, no matter how interesting it may be, is a waste of scarce resources. The use of scarce resources to generate lower value information may lead to lost opportunities for more valuable information. It may also divert the attention of decision maker from important and critical information and may, thus, weaken the decision making process.

In selecting the information that should be routinely published or that should be easily accessible to the RAMP customers, the questions which need to be asked are:

What may be the use of this information in the decision making process?

Are there any other alternatives?

And at what cost?

The issue to be addressed is the value added by the additional information.

Issues

Some of the potential resource allocation and management planning issues and action items are listed here. At this time, these have not been screened for relevance or duplication. These are not necessarily in any preferred or priority order. These are simply reflective of the concerns of those who might be affected by the RAMP. A discourse on each issue or item is stated in *italics*.

Performance Measures Issues and Action Items

What performance measure(s) will be appropriate for the Intermodal Transportation Division? Who and how will it be determined?

Project and program level productivity and timeliness should serve as ITD's performance measures. PPMS may determine and report these measures based on the information available. These are described under Performance Measures of this report.

Should we measure the performance at District level or some sub-program level.

The procedure developed for project and program performance can help in aggregating the highway development performance by District, Org. and technical function. RAMP is capable of generating similar additional information. All information needs should be prioritized based on the value these add to the decision making process. Only the strategic information that directly helps the decision maker should be generated on a routine basis. Other information may be generated on request.

Should we consider performance measures based on funding sources.

If it is believed that the source of funding impacts the highway development performance, the related performance measure may be useful.

What kind of data is needed to measure performance:

- person hours by activity
- number of persons by functions (P3 should convert person hours to number of persons based on availability rate)
- Activity resources by functions
- Miscellaneous cost (e.g., leave time, motor pool, ???)

As a minimum, we need resource (cost and person-hours) estimates by activity as the basic input for macro analysis in the proposed RAMP system. For micro analysis we may need similar information by each employee and more. For expediency, the micro analysis and management may be delayed until the macro system is operational.

Models/Activities/Dictionary Issues and Items

What critical path scheduling (CPS) standards (e.g., level of detail, specificity, minimum or maximum activity duration or elapsed time, etc.) would ensure effective, efficient and economical project management system for ADOT?

No specific standards are established. In general, we need to keep the activities distinguishable with all significant interdependencies identified in the generic scheduling model. The generic model should be loaded with average duration (in workdays), human resources (in person-hours) and total cost (in nominal dollars). These models should be available for customization in terms of the logic, duration and resources by the project team. The schedule update would certainly be effective if the maximum activity duration is less than thirty calendar days (or about twenty two workdays). When the duration of an activity is significantly more than this limit, the activity may be split in two or more sub-activities.

Are the existing CPS scheduling network models satisfactory? Are the existing logic diagrams (network models) consistent with the current highway development process? If not, what should be changed: the number of models, or logic, or level of detail? Should the

models be simplified by consolidating like activities? What would be the consequences of simplification?

The existing network scheduling models were developed by teams of technical staff. These models reflect consensus of those professionals. Since then few significant changes have evolved in the generic highway development process. In addition, a separate model is being developed for the Project Assessment (PA) and Design Concept Report (DCR) processes. These developments will necessitate changes at least in the beginning portion of the existing models.

A large detailed model may make customization of the schedule more complex and time consuming process.

All scheduling models should be reviewed and simplified as necessary. The models should, however, not be simplified to the extent that they lose relevance with the development process. Also, consolidated activities should be of the duration that can be monitored effectively.

With respect to the scheduling network models, is there a need to reconcile with various sections and/or groups as to how information can be shared in order for plan development to occur concurrently rather than sequentially?

It is an important emerging issue. There are several ways of addressing this issue. One most common approach has been the use of Integrated Product Teams (IPT). The IPT has been demonstrated to have shorten the developmental cycle and improves the first-time quality by General Motors, Chrysler, Boeing, US Department of Defense, and Primavera Inc. ADOT's proposed project management process (including the scheduling models) may eventually resemble the IPT process.

Is the existing documentation of the network models and activity definitions adequate and clear? If not, how should these be updated?

The existing documentation of the network models and activity definitions should be reviewed with a team of technical staff and project managers. Based on the recommendations of the team, these documents should be revised.

Resource Issues and Action Items

What level (e.g., number of people, person-hours, person-days, skills and/or titles, grades, on-call or job specific consultants, etc.) of resource loading is desired? Should resource requirements be loaded on a person by person basis or just by job classification or by Org. or by lump-sum hours? How can a technical manager tie-in this information to a team in his/her section? Otherwise, how to help the manager assess, if one team is overloaded and other is

underutilized, even though the total resource needs are balanced?

It is recommended that, initially, resource loading be in "person-days" by skills and by Org. code. The technical manager will be able to access resource utilization information (which includes historical, current and projections) for each Org. code aggregated at each technical function by project and for the program. Information can be available in pre-established or customized tabular and graphical form.

- Should the element of uncertainty be introduced in the resource analysis?

Yes, for decision makers to have more realistic schedules and resource estimates, the PPMS may explore the utility of advanced scheduling tools. The P3 software is compatible to one such tool: Monte Carlo. It is a project risk analysis software from Primavera Systems, Inc. There are many other tools available in the market..

To simplify, should the proposed resource planning system not differentiate between various skill types and levels?

The skill types are covered as resources are planned and their uses monitored at each Org. level within each technical function.

Should the network models have standardized resource loading? Who should estimate the generic resource needs of each activity, and how?

Yes. For most of the activities, we already have the resource estimates. These were developed by various teams which defined the activities in the current models. However, these estimates are generic and need to be re-evaluated for developing each new schedule based on given project scope of work.

The generic estimates should be periodically reviewed and updated as necessary. When a statistically reliable database is developed, we may build a look-up table that may serve as a quick reference for estimating resources for each activity based on given project attributes.

How do we deal with team assignments and other activities that don't show up in Primavera?
How to incorporate "availability rate" in resource analysis with Primavera software? Do we work off of some factor of time available for project work and does this vary for different people or positions or Org.?

Based on the experience with the construction Orgs. and normal annual/sick leave usage, the availability rate has been assumed to be 84 percent. In addition, about 20 percent time has been reserved for non-project related activities including training and pre-design activities, such as project assessment and design concept reports. Thus, the staff will be assumed to be available for 64 percent of times. As a start, these allowances will be applied to all projects

in the 5 Year Program and all ADOT staff.

The Colorado Department of Transportation (CDOT) has developed a system of estimating resources for various activities. Other states may also have similar systems. Recognizing the fact that the definition of all these activities in various states may not be consistent and compatible with the definitions in use at ADOT, would it be beneficial to survey other systems?

The AASHTO Guidelines for Preconstruction Management based on the 1990 survey were reviewed. ATRC helped us in literature-search on the issue.

The ADOT system has evolved and matured with the input of its customers. For this reason, RAMP is proposed to use data already available. Continuous improvements will be sought in RAMP to meet the changing wants and needs of its customers.

Periodic comparison of the scheduling system of other states by AASHTO will be interesting and may be useful for future improvements.

How should the resources be allocated over the elapsed time for each activity? Note that linear and nonlinear resource distribution curves are available in P3.

Very few activities really have linear utilization of resources. However, to expedite the RAMP implementation, initially, linear resource distribution will be assumed for all activities. Later, on case by case basis, nonlinear distribution of resources may be incorporated in the project schedules in consultation with the technical managers and the project managers.

Who will input the resource requirements: the technical manager or the project manager in consultation with the technical manager?

To start the process, PPMS staff will load the CPS activities with generic resources. The project teams will then customize the resource assignments in consultation with the technical managers. For new projects, the project teams will make the initial assignments in consultation with the technical managers. The individual staff or consultant assignments will be done by the technical manager in consultation with the appropriate technical leader.

Should PPMS monitor in some way the resources versus requirements and report on them or leave it up to each discipline? How to minimize monitoring and still achieve program and project management goals and objectives?

Only the 36-Month Schedule and Executive Summary reports will be published regularly. Templates for Project Manager's Summary and Technical Group/Services Summary will be made available for use by the customers who can print their reports when needed. Other

customized resource histograms and reports will be prepared by the PPMS team on request.

Will there be a standard resource utilization report? What other reports will be needed? State the purpose, identify the customers, define the utility and establish the format of each standard report.

Yes, there will be four reports: two will be published and templates for the other two will be provided.

When and how will the RAMP implementation team seek direct input from the customers for making its products and services responsive to their needs?

As RAMP evolves, customers' input will be sought and considered in updating it with the objective of making it responsive to the need of its customers.

When and who will provide the concept and computer training to the customers?

The PPMS staff will design and implement the customer training program.

Performance Measures

According to ADOT's project management process, the project manager has the responsibility of managing highway projects throughout their duration. In this role, the project manager and the project team are accountable for the control of available resources, project costs, schedule and quality. Also, the project manager and the project team are highly visible to in-house and external customers. Their ability to achieve project objectives is highly important.

The primary objective of ADOT's program and project management function is to help complete the design and construction of each project according to desired scope of work, established quality standards, reasonable schedule and equitable budget. A change in one of these four performance features may lead to changes in the other three. Among these, the scope of work is subject to change for many reasons, most important among those being change in wants and needs of the customers. Sometimes, ADOT may have very little or no control on changes in scope of work.

There is no quantitative criteria available that can objectively measure and compare the scope of work or any change therein. To objectively deal with the issue, it is necessary, therefore, to revisit the schedule and budget, and appropriately change the baseline for the affected performance measures as soon as there is any change in scope of work.

The performance criteria related to the budget and actual cost can be assessed by computing the labor performance index (LPI), cost performance index (CPI) and schedule performance index

(SPI). These indices utilize the concept of earned values. The timeliness of the project can be quantified by evaluating the variance between schedule versus actual completion date. These and other performance measures are discussed in the following sections.

It may be noted that due to absence of adequate reliable activity based historical data for ADOT design projects, the project managers may have to rely solely on experience of their team members in developing budget for activities of each project. This may have an impact on the reliability and objectivity of the performance measures used. For this reason, these measures can best be considered less objective and tentative. Extra precaution should be exercised in interpreting these measures and in making decision based on those interpretations. As more reliable activity based project database is built-up, and the RAMP system matures, more team members gain project management experience, objectivity of all performance measures will improve.

Earned Value And Performance Indices

The earned value has been part of cost/schedule control systems since early 1960s. It is a powerful effective tool when used in conjunction with other project management tools, particularly program evaluation review technique (PERT), critical path method (CPM), or simply Gantt chart scheduling system.

For the purpose of discussion here, unless specified otherwise, the term cost and budget may be applied to labor resources, such as person-hours or person-days, or **total** monetary resources (including labor, material and equipment costs) in dollars.

The earned value is calculated as percent complete times the budget. Credit for partially completed activities is also considered in computing the earned value. In the project management profession, earned value is commonly known as budgeted cost for work performed (BCWP). The BCWP is defined as the budgeted amount of cost for completed work plus budgeted for level of effort or apportioned effort activity within a given time period.

In other words, the earned value or BCWP represents the portion of the budget that was allocated to the work that was actually accomplished. The BCWP excludes both schedule and unit-price variance considerations.

The earned value or BCWP represents the **value** of the work performed, which may be different from the actual cost for work performed (ACWP). The ACWP is the amount actually expended in completing the work accomplished within a given time period. In other words, the costs actually incurred for the work accomplished during a specific time period or the costs accumulated up to a certain point in time is called ACWP. The ACWP is the same value as the actual-to-date amount recorded in the current project plan. The cost of the work is independent of the value of completed work and of the plan for accomplishing that work.

When cost is expressed as labor person-hours or person-days, etc., one may use the terms such as: Budgeted labor for work performed (BLWP) and actual labor for work performed (ALWP). The BLWP, here, is earned value. It represents the value of the work performed in labor unit.

Another term, that is useful in project management is budgeted cost for work scheduled (BCWS). The BCWS is the budgeted cost for work scheduled to be accomplished plus the amount or level of effort or apportioned effort scheduled to be accomplished in a given time period. In other words, the BCWS is the amount of work that should have been accomplished by the data date, had the project proceeded according to the target plan. The BCWS is the product of the budget and the percent complete that the target should be on the data date. The concept of budgeted labor for work scheduled (BLWS) may also be used to complement BCWS.

The BCWP, BLWP, BCWS, BLWS, ACWP and ALWP can be applied to any level of the breakdown structure (i.e., program and project deliverables, tasks, sub-tasks, work packages) for work that is completed, in-program, or anticipated.

To determine how well the project is being done or has been done, following indices are calculated:

Labor performance index (LPI) = $BLWP \div ALWP$, where both factors represent **only** labor resources in the same unit.

Cost performance index (CPI) = $BCWP \div ACWP$, where both factors represent **total** monetary resources in the same unit.

Schedule performance index (SPI) = $BCWP \div BCWS$, where both factors represent **total** monetary resources in the same unit.

For exceptional performance, LPI, CPI and SPI > 1.0; for perfect performance, LPI, CPI and SPI = 1.0; and for very poor performance, LPI, CPI and SPI < 1.0.

Variations As Performance Measures

A variance is defined as any schedule, technical performance, or cost deviation from specific plan. Variations are used by all levels of management to verify the budgeting system and the scheduling system. The labor, cost and scheduling system variations should be considered together.

Labor variance (LV) = $BLWP - ALWP$

A negative labor variance (LV) indicates unanticipated excessive labor needs.

Cost variance (CV) = $BCWP - ACWP$

A negative cost variance (CV) indicates a cost-overrun condition.

Schedule variance (SV) = BCWP - BCWS

A negative schedule variance (SV) indicates a behind-schedule condition.

Often these variances are expressed as percentages:

Labor variance percentage (LVP) = (LV/BLWP) * 100 %

Cost variance percentage (CVP) = (CV/BCWP) * 100 %

Schedule variance percentage (SVP) = (SV/BCWS) * 100 %

Additional Performance Measures

The budget at completion (BAC) is the sum of all budgets allocated to the project. This is synonymous with the project baseline. This is what the total effort is planned to cost. If the project scope is changed, the budget should be reviewed and revised, as per ADOT's approved project management process.

The estimate at completion (EAC) identifies either the dollars or hours that represent a realistic appraisal of the work when performed. It is the sum of all direct and indirect costs to date plus the estimate of all authorized work remaining.

EAC = Cumulative actual + the estimate-to-complete the remaining project

The EAC is the best estimate of the total cost at the completion of the project. It should be reassessed and monitored on a monthly basis.

Using these definitions, variance at completion (VAC) may be calculated:

VAC = BAC - EAC

Variance at completion is determined by comparing what total project is supposed to cost and what total project is now expected to cost.

UTILITY OF PROPOSED MEASURES

QUESTION	ANSWER	ACRONYM
How much work should be accomplished in the given period? How much must be earned in the given period?	Budgeted cost for work scheduled. It is the planned cost for the period. Budgeted labor for work scheduled. It is the planned labor for the period.	BCWS BLWS
How much work is really accomplished?	It is the earned value. Budgeted cost for work performed. Budgeted labor for work performed.	BCWP BLWP
How much did the is done work cost?	Actual cost of work performed. Actual labor used for work performed.	ACWP ALWP
What is the magnitude (%) of expected person-hours overrun or underrun?	Labor performance index. Used to forecast labor person-hours needed to complete the project.	LPI
What is the magnitude (%) of expected cost overrun or underrun?	Cost performance index. Used to forecast project cost at completion.	CPI
What is the magnitude (%) of expected schedule/time overrun or underrun?	Schedule performance index. Used to forecast project completion date.	SPI
What is the difference between budgeted and actual cost of work performed?	Cost variance (+ for desirable, or - for undesirable).	CV
What is the change as a % of budgeted cost?	Cost variance percentage.	CVP
What is the difference between planned and expected completion of an activity?	Schedule variance (+ for desirable, or - for undesirable).	SV
What is the change as a % of planned schedule?	Schedule variance percentage.	SVP
What was the total project supposed to cost?	Budget at completion, or total project budget.	BAC
What do we now expect the total project to cost?	Estimate at completion, or latest revised estimate.	EAC
What is the expected difference between budgeted cost and projected cost at completion?	Variance at completion.	VAC

Project Level Performance Measures

In the bottom-up approach recommended here, all of the activity performance measures

illustrated earlier can be applied at the project level. However, since the labor performance index (LPI) and cost performance index (CPI) are easiest to understand and simpler to compute, these are recommended to be published in the standard reports, initially. Other performance measures may be included in these reports on customers' requests.

However, all performance measures will be made available on the P3 network. Some of these are standard P3 products and others can be computed as custom data items with some programming effort. The standard templates will be designed to provide the most current information as the project schedule is updated.

The performance at activity level will be a building block to determining the performance at the project level. Even though, at ADOT, a varying mix of in-house staff and consultant resources are utilized for various activities in designing highway projects, the LPI and CPI at activity level can be aggregated to determine project level indices.

Therefore, the design phase performance indices for each project using the mix of ADOT and consultant resources are defined as:

Labor performance index (LPI) for each project

$$= \frac{\text{BLWP or earned person hours}}{\text{ALWP or actual person hours as of data date for the project}}$$

Cost performance index (CPI) for each project

$$= \frac{\text{BCWP or earned cost}}{\text{ACWP or actual cost in dollars as of data date for the project}}$$

Where:

Earned value (of labor or money) for the activity = Percent complete * Activity budget (for labor or expense)

Earned person-hours for the project = Σ Earned person-hours for each activity

Earned cost for the project = Σ Earned cost for each activity

Actual person-hours for the project = Σ Actual person-hours for each activity

Actual cost for the project = Σ Actual cost for each activity

The recommended procedure for determining the project level performance is outlined below:

Step 1: The project manager in consultation with the team should use generic activity resources (in person-hours) as a guide for estimating (budgeting) resource needs for each activity of the given design project. Next, a resource loaded network schedule based on preliminary PA is prepared. Estimated activity resources are to be added to compute total person hours for the project.

Step 2: Average unit labor rates (dollars per person-hour) are applied to person-hours for

estimating the labor cost of the project. There will be two average unit rates: ADOT rate and consultant rate. The unit labor rate for ADOT should be based on historical experience, and current and projected wages, benefits and other overheads. The unit labor rate for consultant should be based on historical trend adjusted for inflation. The cost estimate related to the use of equipment, motor pool and other services may be considered as a separate item and added to the labor cost for estimating the project's design budget.

Step 3: The estimated design budget for each project may be verified as a percent of programmed construction budget. For fine-tuning this percentage to a more appropriate level, budget of all activities should be normalized to the desired project's design budget.

Step 4: The critical path (i.e. longest path) determines the project duration based on estimated duration of critical activities. If the project duration is different from what is desired, network logic may be reviewed and changed, selected critical activities may be crashed by shifting appropriate resources from non-critical activities to critical activities and/or assigning additional resources to critical activities.

If the new budget estimate is different from the programmed estimate, activity resources should be re-adjusted to minimize the differences. This may also necessitate reprogramming of some projects.

Step 5: Refine person hours and project cost estimates based on final PA or DCR for the project. Repeat Step 3, if necessary. The new budget should be recommended for programming. It should be used in computing performance measure and determining what percent of project budget is design.

Step 6: As the scope of work changes during the design process, originally planned schedule and resources should be revisited using Step 1 through 5. The formal project management process should be followed to make necessary changes in the project schedule and budget.

Step 7: The project manager must ensure timely update of each of his/her project schedule. The project team is accountable for reliability and accuracy of the scheduling information in P3 database. The project team is also responsible for reviewing the current project schedule and analyzing the resource needs with the technical managers before developing alternative strategies and implementing any recommendation.

Project construction budget should continue to be estimated using the current methodology.

Sample computations for activity and project level direct LPI are presented in Figure 4.1 as an illustration. The hypothetical activities shown here may not form a complete network schedule.

FIGURE 4.1: COMPUTATIONS OF ACTIVITY AND PROJECT LPI					
ACTIVITY ID	PLANNED PERSON-HOURS (BAC)	% COMPLETE	EARNED PERSON-HOURS TO DATE (BLWP)	ACTUAL PERSON-HOURS TO DATE (ALWP)	LABOR PERFORMANCE INDEX (LPI)
AE 10	30	100	30	25	1.20
ES 20	20	70	14	20	0.70
GS 05	60	5	3	6	0.50
EP 15	110	10	11	11	1.00
EP 20	70	20	14	21	0.67
BD 35	120	15	18	16	1.13
CS 99	20	0	0	0	NA
FOR THE PROJECT TO DATE	430	21%	90	99	0.91

NA = Not applicable

INTERPRETATION: As of the data date, the activity GS 05 is five percent complete with LPI of 0.50. The project is 21 percent complete with LPI of 0.91. In this illustration, the performance level at which work on the project is progressing, indicates that actual overall labor requirement will exceed the **total** planned person-hours by nine percent. In other words, to be able to complete all pre-construction activities of the project, we may need total of 472 person-hours of resources (EAC). CAUTION: It should be noted that the future performances may not duplicate the past. The past performances (historical data) are only indicative of a possible trend.

A similar table is developed for computing the activity and project level cost performance index (CPI).

FIGURE 4.2: COMPUTATIONS OF ACTIVITY AND PROJECT CPI					
ACTIVITY ID	ACTIVITY BUDGET IN \$ (BAC)	% COMPLETE	EARNED VALUE TO DATE (BCWP)	ACTUAL COST TO DATE (ACWP)	COST PERFORMANCE INDEX (CPI)
AE 10	600	100	600	650	0.92
ES 20	500	70	350	250	1.40
GS 05	1800	5	90	80	1.13
EP 15	2750	10	275	300	0.92
EP 20	2100	20	420	390	1.08
BD 35	6000	15	900	950	0.95
CS 99	400	0	0	0	NA
FOR THE PROJECT TO DATE	14150	19%	2635	2620	1.01

NA = Not applicable

INTERPRETATION: As of the data date, the activity GS 05 is five percent complete with CPI of 1.13. Each dollar, the team actually spent on this activity, generated \$1.13 worth of work for the activity. Currently, associated CV is +10 dollars for this activity. It has cost the team 10 dollars less than originally expected. About 18.6 percent of the project budget has been spent with a CPI of 1.01. In this illustration, the performance level at which project budget is being dispensed and work on the project is progressing, a saving of less than one percent (or VAC of about 80 dollars) is anticipated at the completion of the project. CAUTION: It should be noted that the future performances may not duplicate the past. The past performances (historical data) are only indicative of a possible trend.

Other Budgeting Options

There exist many possibilities. Two significant options for estimating the budget by activities are identified here.

Option A: Like the recommended option described earlier, this is also a bottom-up approach. Use pre-established look-up tables to estimate person-hours for the involved activities based on the known attributes of the project. Average unit labor rates (e.g., dollar per person-hour) are used for estimating the labor budget of the project. Cost of non-labor items may be added to the labor budget. The procedure described earlier may be needed to normalize these estimates to the programmed budget.

Option B: This is a top-down approach. Establish the project design budget as a percent of estimated construction budget at the PA or DCR stage. Distribute this cost over involved activities in a pre-established proportion. Calculate total person hours for design effort based on applicable unit cost (dollars per person hour rate).

Both options require a comprehensive analysis of reliable and compatible historical database.

Timeliness as a Performance Measure

In addition, we should also have the performance measure based on time schedule. This may be measured as the ratio of number of projects advertised and number of projects scheduled in the preceding month. The ratio may be presented as percent. In this case, 100 percent would mean that all projects scheduled to be advertised in the preceding month were advertised in that month. A similar measure can be applied to the preceding annual (fiscal year) program.

Use of the Performance Measures

The performance measures will help ADOT evaluate productivity and degree of success, help in diagnosis of the problems, and develop alternative strategies to deal with the related issues. To enhance the project decision making process, the performance measurements should be used in conjunction with percent complete information and how far ahead or behind the project is with respect to its programmed schedule.

With the aid of the multi-dimensional performance measures discussed earlier, the performance of ADOT staff can be analyzed to determine the level of efficiency.

Variances between planned versus actual should be analyzed to determine reasons for deviations and corrective actions initiated, if necessary.

In order for the project team to develop strategies, the team will also need routine scheduling information some of which is already easily accessible to all Primavera users. RAMP will

provide the remaining information.

P3 and RAMP information can help decision makers at all levels determine future workloads, shift resources from an area to another, and acquire additional resources.

The Construction Management Program - Introduction

ARTEMIS is the nucleus of the Arizona Department of Transportation and the Construction Management Program. The ARTEMIS project scheduling software and databases are used to store and manage ADOT construction resource data. Construction resources are defined as the manpower, equipment, and funds used by ADOT to manage administrative activities associated with construction. ADOT management uses the data stored in the ARTEMIS system to plan and monitor the use of ADOT construction resources.

The CPM is used to plan, schedule, and monitor ADOT's Five Year Highway Construction Program.

ADOT construction projects are contained in an ARTEMIS database residing on ADOT's mainframe computer and on micro computers located at each construction organization (Org). Data entry, network analysis, scheduling, report writing and graphics generation are accomplished using a combination of ARTEMIS products, custom software, and Attachmate Extra! communications software. A brief description of the software that make up the Construction Management Program follows:

ARTEMIS 9000 The fourth generation computer language that makes up the mainframe system. ARTEMIS 9000 is an information management system designed around a relational database and includes a project management command language.

Planning 9000 A menu driven planning and scheduling application that runs on the mainframe computer. Planning 9000 is written in the ARTEMIS 9000 language.

Cost Database A menu driven application developed specifically for ADOT by Metier (now Lucas) Management Systems. The Cost Database is written in the ARTEMIS 9000 language.

DB2 A mainframe database used by the CMP. Actual man-hours and cost data are fed to DB2 from the TRACS. Planning and staffing information is extracted from the CPM networks in Planning 9000.

Attachmate Extra! A Microsoft Windows based communications software that permits data exchange between PCs and the ADOT mainframe.

AR-Link Communications software that permits data exchange between ARTEMIS PC products and the ARTEMIS mainframe products.

AR-Plot PC software that allows plotting of ARTEMIS plot files to screens, plotters or graphics printers.

Standard A program written and maintained by the Program and Project **PlanningMethod** Management Section that facilitates the planning process.

an A program written and maintained by the Program and Project Management Section that facilitates the staffing process.

; A program written and maintained by the Program and Project **Upload**Management Section that facilitates the upload of files to the ADOT mainframe.

System Goals

The Construction Management Program goals are:

1. To develop, collect and maintain records of Construction Engineering (CE) costs on construction projects.
2. To develop and continually update planning values.
3. To provide timely cost and project status reports to the project managers.
4. To collect project information necessary for forecasting construction resources required to administer the ADOT Five Year Highway Construction Program.

System Overview

Construction projects in the Construction Management Program have three phases: planning, scheduling or staffing, and monitoring and updating.

Planning Phase

Highway construction projects are initially identified in ADOT's Five Year Highway Construction Program. The Program and Project Management Section takes each project in the Five Year Program, prepares a Standard Planning Method and creates a planning network of activities and resources based on the type of work and the scope of the project. One of thirteen Standard Planning Models is used to determine the network logic and activity durations for a new planning project. Resource requirements are determined by the Standard Planning Method.

Staffing (Scheduling) Phase

When a project has been awarded to a contractor, the contractor must submit a proposed work schedule to the Resident Engineer within the time frame described in the project contract. When the contractor's schedule is received, the project manager creates a staffing plan using the

Staffing Plan program. Printed output and Artemis compatible files from the Staffing Plan are sent to the District headquarters for the appropriate approvals. Once approved, the District Operations Technician (Ops-Tech) overwrites the planning network with the transmitted files.

Monitoring and Updating Phase

During construction, the Resident Engineer and contractor meet to discuss the project progress. The Resident Engineer enters the progress for each activity into the project staffing plan and uses the information to monitor the contractor's progress and adjust the project resource needs. The updated information is uploaded to the mainframe routinely by the District Ops-Tech. When necessary, the contractor submits a revised schedule to the Resident Engineer. The Resident Engineer creates a revised staffing plan and transmits the files to the District Ops-Tech. The Ops-Tech uploads the revised project to the mainframe and extracts the resource information for the Cost Database.

Eight standard reports and other special reports are available to help the project managers and management monitor costs and manpower usage.

An interface with the Transportation Accounting System captures all project related costs and individual labor distributions. Data entering the system from TRACS is monitored for incorrect information. The information in the Cost Database is reconciled against the TRACS database on a regular basis to ensure integrity.

Operating Procedures

Program and Project Management Section Procedures

1) Planning

Standard Planning Models exist for each of 13 identified contract types. The appropriate contract type and dollar value of a project is used to determine the Planning Values, Productivity Factor and estimated duration of a project. The Standard Planning Method provides a printed output and Artemis compatible files for uploading to Planning 9000. Target Start (TS) dates are assigned to the initial event(s) based on the bid advertisement date. A five character TRACS code is prefixed to each event to maintain the network's uniqueness.

After being uploaded to the appropriate District Planning 9000 PM ID, the network is analyzed, and reports are printed to verify the project's data. The data is then extracted into the Cost Database.

2) Planning 9000

Project Manager IDs have been created and assigned to the appropriate District using the Control ID in Planning 9000. Projects in the Five Year Program are initialized in the appropriate PM ID.

The Artemis calendar is maintained from the Control ID in Planning 9000. The calendar spans a minimum of ten years and contains all approved work patterns used in the CMP.

Resource pools are created and maintained by the Program and Project Management Section in the Control ID. The pools are updated regularly using information provided by the Primary Work Schedule.

The Control ID is used to combine the District multi-projects into a statewide Live-plan. The Live-plan is used to generate statewide reports.

System security is managed by the Program and Project Management Section using the Administration ID. All Planning 9000 passwords and IDs are assigned and maintained by the Program and Project Management Section.

3) Cost Database / DB2

Projects are initialized in the Cost Database by the Program and Project Management Section. Planning information is extracted to the Cost Database from Planning 9000 each time there is a change in the planning network. Project information is added/updated when it becomes available.

District Headquarters Procedures

1) Staffing Networks

When the staffing plan is complete, or when the Resident Engineer adds activity progress, the Ops-Tech uploads it to Planning 9000 on the mainframe.

2) Cost Database / DB2

The District Ops-Tech extracts staffing data from the network into the Cost Database each time there is a change in the staffing network. Staffing objectives and project information is input or revised as necessary. The Eight Standard Reports are generated as necessary.

Construction Organizations (Org) Procedures

1) Creating the Staffing Plan

Upon receipt of the contractor's schedule, the Resident Engineer creates a staffing plan using

the Staffing Plan program. Printed output from the program is sent to the District headquarters for the appropriate approvals. Artemis compatible files created by the spreadsheet are either mailed or electronically transmitted to the District Ops-Tech.

2) Adding Activity Progress to the Staffing Network

Each Org updates their staffed projects using the Staffing Plan program. The project manager will provide activity status on a monthly basis for projects with less than 260 working days (366 calendar days) remaining. For projects with 260 or more working days (365 calendar days), status is added quarterly. The status information required consists of actual start dates, percent completes or remaining durations, and the actual finish dates for each activity in the network.

Updating Planning Networks

Planning networks for projects in the Five Year Highway Construction Program are updated by the Program and Project Management Section as new information is received. The networks are updated using the Standard Planning Method then uploaded to the mainframe. The revised resource information is extracted to the Cost Database and the old planning information is automatically overwritten.

Updating Staffing Networks

Staffing networks for projects 260 working days or longer (365 calendar days) are statused (work progress added) on a quarterly basis. Projects with less than 260 working days (365 calendar days) remaining are statused monthly. As activities begin, the Resident Engineer enters the actual start date of each activity. The project's progress will be reviewed and updated as necessary based on reports from the contractor and from information provided by the project manager. A percent complete (or remaining duration) is provided for all activities in progress and an actual finish date must be provided when the activity is complete. After each update, the revised information is transmitted from the Org to the Ops-Tech, then imported into Planning 9000 by the Ops-Tech.

Revisions to Staffing Networks

Revisions can be caused by weather, change orders, material deliveries, etc. and may consist of the adding, deleting, or modifying of activities and the changing of resource types and quantities including resource delay and resource duration.

Revisions may be based on changes to the contractor's schedule (reported to the Resident Engineer at the weekly progress review meetings), or, in the absence of a realistic schedule from the contractor, the Resident Engineer may revise the schedule based on his/her judgment. When the revisions are complete, the revised network will be transmitted to the District Ops-Tech for uploading to Planning 9000.

PRIVATE CONSULTANT PRACTICES

This section includes brief summaries of project development and management systems employed by private engineering consultants who participated on the PRC.

Since the PRC believes that the platform, hardware, and software system for the choice of the tools that comprise the computer data collection, data processing, data reporting, and data warehousing is a subjective decision, and since each private consulting firm interviewed, as well as ADOT, used total systems that were very dissimilar in components (although very similar in performance), and since Caltrans has chosen a system that is already well established, the PRC has chosen not to make any specific recommendations on platforms, hardware or software.

Although each of the firm's utilize different computer tools to estimate project resources and manage project delivery, there are key elements that are common to all approaches and which apply to the Caltrans Product Driven Zero Based Budgeting and Project Management Program. These include:

1. Step one is identifying and agreeing on the client's needs.
2. Developing a specific scope of work, the associated budget and a realistic schedule for each project.
3. Assigning Project Managers who are experienced and available, and who will be accountable for all aspects of project delivery.
4. Assigning Functional Managers who are experienced in estimating task resource requirements and accountable for on-time delivery within budget.
5. Providing weekly reports which accurately identify current personnel and time charges against specific tasks.
6. Maintaining quality assurance throughout the project.
7. Having the ability to access flexible resource pools on an as needed basis.

Since implementation of the Work Breakdown Structure is relatively new to Caltrans, the major differences between Caltrans and private industry at this time include the following:

1. Private industry is experienced in estimating project specific budgets.
2. Private industry monitors budgets on a weekly basis.

3. Private industry Project Managers are empowered to provide efficient project delivery and are accountable for all aspects including quality, schedule, and budget.
4. Private industry provides incentives for project development efficiencies.

RBF Approach to Scope of Services Development

1. Identify Project
 - a. Need or purpose
 - b. Client
 - c. Stakeholders
2. Identify Project Manager
 - a. Major Functional Discipline
 - b. Relationship with Client stakeholders
 - c. Availability
 - d. Level of experience and expertise
3. Identify Major Work Elements/Discipline Areas
 - a. Project Manager's Responsibility
4. Task Force Meeting
 - a. Formalize Task Force members (Project Manager/Functional Managers)
 - b. Identify Responsibilities
 - c. Critical Issues
 - d. Project Understanding
 - e. Identify Client Needs
5. Draft Scope of Services Major Discipline Areas
 - a. Task Description/Deliverables
 - b. Hours/Personnel
 - c. Fee
 - d. Schedule
 - e. Subconsultants
6. Final Scope of Services
7. Weekly Task Force Meetings
 - a. What has been accomplished
 - b. What will be accomplished
 - c. Issues

Technical
Staffing
Budget
Schedule

8. Weekly Time Reports Aggregated by Task Code
 - a. Actual Persons/Tasks/Hours/Direct Costs
9. Milestone Deliverable Review by Project Manager
 - a. Continuous Quality Monitoring
 - b. Reality Check of Percent Complete Compared to Budget Expended
10. Monthly Project Billing
 - a. Time aggregated by task
 - b. Subconsultant costs
 - c. Direct costs
 - d. Compare budget expended to percent complete

CH2M HILL Project Delivery System

Business environments have become increasingly competitive, leading clients to seek more comprehensive solutions to the delivery of their projects. To maintain a competitive edge in the consulting engineering industry, CH2M HILL needed to adapt to their clients' changing demands. The challenge for the firm is to develop a holistic approach that looks not only at technical solutions but also at all aspects of project delivery. To meet this challenge, CH2M HILL has developed a process-driven project delivery system that incorporates the best principals and practices from the total quality, process improvement, and organization reengineering movements and applies them to the business environment they work within. Their project delivery system provides clients with the comprehensive solutions they demand and provide project managers with a consistent, efficient, and cost effective means of delivering high-quality products.

The Project Delivery Process

At the core of the project delivery system is a process to deliver projects successfully. CH2M HILL's project delivery process is the client-focused application of those principles that will most influence the performance of our projects. Those principles that underlie the project delivery process include project manager as leader, client satisfaction, and consistent project planning and project execution.

The principles and processes described are represented by a model that contains many of the concepts that have always been emphasized at CH2M HILL. However, the successful implementation of the model depends on a thorough understanding of the elements of the project delivery process and their consistent execution.

Application of the project delivery process is *necessary* for the successful delivery of all projects the firm engages in, but is not *sufficient*, by itself, to ensure success. To meet the necessary-and-sufficient test, the process must be integrated with other components of the project delivery system: tools, core skills, a project manager career path, and the support of the firm.

Tools

Tools exist and are continuing to be developed for incorporation into the project delivery system and integration with the process, leading to more efficient project management and improved performance. These tools include monographs, process diagrams, a resource manual, and Task Master, an automated management system for planning, tracking, and controlling projects at CH2M HILL. All of these tools will ultimately be offered on-line.

Core Skills

The core skills are the means by which CH2M HILL's vast resources, experience, and processes are linked with the project delivery process. The linkage is described using process diagrams, monographs, and resource manual topics related to each of the core skills.

The firm's core skills directly related to project delivery are business skills, interpersonal skills, project management skills, technical skills, and client service skills. Each of these five core skills provides a focus for the development of topics addressing subsets of the core skills. For example, details about invoicing would be a subset of business skills.

Project Management Career Path

Development of the project manager career path is an important component of the project delivery system because it reflects the support that the firm has for its project managers. Career path development includes a project managers certification and evaluation program that confirms a project manager's level of competency based on a combination of work experience, training, and evaluation. The certification component of the program reinforces the project delivery system by acquiring familiarity, training, and experience with the project delivery process as a qualification for certification. The evaluation component of the program measures performance and the effective use of the project delivery process.

CH2M HILL Support

The firm's support for both the development of the project delivery system and the faithful application of the project delivery process is essential to achieve benchmark status. Major shifts in corporate philosophy, such as those associated with the project delivery system, require continuous reinforcement by the firm. In order for the new project delivery system and process to be fully accepted and implemented, attitudes and behaviors regarding project delivery need to be aligned with the new philosophy.

Summary

The complete development of the project delivery system and the client-focused application of the project delivery process will help project managers deliver high-quality products efficiently, which will help clients move projects from concept to successful operation. Through the project delivery system, CH2M HILL will deliver the comprehensive solutions our clients need to compete in today's business environment.

PSOMAS PROJECT MANAGEMENT

Psomas and Associates is a privately owned consulting engineering firm located in Southern California. The firm provides Civil Engineering, Land Planning, Water Resource Management, Environmental Engineering, Geographic Information Systems and Geomatics Engineering to clients in the public and private sectors. Many of these projects are multi-disciplined and range in scope and duration to millions of dollars several years. To properly serve our clients and bring about the successful completion of these projects Psomas functions on a group and project management system. Groups of project teams are defined by discipline and managed by Team Leaders. To insure quality of service, continuity and project reporting Psomas has developed both technical and project management manuals. All projects fall within three categories of project management, short term, medium term and long term. Team Leaders and Project Managers must follow all reporting functions and steps defined in the Project Management Manual. These reporting functions and steps begin at the point of project acquisition and carry through to project completion.

Short Term Projects

Short Term projects may be defined as being projects less than \$50,000 and lasting less than three months duration. These projects consist mainly of feasibility studies and site surveys. For these projects short form work plans, consisting of bar graph schedules, line item tasks, total project budgets and lists of deliverable items are developed at the inception of the project. The project manager is responsible for developing these work plans.

Projects are unique client and project numbers at the beginning of a project. The project budget is entered into corporate MIS (Management Information System). All hours and costs incurred by the project team are entered into the MIS via the employees weekly time sheet and receipts for other direct costs. Weekly MIS reports are furnished the project manager by the accounting staff. These reports show costs and hours incurred for the week and the total to date.

Medium Term Projects

Medium Term projects may be defined as being projects less than \$250,000 and lasting less than six months duration. These projects consist of comprehensive studies, site development engineering and mapping projects. For these projects work plans, consisting of bar graph schedules, line item tasks, function budgets and lists of deliverable items are developed at the inception of the project. The project manager is responsible for developing these work plans.

Projects are assigned unique client and project numbers at the beginning of a project. The project budget is entered into corporate Management Information System (MIS). All hours and costs incurred by the project team are entered into the MIS via the employees weekly time sheet and receipts for other direct costs. Weekly MIS reports are furnished the project manager by the

accounting staff. These reports show costs and hours incurred for each assigned function for the week and the total to date. For the medium term projects, project reports are furnished the client on a monthly basis. These reports show the work completed during the past period, meetings attended, special conditions or problems encountered, week scheduled for the next period, anticipated meetings and any upcoming special conditions or problems.

Costs and hours expended for the project are tracked against the original or revised budget. A simple S Curve is used to graphically display the expended costs against the percentage of the project completed. This gives the project team and client a quick view of how the project is performing. Corrective action can be taken before any project overruns become an issue.

Long Term Projects

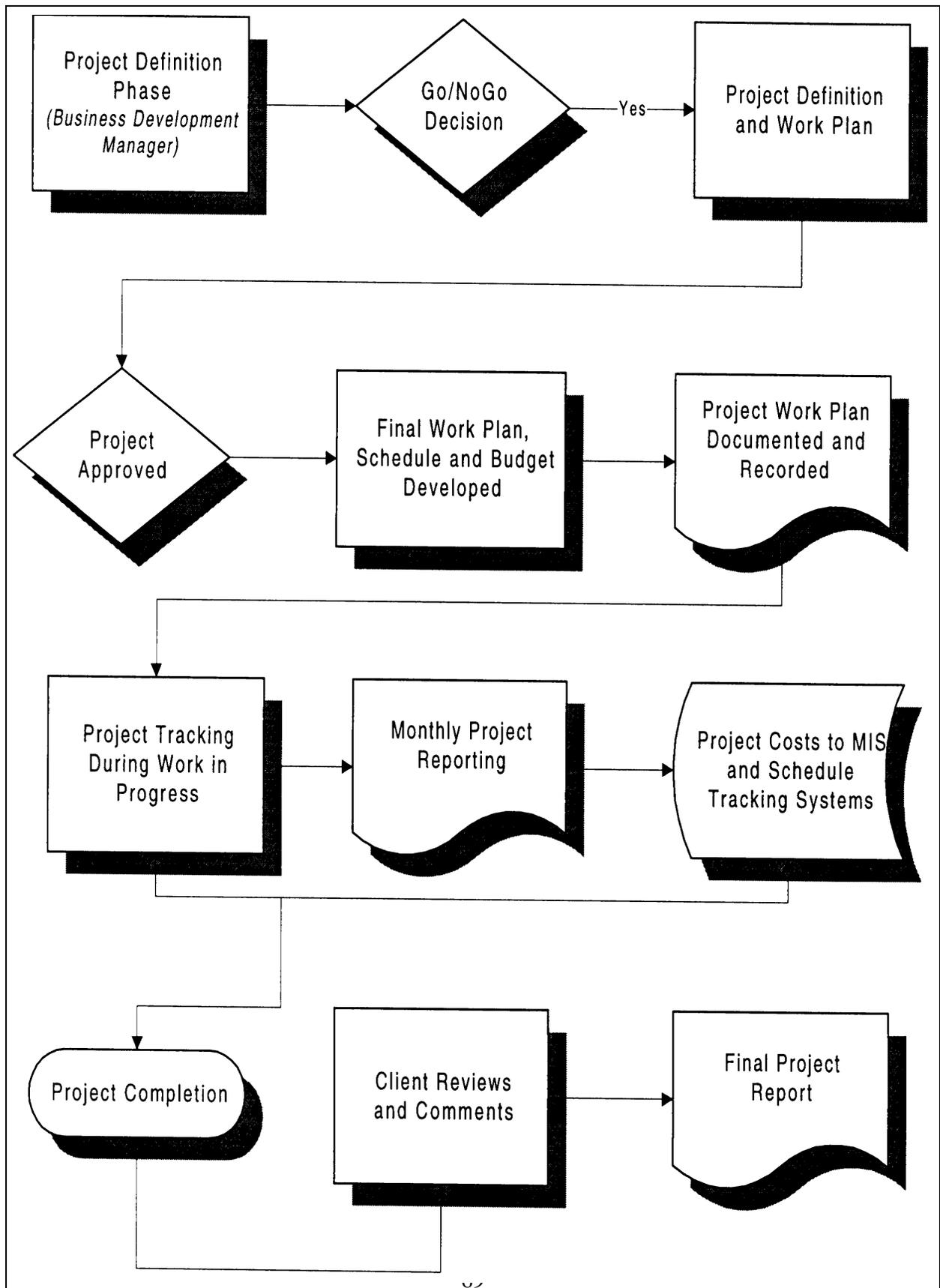
Long Term project are defined as being projects greater than \$250,000 and lasting more than six months duration. These projects consist of major studies, site development engineering, major survey and construction, and Geographic Information Systems (GIS) projects. For these projects work plans, consisting of a technical approach, computer generated schedules, line item tasks with function budgets, resource allocations, technical specifications, project milestones and lists of deliverable items are developed at the inception of the project. The project manager and team leader share the responsibility for developing these work plans. For the scheduling and resource allocation off-the-shelf, Windows based software, such as Microsoft Project, is used. When the project work plan is finalized a baseline is set and all expended time and costs are tracked against the baseline on a weekly basis. The information for the tracking comes from the weekly time sheets and corporate MIS. The tracking effort is carried out by a project assistant, assigned to the project team.

MIS for long term projects, similar to the other two project types, is provided by the corporate accounting unit on a weekly basis. The same type of project reporting, as used for medium term projects, is carried out. For the long term projects monthly Costs to Complete, plotted versions of the schedule and performance measured against the original baseline and milestones are shown. This form of reporting not only allows the project team to measure their performance, but also allows the team leaders and corporate managers to assess future human and capital resource demands and backlogs. Time reported for each member of the project team is converted to costs based on direct salary, direct salary costs and current overhead rates. The product of this reporting is an effective Project multiplier.

Training and Project Audits

Each project manager and team leader is trained in the use of the Psomas Project Management System. The Project Management Manual is divided into two volumes. Volume I consisting of corporate policies, systems and tips, and Volume II containing examples of the required

reporting, tracking and client communication forms. These forms have been incorporated into the corporate data base and are available to each project manager on his/her's desktop computer. This allows for the memorializing of all project documents and reports.



GREINER PROJECT MANAGEMENT PROCESS

Due to the nature of the consulting business, Greiner, as do most firms, recognizes the Project Manager (PM) and Project Team (PT) as the only revenue producing element of the business. The Project Manager reports to the Division Manager. Their responsibility is to provide quality service to the client at a profit level agreed on before project commencement. The PM's responsibilities included:

- 1) Profitability (PI) is measured as the Total Compensation to Greiner less subs and reimbursed direct expenses divided by the total raw direct labor. Each project has a target PI and the Project Manager is measured against the target PI. PI's typically range from 1.0 to 3.2 depending on service type and contract. The PI's in the West trend higher due to capped overheads in the East. A monthly cost to complete is required. If the project is projected to be under performed, the total loss is taken during that month.
- 2) Quality - Local measures are used and involve additional work, repeat work with the client, charge backs and client satisfaction surveys (some formal/most informal).
- 3) Quality Assurance - the PM is responsible to assure the Q/C outlined in the project work plan is accomplished.
- 4) Schedule - The schedule is maintained monthly and is subject to management audit.
- 5) Staffing - Staffing is planned at the beginning of the job and updated weekly, if necessary.
- 6) Collections - PM's are normally charged with client contact and collection at 90 days outstanding for public clients.
- 7) The PM was required to have a written work plan which includes budget schedule, scope, manpower, and quality control program.

The PM orders up staff from the technology leaders who own the production staff. On most projects, a Senior PE (SPE) is assigned. This is the engineer who is in responsible charge. This engineer manages staffing, coordinates between disciplines and with subs, and is responsible for the quality control process. The PM, Technology Leader and SPE agree on scope, man-hour budget, and schedule before and during contract negotiations. Typically, the PE prepares the information. Manpower is allocated using a program known as Power Plan. This is currently in Beta testing in California and Maryland. The objective is to get all offices on Power Plan and allocate resources across the Company.

Current resource leveling is done by first between branch offices within a region and then across regions. Attempts to transfer work electronically (team works in more than one location) has had very limited success. This is due to human factors; the PM wants to see his staff and know the work is being done.

RESPONSES TO SRI REPORT REVIEW

Following are what we believe to be the recommendations from Volume I of the SRI report which are related to our charge area of Project Management and Product Driven Zero Based budgeting. We have followed each of these chosen recommendations with our assessment of the status of Caltrans programs:

I-4-4: *What is the effectiveness of the project development process within current legal constraints?* Caltrans' project delivery process is not effective within current legal constraints, which limit Caltrans' options and often make simple project delivery assignments complex and difficult. We found that Caltrans:

Currently does not have the overall integrated plan or the appropriate organizational structure to execute its multiple project delivery roles effectively.

PRC Response: *The overall integrated plan appears to be in place.*

Is still in the early stages of implementing project management principles and has not yet developed the tailored approach for its own circumstances to ensure strong project-level and functional control.

PRC Response: *Although progress has been made, the statement still is factual.*

Holds neither project managers nor functional managers accountable for project delivery support cost performance and does not have the systems, procedures, and measures to provide effective project management control of projects.

PRC Response: *Although the plan and procedures have been established, the tools are not available to give credibility to the required culture changes.*

Uses guidelines and procedures (compounded by external rules and regulations) that create a bureaucratic hierarchy of requirements and add to the costs and delay of project delivery.

PRC Response: *Although progress has been made to streamline the guidelines and procedures, this statement is still factual.*

I-4-5: *What is the optimum mix of consultants and in-house engineering staff?* We recommend a Constitutional Amendment to allow contracting-out flexibility, and a series of performance measures that will encourage management to use the most cost-effective mix of in-house and contract resources to meet delivery schedules and other deliverables. We look to managed competition to determine this mix.

PRC Response: *Although the flexible resource of contracting-out is presently at a virtual standstill, we concur with this statement with the proviso that “managed competition” means qualifications based selection procedures. Various studies of the Transportation project delivery versus funding for the 50 states have shown that those states that contract out 50% or more of the Capital Outlay Support work have the best earned value for funds expended.*

I-4-6: *What is the appropriate number of regional offices or districts?* The current district structure is an inefficient use of state resources. We identify regionalization of selected functions (while leaving others at a local level) as a means of reducing the inefficiencies.

PRC Response: *This has been implemented. We believe the present organization of Regions and Districts is efficient and effective.*

I-4-7: *What management tools would most benefit Caltrans?* Caltrans needs an integrated set of meaningful business objectives and measures, a set of rewards and disciplinary procedures to enforce compliance, and an effective management information system and strategy to support all of its management efforts.

PRC Response: *We concur, however, although the plan has been prepared, the implementation is just beginning.*

No standard is in place for determining whether Caltrans' overall performance as an organization has improved or deteriorated over time. Specific measures, such as project delivery completion rates and project development cost percentages, have been developed in response to legislature-initiated attempts to enforce efficiency, but these do not measure the productivity or output of the entire organization. Most of the frequently cited measures, such as person-years (PYs) or dollars committed, are inputs, not outputs. This deficiency not only occurs at the department level but cascades down to division, functional, and project levels. The saying, You cannot manage what you cannot measure applies.

PRC Response: *Although far from functional, when fully implemented and functioning the Plan that is presently in place should provide these answers.*

Closely tied to the lack of measures is the lack of group and individual incentives to excel. Individual initiative is not sought except in narrow categories. Exemplary performance is not strongly rewarded and poor performance is not strongly disciplined (except in the most egregious cases). Such a flat incentive structure leads to relatively uniform performance-- performance that tends to focus on following the rules rather than creatively addressing the problems at hand.

PRC Response: We concur, but we have noted no progress in this area.

The lack of an effective information system to provide managers the data they need on organizational performance in a sufficiently timely manner to allow corrective action to be taken makes timely budget adjustments impossible. Such a deficiency cannot remain if the department is to be managed to meet budgeted (dollar and other) objectives.

PRC Response: Although the system is far from functional at this time, when fully implemented and functioning the Plan that is presently in place should provide this information system.

I-10-5 Our fifth key recommendation stipulates that the legislature require capital outlay support costs to be included in the STIP. These costs would supplement the capital outlay estimates and provide a more comprehensive forecast of individual project costs. The provision of this information will help establish a data base for tracking improvements in Caltrans' project delivery efforts over time.

PRC Response: This is being implemented by Caltrans and we strongly concur.

The first two management, leadership, and human resource actions we recommend are (taken together) the single most important change we seek. The establishment of group and individual goals and the rewarding or disciplining of individuals and groups based on their ability to meet these goals is the only effective means available to instill a sense of accountability and timeliness throughout the department. Previous efforts to establish specific goals (such as the establishment of project delivery cost targets) have only frustrated legislators and others with the minimal compliance of the response. Implementation of this key recommendation will require action on several fronts, including:

Development of a new set of Caltrans performance measures to be used by the legislature and governor's office in evaluating the performance of the department and its management.

PRC Response: This is being implemented by Caltrans; however, the PRC has recommended a slightly revised measurement process similar to that used in private practice (see Recommendation No. E-7).

Development of an integrated set of division, functional, project, and individual performance measures and goals that improve accountability through reflecting and reinforcing the department's overall performance measures.

PRC Response: This is being implemented by Caltrans; however, the PRC has recommended a slightly revised measurement process similar to that used in private

practice.

Development of personnel procedures that give management the ability to award or discipline employees in a timely manner based on their performance relative to their goals.

PRC Response: *We concur, however, we noted no progress in this area.*

I-11-8 Our eighth recommendation arises from the need to implement the director's mission, values, and goals statements. We have found that planning--which focuses on multi year policies and strategies as well as on implementation of the director's mission, values, and goals--is sorely needed. An implementation plan for the director's statements is needed to translate expressions of the organization's vision into concrete, measurable steps. By its second year, this implementation plan should incorporate performance measures developed jointly by the governor's office, the legislature, CTC, and Caltrans, as discussed above.

PRC Response: *We believe the Director's Plan is on target and strongly concur with this statement.*

New management information systems will be necessary to implement our recommendations. Other recommendations should lead Caltrans management to rethink the department's basic business processes (particularly in the area of project delivery); they can then begin an effort to reengineer the business process and, as part of these actions, to redesign the related data systems to fit and support the reengineered business process. This systems redesign element of the project delivery reengineering effort is our ninth key recommendation.

PRC Response: *We strongly concur, but believe that although the system is being implemented, it is far from operational and should not be mandated for use until it is a user friendly, complete functioning system. Otherwise, it will frustrate and lose credibility with the very project managers and functional managers it is supposed to help.*

Our tenth key recommendation endorses Caltrans' efforts to enhance the links between individual system islands by developing data bases at a new level. The Data Warehouse is the first example of this new data base level. The initial Data Warehouse contains general information about projects and project-related PY and capital costs and is automatically updated as other data bases are changed. Although we support Department of Information Systems (DIS) efforts, we view these as interim efforts that should be abandoned when data systems in a functional area (such as project delivery) are redesigned as part of a broader business process reengineering effort.

PRC Response: *The data base being proposed by Caltrans appears to be on the right track, but too much may be expected from it, it is not yet operational, and it may be overly complex for widespread use.*

I-12: Finally, we recommend that the project delivery process be structurally overhauled (reengineered) to reduce the long time frames and extensive amount of rework associated with current projects. Significant cost savings are possible by reducing the time required to deliver projects and eliminating unnecessary steps and rework associated with the current design, approval, and permitting processes. To accomplish this, we recommend the following objectives:

Integrate project delivery considerations explicitly into the overall strategy planning of Caltrans.

PRC Response: *We agree, but noted no advancement in this area.*

Streamline and simplify the involvement of regulatory agencies and other stakeholders in project planning, early project development, and permitting processes.

PRC Response: *We agree and believe that this is underway and that the Project Manager should have this responsibility.*

For complex projects, give the project manager more authority and make that individual more in charge of and accountable for project delivery results; with more numerous, less-complex projects, emphasize the role of the functional manager and make that function more responsible and accountable for project delivery results.

PRC Response: *We believe that this is underway but that the Project Manager's role should be paramount for all types of projects.*

Develop and implement a comprehensive performance management system for planning, measuring, and controlling projects, including specific targets, measures, and accountability mechanisms for project delivery support costs: provide support cost estimates in the project study reports (PSRs); and include support cost estimates in the STIP (as previously recommended).

PRC Response: *We believe this is underway but that it will be a while before it is operational since it lacks both the data base and a reporting tool to be on line.*

Attack bureaucratic barriers in the administration of external contracts, oversight of external consultants, and right-of-way activities.

PRC Response: We strongly agree.

I-16: RECOMMENDATIONS

To move from findings and options to recommendations, we were guided by three general approaches to change and a series of five criteria. The general approaches reflect our management consulting experience and theory, combined with our perception of what has (and has not) worked at Caltrans in the past. The five criteria reflect desired organization and management qualities and characteristics; these include a desire for enhanced efficiency and effectiveness, strengthened leadership, improved accountability, and greater responsiveness to stakeholders.

Alternative Approaches to Change

The audit team considered three distinctly different degrees of changes to address the problems identified with Caltrans and related state transportation issues. These are distinguished from one another by the extent to which they vary from current practice. They include approaches that seek to ameliorate identified problems by 1) using incremental enhancements and procedural changes within established rules and practices, 2) restructuring selected practices and relaxing current rules and procedures to allow for new nonbureaucratic procedures to be adopted, and 3) seeking increased use of private sector resources and capabilities, while reducing state resources. Although we combine elements of all three, taken as a whole, our recommendations tend to be a blend of the latter two approaches.

1. The first type of approach to change would entail seeking resolution to the myriad of problems by selective changes and strengthening to existing practices. It is probably the easiest to implement and is the most familiar form of change to Caltrans and the legislature. Improving time-charge collection mechanisms, enhancing management systems and project software, and increasing staffing to overcome apparent bottlenecks such as arise in project delivery, the seasonal shortage of specialists, and processing disadvantaged business enterprise-- DBE--applications) are examples of this type of change. The argument for choosing this approach is that by fully staffing Caltrans and introducing changes to improve selective procedures, Caltrans would improve all aspects of its performance.

Unfortunately, although this approach could resolve selected problems, we see little evidence that changes of this sort would address the fundamental, underlying problems identified in the culture and work style at Caltrans. They would do nothing to address the process (versus product) orientation of the department, nor would they enhance the ability of management to manage effectively. This approach reflects the changes that have occurred in past years and have led to the present level of frustration with Caltrans' ability to manage the transportation resources with which it

is entrusted.

PRC Response: We agree.

2. The second type of approach to change would entail redesign of existing systems and relation or change to numerous rules and procedures. In brief, the goal of these changes would be to instill a product (in contrast to a process) orientation. It would be achieved by giving managers increased flexibility for action and increased responsibility for the outcome of these actions. If coupled with a set of performance measures quantifying the financial and delivery improvement objectives of the policy-setting bodies, such as the legislature and governor's office, then this approach could establish a more business-like Caltrans within the domain of state government.

The main drawback of this approach is that it requires extensive review of existing work rules and enabling legislation, followed by changes to this legislation. Such an approach will require (and attempt to instill) a major new orientation by Caltrans management and rank-and-file.

PRC Response: We believe this is a major part of the present Product Driven Caltrans plan.

3. The third approach to change would entail a greater reliance on public/private competition to achieve economic and time-related efficiencies believed to be available in the private sector. Outside (private sector) resources would be utilized on a competitive basis with internal staff resources to provide managers options in obtaining the lowest cost, most timely support services available. The element of competition forces monopoly organizations (including government agencies) to increase their efficiency if they wish to continue as a service provider.

The main drawback of this option is that it has the potential to dramatically change the character of employment at Caltrans, which might create resistance from some elements of the work force. The cost disadvantage associated with contracting-out has not been proven one way or the other; we conclude that little or no adverse cost impacts would be realized if this approach were used competitively, and improvements in responsiveness might be realized.

PRC Response: We strongly recommend a blending of approaches 2 and 3. We believe Caltrans has begun implementing parts of Alternative 2. We support Alternative 3, but it must be implemented under the Quality Based Selection process.

I-17: Criteria

We used the following criteria to select among the options;

1. **Enhanced Efficiency**--improvements to current operations that lead to increased output or productivity at equal or reduced cost. Costs can be measured as time, money, and/or hours of staff effort. Enhanced efficiency is demonstrated by more work being done with the same or reduced resources. Caltrans' programs and budget responsibilities in the present era of fiscal constraints demand these improvements if public trust is to be maintained.
2. **Enhanced Effectiveness**--improvements in producing or obtaining desired results from an activity or effort. Enhanced effectiveness is demonstrated by a greater ability to get the job done.
3. **Strengthened Leadership**--from Caltrans and from the two state entities with policy-setting responsibilities. Stronger leadership can be provided by Caltrans management acting alone only up to a point; greater advances require the simultaneous and congruent efforts of the legislature and the governor's office.
4. **Accountability**--in the performance of individuals, organizational units, and programs, with an emphasis on managerial accountability. We believe that desired behavior is more enduringly implemented if rewards and disciplinary procedures can be used to motivate performance, rather than the application of external standards.
5. **Responsiveness to Stakeholders** (external as well as internal)--by honoring commitments and by enhancing the time consciousness of organizational responses. Responsiveness is not synonymous with agreement; it does imply that needed changes are implemented over a time frame that honors commitments. Reduced delays for internal (process-related) reasons and enhanced service delivery would be characteristics of improved responsiveness.

PRC Response: We strongly concur with these five criteria as measurements, and believe they are part of the Caltrans product driven plan. However, we do not believe they are presently being implemented.

I-20-R8: Develop Appropriate Performance Measures

No set of overall department measures exist that desegregate into division, functional unit, project, and individual staff targets to use as the basis for regularly tracking achieved performance versus target and for annual performance reviews. Such measures are essential if Caltrans is to improve its efficiency and productivity. We recommend that Caltrans management undertake development of a department-wide set of integrated performance measures and obtain agreement on this set (at least the department-level portions) from the agency and legislature.

PRC Response: We believe the Caltrans plan will provide these performance measures but they are not now in place. We also have set forth performance measurements used in private practice.

Finding L5: Professional Staff Planning at Headquarters Linked with District Workload Forecast.

I-20-R9: Improve the Professional Staff Planning Process by Increasing Top-down and Bottom-up Integration

The process of professional staff planning relies heavily on PYPSCAN: indeed, until recent years, it was reportedly almost the sole basis for such planning. This process could be improved if a more balanced top-down and bottom-up approach were taken to staff planning, reflecting the types of skills, local measure work, and other information that is known at the district level and is not captured by PYPSCAN.

PRC Response: We strongly agree.

I-21-R10: Modify PYPSCAN to Provide Greater Accountability

PRC Response: PYPSCAN should be phased out after XPM is phased in.

I-21-R11: Include Capital Outlay Support Cost Estimates in the STIP

Representatives of the legislature and their staffs, executive branch staff, and TC commissioners and staff have expressed major concerns about the lack of a clear and accepted analytical basis for establishing the size of the capital outlay support budget. Similar concerns are expressed with Caltrans' lack of measurement tools to monitor and manage capital outlay expenditures. Many of these issues are not being addressed by a Capital Outlay Support Task Force in Caltrans. In the policy realm, however, modifications to PYPSCAN to better reflect the variability of project types and inclusion of capital outlay support cost estimates in the STIP would assist monitoring of these expenditures over time (see also Recommendation R65).

PRC Response: Some data base systems such as XPM should be used, not PYPSCAN for this task. However, XPM is still in the implementation stage and not yet operational.

Finding F4: Review Caltrans Billing Rates for Competitively Bid Work

I-21-R15: Establish Billing Rates for Caltrans Reflecting Full Cost Recovery

Caltrans has a series of rates used when work is undertaken for others, such as measure counties. If increased competition is to be sought with the private sector for internal design work, then billing rates will be crucial to fair competition. Without full recovery billing rates

for Caltrans, the incentives to achieve increased efficiencies is reduced. The contents of the rates used for outside (and, in competition with contracted-out suppliers, inside) work should be reviewed to determine if they fully recover Caltrans' costs. New rates need to be established for areas such as maintenance that are not yet bid competitively.

PRC Response: *We strongly concur, however, price competition should never be a part of negotiation for retaining professional services.*

Finding H1: Need for Individual and Group Performance Awards

I-22-R16: Seek Opportunities to Provide Monetary and Nonmonetary Rewards and Disciplinary Actions

Caltrans offers little formal incentive for employees to excel. This problem is not unique to the department, but is common to government civil service systems in which both rewards for exemplary behavior and below-average pay raises or other disciplinary actions for substandard performance are generally avoided. Effective performance incentives and disciplinary procedures are required.

PRC Response: *We strongly concur. Present practices are not sufficient.*

Finding H2: Obtaining Efficiencies and Cost Reductions Through Contracting Out

I-22-R17: Seek a Constitutional Amendment to Remove Impediments to Contracting Out to Increase Flexibility, Efficiency, and Accountability

The question of whether Caltrans should (or legally can) contract out engineering design and other technically specialized work and what benefits would accrue to the state from such a practice has been argued in several studies and in the courts. SB 1209, enacted in September 1993, provides the department new latitude and flexibility to meet its project delivery commitments in a timely manner with the use of contract assistance. Beyond this bill, however, remains the provisions of Article VII of the state constitution protecting state employee rights to undertake work for which they are capable.

Our findings indicate that studies produced to date on the cost-effectiveness of contracting out have been sufficiently flawed that no definitive answer is yet available; no study has shown that contracting out will or will not be more cost-effective for the state.

We do not foresee a timely judicial or legislative resolution to the contracting-out question. We therefore recommend that a constitutional amendment be sought to permit competitive procurement of services.

PRC Response: *We strongly concur.*

Finding H5: Difficulties Obtaining Specialists

I-23-R20: Identify Needs and Simplify Procedures for Obtaining Specialists

Environmental planning requirements seem to be increasing, with more specific skills required to respond to concerns of other agencies and special interest groups; Caltrans must have access to the skills needed to evaluate and design projects without delaying project completion. Both the consultant hiring process and employee hiring processes are extremely time consuming and Caltrans districts or headquarters have difficulty acquiring persons with specific skills without delay of projects. We recommend a series of simplifying procedures to obtain these skills.

PRC Response: We strongly concur.

R30: Assess the Future Need for Mainframe System Development

PRC Response: This has been done and the findings are now being implemented.

I-25-R31 Upgrade DIS Systems Development Practices

DIS needs to modernize its applications systems development practices. DIS recognizes the need to invest in CASE hardware and software tools together with staff training to use the new tools. The 1991 Strategic Directions plan included a program to introduce more modern systems development approaches in DIS. The recently introduced Data Warehouse system was developed with CASE tools and employs a new-to-DIS relational data base manager (DB2). SRI recommends, however, that before DIS invest further in mainframe systems infrastructure (such as new development tools), it examine the future role of mainframes in Caltrans. We further recommend that once the extent of the mainframe future is understood, that DIS implement a new systems development environment for mainframe systems and microsystems software development personnel, consistent with that future.

PRC Response: We assume this resulted in the XPM based project manager system and is therefore being implemented.

Finding M4: Out-of-date Staff Skills

I-26-R32 Upgrade DIS Staff Skills and Capabilities

DIS will need to invest in staff retaining to enable Caltrans to take full advantage of new technologies. DIS development staff's knowledge and skills are attuned to COBOL programs in a mainframe environment, yet the current technological trend is unmistakably away from the current skill sets of DIS staff. The major new systems that have been developed in the past 5 or 6 years have invariably used a quite different technology set, including specialized minicomputers (rather than mainframes), single-purpose data networks, and specialized data

bases. We recommend that DIS undertake comprehensive staff training and that the training program recognize these new methods and technologies.

PRC Response: *We believe this is underway*

Finding M6: Ineffective Management of Technology

I-26-R34 Adopt and Promulgate Technology Standards

Caltrans uses a variety of information systems technologies. That variety sometimes impedes the adoption of more cost-effective methods and makes simplification and streamlining of processes more difficult. Further, Caltrans has no effective method for exploiting new information services technology. The current planning and budgeting approach perpetuates the division of Caltrans systems into narrowly focused islands and tends to disregard opportunities to make major breakthroughs. SRI recommends that DIS give a relatively high priority to the adoption and promulgation of standards that will govern the selection and purchase of new hardware and software.

PRC Response: *This has been substantially completed with the exception of ancillary hardware and software to enhance the reporting process.*

Finding M7: Significant Networking Requirements

I-26-R35 Enhance the Network

Caltrans needs effective networking to allow its computers and other information-handling devices to work together. The Executive Summary of the Strategic Directions Plan notes that the directorate has emphasized the desire for all Caltrans knowledge workers to have electronic access to corporate data and the ability to use it competently. Nonetheless, major data exchange barriers persist. SRI recommends that DIS establish data interchange standards that will allow users to import data into, and export data from, their standard PC and workstation programs, presumably via electronic mail, and to exchange data between PCS and mainframe programs.

PRC Response: *This is being implemented by Caltrans and should be completed when the overall XPM system is fully operational.*

I-27-R45 Focus Resources and Shorten Durations to Increase Overall Productivity

Caltrans' pipeline of projects resembles a job-shop factory with fixed functional stations. Each function is working on many projects at the same time. The challenge is to balance resources and deliver a large number--approximately 650--unique projects each year while maintaining progress on hundreds of others. Implementing Caltrans' new project management objectives on top of this factory-like process may not work unless specific

allowances are made for the number of projects involved and the need for strong functional areas. Caltrans needs to reengineer the current process to develop a unique project delivery approach that ensures strong project level and functional control.

SRI finds that one project delivery model cannot be efficient for the spectrum of design projects that Caltrans undertakes. For less complex projects, we recommend a strong role for the functional managers and a planning function with project coordinators. For complex projects, we recommend an enhanced project manager model with authority on project issues passed to the manager. We further recommend that this hybrid management approach be implemented statewide (eliminating individual district discretion) to facilitate development of common tools, measures, and guidelines to enhance transferability of skills and learning experiences. Finally, to improve productivity on projects, reduce delivery costs, and improve schedule performance, we recommend that Caltrans focus its resources and reduce the number of active projects underway at any one time to reduce stops, starts, and long periods of low-productive coordination.

PRC Response: We believe this is the plan Caltrans is implementing although it is a culture change that could take a generation of new program and project manager leadership to complete its implementation.

I-28-46 Simplify the Project Approval and Permit Processes to Obtain Earlier Stakeholder Involvement and Commitment

PRC Response: We concur.

I-28-47 Devote More Caltrans Resources to Planning, PSR, and Early Project Development Stages

PRC Response: We agree but it must be lead by the Project Manager.

I-28-48 Adopt a Split-Level STIP Funding Approval Process

PRC Response: We strongly concur.

I-28-49 Experiment with Risk-Taking Project Delivery Approaches

PRC Response: We believe this is an integral part of the Caltrans plan although it is a culture change and could take a generation of new leadership to complete.

I-28-R50 Develop Early Project Screening Technique

Public infrastructure projects are characterized by their extensive external stakeholder involvement and long time frames for defining project scope. Caltrans requires a flexible approach that can respond to the multiplicity of stakeholders, develop early consensus and

commitment among those stakeholders, integrate their concerns and needs, and yet still be subject to management control.

We recommend that Caltrans take significant action on changes to current legislation to rationalize the process by which regulatory agencies and other stakeholders are involved in project planning and early project development. The current approach results in extended project delivery durations and elevated project support costs. Specifically, we first recommend establishing a multi-stakeholder task force to improve/reengineer the process for obtaining external stakeholder approvals and permits; the task force would be charged with developing mutually acceptable project solutions that would obtain buy-in at the planning stage rather than challenging a project in the design phase. Second, we recommend that Caltrans devote more capital outlay support resources to the planning, PSR, and early project development stages to result in anticipated savings in subsequent time and staff effort (analogous to concurrent engineering changes introduced by manufacturing firms). Next, we recommend a split-level STIP funding approval process to avoid time and budget commitments when large uncertainties in both have not yet been resolved. We recommend that projects be screened according to the extent their delivery is at risk and that different approaches and resource allocations be used for lower-and higher-risk projects.

PRC Response: We concur, but believe it must be under the control of the Project Manager.

Finding D4: Contracting-Out to Facilitate Project Delivery

I-29-R51 Reduce Contracting-Out Administration Requirements Substantially

I-29-R52 Change Contractual Terms

I-29-R53 Enhance Efforts to Develop Partnership-Like Relationships with Outside Consultants

I-29-R54 Implement an Early Warning System for Contracting-Out Projects

Caltrans' resource allocation procedures require planning for the use of outside consultants approximately 18 months in advance. In addition, Caltrans' procedures to process consultant contracts takes at least 8 months to complete. The cumbersome planning and contract administration process for contracting-out limit Caltrans' ability to meet its overall project delivery goals in a timely manner and contribute to problems in relationships with external consultants. Opportunities to respond quickly to local needs, take risks, and delivery projects cost-effectively, which are provided by the flexibility to contract out, are missed.

Despite recent changes in the administration of the contracting-out process, we found that substantial improvements are still required, and we recommend significant streamlining of

the contracting-out process to enhance Caltrans' ability to manage external professional service efforts effectively. We recommend that Caltrans seek an identified series of process and legislative changes to reduce to 2 months the time required to award A&E (architect and engineering) contracts. We recommend, through statute and policy changes, that allowances be made in the contractual and commercial conditions for quick agreement and issuance of change orders during the course of a project, as well as the use of contingencies, fixed billing rates, performance warranties, guarantees, and, if needed, fixed-price contracts. We recommend that Caltrans enhance its efforts to develop partnership-like relationships, rather than adversarial relationships, with consultants in the contracting-out program. And, finally, we recommend that an early warning system be developed to assist both Caltrans and its consultants in spotting problems in a project and responding to them quickly.

PRC Response for R51, R52, R53 and R54: We strongly concur with all of the recommendations listed above, but have noted that no aggressive action can be taken until contracting-out again becomes a flexible resource for Caltrans.

Finding D5: Lack of a Cost-Control Culture

I-30-R55 Develop a Set of Meaningful Measures of Service Efficiency and Effectiveness to Support Costs at the Project Level

PRC Response: We concur and believe Caltrans has this underway.

I-30-R56 Provide Support cost Estimates in the PSR

PRC Response: We concur and believe Caltrans has this underway.

I-30-R57 Review the Design and Procedures for Project Cost Accounting to Ensure Proper Charging of Time to EAS, Realistic Allocation of Overhead Back to Projects, and Timely Data Input and Retrieval of Information

Caltrans management does not hold the project manager and functional managers accountable for project delivery support cost performance nor does it have the systems and procedures to provide effective support cost control of projects. As a result, Caltrans does not yet have support cost control at the individual project levels to achieve its project management and project delivery objectives.

We recommend a series of reviews and measures that will strengthen support cost identification and increase individual accountability for support cost spending; some of these overlap with Recommendation R8. Coupled with these procedural changes is our recommendation to provide group incentives for improving resource productivity, which overlaps with Recommendation R16. Our recommendation to review the design and procedures for project cost accounting overlaps with Recommendation R38.

PRC Response: We concur and believe Caltrans has this underway.

Finding D6: Matrix Project Management Alternatives

Caltrans has a patchwork of project management approaches implemented in its districts. Caltrans districts were delegated the authority to develop their own individual project management strategies based on headquarters' guidelines. Each has its own approach, resulting in a number of suboptimal results. In addition, with responsibility for 5 to 25 projects in various stages of delivery, project managers at Caltrans have little time for the close coordination, expediting, and networking on each project that helps minimize and resolve conflicts. This finding has been addressed by recommendation R43.

PRC Response: We concur and believe Caltrans has this underway.

Finding D7: Need for Enhanced Project Managers; Skills and Experience

I-30-R58 Develop a Pool of Project Managers

With Caltrans' commitment to project management less than 5 years old, few staff members have extensive experience as project managers. As delegation of project responsibilities increases, project managers will become more involved in planning at one end and construction at the other, will work more with external agencies and the community, and will make more decisions on non-highway design issues. Caltrans will need to develop future project managers with the diverse skills, experience, and leadership to effectively carry out their project delivery duties.

To meet these needs, we recommend strengthening the project management function through such actions as creating project management classifications, opening project manager assignments to non-licensed (PE) professionals who demonstrate superior management skills, and assigning high-potential candidates to key project manager positions. These recommendations are closely linked to those recommending changes in the project management process (R40 through R45).

PRC Response: We concur and believe Caltrans has this underway.

Finding D8: Need for a Project Delivery Performance Control System

I-31-59: Develop a Comprehensive Performance Control System

PRC Response: We concur and believe Caltrans has this planned but not yet underway.

I-31-60: Develop Support Cost and Quality Project Delivery Measures to Apply Across All Districts

PRC Response: We concur and believe Caltrans has this planned but not yet underway.

I-31-61: Develop Functional Unit Measures

PRC Response: We concur but believe Caltrans is presently developing these norms as unit measures, but they are still months away.

I-31-62: Institute an Annual Independent Review of Caltrans' Performance Measurement and Accountability System

PRC Response: We recommend a biannual external peer review by a task force rather than a standing committee.

I-31 - Finding D8: Insufficient Project Management Tools

I-31-R64: Develop Other Managerial Tools for Functional Capacity Planning, Resource Management, Budgeting, Scheduling, and Performance Measurement

PRC Response: We believe Caltrans has this underway, but it appears that it will be several months before it is fully operational.

I-31-R65: Modify PYPSCAN to Permit Greater Flexibility and Accountability

PRC Response: We believe PYPSCAN should be kept available as a reality check until XPM is fully operational and then retired to the Smithsonian.

I-31-R66: Expand Use of CADD as an Engineering Tool

Caltrans' project and functional managers currently lack the necessary information technology tools to enable them to plan, budget, schedule, and obtain timely status information for their projects. Key needs include:

One set of tools statewide

Flexibility to fit individual project needs (not all projects require the same detail or structure)

Timely integration with actual progress and capital outlay support cost data

Fit with overall program planning (i.e., PYPSCAN)

Our prior recommendations addressing MIS needs (particularly recommendations R28 and R29) apply to this same need for reengineering this portion of the project delivery process. For the hybrid project management approach to work, we recommend that Caltrans design

and implement tools (of the sort identified in the recommendation title) for function management to complement the tools and measures that we have recommended for individual project management. Modifications to PYPSCAN to obtain a clear and acceptable analytical basis for establishing the size of the capital outlay support budget are recommended. (This overlaps the same concerns giving rise to Recommendations R9 and R10.) As an extension of our recommendations for enhancing Caltrans' MIS technological capabilities (R32 and R34), we recommend that the department reassess its current use of CADD and evaluate the future potential for using it to improve project delivery efficiency and effectiveness.

PRC Response: We believe this is underway with XPM but still several months away from being operational.

Finding D10: Excessive Bureaucratic Guidelines, Procedures, and Standards

R67: Train Caltrans' Staff and Outsiders on Project Delivery Procedures and Standards

PRC Response: We believe Caltrans has this underway.

R68: Simplify Guidelines and Procedures for Administrating Work Contracted Out

PRC Response: We believe Caltrans has this underway.

R69: Investigate Mechanisms for Reducing Schedule Impact of Right-of-Way

PRC Response: We believe Caltrans has this underway.

R70: Increase Consultant Participation and Streamline Oversight

Caltrans guidelines and procedures create a bureaucratic hierarchy of requirements that can add to the costs and delay in project delivery, particularly when nontraditional projects (and outside parties) are involved. This series of recommendations address aspects of the reengineering of the project delivery process dealing with the way control and procedures are involved in project delivery. Specifically, we recommend training of staff and outsiders to allow project personnel to expedite delivery of the work and to avoid costly mistakes. We recommend a review process to assess the effectiveness and value-added by Caltrans review of consultant work. Similarly, we recommend a focused evaluation of the right-of-way process to reduce average time necessary by a target of up to 509%. And finally, we recommend a task force to focus on the question of how Caltrans' oversight functions can be appropriately reduced while transferring much of the quality assurance/quality control responsibilities to private consultants.

PRC Response: We believe that Caltrans is ready to implement significant consultant participation with reduced oversight, as soon as the legislative hurdles are cleared.

Finding D11: Weak Link Between Project Start-Up and Completion Responsibilities

R71: Link Project Start-Up and Completion Responsibilities by Clarifying Roles in Planning, Project Development, and Construction

PRC Response: We believe the project management plan being implemented by Caltrans will achieve this goal.

R72: Develop a Shared Responsibility Within Functions for Project Delivery

Strong links between project delivery and planning (upstream) and project delivery and construction (downstream) are encouraged in theory but are weak in practice. Project managers tend to be assigned projects as they come over the fence and tend to pass on projects over the fence to construction.

SRI recommends enhancing linkages between the steps involved in project planning, delivery, and construction by defining the responsibilities of each of the parties involved from the PSR stage through construction; the objective is to achieve a smoother transition between stages. In complex projects, however, the project manager should have oversight responsibility for all elements. Secondly, we recommend that Caltrans create a program of awareness and communication that brings representatives from planning, project development, construction, and maintenance together to develop a shared responsibility for project delivery and construction.

PRC Response: We believe this is the Caltrans' plan that is presently being implemented. If the project manager is given the authority, as well as the responsibility proposed by the plan and stated by the Director, to manage the project from beginning to end, the goal will be achieved.

APPENDIX

Appendix A
PEER REVIEWER'S BIOGRAPHIES
AND CORPORATE PROFILES

Robert W. Bein, P.E.
Chief Executive Officer
Robert Bein, William Frost & Associates

Mr. Bein has over thirty-five years of professional engineering experience. Originally joining the firm as Chief Engineer, he has had responsible charge of all engineering work performed by the company for both private sector and public agency clients. He became President of the firm in 1964 and Chief Executive Officer in 1991. During his tenure as CEO, the firm has experienced its most dramatic growth and recently celebrated a half century of professional service. Under his leadership, the firm has achieved the status of one of southern California's top civil engineering, land planning and surveying organizations. In his role of corporate and professional leadership, he has played an active part in professional organizations and civic affairs in local, state and national involvements including National Director and Vice President, Zone IV, for the American Society of Civil Engineers and Past State President, Consulting Engineers and Land Surveyors of California.

Robert Bein, William Frost & Associates Corporate Profile

Robert Bein, William Frost & Associates (RBF) is a full service consulting firm providing planning, engineering, surveying and related professional services. Founded in California in 1944, RBF maintains a current staff of over 350 employees with local offices in Irvine, Temecula, Palm Desert, San Diego, Camarillo, Walnut Creek, Redlands, Los Angeles and San Jose, California.

RBF offers a diversified range of professional consulting services, including all facets of civil, structural, electrical, mechanical, energy and traffic engineering; water resources engineering; environmental analysis; land planning; landscape architecture; subdivision mapping; field surveying; aerial mapping and photogrammetry; global positioning satellite surveying; geographic information systems; computer services; video production; visual analysis; media services; construction staking; and construction management to both public and private sector clients. The RBF professional staff is experienced in transportation planning, land use and site planning; general and specific plan; public works engineering; residential subdivision design; hotel and resort site development engineering; environmental analysis and documentation; public financing; construction surveying; project management; and construction administration and inspection.

RBF maintains active Project and Total Quality Management Programs throughout the Firm. RBF voluntarily participated in the Organizational Peer Review Program of the American Consulting Engineering Council. Experienced professionals in the field of engineering were invited to examine the firm's practices and procedures in six major areas: overall management, development and business development. RBF received an Excellent rating from the Peer Review, and with the subsequent implementation of the results, has served to further improve the

firm's service to clients and the firm's professional practice.

William Carley, P.E.
Senior Vice President
CH2M HILL

Mr. Carley is a senior engineer, specializing in transportation engineering for CH2M Hill. His background includes progressively increasing responsibility and involvement in a wide variety of transportation projects, where he has been involved as a design engineer, project engineer, project manager, quality manager and Principal-In-Charge. Some of his involvement in project include emergency response services to Caltrans immediately following the Loma Prieta earthquake, the Cypress Replacement Project for Caltrans, the Oyster Point Interchange Project for Southern San Francisco, the *-880 Widening Project for ACT and the Port Chicago Highway Project for the City of Concord. Mr. Carley is a registered Civil or Professional Engineer in seven states, including California where he is a registered Civil Engineer

Mr. Carley has also served in a series of line management positions of increasing responsibility to his present position as a Senior Vice President and Operations Manager for CH2M Hill's Transportation Business Group. In this present position, Mr. Carley is responsible for the overall financial performance of the firm's transportation operations, workload forecasting, facilitation of workload leveling, key staffing of strategic projects, and the installation of the CH2M HILL Project Delivery System into transportation projects. In addition, Mr. Carley serves his professional and living communities through membership and active participation in several societies, community, and religious organizations.

CH2M HILL Corporate Profile

CH2M HILL is a global project delivery company providing strategically integrated services to public and private clients in the fields of transportation, water, environment, industrial facilities, and related infrastructure. They provide a full range of management, technical and support services needed to move projects from concept to successful operation. Core services include consulting, project development finance, program management and operations.

CH2M HILL has approximately 7,000 people in about 100 global locations. They have recent, directly applicable experience to the change that Caltrans is currently undergoing. They recently have changes, improved, or installed several components to their management systems, including:

- An electronic time and expense recording system linked to project accounting system.
- A new general ledger and project accounting system providing many levels of management information, access and security.
- A newly improved electronic project management budget and schedule tool linked to the project accounting system, and
- A recently developed Project Delivery System for improved and consistent project setup, management, team alignment and performance.

Fred W. Henstridge, P.L.S
Principal/Program Manager
Psomas and Associates

As a Program Manager, Mr. Henstridge is responsible for project acquisition, planning, scheduling, technical approach, financial management client service and the overall success of multi-discipline projects. In this role he is also responsible for directing the efforts of various alliance firms that may be involved in the project.

Mr. Henstridge has over 38 years of professional experience in Land Surveying, Mapping, Transportation Engineering and Geographic Information Management, and is professionally registered in five states. Ten of those years were spent with the California Department of Transportation (Caltrans), where he was the chief surveyor on the I-405 and I-105 freeway construction projects, and the Orange-Los Angeles County Geodetic Control Net. In 1972 Fred started his own engineering and surveying consulting firm that was acquired by Psomas and Associates, in 1982. Since that time, he has been a Principal of Psomas, and Principal Manager for major Geomatics and Transportation projects.

Psomas and Associates Corporate Profile

Psomas and Associates is a multi-discipline engineering consulting firm providing service to domestic and international clients. Established in 1946, Psomas has offices throughout the State of California with its corporate headquarters in Santa Monica. The firm provides the following services to public, private and corporate clients.

- Civil Engineering Design
- Construction Surveying
- Environmental Services
- Geographical Information systems Services
- Geomatics Engineering
- Governmental Relations and Entitlement Services
- Pipeline Information Services
- Program Management
- Water and Wastewater Resource Engineering

Psomas has offices in Costa Mesa, Los Angeles, Riverside, Sacramento and Santa Monica. Currently the firm employs 280 professional, technical and administrative staff.

Victor M. Mendez, P.E.
Assistant State Engineer - Statewide Project Management
Arizona Department of Transportation

Victor is a registered professional civil engineer in the State of Arizona. He received his Masters in Business Administration from Arizona State University in December, 1994. In May, 1980 he graduated from the University of Texas at El Paso with a Bachelors of Science degree in civil engineering.

Throughout his professional career Victor has worked on a variety of engineering projects and managed several programs.

He promoted into his current position as Assistant State Engineer - Statewide Project Management at the Arizona Department of Transportation (ADOT) in 1995. Throughout his 11 year career with ADOT, Victor has managed several offices with responsibility for managing projects on a statewide basis, implementing quality initiatives, establishing a project management program, implementing management information systems, and providing project scheduling expertise and support.

Early in his professional career, Victor worked for 5 years with the United States Forest Service in Oregon and Arizona. He managed and designed a multitude of civil engineering public works projects and was extensively involved in planning and programming activities.

Appendix B

SEE SEPARATE NOTEBOOK

Appendix C

PEER REVIEW COMMITTEE RAW NOTES

MEMORANDUM

To: Bob Bein
From: Gary Warkentin
Date: September 3, 1996
Subject: Caltrans Capital Outlay Support (COS) Budget Peer Review Meeting Notes

The following is a compilation of my notes from the four meetings that we attended with Caltrans on July 29th, July 30th, August 1st and August 13th and the LAO conference call on August 19th, and the conference calls with John Dietrich of XPM Inc. and Ross Chittenden on August 29, 1996:

Caltrans Headquarters - July 29, 1996

1. Tony Harris stated that Peer Review Committee (PRC) should document, as part of interviews with Headquarter's staff and local District staff, Caltrans future plans and objectives relative to implementation of a project development workload model that estimates resources at a project level and progress to date. He provided a handout of the presentation outline given to the Legislative Assistant's Office on April 8, 1996.
2. Bob Bein stated that the PRC would develop specific quantitative measurement criteria as part of the Peer Evaluation to augment the November 30, 1995 COS Performance Measures Report.
3. Tony Harris asked that recommendations be provided based upon private industry practice and Arizona Department of Transportation practice.
4. Bob Bein stated that the report will serve to document and assure Legislature that Caltrans is progressing as directed and identify potential enhancements to the proposed budgeting and project management system.

5. Bill Carley asked for a clear definition of the problem that is to be addressed by the PRC.
6. Tony Harris stated that the problem is that the State Legislature has lost confidence in Caltrans ability to budget and schedule their Capital Outlay Program.
7. Dick Weaver stated that the Legislative Assistants Office is concerned about the Districts ability to provide timely delivery of programmed projects.
8. Bill Carley stated that the documentation that has been provided to the PRC describes the tools that Caltrans will be utilizing in developing their Capital Outlay Support Budget, but not the process for utilizing those tools.
9. Bill Carley asked if progress benchmarks have been identified and analyzed.
10. Tony Harris stated that Headquarters was hesitant to establish project management benchmarks since they were in the process of changing from utilizing PYPSCAN to XPM.
11. Bob Bein asked if the XPM software was more than a scheduling tool.
12. Tony Harris stated that Caltrans was in the process of developing Work Breakdown Structures and average times to prepare tasks. This information will be provided to Project Managers to use as a guide in estimating time requirements for tasks.
13. Roger Lehman provided an overview of PYPSCAN. It provides program level schedules based on historical data of over 7,000 projects which have been classified into 120 project types. It is a tool which provides estimates for overall program needs. It is not a good tool for estimating or monitoring specific project schedules and budgets. XPM software has been designed to schedule at a project specific level.
14. Victor Mendez stated that whatever tool is used it is essential that it is capable of providing good data to make good management decisions.
15. Bill Carley asked if PYPSCAN provides good program level estimates of resource requirements.
16. Caltrans - The general consensus of all Caltrans representatives at Headquarter's was that

PYPSCAN provides a good estimate of program resource requirements, but that it is not capable of accurately estimating or monitoring specific projects.

17. Roger Lehman provided a brief history of PYPSCAN. In the 1970's the 12 individual Caltrans Districts prepared budgets 12 different ways. District Director Adriana Gianturco directed Caltrans to develop a uniform process for program budgeting. PYPSCAN was developed to address the need for uniform program budgeting.
18. Bob Bein asked what XPM will provide that PYPSCAN does not provide.
19. Roger Lehman stated that XPM will provide project level detail of resource requirements. These requirements will be identified for specific tasks or subfunctional categories.
20. James van Loben Sels stated that Caltrans is in transition and that Project Managers are assuming responsibility for the development of projects from their inception through construction. Caltrans has the responsibility to provide customer service to highway users and local agencies. The current transition is a change from the past where the cost capital outlay support was not critical. The development cost of projects has not been the focus of Caltrans attention in the past. Now there will be an emphasis on not only timely project delivery but also on how much it costs to deliver a project. The Capital Outlay Support Budget will be developed in a new way. Rather than using PYPSCAN as a top down program level budgeting system, specific budgets will be prepared for each project. Individual project budgets will be rolled up to form a bottoms up program budget.
21. James van Loben Sels stated that Caltrans exceeded their goal of 90% project delivery for last year with 96% of the programmed projects delivered and all programmed funds expended.
22. James van Loben Sels stated that budget resource norms would be established for specific tasks that are required to develop a project. He also stated that real time charging is not currently available. He added that times have changed. In the past, Caltrans performance was evaluated on how many miles of roadway were constructed each year. Today, both the schedule and cost of project delivery are very important.
23. Bob Bein stated that various criteria have been identified in the 1995 Report to the Legislature on Capital Support Performance. He said the PRC will attempt to identify measurements that are quantifiable including quality of work and client satisfaction.

24. David Herzberg provided a demonstration of how information is loaded into the existing PYPSCAN program including variables such as type of project, type of environmental clearance and estimated construction cost.
25. Mohammad Maljai provided an overview of Caltrans Project Management Standards and three components of their proposed approach to Project Management:

Work Breakdown Structure (WBS)
Resource Breakdown Structure (RBS)
Organizational Breakdown Structure (OBS)

This presentation is outlined under the title Project Management Standards.

26. Nigel Blampied stated that there are currently time accounting errors on approximately 35% of the electronic time sheets. In order for XPM to be an effective project management tool, accurate recording of time from the Caltrans Time Recording System (TRS) needs to be linked to XPM and project budgets.
27. Victor Mendez stated that throughout a large organization there exists different interests at different organization levels. To effectively manage at each of these levels, from program level to subfunctional task level, accurate reports should be available at the appropriate level of detail.

28. Jim Shepard provided an overview of the process that Caltrans intends to use in managing the Capital Outlay Program. The proposed system is intended to monitor project status on a monthly basis utilizing XPM software to roll up project specific resource requirements into overall program resource requirements. This function is not currently automated. Local District project management will provide a monthly estimate of per cent complete, hours to complete and, if complete, when the project was completed. An outline was provided of this management process.
29. Greg Magaziner provided an overview of the Person Hour Estimating Norms that are being developed as a XPM guide for estimating resource requirements. He distributed an outline of the task force charter that has been established to compile this information.
30. Tony Harris provided an overview of Headquarters role in managing the capital Outlay Projects and implementing the Work Breakdown Structure approach to projects. Meetings are held with District representatives 2 days a month. Quarterly reports are provided to the CTC on program status. A Warroom Report has been prepared for projects in every District which provides a overview of project status and responsible Project Manager. If delays in project delivery are identified by Project Managers, requests must be made to Headquarters which document why schedule is delayed and are subject to Headquarters approval.
31. Bill Carley initiated discussion of how Capital Projects are identified for inclusion on the STIP. A process diagram was drafted which illustrated the major steps. He noted as the diagram was developed, the need for Caltrans to work closely with the Legislature in identifying and prioritizing projects to expedite project delivery.
32. Victor Mendez stated that ADOT strives to maintain level staffing of their organization and that consultants are utilized to meet peak resource requirements and maintain project schedules.
33. Tony Harris stated that Caltrans would also out source work if not legally constrained.

Caltrans Districts 1, 2 and 3 - July 30, 1996

1. Bob Bein stated that the PRC learned from Headquarters about many of the changes that have occurred to improve the efficiency of Caltrans project delivery. The goal of the PRC will be to review what has been done to date, what is planned to be done in the future and provide recommendations on potential refinements to improve project delivery. He stated that the PRC learned that XPM in its current form is not a budgeting tool but that it is capable of providing much greater project specific detail than PYPSCAN.
2. Irene Hamura identified that the major impediments to project delivery within their Districts include curtailment of contracting services with consultants and limitations on the use of student assistants. The reduction of Capital Outlay Support services budgets and emphasis on project delivery of near term projects has resulted in reallocation of human resources (PY's) from future projects to meet schedules of near term projects. This will delay the scheduled delivery of future projects.
3. Bob Bein asked what can be done to help this situation.
4. Irene Hamura said that what is needed is support, both technical and human resources. Electronic time cards are being effectively used within the Districts but there is not currently a link between the Time Recording System (TRS) and XPM so that Project Managers can accurately monitor the progress of their projects.
5. Steve Kirkpatrick said that they are presently in a transition period of how project delivery is monitored. Current Project Managers extract time (cost of capital support) manually from the TRAMS program (Q48 Report). To be done efficiently throughout the Districts will require a direct link between XPM and the weekly time charges.
6. Steve Kirkpatrick provided an overview of how the budgeting process is being accomplished in District's 1, 2 and 3. All projects are managed by 9 single hat Project Managers. The challenges that their Districts face are:

Resources are not available to deliver what is programmed in the STIP.
To meet prior STIP program commitments with existing resource limitations.
How to resource emergency requirements and maintain program schedules.

7. Russ Lightcap stated that they need to provide justification for their resource needs. For fiscal year 1996/1997 the Capital Outlay Support Budget was based on PYPSCAN. For

fiscal year 1997/1998 the budget will be developed, from the bottom up, based upon specific project requirements. A zero based budget will be developed for planning, maintenance and other activities.

8. Irene Hamura stated that the ability to contract consultant services to assist with storm damage or other emergency services is necessary. When the District transfers existing human resources in situations like these, it takes resources from future projects, which will ultimately result in delay of project delivery.
9. Brain Crane and Shirley Choate provided an overview of the Districts' Project Work Plan and Work Agreements. These are being utilized by the District to estimate specific resource needs for each programmed project and document an agreement between the Project Manager and functional managers to provide required services.
10. Steve Kirkpatrick said that having the right people to manage and implement projects is essential to the success of the program. The approach to Project Management in District's 1, 2 and 3 was to identify those people by District and assess workload by region.
11. Russ Lightcap asked what their workload was.
12. Steve Kirkpatrick stated that Project Management is currently 4% of capital support and that District 3 will input their projects into XPM by December 1, 1996.
13. Bob Bein asked how project priority conflicts are resolved with functional managers.
14. Steve Kirkpatrick stated that the North Region Chief for Design, Dick Melim is responsible for coordinating and allocating functional design resources.
15. Bob Bein asked if norms are required.
16. Steve Kirkpatrick said they would be useful because many managers were not experienced in estimating the amount of resources for specific tasks.
17. Steve Kirkpatrick stated that the use of single hat Project Managers will result in the most effective management of projects.

18. Nigel Blampied noted that overhead allowance for capital support has been reduced from 25% to 12.5%. It was noted that this reduction has resulted in project management staff being responsible for some tasks that could be more cost effectively accomplished by support staff such as document reproduction and motor pool service.
19. Trin Campos provided an overview of how a project Work Plan was developed for SR-80. The project has been loaded into XPM. He stated that for the XPM schedule to truly be a resource to Project Managers that the functional managers should be able to access and update their individual functional schedules for monthly review by the Project Manager.
20. Trin Campos stated that for XPM to be effective as a project management tool, it must be linked to the Time Recording System (TRS) so that resource expenditures can be accurately monitored.

District 4 - August 1, 1996

1. Denis Mulligan introduced the District 4 representatives which included:

Bao Chan - XPM Project Management Support

T.C. Wang - PYPSCAN Program Resource Lead

Pochana Chongchaikit - PYPSCAN Program Resource Support

2. Bill Carley stated that the goal of the PRC was to assist the Legislative Analyst's Office with assessing Caltrans method of project budgeting and management. He said that the PRC has learned that PYPSCAN is a macro level scheduling and budgeting tool and that XPM is a resource loading and scheduling tool. The PRC met the day before with District 3 to understand their approach to project management and use of PYPSCAN and XPM.
3. Victor Mendez stated that we also learned about Work Plans and the role of the Functional Manager.
4. Russ Lightcap stated that our meeting with Headquarters and District 3 also included an overview of Work Plans and Work Agreements.
5. Bill Carley stated that District 3 was generally a rural environment as compared to the urban environment of District 4. The goal of the PRC is to provide an outside perspective to

Caltrans. The challenges that they face are not unique. ADOT and private industry also have similar challenges with budget limitations.

6. Denis Mulligan provided an overview of District 4. It is comprised of 9 counties and includes responsibility for Toll Bridges and Tax Measures Oversight. They currently have \$1.5 billion under construction.
7. Denis Mulligan noted that PYPSCAN is an excellent tool for what it was intended, Program Level estimating, but it is poor when used for what it wasn't intended, project specific analysis.
8. Denis Mulligan stated that future reports should be developed that graphically illustrate project status which will aid in project management assessment.
9. Bill Carley asked if District 4 will have XPM operational by the end of the year.
10. Denis Mulligan stated that it will not be fully operational.
11. Bill Carley asked how District 4 last year did on the performance goals established by the State Legislature.
12. Denis Mulligan stated that District 4 exceeded the 90% project delivery last year but next year wouldn't be as good. There are several reasons why District 4's project delivery is not anticipated to meet the 90% goal. They presently have 59 personnel vacancies and 30 PY's have been reallocated to construction inspection. The District is constrained because they are not allowed to contract with consultants to meet emergency situations which require reallocation of existing resources.
13. Denis Mulligan stated that the District would realize improved project delivery if they were provided greater flexibility in utilizing on-call contracts for consultant services with caps greater than \$500,000. This would allow project management to meet peak resource requirements to ensure project delivery schedules.
14. Bill Carley asked if CTC approval of the STIP includes changes to the scheduled delivery of projects.

15. Denis Mulligan stated that it is not a static process.
16. Russ Lightcap asked for a characterization of how District 4 Capital Outlay Support Budgets will be developed.
17. Denis Mulligan stated that project budgets for 1997/1998 would be prepared using a combination of PYPSCAN and bottoms up project budgets.
18. Russ Lightcap asked how Owner/Operator budgets were funded.
19. Denis Mulligan felt that they also were under funded.
20. Bill Carley asked how effective is PYPSCAN as a scheduling tool?
21. Denis Mulligan stated that it is good as a program level tool and as a general guide. He feels that XPM will be useful on specific projects but that it must be linked to TRS to truly be a project management tool.
22. Bao Chan stated that 566 projects need to be input into XPM for District 4. The average time to input information is 4 hours per project.
23. Denis Mulligan stated that the composition of District 4 project management is 15 dual hat Project Managers and 5 single hat Project Managers. He said that District 4 is not currently using Project Work Breakdowns on projects.
24. Bao Chan provided a demonstration of TRS input review and also XPM data input.

District 12 - August 13, 1996

1. Bob Bein described the meetings that were held with Headquarters, District 3 and District 4 and the development of Project Management at each District.
2. Clarence O'Hara described the Project Management Organization at District 12 for Capital Outlay Support (COS). It is comprised of 7 one hat and 1 two hat Project Managers. Their COS budget for 1996/1997 is 445 PY's.
3. Russ Lightcap asked what is the average number of projects per Project Manager.
4. Jim Beil stated that it was dependent on the complexity of projects and that District 12's management structure has been organized in accordance with Caltrans Project Management Manual.
5. Russ Lightcap asked what the responsibilities of the Project Manager are compared to the Resident Engineer.
6. Jim Beil stated that the Project Manager is responsible for project administration including resource management. The Resident Engineer is responsible for all construction activities in the field.
7. Gail Farber stated that meetings are scheduled on a monthly basis to coordinate activities such as claims and schedule between the Project Manager and Resident Engineer.
8. Bob Bein asked how the Project Manager is able to acquire additional resources if they are required.
9. Jim Beil stated that there is not an existing work load leveling plan. Until a tool is provided to more accurately estimate work load peaks and valleys, it is performed by the seat of the pants .
10. Gary Slater stated that this issue results in robbing resources from future projects to deliver current projects.
11. Clarence O'Hara stated that 1995/1996 was an average year for distribution of specific

functional requirements within the District. 1996/1997 will require a shift in staff resources to reflect a reduction in construction activity and an increase in design activity.

12. Russ Lightcap stated that this appears to be a management of resources to reflect District priorities.
13. Jim Beil stated that this can be very difficult since not all personnel can easily transfer from one function to another.
14. Russ Lightcap asked if milestone schedule delays are reported to the Legislature?
15. Jim Beil stated only projects scheduled for delivery within the fiscal year.
16. Nigel Blampied said that level of reporting is not currently required by the State Legislature.
17. Bob Bein asked how much has District 12 developed the use of XPM; how the use of PYPSCAN is planned for the future; what does the District need to manage projects and to what level does project information need to be recorded on the Time Recording System.
18. Dipak Roy stated that Project Managers negotiate task requirements with Functional Managers based upon historical data and this has been done for the last four years.
19. Jim Beil stated that project milestones are established using PMCS.
20. Mel Placilla asked how functional managers can commit to schedules of multiple projects.
21. Jim Beil said that this is very difficult presently because it is difficult to see the future workload requirement peaks and valleys. XPM is presently very limited in showing this information.
22. Brent Felker said that the District priority is first schedules and second resources. Resources can be manipulated to meet schedules and the goal is to balance schedule commitments with resource requirements. This can be accomplished with cash overtime and other flexible resources.
23. Russ Lightcap asked if District 12 was working towards implementing Project Work Plans.

24. Gary Slater stated that it can be very difficult for small branches or discipline areas to establish priorities for support of multiple projects.
25. Brent Felker stated that good examples of this are CADD Support and Traffic Design which experience major changes in work load and because of function specialities it is not practical to shift personnel.
26. Jim Beil stated that Work Plans are required to manage all major projects under construction. The Resident Engineer is responsible for preparing the Work Plan.
27. Jim Beil stated that there are nine task forces for developing task norms. One aspect of project management that is missing is current information on how much resources have been spent on a project.
28. Bob Bein asked if it was Caltrans goal to use XPM as a tool to estimate task norms in the future.
29. Nigel Blampied stated that it is.
30. Chris Mokus stated that one problem that currently exists is that overhead is not captured in the project accounting. He said an example of this was the I-5 project, which had a high level of Headquarter's Oversight.
31. Nigel Blampied said that there were 3 or 4 EA's for Headquarter's services that are ultimately transferred back to a project such as CADD and Materials Investigation.
32. Bob Bein asked if the Project Manager has control of overhead charges.
33. Brent Felker stated that they don't.
34. Brent Felker stated that Project Managers have the flexibility to reallocate resources within their overall projects. If they are unable to balance project requirements within their overall resource budgets they contact Clarence Ohara for the possible reallocation of resources from other Project Managers.

35. Bob Bein stated that signed work agreements are used in District 3. He asked if they are used in District 12.
36. Gail Farber stated that District Work Plans will be in the XPM system by February, 1997. She distributed a monitoring chart which illustrates status of individual projects. The I-5 Project and Seismic Retrofit Project are pilot projects within District 12 that are to have signed Work Plan input into the XPM system by September, 1996. The District goal is to identify and eliminate problems on these pilot projects before implementing the system throughout the District.
37. Jim Beil stated that one problem has been that Headquarter's Engineering Service Center has not committed to project schedules and budgets.
38. Russ Lightcap asked who reviews project Work Plans at Headquarter's?
39. Gail Farber stated that project Work Plans receive a reality check at Headquarters using PYPSCAN as a guide. Another guide is the percentage of construction cost which is generally 20%.
40. Jim Beil stated that another check will be the workload norms that are currently being developed.
41. Bob Bein asked why the Legislature would be interested in project specific detail?
42. Brent Felker stated that the Legislative Analyst's Office may want to look at project specific detail as a check of overall program budget review.
43. Chris Makus stated that the information in XPM will provide task development resource requirements for future projects.
44. Jim Beil stated that the Work Breakdown Structure is the core of the Work Plan.
45. Russ Lightcap asked if District 12 will meet the XPM implementation schedule in December.
46. Jim Beil stated that unless project status information can be provided at that time XPM will not be implemented as planned.

47. Chris Makus stated that the interface capability of TRS with XPM is behind schedule.
48. Gail Farber stated that District 12 has only a few of the UNEX based work stations that will operate XPM.
49. Jim Beil stated that for XPM to be an effective project management tool it needs to be accessible by all Project Managers.
50. Russ Lightcap asked what is delaying implementation.
51. Jim Beil stated that XPM is not fully operational in a windows environment and that there are also issues relative to the security of data once it has been input into the system.
52. Nigel Blumpied stated that Headquarters Information Systems is responsible for providing the link between XPM and TRS.
53. Russ Lightcap asked if TRS is working well.
54. Jim Beil stated that he thinks so.
55. Bob Bein asked if employee time reports are reviewed at the District.
56. Jim Beil stated that they are reviewed by the employee's supervisor.
57. Chris Makus stated that project costs are aggregated and reported as group costs or cost centers.
58. Gail Farber stated that a Business Plan with Performance Measures has been developed for District 12. The District intends to monitor earned value of projects by tracking expenditures in comparison to project budgets.
59. Bob Bein confirmed that the District intends to monitor project budgets in dollars rather than PY's.
60. Brent Felker stated that the purpose of the strategic planning process is to identify department

priorities and project priorities. District 12 is interested in being able to measure program performance in areas such as quality of work and cost of project delivery.

61. Bob Bein identified other potential performance areas including: schedule, budget, permits, bid cost and change orders.
62. Brent Felker added that additional performance areas would be safety, traffic, congestion management and cost of maintenance.
63. Gail Farber stated that one way Caltrans has leveled resources is by brokering work between District offices.
64. Mel Placilla asked who manages the brokered work.
65. Brent Felker stated that the originating District maintains project management responsibility for the project. An example of brokered services is making available to other Districts the right-of-way services that are available at District 12 by means of a Right-of-Way Service Center.
66. Russ Lightcap asked if there are other Right-of-Way Service Centers?
67. Brent Felker said there were not, and that this was probably a permanent arrangement. This may occur more in the future for specialized functional units.
68. Bob Bein asked how District 12 likes bottoms up program budgeting, how is it progressing, if they think Headquarters has the mind set to implement it and what tools project managers need to do their jobs.
69. Jim Beil stated that Work Breakdown Structures and XPM should be able to provide the needed project management tools. Functional groups need to plan and work with the Work Breakdown Structure.
70. Chris Mockus stated that currently functional managers do not know how to estimate tasks.
71. Brent Felker asked Dipak Roy if this works.
72. Dipak Roy stated that there is no monitoring of functional group activity.

73. Gail Farber stated that implementation of project management is significant cultural change at Caltrans.
74. Jim Beil stated that in general, one hat project managers are not well accepted.
75. Bob Bein asked which of the following development approaches District 12 would prefer.
- 1). Headquarters would continue to work with vendor to improve XPM capabilities.
 - 2). Headquarters would continue to work only with pilot District 3 to improve XPM and project management process.
 - 3). Headquarters would work with all Districts step by step.
76. Chris Mockus stated that District 12 is already on Approach 3.
77. Gail Farber noted that communication of information gained in District 3 utilizing XPM should be improved in the future.
78. Chris Mockus stated that a pilot program could have been effective, but now it is too late. He stated that the expectations of XPM's capabilities have not been realized. There have been fire drills to meet XPM implementation schedules only to have the schedules delayed. Realistic XPM expectations need to be identified.
79. Nigel Blumpied stated that District projects will be rolled up into a Program Budget in XPM in February.
80. Chris Mochus stated that workloads are still allocated in the District on a percentage basis and not by Work Breakdown Structures.
81. Bob Bein asked if there are rewards for performance.
82. Brent Felker said there were not.
83. Gail Farber stated that the District realizes the importance of this as an element of their Business Plan.

84. Bob Bein stated that in private industry rewards include salary increases and bonuses. There is termination for poor performance.

85. Gail Farber said, We have pot luck lunches.

District 7 - August 13, 1996

1. Bob Bein stated the goal of the Peer Review Committee was to assist Caltrans in identifying ways to improve project delivery. Previously, the Committee has meet with Headquarters, District 3, 4 and 12.
2. Ken Steele stated that District 7 has been implementing project management for the last 20 years. In the past, Project Managers were mostly two hat , as they functioned as both team leader and Project Manager. In 1995, the District changed to single hat Project Managers. There has been resistance to this approach on some projects. The single hat Project Manager is controversial and will require a significant cultural change at District 7. 1995/1996 realized project delivery of over 96%. Today, District 7 has over 700 projects programmed for delivery.
3. Cindy Quon is the Single Focal Point at District 7. She stated that they have 15 Project Managers with a diverse program that includes over 100 cities, Metropolitan Transportation Authority and an aggressive seismic retrofit program.
4. Russ Lightcap asked what the difference is between Resident Engineers and Project Managers.
5. Cindy Quon stated that the Project Manager is responsible for overall project management. Resident Engineers are responsible for field administration.
6. Chuck Rendall asked what was the range in project size within the District.
7. Cindy Quon stated that projects range from \$1 million to \$30 million. Major project categories include:

STIP	\$952 million
Toll Bridge	\$10 million
SHOPP	\$212 million
Minor	\$13 million
Locally Funded	\$400 million
Alameda Corridor	\$1.8 billion

Nine hundred (900) PY's are programmed for Capital Outlay support for 1996/1997. Seventy (70) PY's of construction management will be contracted out. There are no two hat Project Managers. The average project load per Project Manager is 30 projects. The Project Managers have been instrumental in the District's success realized to date.

8. Ken Steele stated that in the past the Project Engineer served as the Project Manager. This has required a major cultural change at District 7.
9. Cindy Quon distributed a Program / Project Management Flow Chart. She described how the functional managers are responsible for technical aspects of the project and the Project Manager is responsible for project delivery.
10. Bill Weldele described how, as Program Manager, he works directly with Headquarters on resource allocation and then distributes all programmed resources equitably to District 7 Project Managers.
11. Cindy Quon stated that Headquarters resourced 70% of the total resources requested by District 7 for 1996/1997.
12. Cindy Quon noted that XPM has been selected as the Districtwide project management tool. It was obtained for the purpose of monitoring the District 59 Seismic Retrofit program. Problems were identified and Headquarters was notified at that time. It will not be utilized in District 7 until it is debugged in District 3. Norms will be required for specific functional tasks as functional managers are not experienced in estimating resource requirements.
13. Russ Lightcap asked what is the percentage of Capital Outlay Support that is allocated to Project Management.
14. Cindy Quon stated that there are 15 Project Managers to approximately 900 staff, or about 1.5%. She added that overtime compensation is about 3% of the total budget.
15. Stephanie Turk distributed the District Project Management Implementation Plan.
16. Elhami Nasr presented an overview of how District 7 is currently managing projects using Prima Vera and other PC programs.

17. Stephanie Turk stated that District 7 has provided specialized computer training to equip Project Managers with the tools they need to manage projects.
18. Russ Lightcap asked how accurate time reporting is in District 7.
19. Stephanie Turk stated that it is much improved and training has been provided in recognition of the importance of accurate time reporting.
20. Stephanie Turk provided an update of District 7's use of XPM. It is recognized as a tool to assist in Project Management. Until it is functional, District 7 is using a Band-Aid approach of Prima Vera and other project management software. Data that has been input can be electronically transferred to XPM when it is operational.
21. Bob Bein asked if XPM will be operational in District 7 by February, 1997.
22. Stephanie Turk said that it probably won't be operational. Currently, it is very cumbersome to input project data. The average input time is 4 to 6 hours.
23. Cindy Quan stated that Tony Harris will not release XPM for Districtwide use until it is fully operational.
24. Stephanie Turk stated that it is hard to extract data from XPM and to secure data.
25. Cindy Quon stated that District 7 intends to continue the Band-Aid approach until XPM is operational.
26. Ken Steele stated that he wasn't sure why the District is locked into XPM as a project management tool.
27. Elhami Nasr stated it will be important for Project Managers to understand how XPM works for it to be a truly effective project management tool.

Legislative Analyst's Office (LAO) - August 19, 1996

A telephone conference was held to discuss the Caltrans Capital Outlay Support Peer Review

with the LAO.

1. Bob Bein asked how the LAO would like to see the report tailored so that it would be most useful to them.
2. Michael Cunningham stated that the report should be prepared so that it can be of service to Caltrans and be constructive.

He stated that a general concern of the LAO is that PYPSCAN has been used to work backwards in determining staffing levels. The LAO desires to have a clear understanding of methodology used in determining staffing levels and identifying the most efficient level required for Capital Outlay Support.

3. Bob Bein stated that private industry has the ability to continually monitor budget expended in relation to percentage of work completed. The Project Manager is given the responsibility for this monitoring.
4. Michael Cunningham stated that the LAO was provided an hour briefing on Caltrans Project Management approach. They are concerned that slop that has occurred at a macro program level will now occur at a micro project level. Measurements are needed for project development. The second phase of this Peer Review will include a review of Caltrans approach to project Management.
5. Bob Bein stated that the norms that Caltrans has at this time are program level. To develop them at a project or task level will take time.
6. Russ Lightcap asked what is the status of the 1997/1998 budget and how will it be developed.
7. Michael Cunningham stated that it is open at this time.
8. Bob Bein stated that project management has taken root in Caltrans and that bottoms up project budgeting will occur. He expressed desire that Legislature will allow Caltrans to develop the program and create the significant culture changes.
9. Michael Cunningham stated that it cannot be worse than before the changes were started. He recognized that interim measures may need to be taken before XPM is fully operational, but

stressed the need for a long term plan and implementation monitoring.

10. Russ Lightcap stated that projects budgets are being developed that are product driven rather than schedule driven.
11. Michael Cunningham stated that an annual retrospective analysis would be helpful to the Legislature so that changes in the program could be reconciled and accomplishments could be compared to planned activities.
12. Bob Bein stated that accountability needs to take place at the Project Management level basis weekly and yearly.
13. Michael Cunningham asked if in the Committee's opinion Caltrans was on the right track.
14. Bob Bein said they were, but reiterated that this is a tremendous cultural change, from Headquarters down through the individual Districts, and not all have bought into the program. Project Managers must be allowed to, and empowered to, effectively manage projects.
15. Dana Curry stated that this update is encouraging and asked if there is a large difference between how resources are allocated to Caltrans and how they are spent.
16. Bob Bein stated that Districts have previously budgeted based upon historical experience. This has created a problem when budgets are then applied to specific projects. With the bottoms up approach, Project Managers will be required to buy into budgets and schedules. Staffing requirements change annually. Caltrans is constrained by limitations on adding or eliminating staff and also inability to contract support services.
17. Russ Lightcap stated that flexible resourcing and credible resource need documentation will be essential to a successful program. Existing problems include culture and XPM technology.
18. Dana Curry stated that the Legislature would like to see what Caltrans can commit to deliver with existing staff. If this is less than the full program, what additional resources would be required. At the present time the program is not defined to the satisfaction of the Legislature.
19. Bob Bein said that in the past, projects were schedule driven, not budget driven. Recognition

of the need for both of these project component needs to be instilled in Caltrans Project Managers.

20. Russ Lightcap stated that the proposed budgeting system will be implemented, but that the change will take time.
21. Bob Bein stated that XPM is a management tool and not project management. The Committee will provide recommendations on potential improvement areas. He recommended that PYPSCAN not be eliminated until XPM is fully operational and tested.
22. Mark Cunningham stated that he is looking forward to the report.
23. Dana Curry asked who is representing ADOT.
24. Bob Bein said that Victor Mendez is ADOT's representative and that the report will include a good description of ADOT and how they develop and monitor project budgets.
25. Bob Bein said that the Committee would be happy to discuss the report with the LAO after it is completed.

John Dietrich, XPM Inc. - August 29, 1996

1. Bob Bein began discussion by describing goal of the PRC and previous meetings with individual districts on workload development and project management.
2. John Dietrich stated that he had over 25 years of project management experience and welcomed the opportunity to discuss implementation of XPM at Caltrans.
3. Russ Lightcap noted that according to the DMI 44 Plan, the Oracle interface with XPM was behind schedule.

4. Bob Bein asked what has been done to provide a link between TRS and XPM and what do future linkage plans include.
5. John Dietrich asked to provide a background on XPM implementation at Caltrans. He stated that it was purchased by Caltrans 3 years ago and that no active consulting relative to implementation was provided by XPM Inc. until December, 1995. He stated that prior to that time, although XPM Inc. desired to participate in the implementation process at Caltrans, they were never requested to provide assistance. The program was purchased by Caltrans from a separate entity, XPM Partners.
6. John Dietrich stated that Ross Chittenden's staff has many questions, but when training services were offered to Caltrans they were declined.
7. John Dietrich stated that his goal was to implement a program with Caltrans that could serve as a model for other State Transportation Departments. Unfortunately, the project has turned into an albatross . He stated that their only involvement was to fix bugs and often tapes would arrive that had problems , but not specifically identified. There was no partnering between XPM Inc. and Caltrans on the implementation of XPM.
8. John Dietrich stated that a meeting was held with Headquarters in December, 1995 to define a process for successfully implementing XPM at Caltrans. A decision was made to focus on District 3.
9. John Dietrich stated he was accompanied by Ross Chittenden on a meeting with District 3 which was very productive.
10. John Dietrich stated that he was asked to provide a variety of views of data using XPM. These were presented at a meeting with Caltrans on January 31, 1996. Caltrans stated that this is what they want . Tony Harris stated that Work Breakdown Structures would first be required.
11. John Dietrich stated that what was needed was a detailed implementation plan including consultation and training for Caltrans staff in the use of XPM. He added that he has provided a proposal to Caltrans to provide these services, but it was not executed.

12. Russ Lightcap asked if reports and graphs can be generated by XPM without Granada. John Dietrich said yes.
13. Bob Bein asked Mr. Dietrich what he felt was the primary reason for the problems that Caltrans has experienced with the XPM implementation.
14. John Dietrich stated that he didn't feel that Caltrans could efficiently implement XPM without proper training and consultation from XPM Inc.
15. Russ Lightcap asked how long it would take to train representatives from District 3 to efficiently use XPM.
16. John Dietrich stated one week.
17. Bob Bein stated that the four districts that the PRC visited were frustrated by XPM and were using band aids to manage projects on an interim basis.
18. Gary Warkentin asked if there were any XPM success stories that were similar in scope to Caltrans.
19. John Dietrich provided United Airlines Maintenance in Oakland as a reference (Jim Patterson, 510-382-8104).

Ross Chittenden - August 29, 1996

1. Russ Lightcap began conversation by stating that we had just spoken with John Dietrich of XPM Inc. and introduced Bob Bein as the Chairman of the PRC.
2. Bob Bein gave a background of the PRC's discussions to date.
3. Ross Chittenden stated that Caltrans was very dissatisfied with XPM and outlined six critical areas:
 1. Functionality
 2. Productivity (User Friendly)
 3. Security

4. Data Base (Proprietary)
 5. Capacity (Enormous Memory Requirements)
 6. Overall Vendor Support
-
4. Ross Chittenden stated that Caltrans has experienced over 100 defects with an average response time by XPM of 10 weeks.
 5. Ross Chittenden stated that Jim Suszka, President of XPM Partners was signatory to Caltrans' contract. XPM Partners provided a sub-contractor (Jim Patterson, initially of Management Analysis Company, later XPM Partners Consulting, Inc.) as the Project Manager.
 6. Ross Chittenden stated that in addition to lack of outside vendor support, there has been a lack of internal support from the Information Service Center.
 7. Bob Bein asked if sufficient information has been provided by XPM Inc. to implement the system. Ross Chittenden answered no.
 8. Bob Bein asked if training support has been offered by XPM Inc. to Caltrans. Ross Chittenden answered no.
 9. Bob Bein asked if Caltrans had contacted United Airlines on their application of XPM software.
 10. Ross Chittenden stated that Caltrans was planning to build their own applications.
 11. Russ Lightcap asked if the XPM implementation schedule needs to be revised.
 12. Ross Chittenden stated yes. District 3 has no TRS interface with XPM.
 13. Bob Bein asked if XPM is the wrong project management tool for Caltrans.
 14. Ross Chittenden stated that there have been significant problems. Much has been learned to date and a great deal of information has been generated.

15. Ross Chittenden asked what John Dietrich had said regarding the implementation of XPM.

16. Bob Bein stated that John Dietrich felt that XPM Inc's offers for training had been ignored by Caltrans.

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Appendix D

PROJECT MANAGEMENT ACTIVITIES

PROJECT MANAGEMENT HANDBOOK

VII. PROJECT MANAGEMENT ACTIVITIES

The specific Project Management activities are as follows:

PROJECT MANAGEMENT ACTIVITY CHART

ACTIVITY	Responsibility						
	HQ	DD	SFP	PMS	DDC	PM	FM
ASSEMBLE THE WORKPLAN - (Starts at PID Development Phase)							
Assemble Project Team							
Designate the Project Manager			X				
Identify Project Team Disciplines						X	
Request Team Members from Functional Disciplines						X	
Assign Team Members					X		X
Develop Baseline Workplan Schedule							
Define Scope of Work						X	X
Provide Generic Project Workplan Template to Project Team				X			
Tailor Generic Workplan to Project (Activities,Durations, Resources)						X	X
Schedule Workplan to fit Resource availability and Program Priorities				X		X	
Commit to Baseline Schedule						X	X
Approve Baseline Schedule			X				
MONITOR WORKPLAN							
Update Workplan							
Update activity status for hours (05) expended, % of activity complete, hours to complete							X
Update Corporate information Systems and Report on Project				X		X	
Monitor Performance							
Monitor Earned Value Performance Indicators (baseline against current schedule)						X	
Create Exception Reports				X		X	X
Coordinate with Project Team Members						X	X
Coordinate with Outside Agencies						X	X
MANAGE WORKPLAN							
Identify Impacts to Workplan							
Identify potential changes to Workplan	X	X	X	X	X	X	X
Resolve Potential Changes to Workplan (attempt resolution at lowest possible level)							
Determine if change is necessary			X		X	X	X
Investigate, analyze, negotiate, develop action plan, obtain resolution to change				X		X	X
Analyze project, district and statewide impact of change				X		X	X
Revise Workplan, Process SCS Change Document and Revise Baseline if necessary						X	

ACTIVITY	Responsibility						
Approve Revised Workplan			X				

*PMS will perform these duties until access to Project Schedule Tool is provided to the FMs

PID=Project Initiation Document, DD=District Director, SFP=Single Focal Point for Program/Project Management, PPMS=Program/Project Management Support, DDC=District Division Chief (other than DDC PPM), PM=Project Manager, FM=Functional Manager

Appendix E

XPM SOLE SOURCE JUSTIFICATION RFP EXCERPT

XPM SOLE SOURCE JUSTIFICATION RFP EXCERPT

II. UNIQUE PERFORMANCE CRITERIA

A critical need exists in Caltrans for a project scheduling tool which will integrate data from the districts into a single state-wide summary. The tool must possess a number of key functions which are deemed necessary to successful completion of complex construction and maintenance projects. The functional requirements are listed below:

- A. For a single project, the tool must have the capability to:
1. Schedule the work involved in project development from project inception to construction completion.
 2. Schedule the work at a level of detail which allows Project Managers and Functional Managers to establish a credible and achievable plan.
 3. Allow managers to continuously monitor and update the plan.
 4. Detail the Work Breakdown Structure and the Organization Breakdown Structure.
 5. Allow functional managers to assign work to specific work groups or individuals.
 6. Integrate schedule data with financial data (the latter includes budgeted resources, encumbrances and expenditures).
 7. Support the monitoring of performance in terms of time, cost and progress to date.
 8. Support the analysis of change or potential change (what-if).
 9. Maintain historical records of projects (including schedule and cost changes, resource usage, performance, etc.).
- B. The tool must serve as an enterprise-wide planning tool for multiple projects. Some required capabilities have the ability to:

1. Plan the sharing of limited resources across multiple projects.
 2. Create multiple dependencies between separate projects, (e.g. Project A must be completed before Projects B and C start).
 3. Balance resources based on work priorities and resource demand and availability (at the option of the planner resource balancing must be accomplished across either all projects or any selected sub-set of projects).
 4. Provide different levels of access and permissions (privileges) to multiple users.
 5. Operate in a distributed hardware environment and allow simultaneous access to project data by users in different locations.
 6. Provide summary reports for upper management and executives while providing detailed data of day-to-day operations for Project Managers.
 7. Roll-up and summarize data across all projects or any selected subset of projects in the enterprise.
- C. Some general requirements are common to both single project and multiple-project use. Among these requirements are:
1. Case of learning for persons of varying project scheduling skills.
 2. Optional reporting capabilities in standard tabular form, on-screen graphical display and special customizable forms.
 3. Built-in special report capabilities including comparisons of resource needs vs. Availability, cash flow projections and earned value computations.
 4. Ease of project modification to reflect changes in circumstances.

III. WHY UNIQUE PERFORMANCE CRITERIA ARE REQUIRED

Current Project Management Practice in Caltrans

The project development process requires the scheduling, monitoring and control of projects at a detailed task level. Caltrans has identified up to 540 unique tasks for the most complex projects. Actual progress of both work and resource consumption is monitored against a baseline plan. The measurement of performance is determined by earned value, a calculation derived by comparing actual time required vs. planned duration, resource consumption vs. estimated resource needs, and actual work completed vs. total work planned. This concept requires integration of task level project schedule data with resource expenditure information.

As an interim solution, Caltrans adopted Primavera Project Planner (P3) as the high-end multi-project scheduling tool and MS Project as a low and single-user tool. P3 and MS Project both operate under DOS on PC workstations. P3 has been partially implemented in many of the Caltrans districts and has proved a useful tool in both scheduling and monitoring projects, developing project schedules and controlling work in progress. However, the full potential of P3 was not achieved due to the following reasons:

1. Each district employed one or more stand-alone installations of P3 without integration of PMCS / PYPSCAN data or TRAMS financial data. A given project's schedule requires up to three scheduling tools. The export of PMCS data into P3 has been partially accomplished in District 4 (Oakland) with the use of the so-called Black Box (a piece of custom written code). Use of the Black Box requires specially written code to accommodate the organizational structure of the individual district. TRAMS expenditure data is still not captured in a timely fashion which would allow its use in monitoring and controlling a task-level project schedule. The calculation of earned value is rarely done in Caltrans.
2. No attempt has been made to integrate the P3 schedule data into a single state-wide view of on-going and scheduled projects. This failure is due to a combination of factors which includes the lack of business standardization, the limitations of the Caltrans WAN and LAN infrastructure, and the limited availability of PC's which are adequately configured to maintain large project schedules. Caltrans has no corporate database platform to capture and store project schedule data on a state-wide basis.

The requirements of an integrated project management system, as specified in the FSR titled Feasibility Study Report for a Project Management Database and dated December 1990, include the implementation of a project scheduling and control system with resource management capabilities on a corporate database platform. Caltrans contracted with TeraData Professionals, Inc., to perform the work outlined by the FSR. The project was

unsuccessful, however, resulting in mutual termination of the contract. As a result of this experience, Caltrans officials submitted a Special Project Report to the Department of Finance, Office of Information Technology, outlining the revised approach to delivery of a new Project Management System Database. In the interim, Caltrans continued to use PMCS / PYPSCAN, Primavera Project Planner and MS Project to schedule projects - without automated integration of expenditure data.

Appendix F

GLOSSARY OF ACRONYMS

GLOSSARY OF ACRONYMS

ACRONYM	DEFINITION
AASHTO	American Association State Highway Transportation Officials
ACWP	Actual Cost for Work Performed
ADOT	Arizona Department of Transportation
ALWP	Actual Labor for Work Performed
ASU	Arizona State University
ATRC	Arizona Transportation Research Center
BAC	Budget At Completion
BCWP	Budget Cost for Work Performed
BCWS	Budget Cost for Work Scheduled
BIA	Building Industry Association
BLWP	Budgeted Labor for Work Performed
CATS	Contract Administration and Tracking System
CDOT	Colorado Department Of Transportation
CE	Construction Engineering
CMP	Construction Management Program
CPI	Cost Performance Index
CPM	Critical Path Method
PPMS	Program and Project Management Section
CPS	Critical Path Scheduling
CTC	California Transportation Commission
CV	Cost Variance

ACRONYM	DEFINITION
CVP	Cost Variance Percentage
DBF	Data Base Files
DCR	Design Concept Report
DIS	Department of Information Systems
EA	Expenditure Authorization
EAC	Estimate And Completion
ESC	Engineering Service Center
FHWA	Federal Highway Administration
GIS	Geographic Information System
HURF	Highway User Revenue Fund
IPT	Integrated Product Teams
ITD	Intermodel Transportation Division
JLBC	Joint Legislative Budget Committee
LAO	Legislative Analysts Office
LPI	Labor Performance Index
LV	Labor Variance
LVP	Labor Variance Percentage
MIS	Management Information System
NCHRP	National Center for Highway Research Programs
OBS	Organizational Breakdown Structure
OSPB	Office of Strategic Planning and Budgeting
PA	Project Assessment
PERT	Program Evaluation Review Technique

ACRONYM	DEFINITION
PI	Profitability Index
PM	Project Manager
PMCS	Project Management Control System
PRC	Peer Review Committee
PY's	Person-Years
PYPSCAN	<u>P</u> erson <u>Y</u> ear and <u>P</u> roject <u>S</u> cheduling and <u>C</u> ost <u>A</u> nalysis
RAMP	Resource Analysis and Management Plan
RBS	Resource Breakdown Structure
SHOPP	State Highway Operation and Protection Plan
SPE	Senior Project Manager
SPI	Schedule Performance Index
SRI	Standard Research Institute
STIP	State Transportation Improvement Program
SV	Schedule Variance
SVP	Schedule Variance Percentage
TRACS	TRansportation ACcounting System
TRAMS	TRansportation Accounting and Management System
TRB	Transportation Research Board
TRS	Time Recording System
TSM	Traffic System Management
VAC	Variance and Competition
WBS	Work Breakdown Structure
WEN	Work Estimating Norms

ACRONYM	DEFINITION
XAAC	XPM Administrator's Advisory Council
XPM	Abbreviation for the software package eXpert Project Management
TERMS	DEFINITION
Activity	A discrete unit of work that produces some product or decision. In XPM use, it denotes the lowest level in the Work Breakdown.
Capital Outlay Support	A somewhat loose term that implies the roadway projects that are funded by State and Federal money, program-coded in TRAMS as 20.10, 20.10, 20.30 and some 20.40.
Charge District	The charge district the organizational entity that manages the work and receives the benefit of the work.
Pseudo Activities	In certain cases, it is helpful to allow addition of an activity to represent a small grouping of activities when reporting to each one might be onerous.
Single Focal Point	A person in each district designated to answer questions or raise issues on project management of the Capital Outlay Support roadway projects.
Task	A discrete unit of work or summary of activities that, when completed, produce some product or decision. In XPM use, it denotes a unit of work that has lower level breakdown. It is a summary. Since an activity can become a summary task by adding lower level activities, these terms are relative to the discussion and may be used interchangeably in most circumstances.
Template	An outline or master plan of tasks and activities that can be modified for a specific project. The template can contain the usual set of activities for some type of project or it can contain all possible activities.