State of California
Department of Transportation
Division of Research and Innovation

Research Manual

2007

I, Lawrence H. Orcutt, Chief, Division of Research and Innovation, Department of Transportation, of the State of California, do hereby certify that the State is in compliance with all requirements of 23 U.S.C. 505 and its implementing regulations with respect to the research, development and technology transfer program, and contemplate no changes in statutes, regulations, or administrative procedures which would affect such compliance.

Preface

The Division of New Technology and Research has a new name: the Division of Research and Innovation (DRI). The new title reflects a change in vision, one that emphasizes the needs of a broader range of customers, participation from diverse committees representing staff at all levels of functional areas within the California Department of Transportation (Caltrans), and a commitment to increasing the number of deployed research projects that solve the transportation problems in California and the nation.

To accomplish these goals efficiently, we:

- Rely on Caltrans customers to identify and develop problem statements for research projects.
- Use "roadmaps" to develop research programs.
- Include top management in our research and deployment steering and advisory committees to guide the project selection and funding allocation decisions.
- Solicit research proposals from a wider range of researchers.

In addition, we have established strategic research focus areas to implement Caltrans' goals, and a separate unit dedicated to deployment and technology transfer.

This Research Manual provides in-house researchers, Caltrans staff, academic and private-sector researchers, and others interested in DRI's program with the information they need to develop, select, fund, and implement research that benefits the traveling public in California. The Research Manual also fulfills the U.S. Department of Transportation requirements to assure the applicability of Caltrans' research in meeting national research goals.

DRI is pleased that you have chosen to use the Caltrans Research Manual (2006) for your research needs. This new edition is available online at: www.caltrans/hq/research/.

LAWRENCE H. ORCUTT
Division Chief
Division of Research and Innovation

Acknowledgements

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The Caltrans Research and Deployment Steering Committee, for their commitment to creating and guiding a customer-oriented research process.

The Caltrans Research and Deployment Advisory Committee and the Program Steering Committees, for their leadership in coordinating and prioritizing the many research needs of the Department.

The Technical Advisory Panels, for their tireless and professional efforts in developing research problem statements and recommending research proposals that best meet those needs.

The staff researchers and managers of Caltrans' Transportation Laboratory, districts, and divisions, for their continual support of the research process.

DRI's staff and management, whose support has been essential for the development and implementation of Caltrans' research and deployment program.

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1.1 Overview of the Division of Research and Innovation

The purpose of the California Department of Transportation (Caltrans) Division of Research and Innovation (DRI) is to stimulate innovation by performing applied, customer-developed and focused transportation research that yields tangible products and improved processes that enhance mobility across California. Innovations in methods, materials, technologies, policies, and practices enable Caltrans to effectively use and manage public facilities and services, protect public investment in transportation infrastructure, and enhance and expand mobility options.

The DRI is responsible for administering Caltrans' research program and is comprised of six offices:

- Materials and Infrastructure
- Management Support
- National Liaison
- Planning, Policy, and Innovation
- Technology Applications
- Traffic Operations Research

DRI seeks to take full advantage of strategic opportunities to find low-cost, public, and private solutions that substantially increase the value of taxpayer dollars invested in present and future public infrastructure, and make California's technological industries competitive in emerging global transportation technology markets.

With direction from Caltrans' Research and Deployment Steering Committee (RDSC), a committee comprised of District Directors and Deputy Directors, DRI:

- Establishes and facilitates the process to identify, select, program, manage, and implement research.
- Meets all federal-aid program requirements, including the preparation and maintenance of Caltrans' Research Manual and the State Planning and Research (SPR) Part II, Annual Work Program.
- Sets the research agenda based on the involvement and participation of its internal and external customers.
- Performs and develops applied transportation research for all modes of transportation.
- Provides technical assistance to its customers to deploy transportation research products.
- Engages in both short- and long-term research.
- Manages research projects.
- Obtains funding for the research.

Caltrans Mission, Goals, and Values

Mission:

Caltrans improves mobility across California.

Caltrans strives to be the highest performing transportation agency in the country. In pursuit of our mission, we continue to build a talented and diverse team and to strengthen ties with our partners. To keep California moving, we commit ourselves to the following goals and values:

Goals:

Safety.....Provide the safest transportation system in the nation for users and workers.

Mobility.....Maximize transportation system performance and accessibility.

Delivery.....Efficiently deliver quality transportation projects and services.

Stewardship..Preserve and enhance California's resources and assets.

Service.....Promote quality service through an excellent workforce

Values:

- Integrity
- Partnership
- Customer Focus
- Communication
- Empowerment
- Commitment
- Teamwork
- Innovation

Strategic Research Plan

Caltrans is developing a Strategic Research Plan (SRP) that will guide prioritization and selection of departmental transportation research projects. The SRP will include the development of research roadmaps, and research outcomes to ensure that all research projects supported by Caltrans are in alignment with Caltrans' Mission, Goals, and Objectives. Each Research roadmap will identify all the separate research projects and activities needed over time, to accomplish a clearly defined Research outcome. Research roadmaps will facilitate programming research activities and provide guidance to partnering with other organizations with common research needs. The Research outcomes will be written statements that identify strategic objectives that support accomplishment of a department goal.

Researchers

DRI conducts some research using in-house Caltrans resources. However, if the necessary personnel, expertise, or equipment are not available in-house, DRI collaborates or contracts with public- and private-sector researchers.

Caltrans' collaborative approach to research allows us to leverage state funds by working with partners, such as the Transportation Pooled Fund Program and the Transportation Research Board (TRB).

Research Results

Research projects typically produce these end products:

- A clear implementation plan.
- A published final report.
- Technology transfer to customers and other interested parties.

Often, the research results are implemented through new specifications, standard plans, test methods, computer programs, manual changes, or policy and procedure memos. Deployment of transportation research is a high priority for Caltrans. DRI has committed resources to work with our customers to implement research products and services.

1.2 Legal Authority for Research

Federal Laws

The federal law, "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users," also known as SAFETEA-LU, was enacted on August 10, 2005. It outlines federal priorities for transportation and authorizes funding for the State Planning and Research Program (SPR), Parts I and II, as well as other programs, through September 30, 2009.

Federal Regulations

The authority for a state research organization to use federal funds is found in United States Code (USC) Title 23-Highways, Chapter 5 Research and Technology, Section 505. The authority for a state to administer State Planning and Research funds, (Parts I and II), is found in the Code of Federal Regulations, (CFR), Title 23, Part 420, Planning and Research Program Administration.

State Laws

The authority for Caltrans to perform research is found in Government Code Section Title 2, Division 3, Part 5, Chapter 4, Section 14452.

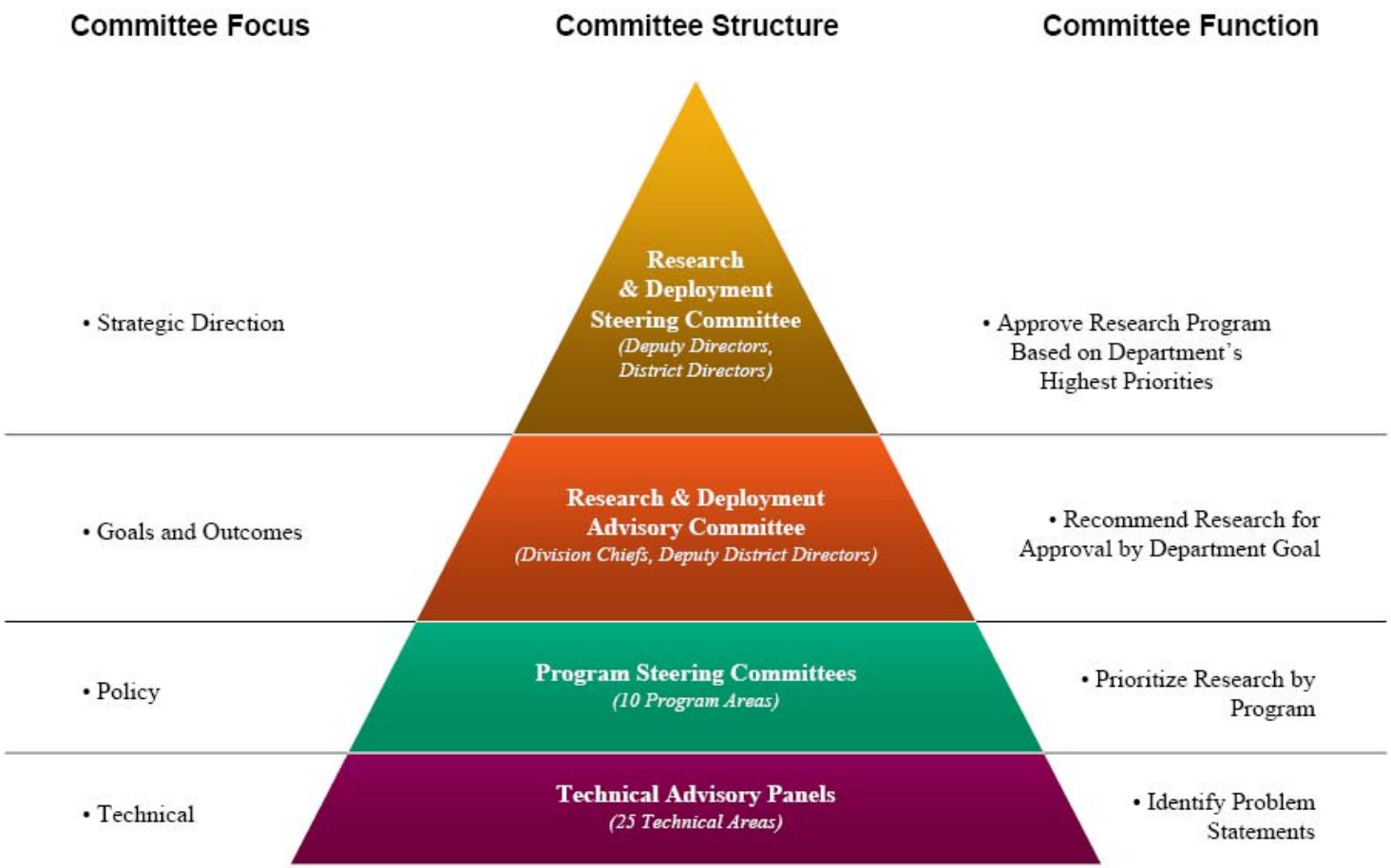
1.3 Research Committees and Panels – Responsibilities and Membership

Caltrans has established the following committees to develop the Strategic Research Plan, select and oversee research projects, and support the deployment of research products:

- Research and Deployment Steering Committee (RDSC)
- Research and Deployment Advisory Committee (RDAC)
- Program Steering Committees (PSCs)
- Technical Advisory Panels (TAPs)
- Project Panel (PP)

Figure 1-1 provides an overview of the committee structure.

Figure 1-1: Overview of Committee Structure



Section 2
Program Development

2.1 Development of the Research Program

Introduction

The California Department of Transportation (Caltrans) has developed, established, and implemented a coordinated process to identify research needs, conduct research, and implement research results. This effort covers a broad range of high-priority transportation issues focused on Caltrans' goals. The process is iterative and includes input from committees representing all functional areas of Caltrans and all levels of staff, ranging from technical experts to executive management.

2.2 Research Committees

Caltrans' Division of Research and Innovation (DRI) research selection process emphasizes customer participation throughout the research process along with effective deployment and customer ownership of the research products. The research committees are an important way of involving the customers in the research selection, management, and deployment process. The research committees are described briefly below. Additional information is provided in Figure 2-1.

Research and Deployment Steering Committee

The Research and Deployment Steering Committee (RDSC) approves the Strategic Research Plan, approves projects, adopts an annual program of research projects, and champions deployment of research products.

Research and Deployment Advisory Committee

The Research and Deployment Advisory Committee (RDAC) reports directly to the RDSC and advises that committee on the Strategic Research Plan, the annual program of research projects, and deployment of research products.

Program Steering Committees

The Program Steering Committees (PSCs) identify program-level outcomes and priorities, adopt multi-year research roadmaps, approve the scope of work for new tasks for continuing projects and support deployment of research products.

Technical Advisory Panels

The Technical Advisory Panels (TAPs) provide technical expertise essential to a quality research program. They recommend research problem statements and proposals to the PSCs and identify deployment opportunities.

Figure 2-2 shows the current PSC/TAP structure.

2.3 DRI Program Development Responsibilities

The DRI manages the program development process and coordinates development of the Strategic Research Plan and the annual program of research projects.

- Provides staff support to the RDSC and RDAC.
- Advises the PSCs and participates on the TAPs.
- Works with PSCs amd TAPs to coordinate development of research roadmaps.
- Prepares draft and final documents, including the Strategic Research Plan and the annual program of projects.
- Manages the off-cycle research process.
- Solicits research proposals.
- Coordinates Caltrans' research activities with the University Transportation Centers (UTCs).
- Coordinates Caltrans' research activities with transportation organizations such as the Transportation Research Board (TRB) and the

transportation committees of American Association of State Highway and Transportation Officials (AASHTO).

- Facilitates partnered-research activities at the regional and national levels that include transportation pooled-fund projects and the TRB cooperative research programs.

Figure 2-1: Research Committee Membership and Functions

Committee	Membership	Function	Staff Support
Technical Advisory Panels (TAPs)	Technical experts from Divisions, Districts, DRI, and external partners, as appropriate to the research area.	• Develop problem statements, recommend revisions to research roadmaps for PSC approval • Review and rank proposals. • Identify deployment opportunities.	Sponsoring Divisions with support from DRI.
Program Steering Committees (PSCs)	Division Chiefs of lead and contributing Divisions, District representatives, and external partners as appropriate for the program category.	• Identify key program outcomes. • Annually approves multi-year research roadmaps. • Develop program-level research priorities. • Develop program-level ranking of proposals. • Support deployment of research products. • Approve scope of work for new tasks for continuing projects	Lead and supporting Division's for each PSC with support from DRI, e.g., schedule and format, support in development of research roadmaps.
Research and Deployment Advisory Committee (RDAC)	Division Chiefs, Deputy District Directors, Federal Highway Administration (Ex-Officio), Federal Transit Authority (Ex-Officio).	• Advises RDSC on research objectives and strategies. • Recommends Strategic Research Plan to RDSC. • Recommends annual program of research projects. • Actively sponsors deployment of research products. • Participates in and supports Caltrans' involvement in national research programs.	DRI with support from lead Divisions for PSCs.
Research and Deployment Steering Committee (RDSC)	Deputy Directors, District Directors, Federal Highway Administration (Ex-Officio), Federal Transit Authority (Ex-Officio).	• Approves Strategic Research Plan. • Sets research priorities for Caltrans. • Determines funding allocation among research programs. • Adopts annual program of research projects. • Oversees development of more effective research deployment processes. • Oversees Caltrans' support for, and participation in, national research programs. • Approves Projects	DRI with support from lead Divisions for PSCs.

Figure 2-2: PSC/TAP Structure

Program Steering Committee (PSC)	Technical Advisory Panel (TAP)
Design and Construction	• *Construction* • *Landscape/Erosion Control* • *Roadway Design*
Environment	• *Biology* • *Cultural Factors* • *Environmental Engineering* • *Environmental Management*
Geotechnical/Structures	• *Geotechnical* • *Structures*
Maintenance	• *Employee Safety* • *Homeland Security* • *Roadside* • *Winter Maintenance*
Modal	• *Modal*
Pavement	• *Pavement Standards Team*
Planning, Policy, and System Information	• *Air Quality, Energy/Alternative Fuels* • *Bicycle/Pedestrian* • *Land Use/Regional/Economics* • *System and Corridor Planning/Goods Movement*
Right of Way and Land Surveys	• *Right of Way* • *Surveys*
Rural	• *Rural Intelligent Transportation Systems*
Transportation Safety and Mobility	• *Mobility* • *Roadway Safety Appurtenances* • *Traffic Safety*

2.4 Research Selection Process

The research selection process is composed of annual and off-cycle components.

Strategic Research Plan

Caltrans is developing a Strategic Research Plan to guide selection of annual and off-cycle projects. The process being used to develop the Strategic Research Plan is described in Appendix A. This plan should be reviewed every three to five years to ensure it is strategically aligned with the Departments and the RDSC's research goals and objectives.

Annual Research Cycle

The annual research cycle provides an opportunity to reassess the strategic alignment of ongoing and planned research, as identified in the Strategic Research Plan, and to respond to new challenges and opportunities. The components of the annual research cycle are as follows:

- Strategic Direction. The RDSC, in consultation with the PSCs and RDAC, may at any time review, and refine as appropriate, the existing strategic objectives and outcomes.
- Research Progress. The TAPs will work with DRI to assess progress made on projects within each TAPs area of expertise, and will recommend any changes to the research roadmaps.
- Project Progress. The Project Panel will develop the scope of work for new tasks for continuing projects.
- Research Gaps. The PSCs and TAPs will work with DRI to identify new projects needed to respond to revised strategic objectives and outcomes.
- Research Funding. DRI will work with RDAC to assess the ability to fund recommended research within the available DRI budget capacity. This activity will include maximizing Caltrans resources by seeking opportunities to partner with other agencies, private-sector, or universities with common interests.
- Research Priorities. RDAC will score and rank projects by Caltrans goal. Based on the resulting ranking, RDAC will recommend a revised Strategic Research Plan and a program of projects to RDSC. RDSC will approve the final Strategic Research Plan and program of projects.
- Annual Research Program. Once the final program of projects has been approved, the DRI will:
  1. Identify projects to be included in the Federal Highway Administration (FHWA) State Planning and Research Part II Annual Work Program.
  2. Solicit partners for those projects identified as promising transportation pooled-fund projects.
  3. Submit problem statements for projects identified as being of potential interest to a National Cooperative Research Program.
  4. Identify projects to be funded under the State Research and Technology Program.
- Problem Statement/Scopes of Work. The Project Manager will work with TAPs, and partner agencies, as appropriate, to refine and develop Problem Statements for new projects. The Project Panel will develop the scope of work for new tasks for continuing projects.
- Research In Progress. The Research Program will be transmitted to the TRB Librarian annually for inclusion into the TRB Research In Progress.

Off-Cycle Process

The off-cycle process provides an opportunity for the research committees to consider research problem statements or project proposals that cannot wait for the next annual research cycle. The approval process is accelerated, because of the urgent nature of the request.

The off-cycle process also provides a flexible way to respond to solicitations that are received throughout the year (e.g., pooled-fund projects, grants, etc.).

Each problem statement or proposal that is submitted is sent to the appropriate PSC and TAP for review. The PSC confirms that the project is

aligned with the Strategic Research Plan and identifies the level of customer support. DRI reviews the project to determine availability of resources and urgency of need.

Proposals are sent to the RDSC for review and approval if the proposal cannot wait for the annual research cycle, has adequate customer support, and can be funded and managed with current and future year funding.

See Appendix B for a graphic presentation of the off-cycle process.

Advanced Research

Advanced research, previously referred to as "out-of-the-box" research, is high-risk, high-reward research that has the potential to produce real breakthroughs in methods used to build, maintain and operate California's transportation system (e.g., using state-of-the-art technologies, innovative processes and new materials).

The RDSC sets the policy for allocating resources available for advanced research. DRI is responsible for developing a recommended program for advanced research, including working with partners such as the FHWA, other states, universities and the private sector. In addition to the program established by DRI, researchers are given an opportunity to submit small proposals (under $25,000) for "innovative topics".

2.5 Additional DRI Program Responsibilities

In addition to providing oversight and assistance for the committees and panels, DRI also has the following management and implementation responsibilities:

- Write, publish, and update the Research Manual.
- Manage the SPR Program Part II as described in this Research Manual and in accordance with the Code of Federal Regulations.
- Monitor the progress of research projects, including biannual reporting.
- Prepare the SPR Part II Annual Work Program and Annual Accomplishment Report for the FHWA.
- Recommend amendments to the SPR Part II Annual Work Program, i.e., add, continue, modify, or terminate research projects.
- Prepare and submit to FHWA appropriate reports and other documentation as requested.
- Maintain a research database to track program activities, schedules, accomplishments, and fiscal commitments.
- Conduct and/or arrange for training.
- Work cooperatively with universities for technology transfer of Caltrans research products through support of the Local Technical Assistance Program (LTAP) at UC Berkeley.

2.6 Research Program Effectiveness

The DRI will use the TRB Synthesis, "Seven Keys to Building a Robust Research Program" criteria for evaluating the effectiveness of the research program. The seven keys to building and maintaining a robust program include:

- Founded on Trust - trust relationship between research unit and parent organization
- Market Boldly-step forward to become an effective research advocate
- Root It in Economics-economic rationale for research and program
- Make Deals Unabashedly-leverage opportunities for joint research
- Insist on Accountability-be accountable for resources and outputs
- Embrace Policy Research-pursue policy research to address key department issues
- Empower the Staff-foster a climate of innovation and collaboration with customers

The results of this evaluation will be included in the Annual Report to the FHWA.

2.7 Research Proposals

Research proposals document the projected research needed to find a solution to a specific

problem. The proposal provides sufficient information to assess the probability of solving the identified problem.

Proposals must clearly define the objective, provide a detailed work plan for achieving the objective, and indicate how the research findings are expected to be used. In addition, proposals must provide a staffing plan, a detailed task and time schedule, and a complete cost estimate mapped to the tasks and time schedule.

Research proposals should also include a literature search that discusses any findings, comments and concerns from ongoing and earlier related research.

Soliciting Research Proposals

The DRI solicits research proposals using one of the solicitation mechanisms below:

- Request For Proposals (RFP)
- Call For Submissions (CFS)
- TRB's Cooperative Research Programs
- Transportation Pooled Fund Program

These solicitation mechanisms are defined in more detail in Appendix D.

Solicitations to address new research needs are based on approved problem statements. Solicitations to address a new phase of a continuing research project are based on the defined scope of work for that phase.

University Transportation Centers

Caltrans has contracts with California's federally designated University Transportation Centers (UTC's). These contracts provide Caltrans with another mechanism for meeting its research needs. Each UTC solicits research for its program using a RFP. Prior to development of the RFPs, Caltrans provides information on its Strategic Research Plan that was developed and approved by the RDSC. The UTCs select research that is consistent with their own strategic themes. The UTCs include the problem statements or research questions in their RFPs. Caltrans participates in the process of proposal review, and review of the final report.

Unsolicited Proposals

Caltrans occasionally receives unsolicited proposals for research or special studies from universities, consultants, outside agencies, and others. The DRI reviews these proposals throughout the year as they are received and determines if there is interest in the proposal by:

- Conducting a review by the DRI staff to insure the proposals are consistent with the Strategic Research Plan.
- Submitting the proposal to the appropriate PSC and TAP.

If there is interest in the proposal, the DRI staff will work with the TAP to incorporate the proposal into the regular or off-cycle approval.

2.8 Funding Sources

Transportation research is generally financed through federal, state, and/or local funds. DRI helps arrange for appropriate funding, based on the nature of the study to be undertaken and the availability of funds.

Of the programs listed below, the FHWA SPR Part II is the main *federal* funding source for Caltrans research. DRI receives funds from other federal entities as well, including the Federal Transit Administration (FTA). Leveraged resources are available through the Transportation Pooled Fund Program and research sponsored by the TRB and the National Cooperative Research Programs.

The principal source of *state* funding for research is the State Highway Account.

FHWA—State Planning and Research Program

United States (U.S.) Code Title 23 Highways, Chapter 5 Research and Technology, provides for SPR funding. Two percent of the total funds apportioned to the states each year, including California, are designated for planning and research activities. Of this amount, not less than 25 percent must be spent on research, development, and technology transfer activities relating to highway, public transportation, and intermodal transportation systems (SPR Part II

funds.) The remaining funds (SPR Part I funds) are used for transportation planning activities.

Federal funds typically provide for 80 percent of the research projects in the SPR Part II Annual Work Program, and state funds provide for the remaining 20 percent. FHWA has the ability to wave the state match if the interests of the Federal aid highway programs are met (23 CFR 420.119(d).

Transportation Pooled Fund Program

Transportation pooled-fund (TPF) projects are cooperative research projects that strive to solve problems of mutual interest among several agencies. The FHWA, Caltrans, or other state departments of transportation typically solicits pooled-fund projects. However, other agencies or organizations may participate as well. Participating entities provide funding or other resources of value to the project. When widespread, regional, or national interest is demonstrated for a significant problem, research studies of major importance may be conducted on a cooperative basis by several states, the FHWA, and third parties (a municipality or metropolitan planning organization, college/university or a private company). Transportation pooled-fund projects normally receive a funding match waiver from FHWA that allows the State to use 100 percent SPR Part II funds for project costs. The Transportation Pooled Fund Program is discussed in more detail in Section 6.

US DOT Administration Research Contracts

The FHWA, FTA, or other federal agency as research contracting parties, may negotiate with Caltrans (as the contractor) to conduct research through grant processes. Agreements of this kind typically provide 50 percent to 100 percent federal reimbursement of Caltrans' costs.

State Financed Program

Research in California may be financed with state funds, principally through the State Highway Account.

Cooperative Research Programs

The DRI's National Liaison Office coordinates and facilitates Caltrans' nominations of problem statements and project panel members for cooperative research programs. The project panel members direct the selected research projects.

National Cooperative Highway Research Program

National Cooperative Highway Research Program (NCHRP) is administered by the TRB and sponsored by the member departments (i.e., individual state departments of transportation) of AASHTO in cooperation with FHWA.

The state departments of transportation are the sole sponsors of the NCHRP in cooperation with FHWA. Support is voluntary and funds can be drawn from the states' Federal-Aid Highway apportionment of SPR funds. Furthermore, the funds can be spent only for the administration of problems approved on ballot by at least two-thirds of the states. Each state's allocation amounts to five and one half percent of its total SPR apportionment and is set forth in supplementary tables issued with each year's Federal-Aid Highway apportionments.
(www.trb.org)

Transit Cooperative Research Program

The Transit Cooperative Research Program (TCRP) was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and reauthorized in 1998 by the Transportation Equity Act for the 21st Century (TEA-21). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies, acting through the TRB; and the Transit Development Corporation, Inc., a nonprofit educational and research organization established by the American Public Transportation Association. The memorandum agreement was updated on January 12, 1999.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at anytime. It is the responsibility of the TCRP Oversight and Project Selection (TOPS) Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.
(www.trb.org)

Airport Cooperative Research Program

The Airport Cooperative Research Program (ACRP) was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The ACRP is sponsored by the Federal Aviation Administration and managed by the National Academies, acting through TRB, with program oversight and governance provided by representatives of airport operating agencies.

Research problem statements for ACRP will be solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the ACRP governing board to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Surface Transportation Environmental and Planning Cooperative Research Program

Section 5207 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) established the Surface Transportation Environment and Planning Cooperative Research Program (STEP). The general objective of the STEP is to improve understanding of the complex relationship between surface transportation, planning, and the environment.

The STEP will be the sole source of SAFETEA-LU funds available to conduct all FHWA research on planning and environmental issues. In addition, the U.S. Congress mandated several special studies, i.e., Report on Non-Motorized Transportation Pilot Program (Section 1807 of SAFETEA-LU) and the Annual Report for the Surface Transportation Project Delivery Pilot Program (Section 6005(h) of SAFETEA-LU). STEP will also be the funding source for these projects.

FHWA is administering this program and determining the process for implementing the STEP Program. .
(http://www.fhwa.dot.gov/hep/step)

National Cooperative Freight Research Program

The National Cooperative Freight Research Program (NCFRP) was authorized in SAFETEA-LU. The NCFRP will be sponsored by the U.S. Department of Transportation's Research and Innovative Technology Administration (RITA) and managed by the National Academies, acting through its TRB, with program governance provided by an Oversight Committee including a representative cross section of freight stakeholders. Work on the NCFRP will begin as soon as a funding agreement is executed between RITA and the National Academies.

The NCFRP Oversight Committee will formulate the research program by identifying the highest priority projects and defining funding levels and expected products. Research problem statements, recommending research needs for consideration by the Oversight Committee, will be solicited periodically but may be submitted to TRB at any time.
(www.trb.org)

Hazardous Materials Cooperative Research Program

A pilot cooperative research program focused on hazardous materials transportation was authorized in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The Hazardous Materials Cooperative Research Program (HMCRP) is sponsored by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) and managed by the National Academies, acting through its TRB. A contract to begin work on the HMCRP pilot has been executed between

PHMSA and the National Academies and became effective on September 1, 2006.

The HMCRP Oversight Panel will formulate the research program by identifying the highest-priority projects and defining funding levels and expected products. SAFETEA-LU, in authorizing the HMCRP, referred to nine examples of topics to be considered for HMCRP research. The Oversight Panel will prioritize studies within the scope of these nine examples.
(www.trb.org)

Commercial Truck and Bus Safety Synthesis Program

The Commercial Truck and Bus Safety Synthesis Program is a new cooperative research program sponsored by the Federal Motor Carrier Safety Administration (FMCSA) and administered by the TRB. The program was authorized in late 2001 and began in 2002 in support of the FMCSA's safety research programs.

The program initiates several synthesis studies annually that address concerns in the area of commercial truck and bus safety (http://www.trb.org).

2.9 State Planning and Research Part II Annual Work Program

Caltrans DRI documents federally funded research projects and administrative costs in the SPR Part II Annual Work Program as required by Title 23, Section 420.111. The SPR Part II Annual Work Program is developed and approved before the beginning of each new state fiscal year and describes the research work to be performed and estimated costs for that year and future years. The SPR Part II Annual Work Program includes federally funded research and transportation pooled-fund projects. Research funded from sources other than SPR are not required to be included in the SPR Part II Annual Work Program.

Caltrans manages the SPR Part II Annual Work Program in accordance with its certification by the FHWA, as pursuant to CFR Title 23, Parts 420 and Title 23 U.S. Code Section 307 and 505. Provisions of this Research Manual also guide preparation and implementation of the SPR Part II Annual Work Program.

Modifications to the SPR Part II Annual Work Program may occur as a result of the RDSC's approval of off-cycle research projects and project scope and/or funding level changes. These modifications will be transmitted to FHWA through an amendment. Amendments to the SPR Part II Annual Work Program follow the same approval process as described above.

Obligation of Funds

The SPR Part II Annual Work Program is submitted to the local FHWA Division Administrator for review and approval. When the FHWA returns the SPR Part II Annual Work Program with its approval, OMS will request the Division of Budgets (Budgets) to obligate the funding by submitting a FNM 76 to the FHWA for approval. FHWA's approval of the FNM 76 obligates the projects' funds. No work shall begin prior to having the authorization to proceed.

Specifically for pooled-fund projects, the request to obligate funds should include the following information:

- Title of the study.
- Project description.
- Amount to be obligated.
- Fiscal year the obligation is to be made.
- Study number assigned by the FHWA.
- Name of the lead state.
- Contact information for any questions.

State departments of transportation obligate their federal funds through their local FHWA Division offices in the Fiscal Management Information System (FMIS). The use of non-federal funds will be considered on a case-by-case basis for private industry, foundations, and universities, or any other participants. Contact the DRI Office of National Liaison for information on how to handle private funds.

Inactive Projects

The DRI will review, on a quarterly basis, inactive projects (i.e., projects for which no

expenditures have been charged against Federal funds for the past 12 months) with unexpended Federal obligations and shall revise the Federal funds obligated for a project within 90 days to reflect the current cost estimate, based on the following criteria:

- Projects inactive for the past 12 months with unexpended balances more than $500,000.
- Projects inactive for the past 24 months with unexpended balances of $50,000 to $500,000.
- Projects inactive for the past 36 months with unexpended balances less than $50,000.

TPF projects where Caltrans is the Sponsor or Lead Agency, the DRI will request the FHWA to deobligate any remaining funding. TPF projects where Caltrans is the Partner Agency, the DRI will submit a letter to the Lead Agency and FHWA requesting the deobligation of any remaining funding.

2.10 Peer Exchange of the Research Program

Peer Exchange

"Peer Exchange" is a program evaluation method used to identify and convey successful practices and policies for managing a research program. The Federal Peer Exchange process, described below, helps Caltrans develop successful and more effective research programs through constructive peer comments. The Exchange should be conducted periodically (e.g. every three years) to evaluate research topics selected by DRI and generally covers topics within the following:

- Development
- Administration
- Delivery
- Benefits.

Peer Exchange Team

The Peer Exchange Team is made up of research managers from DRI, other state departments of transportation, federal agencies, private sector, and universities. The host states sponsoring the exchange selects a team. At least two members of the team should be on the FHWA list of qualified peer reviewers, which includes reviewers from other state highway research programs, university research programs, the FHWA Division, Resource Center or Headquarters (Washington DC) staff, AASHTO, and/or TRB staff.

When invited, Caltrans also participates in Peer Exchanges of other states and the FHWA.

Peer Exchange Team's Responsibilities

The team prepares a report of its findings. The report findings include recommendations that each team member identifies for his or her respective agency for consideration. The team presents it's findings to the Director of Caltrans, Deputy Directors, and the RDSC as appropriate.

Implementing the Peer Exchange Recommendations

Caltrans forwards a copy of the report to the FHWA Division Administrator along with appropriate Caltrans comments and/or corrective actions to address the findings presented. States incorporate the recommendations of the Peer Exchange, and Caltrans typically applies the peer recommendations that are applicable and consistent with the needs of the Research Program.

2.11 FHWA Review of the Research Program

FHWA reviews all state programs for effectiveness and compliance with Federal-aid requirements for continued state certification. Caltrans cooperates with FHWA.

Section 3
Managing and Conducting Research Projects

3.1 Introduction

Research projects are primarily performed in either of two ways: contracted research and in-house research.

A research project is a temporary endeavor undertaken to produce a deployable product or service. A project can be broken down into tasks. Each task produces distinct deliverables that support a project. It may have both contracted and in-house portions. Additionally, a single research project may have multiple contracts.

A project has deployable products or services. A task has deliverables. A project can be made up of a number of tasks that can occur either sequentially or in parallel. A "family" is a grouping of related projects. See Appendix E.

The previous section describes how research needs are identified and how the annual program of research projects is determined. This section describes in more detail the procedures for managing and conducting research projects. The procedures common to all research will be discussed first. Procedures unique to contracted research will be presented next. Finally, procedures unique to in-house research will be presented.

3.2 Procedures Used for all Research

Project Management

The Project Manager is responsible for overseeing the research project, including the following responsibilities:

- Preparing and processing the Research Project Input Document (RPID).
- Forming the Project Panel.
- Keeping the research project on schedule and within budget.
- Managing project issues and risks.
- Managing project changes.
- Reviewing and submitting financial and biannual reports.
- Maintaining all project files and repositories.
- Assuring the quality of all research products.
- Submitting research products for deployment.
- Managing the project equipment.
- Keeping the customers informed of progress.
- Closing the project.

Project Panel

All projects will have a Project Panel. The membership of the Project Panel is flexible depending on the size and complexity of the project. At a minimum, the Project Panel will consist of the Project Manager and the customer representative. If a project involves several functional areas or requires special expertise, the Project Panel should also include experts to guide the project during the research activities. The Project Panel may have representation from academia, industry, non-governmental organizations, local government, and the United States (U.S.) Department of Transportation agencies [Federal Highways Administration (FHWA), Federal Transit Authority, etc.]. The pooled-fund projects form a similar committee called the Technical Advisory Committee. The Project Panel Chair will review, for approval, Project Panel members recommended by the Project Manager.

The Project Panel will be formed immediately after the Research and Deployment Steering Committee approves the research project. The Project Panel will meet to refine the problem statement and to develop general guidance for the Project/Contract Manager. The Project Panel members are expected to provide most of their guidance through Project Panel meetings; however, individual member communications

may take place with the Project Manager. The Project Panel members are encouraged to direct their communication with the researcher through the Project Manager. The Project Panel will receive all Biannual Reports and Annual Reports. The Project Panel will choose the frequency of its meetings based on project milestones and needs, but will meet at least once a year. Project Panel travel expenses may be paid from the research project budget.

The Project Panel may have responsibilities for the following activities:

- Work with researchers to monitor progress and facilitate the resolution of problems or delays.
- Making recommendations to Project/Contract Manager regarding the selection of the project or task contractor, project scope, budget, time modifications, and continuation of studies.
- Reviewing and evaluating draft reports to assess the accomplishment of project objectives and suitability for report publication and reviewing final reports to ensure compliance with comments.
- Recommending an implementation plan of favorable research results, and coordinating and assisting any implementation activities.
- Identifying and coordinating roadway test locations or sections with California Department of Transportation (Caltrans) Districts.
- Will develop the scope of work for new tasks for continuing projects.

Changes in a Research Project

Requests for changes in time, scope, or cost of an on-going project will be submitted by the Principal Investigator or the designated researcher to the Project Manager and forwarded to the appropriate Caltrans Division of Research and Innovation (DRI) Office Chief. The request must describe any changes to the original proposal and state why these changes are needed. A modified proposal should accompany the request. The DRI Office Chief recommends changes to the Chief of the Office of Management Support (OMS) and the Chief of the DRI for approval. As applicable, the Project Manager coordinates with the Project Panel and with other project customers in notifying the Principal Investigator/researcher of the status of the request.

If the research project receives State Planning and Research (SPR) Program Part II funds, the changes must be included in an amendment to the SPR Part II Annual Work Program.

Project Close Out

There are three types of projects within the DRI research program that need to be closed out:

- Contract Research
- In-House Research
- Transportation Pooled-Fund (TPF) Research

While actual close out procedures are project or contract specific, the process is as follows:

- The Principal Investigator and/or the research contracting entity is notified of the contract end date.
- Stakeholders are notified of the intent to close the project.
- The remaining work and final invoice (funding) is approved.
- All project records are closed.
- The final results and conclusions are published and distributed.

The responsibility of the Project Manager is greater with in-house research. Since the Project Manager also acts as the researcher, the additional responsibilities include final delivery of the research product and related equipment disposition.

Further details for the contract and in-house research close out process are identified on the DRI Project Management website at: http://onramp.dot.ca.gov/newtech/project_management/research_project_closing_procedures/index.htm.

The process for closing out TPF research projects is identified in the TPF Project Completion, Section 6.4 of this Research Manual.

Terminating a Research Project

Research projects may be terminated in whole or in part under the following conditions:

- By Caltrans, if the researcher materially fails to perform in accordance with the research agreement (a contract, in the case of contracted research; a research proposal, in the case of in-house research).
- By Caltrans, with the consent of the researcher, in the case where both parties agree on the termination conditions.
- By the researcher, upon sending to Caltrans written notification setting forth the reasons for such a termination such as effective date and, in the case of partial termination, the portions to be terminated.

The following paragraphs provide additional details on the process of terminating research projects.

While working on a research project, the researcher and/or Project Manager may determine that further research in this area may not be productive or that the desired outcome may not be achievable. If this situation occurs, the researcher and Project Manager shall discuss the matter with the customer to determine if modifications to the scope of work could still produce beneficial results. If it is decided that the project cannot be salvaged, the Project Manager must submit a recommendation to terminate the project to the Chief of the OMS and the Chief of the DRI for review and concurrence. The Termination Report will be prepared in accordance with Section 4.2. If the research project receives SPR Part II funds, the FHWA will be formally notified of the decision to terminate the project, and it will be closed out in accordance with federal requirements.

For cases involving failure to perform or material breach of contract, a written notice of immediate termination may be served. This "Termination Letter" serves as written notice to the researcher and/or the contracting entity. The letter shall explain why the work is not satisfactory and what corrective actions are expected. The Principal Investigator/designated researcher (and/or the contracting entity) will then be given a specified period of time to perform at a level that meets expectations. During this period of time, the Project Manager must not authorize payment to the contractor for any work not performed in a satisfactory manner.

Caltrans' Legal Division should also be consulted to review the Termination Letter and make recommendations on how to outline the steps to be taken.

A copy of the letter will also be submitted to the Division of Procurement and Contracts (DPAC). The process to terminate a contract can be found on DRI's Project Management web site (http://onramp.dot.ca.gov/newtech/).

Equipment Management

With reference to the Code of Federal Regulations (CFR), Title 49, Section 18.32 and in accordance with the State Administrative Manual (SAM) Section 8600, all equipment over $5,000 will be entered and maintained in an Equipment Inventory Database by the contract research organization. The database information is to be provided annually to the Project Manager for review. Each inventory entry is to contain the following minimum information:

- Inventory control number.
- Brief description of the equipment.
- Make, model, and serial number (if purchased).
- Date of delivery, if purchased, or date of completion of construction, if done in-house with funds provided by a Task Order.
- Cost as charged to the research project.
- Physical location.
- Date that Caltrans authority was granted for the equipment to be acquired or constructed.

At the completion of the research project, the Project Manager will assure the development of an accurate and complete final equipment inventory. Equipment may be transferred to Caltrans, transferred to another research contract,

or surveyed/disposed of by the research organization if the equipment is no longer of value. Final disposition of the equipment is documented and approved by the Project Manager and copied to the DRI OMS.

3.3 Procedures Used for Contracted Research

Most Caltrans research projects are performed using contracts. This approach is beneficial because it enables Caltrans to:

- Bring scientific and technical knowledge to bear on transportation problems by leveraging expertise that does not exist within Caltrans.
- Perform more work than can be done with existing staff resources.

An individual research project may include more than one contract, or the project may include contracted and in-house portions.

Executing Research Contracts

DRI awards research contracts in accordance with approved Caltrans contracting procedures. The Project Manager is responsible for preparing the documents necessary to execute the research contract.

If the contractor is a public university or another state agency, an interagency agreement will typically be the type of contract executed.

Caltrans may also enter into a master interagency agreement with public colleges and universities. These agreements save time and resources by establishing the basic agreement terms and conditions in one document and enable Caltrans to contract for research in supplemental, work-specific contracts. Currently, there are two work-specific contract methods:

- Research Technical Agreements
- Task Orders.

(See Appendix D for more information)

A standard agreement type of contract is used for other cases, including when the contractor is a:

- Private-sector consultant, laboratory, or university.
- Governmental entity that is not a public university or state agency.
- Public university foundation.

Contract Contents

Contracts or agreements for research projects have several informational requirements, including:

- Names of all parties involved.
- A brief statement of the research objective(s).
- A statement of work to be performed. Generally, the final statement of work incorporates the contractor's research proposal by attachment.
- A description of the basis for payment, detailed budget sheet and allowable costs.
- A requirement that research work will be completed within a specific time period, and that progress reports be delivered at specific intervals.
- A list of other deliverables and the corresponding delivery due dates.
- In accordance with the requirements found in CFR Title 23 and in accordance with the contract requirements from DPAC, a statement regarding the ownership of research data, publication rights, patent rights, civil rights clauses, dispute clauses, contingent fees, liability, inspection of work, access to records, cost principles, records retention requirements, and equipment inventory record requirements.
- The start date and expiration date of the contract.

Managing Contracted Research

Contracted research is managed by a Project Manager and a Contract Manager. At times, one person serves in both roles. At other times, the Contract Manager is a separate person who manages a specific contract (or contracts); and who, for the purposes of the research project, functions under the lead of the Project Manager.

The Contract Manager is the Caltrans staff person that is responsible to the Project Manager for:

- Negotiating and finalizing the contract or contract amendment.
- Monitoring the overall performance of the contractor.
- Assuring the quality of all contracted products.
- Ensuring adequate contract performance and progress.
- Approving and processing contract invoices (including any contract claims up to the date of the final settlement of the contract).
- Assisting the Project Manager in equipment management.
- Receiving the final equipment inventory from the contractor.
- Completing the Contract Performance Evaluation.

Caltrans Contract Managers receive formal contract management training and comply with the requirements in the "Service Contract Manager's Handbook" (http://admin.dot.ca.gov/pc/handbook.shtml).

Contract Performance Evaluation

As defined in the California Public Contract Code (PCC Section 10369), each Contract Manager shall conduct a post-evaluation, by completing the post-evaluation form, of each research contract totaling five thousand dollars ($5,000) or more. The Contract Manager shall evaluate the performance of the contractor in doing the work or delivering the services for which the contract was awarded. The form is titled "Contract/Contractor Evaluation Form (STD 4)" and is provided by DPAC with each executed contract. The form is also available on the Department of General Services web site.

3.4 Procedures Used for In-House Research

In-house research differs from contracted research in that the researcher is typically also the Project Manager. Performing research in-house has important benefits to Caltrans. It enables Caltrans to:

- Give transportation administrators and managers accurate and substantive advice quickly, during emergencies, and urgent problem situations.
- Bring scientific and technical knowledge to bear on transportation problems.
- Assess emerging research results quickly and determine appropriate solutions to benefit California transportation programs.
- Evaluate field-implemented transportation innovations for cost saving and safety implications.
- Provide a professional knowledge base to solicit, award, monitor, and evaluate the quality and cost-effectiveness of contracted research.

Qualifications of Researchers

The researchers must:

- Have expertise in the subject area of the research and the research techniques to be used in the proposed research project.
- Be available to dedicate the required amount of time to the research during the life of the project.
- Liaison with the committees and panels identified in other sections of this Research Manual.

Processing and Funding Source

In-house researchers work with other DRI staff to prepare the proposal and carry out the research. DRI requires in-house researchers to prepare a proposal that provides essential information used to program the project. If the research receives SPR Part II funds, it must be approved for inclusion in the SPR Part II Annual Work Program.

Research Project Development

For in-house research projects, the Project Manager may be the researcher in DRI or in another Caltrans District or Division. The researcher must:

- Design a detailed research methodology that is based on the research proposal.
- Develop a work plan that will accomplish the research goals within the proposed time

frames and cost and staffing budgets.

- Adhere to the original research proposal, unless they determine that the research objectives cannot be met under the original plan.
- Control the scope of the project.
- Prepare a final report at the conclusion of the project.
- Provide deliverables, when appropriate, during the course of the research (e.g., databases, computer programs, and equipment.

The researcher is encouraged to consult National Cooperative Highway Research Program Report 20-45, "Scientific Approaches to Transportation Research", for detailed guidance on conducting research.

Analysis and Reporting

- Maintain objectivity. Prevent preconceived notions from influencing their analysis and conclusions.
- Prepare and submit progress reports. Frequency of these reports can vary. For specific report information, see the Project Management website.

Section 4

Reports and Presentation of Research Findings

4.1 Preparation of Research Reports

An essential element of all research projects is to communicate their status, results, and findings to managers, reviewers, and other interested parties or potential users.

Carefully written reports and presentations are the means for conveying important research results and findings that may later be deployed as operational techniques, practices, or policies. Without them, the value of even the best research is diminished.

Researchers, along with Project Managers, should plan for the reporting and presentation requirements from the outset of the project. This section explains more on the reporting process.

All reports shall comply with the Americans with Disabilities Act by adding the following text to the front of the report:

"For individuals with sensory disabilities, this report is also available in Braille, large print, on audio cassette, or computer disks, if requested. To obtain a copy of the report in an alternate format, please call or write to the Division of Research and Innovation, P. O. Box 942873, MS-83, Sacramento, CA 94273-0001, 916-654-8899, or use the CA Relay Service TTY number: 1-800-735-2929, or dial 711."

4.2 Types of Research Reports and Responsibility for Preparation

Research development processes require that the Principal Investigator or designated researcher and the Project Manager submit a variety of reports. The type of report is determined by project/program fund source, by scope of research, and/or as reflected in the research contract requirements.

The State Planning and Research (SPR) Part II funded projects require that the reports identified below be issued.

- Research Progress Report
- Final Report
- Annual Accomplishment Report

As required by Code of Federal Regulations (CFR) Title 23, Section 420.117, reports are due to the Federal Highway Administration (FHWA). The frequency of these reports vary. Please refer to DRI's Project Management website for additional information.

This section lists recommended content for each report type, provides guidelines for preparation of the reports, describes the kind of activities associated with their preparation, and lays out the expected roles and responsibilities for those engaged in the adminstration of the reports.

Research Progress Report

The Research Progress Report is the primary tool for reporting research project information on a sustained basis. The Report enables the Project Manager to monitor the research project workplan's adherence to the established schedule and to track expenditures against the approved budget. In addition to the Project Manager, the Report is utilized by Caltrans management and by the Project Panel to gauge the progress of research towards achieving solutions to problems and to ascertain the potential for producing significant results that can be implemented.

Reports also aid the decision makers, internal and external project stakeholders, as well as research and resource administrators to assess the viability of continuation towards product deployment.

The Principal Investigator/designated researcher prepares and submits Research Progress Reports

to the Project Manager. Depending on the provisions of the contract, the project documentation, or other agreed upon arrangements, the Research Progress Report may be issued in electronic or hard copy format. The due dates for submittals and any requirement for automated/web-based submittals should be listed in the contract.

Research Progress Reports are required to be submitted to the FHWA. Please refer to DRI's Project Management website for details.

For ease of reference, Appendix F represents the typical format for the content of the Report.

Final Report

The Final Report documents all pertinent project information including research problem definition, research objectives, methodology, summary of findings, the significance of the results, and executive summary. It establishes an important link between the knowledge discovered, the implementation of recommendations, and deployment of the results. The Final Report should also demonstrate whether the investigation accomplished the objectives laid out in the research proposal and should include a description of challenges that impacted the course of study and its outcome.

The content of the Final Report should include the researcher's conclusions and clear explanations of their importance, potential applications, and benefits. The author should articulate the reasoning behind the conclusions and present the material logically so that a wide range of audiences can understand its content, recommendations, and implementation measures. To the extent possible, the Final Reports should anticipate and address the reader's potential questions.

Prior to submittal of a Final Report, the Project Manager and Project Panel reviews the draft Final Report for approval. The review will conform to the applicable provisions of the research contract. A transmittal letter from the Principal Investigator or designated researcher accompanies a submittal of the draft. If the research project involved SPR Part II funding, the transmittal memo should indicate the proposed disposition of nonexpendable equipment charged to that project. The memo should include a brief statement of the problem addressed along with conclusions and any recommendations including implementation or deployment measures. The Project Manager circulates the draft to the Project Panel, customer divisions, and project stakeholders for review and feedback. The Project Manager compiles the comments received and forwards to the Principal Investigator or designated researcher to be incorporated in the Final Report.

The Principal Investigator/designated researcher prepares the Final Report and submits it to the Project Manager for review and approval prior to publication.

Published Final Reports are to include a completed Technical Report Documentation Page, form DOT-F-1700.7. Appendix G represents the typical format for the content of the Final Report. Appendix H depicts the Technical Report Documentation Page (Form DOT-F-1700.7)

Annual Accomplishment Report

In conformance with CFR Title 23 Section 420.117, the Annual Accomplishment Report is required by FHWA for research projects funded through the SPR Part II Annual Work Program.

The DRI Office of Management Support (OMS) compiles the overall Annual Accomplishment Report for submittal within 90 days after the end of the reporting period. The Annual Accomplishment Report lists each continuing project until the Final Report is issued.

The Annual Accomplishment Report is primarily derived from the information provided by Project Managers for individual research projects.

Termination Report

In situations necessitating the termination of research, the Project Manager submits a recommendation to terminate the project to the Division Chief of DRI and to the Chief of DRIs OMS for review and concurrence. In collaboration with the Principal

Investigator/designated researcher, the Project Manager prepares the Termination Report to document project closure and the disposition of applicable elements of the research contract. Guidelines for preparation of the Termination Report are available on the DRI Project Management website.

For ease of reference, Appendix I lists the format of the Termination Report.

4.3 Intellectual Property

Copyrights

Researchers may copyright any books, publications, or other copyrightable materials developed in the course of their project. The FHWA and Caltrans reserve a royalty-free, nonexclusive, and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use, the copyrighted work for their own purposes

Patents

For research projects that receive federal funding, Caltrans and its subcontractors are subject to the provisions of 37 CFR part 401 governing patents and inventions. They must include or otherwise cite the standard patent rights clause at 37 CFR 401.14, except for sub-part 401.14(g), in all subgrants or contracts. In addition, Caltrans must include the following clause, suitably modified to identify the parties, in all subgrants or contracts for experimental, developmental, or research work: "The subgrantee or contractor will retain all rights provided for the State in this clause, and the State will not, as part of the consideration for awarding the subgrant or contract, obtain rights in the subgrantee's or contractor's subject inventions."

Section 5

Deployment, Dissemination of Research, and Technology Transfer

5.1 Introduction

Deployment of transportation research has become a national priority. The California Department of Transportation (Caltrans) and the Division of Research and Innovation (DRI) have committed staff and resources to implement useful research findings as quickly as possible.

Deployment is commonly defined as incorporation of research results into everyday practices of customers and is the last stage in the research process. Deployment may include a new or revised policy, procedure, standard, design, specification, test method, computer program, or manual change. It may also include the development, marketing, and use of new products, including new kinds of equipment.

5.2 Deployment Process

The researcher, customer, Project Manager, and Research Deployment Branch have specific responsibilities in the deployment process.

Research Deployment Branch

The DRI Research Deployment Branch has developed a deployment process that can be broadly applied by project managers, and is building a knowledge base and expertise in research deployment. The deployment process is based on Caltrans' Five Stages of Research Deployment (Appendix J).

The Research Deployment Branch works with researchers, customers and Project Managers throughout the research process, to facilitate eventual deployment of research products. Early in the research process, the Research Deployment Branch reviews proposals, to identify those that appear to have the greatest potential for future deployment. During the course of the research, the Research Deployment Branch is available to consult on ways that successful deployment can be enhanced. Research in later stages of deployment that show particular potential are selected for more intensive deployment support, including (as needed) development of a business case, development of risk management and marketing plans, and understanding of patent, licensing and product commercialization issues.

The Research Deployment Branch reports to the DRI management on the quality of the deployment program. The Research Deployment Branch works with Project Managers to gather, monitor and track deployment status, and to report deployment trends. The Research Deployment Branch prepares summary reports, and provides deployment updates to the DRI management on a regular basis (http://www.dot.ca.gov/research/deployment_support/index.htm).

Researcher

The researcher plays an important role in the preparation of information, materials, and mechanisms needed to deploy the research findings. The researcher presents these findings in a readable form and makes recommendations on how these findings can be implemented.

The researcher works with the Project Manager to develop suitable mechanisms for deployment, and participates in technology transfer activities. Examples include presentations and training classes. The researcher may also participate in the development of marketing brochures, user manuals, or any other mechanisms that are suited to effective deployment of the research results.

Customer

The customer, typically a Caltrans Division or District, engages in the project throughout the entire research process. Customer participation is especially important since the customer is needs to assure that resources will be available to deploy the new policy, practice, product, or service.

The customer may be the end-user, or a sponsor or champion for another public entity deploying new technology (e.g., Caltrans Division of Mass Transportation sponsoring research for a transit district).

Project Manager

The Project Manager will coordinate with the appropriate Technical Advisory Panel or Project Panel for expert review of final reports. The most promising research results will move up to the Program Steering Committee for review and approval. The selected ones will be presented to the Research and Deployment Advisory Committee and the Research and Deployment Steering Committee for research priority and policy guidance with regard to dissemination and implementation of final research results.

The Project Manager must work with the customers to evaluate the completed research and place it in context with Caltrans' operations. This includes:

- Identifying methods, approaches, materials, or technology and other findings from the research that can be implemented.
- Assisting the researcher to understand how the research results can benefit Caltrans.
- Approving all research reports, including films and videotapes, and any reports with specific findings, as discussed in Section 4 of this Research Manual.
- Preparing a summary document describing the problem studied, the findings, what they mean and how they should be implemented by Caltrans or other organizations, and expected benefits.

California Center for Innovative Transportation

The DRI Research Deployment Branch works closely with the California Center for Innovative Transportation (CCIT). The CCIT mission is to facilitate and accelerate the development, commercialization, and deployment of promising transportation technologies and systems that are developed by all the research funded by Caltrans. The CCIT role includes involvement in research projects during all five stages of deployment.

Deployment Plans (under development)

5.3 Technology Transfer (T^2)

Overview

Technology transfer activities, as defined by the Code of Federal Regulations, Title 23, Section 420, are those "that lead to the adoption of a new technique or product by users." These include "dissemination, demonstration, training, and other activities that lead to eventual innovation."

While deployment focuses primarily on the implementation of the DRI research results within Caltrans, technology transfer includes the sharing of those results with the larger transportation community. It also includes identification and sharing of best practices that have been developed by others. For example, best practices identified by the Federal Highway Administration (FHWA), Transportation Research Board (TRB), American Association of State Highway and Transportation Officials (AASHTO), and individual state departments of transportation, are reviewed for relevance to Caltrans. Sound practices and innovative technologies are shared with Caltrans, as well as with county- and municipal-level agencies within the State.

Technology transfer allows all agencies involved to solve transportation problems in a more cost-effective and timely manner than would otherwise be possible, and to adopt state-of-the-art innovations to enhance the quality of service offered to the public.

The DRI is partnering with the Local Technical Assistance Program (LTAP) to produce technology

transfer products and services. The DRI and Caltrans will foster a program that emphasizes technology transfer on the national as well as local levels. Caltrans actively participates in the AASHTO Technology Implementation Group and the TRB's Ideas Deserving Analysis Program.

Local Technical Assistance Program

LTAP is composed of a national network of centers – one in every state, Puerto Rico and regional centers serving tribal governments. The LTAP centers enable local counties, parishes, townships, cities and towns to improve their roads and bridges by supplying them with:

- A variety of training programs
- An information clearinghouse
- New and existing technology updates
- Personalized technical assistance
- Newsletters

Through these core services, LTAP centers provide access to training and information that may not have otherwise been accessible. Centers are able to provide local road departments with:

- Work force development services
- Resources to enhance safety and security
- Solutions to environmental, congestion, capacity and other issues
- Technical publications
- Training videos and materials (see web link below)

See the following link for information about LTAP: http://www.ltapt2.org

DRI provides additional funding to the LTAP as part of its partnership to provide tech transfer services to public agencies in California. Services include:

- Developing and organizing training.
- Organizing workshops and conferences.
- Developing and distributing newsletters and reports.
- Preparing training courses, users' manuals, and on-site demonstrations.
- Maintaining a strong network of technical expertise available to local governments.

Report and Publication Distribution

The LTAP assists DRI in dissemination of research reports as required per state and federal regulations, including submission of reports to the Transportation Research Information Service (TRIS). In addition, short summaries of reports or other publications, such as marketing brochures, are often prepared to assist in dissemination of key findings. The following provides a link to current research reports, project summaries, and archived research reports:

http://www.dot.ca.gov/research/researchreports/index.htm

Tech Transfer Newsletter

The LTAP Tech Transfer newsletter features timely articles and practical information including reports on innovation, practical applications of research, and best practices relevant for today's transportation professional. DRI often provides content for articles to be included in the newsletter. This newsletter is published quarterly and distributed to readers with funding under the LTAP, from the FHWA, Caltrans Division of Local Assistance, and DRI. The newsletter can be found at the following link:

http://www.techtransfer.berkeley.edu/newsletter/

Presentations/Workshops

Researchers are required to present their findings to Caltrans at the conclusion of each major phase of their research. When a topic is known to be of particular interest, a workshop is often developed to present findings to a larger audience. The DRI works with the LTAP to develop workshops. In addition, recent workshops have been developed in collaboration with the University Transportation Centers (UTCs), and with CCIT.

Training Courses

DRI works with the LTAP to develop training courses covering specific topics of interest. DRI also refers Caltrans employees to a variety of other sources for training, including the many university programs available in the state, and the course offerings of the National Highway Institute.

Construction-Evaluated Experimental Feature Program

The purpose of the Construction-Evaluated Experimental Feature Program is to encourage highway agencies to evaluate new or innovative highway technology, or alternative standard technology, under actual construction and operating conditions by means of a program of experimental construction projects. Caltrans' Division of Construction acts as a liaison with the FHWA in construction-evaluated projects on highway projects and technology application projects (http://www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm).

Caltrans' guidelines for the Construction-Evaluated Experimental Feature Program can be found on the Division of Design web site (http://www.dot.ca.gov/hq/oppd/rescons/CEWP_Guidelines_09-28-06.pdf).

Section 6
Transportation Pooled Fund Program

6.1 Overview

The Federal Highway Administration (FHWA) sponsors the Transportation Pooled Fund (TPF) Program. It allows the FHWA to partner with state agencies and other organizations with a shared interest in solving transportation-related problems. The partners may pool funds and other resources to solve common problems through research, planning, and technology transfer.

To initiate a pooled-fund study, at least two states, or one state and the FHWA, must collaborate. These agencies can, in turn, partner with local and regional transportation agencies, private industry, foundations, and universities.

The TPF web site contains information on program procedures and current and proposed studies (http://www.pooledfund.org).

6.2 Transportation Pooled Fund Roles

In a pooled-fund study, the California Department of Transportation (Caltrans) may be the lead agency, the sponsor agency, or a partner agency.

Lead agency

The lead agency may be the Transportation Research Board (TRB), the FHWA or a state transportation agency. The lead agency's responsibilities include:

- Administering the pooled-fund study.
- Negotiating the research contract.
- Organizing the technical advisory committee.
- Coordinating the administrative activities between the research partners.
- Publication and distribution of the reports.

Sponsor Agency

The sponsor agency is the state transportation agency or the FHWA that formally proposes the study and solicits participation and funding contributions from study partners.

Partner Agency

The partner agency contributes funds or in-kind resources to the study. Study partners may include state transportation agencies, the FHWA, other federal agencies, regional and local transportation agencies, academic institutions, associations, foundations, private companies, and others.

FHWA Technical Liaison

A FHWA Technical Liaison is assigned to each pooled-fund study at the beginning of the study. Liaisons give technical feedback and funding advice, as appropriate for the study. Liaisons may participate in their pooled-fund project Technical Advisory Committee (TAC) activities by e-mail, teleconference, or in person.

Caltrans Contact

The contact for pooled-fund programs is the Chief, Office of National Liaison, within Caltrans' Division of Research and Innovation (DRI).

6.3 Caltrans As The Sponsor Or Lead Agency

Project Initiation

Problem Statement

The first step for a sponsor agency to initiate a pooled-funded project is presenting a Problem Statement. The Problem Statement must include the following information:

- Project title.
- Project description.
- Project budget.
- Project goal.
- Estimated project duration.
- Deliverables.
- Sponsor's contact information.
- Project Manager contact information.
- TAC Liaison contact information.
- Financial contribution from the lead agency. [The sponsor agency should also request 100

percent funding from the State Planning and Research (SPR) funds.]

The problem statement may also indicate if the sponsor agency plans to be the lead agency, or if an eligible project partner has agreed to be lead agency.

For some studies, Caltrans will be the sponsor agency but does not want to be the lead agency. In these cases, Caltrans may agree to act as lead agency at the outset, but request that representatives of the participating partners decide who will be the actual lead agency after the partnership is formed.

When the Problem Statement is approved by the Research and Deployment Steering Committee (RDSC) (Section 2.2), the DRI Office of National Liaison will post it to the TPF web site (www.pooledfund.org) where proposed projects are announced. All authorized web site users then receive an e-mail invitation to participate in the pooled-fund study.

Federal funds typically provide for 80 percent of the research projects in the SPR Part II Annual Work Program, and state funds provide for the remaining 20 percent. Transportation pooled-fund projects normally receive a funding match waiver that allows the State to use 100 percent SPR Part II funds for project costs, at the request of a lead state if it is in the interest of the Federal-aid highway program. The DRI Office of Management Support (OMS) transmits to the FHWA Division Administrator the request for waiver of the non-Federal match for SPR funds used on the project. If the FHWA Division Administrator concurs with the request, it is then forwarded to the FHWA headquarters–Turner Fairbank Highway Research Center for approval. The FHWA will notify Caltrans if the project will be 100 percent federally funded.

Project Viability

When the project solicitation has received the required funding commitments from partner agencies, the FHWA Headquarters assigns a pooled-fund number, informs the partner states the project has been approved, and requests the states to obligate funds.

If, at the end of a quarter, the invitation to participate has not garnered the funds needed to initiate the study, the sponsor agency may do one of the following:

- Decide to change the scope of the project relative to the level of commitment.
- Ask the FHWA to re-post or extend the solicitation. TPF web-users will receive notification about re-posted projects.

The sponsor agency may ask for the solicitation to be re-posted for one or more quarters, but not more than one year. (One year gives all partners adequate time to respond, if they choose to.)

If, after a year, the project has not received sufficient funding commitments, the sponsor agency may request that the project be placed in the archive section of the TPF web site, where projects that did not receive sufficient funding are listed. Reviewing the archived studies may help potential sponsor agencies to decide whether to pursue similar research. Once archived, all commitments to the project are released.

Obligation of Funds

Obligation of funds is discussed in Section 2.9 State Planning and Research Part II Annual Work Program.

6.4 Caltrans Project Management Responsibilities (Lead Agency)

The sponsor agency may choose to serve as the “lead agency” or project partners may choose to have the TRB, FHWA or a partner agency manage the project.

The lead agency is responsible for managing the project, including the following:

- Establishing a technical advisory committee.
- Developing a work statement.
- Selecting researchers.
- Project monitoring and reporting.
- Project completion.
- Distributing the product.
- Implementing the research.

If Caltrans is the lead agency, it will incorporate its own terms and decision-making processes into the duties listed above. One important step is to verify that DRI has sufficient budget capacity to accommodate all of the pooled-funds.

(See Sections 3 of this Research Manual for more information on In-House Research and Contracted Research.)

Technical Advisory Committee

Each project partner may appoint a technical expert to serve on the TAC. The TAC serves for the duration of the project. The committee's duties include:

- Drafting and approving the project work statement.
- Selecting the best-qualified researchers to conduct the project.
- Reviewing project progress reports and annual reports.
- Accepting project deliverables and final reports.
- Completing implementation activities.
- Caltrans as the lead state will assign a TAC liaison that will not be the Project Manager.

TAC members participate in all project-related meetings and briefings. If there is a vacancy in the TAC, the appropriate project partner will appoint a new technical expert within 30 days of the vacancy.

Travel and communication expenses for project partners associated with participation on the TAC will be paid out of the project's funds, unless otherwise specified for the individual project.

When the TRB serves as Project Manager, there is no TAC. Instead, the TRB selects a panel of experts that may not include representatives from each of the project partners. The TRB will then ask federal agencies, states, universities, relevant associations, and numerous other organizations for nominees for panel membership, and select the panel members on the basis of their expertise. These panels will typically have eight to ten members.

The TAC shall meet as required or at least once a year.

Plan of Work

The lead agency will convene a meeting of the TAC to establish the partnership and develop the work statement. The work statement will be incorporated into a Plan of Work that should include the following elements:

- List of partners.
- Problem statement.
- Work statement.
- Researcher requirements.
- Project performance timeline.
- Estimated budget.
- Project communications requirements.
- Deliverables.
- Implementation plan.

Researcher Selection

The lead agency uses the Plan of Work to initiate the researcher selection process. The TAC shall meet to select the most qualified researcher, however, the selection process is governed by the contracting laws and regulations of the lead agency.

After the most qualified researcher is chosen, the project is initiated through an agreement, work order, or contract that is consistent with the lead agency's Conduct of Research procedures. The lead agency will include the members of the TAC in the project kick-off meeting.

Project Monitoring and Reporting

Active monitoring of all elements of the project is critical to the success and impact of a pooled-fund effort. While the lead agency is in charge of managing the project, all TAC members need to be actively involved in reviewing and providing comments on progress reports and preliminary findings that are developed by the researcher.

Quarterly Progress Reports

The researcher will provide quarterly progress reports 30 days after the end of the reporting period. The lead agency or the TAC may request that these reports be issued more frequently. These reports communicate key information about the progress of a project with the project partners and with the transportation community at large.

The progress reports include information about project and funding status, and any preliminary findings. The researcher should also include a review of tasks completed in the previous quarter and a plan of tasks to be completed in the upcoming quarter.

All progress reports, including reports on projects managed by the TRB or FHWA, will be posted to the pooled-fund program web site.

Project Payments

The Project Manager shall submit an invoice at least quarterly for project expenditures to the FHWA for reimbursement. The lead agency must request reimbursement of these payments through the standard invoicing process by submitting a Form PR-20. Reimbursement is made by the FHWA from the project fund created by funds from the project partners and assesses the project partners' contributions proportionately. Reimbursement may not exceed the funds that have been obligated for the project.

Annual Report

An Annual Report should be made for each project on or about the anniversary date of the project's initiation. This web-based report should include the information contained in the quarterly progress reports, as well as expanded information on the project findings, conclusions, and recommendations if the project has been completed.

Project Completion

Unless the lead agency grants an extension, the researcher must complete the project within the timeline prepared in the Plan of Work. It must be completed in an orderly manner to increase the implementation potential of the project findings, conclusions, and recommendations.

The three key elements of successful completion are:

- Delivery of useful and usable products.
- Final report with an easily understandable executive summary.
- Final payment to the researcher.

Deliverables

At the outset of the project, the lead agency, working with the TAC members, must ensure that the Plan of Work specifies the useful and usable products the researcher is expected to deliver. Deliverables may include reports, models, recommendations, software, new or improved products, or other deliverables appropriate to the study.

Where applicable, technology innovation sessions should be scheduled for the researcher to demonstrate, explain, or provide instruction on the project deliverables. TAC members should pursue opportunities to showcase the project findings, recommendations, and conclusions.

The TAC is charged with acceptance of project deliverables.

Final Report and Summary

Each project must contain a final report that details the work processes, findings, and recommendations. An executive summary will accompany each final report. The summary may be in a format proposed by the lead agency, e.g., short multi-page report, flyer, etc., but it must provide concise and useful information on the study and explain how the reader may access the full report and obtain information on other individual deliverables.

When appropriate, the final report should include:

- Discussion of the problem that was researched.
- Review of current practices.
- In-depth review of the procedures and processes used to conduct the project.
- Conclusions and recommendations.
- References, bibliography, and acknowledgments that includes a list of the TAC members for the project.

Final Invoice Payment

Once all products and reports have been delivered and accepted, the researcher receives payment for the final invoice. The FHWA will reimburse the lead agency for the remaining costs of the project, up to the obligation limits.

The lead agency will complete a Certification of Completion or other documentation indicated in the lead agency's FHWA-approved Conduct of Research Manual. The Certification of Completion completed by the lead state is submitted to the FHWA. The Certification of Completion is to state that the project requirements have been met and that all vouchers have been submitted, paid, and no additional claims will be made against the project money. Copies of the Certification of Completion are sent to all project partners. The lead agency updates the web site to reflect that the project has been completed. The lead agency may request an After Action Review with the researcher to measure the projects processes and outcomes.

Product Distribution

The lead agency will ensure that the project partners receive all project reports and deliverables as well as federally required distribution libraries and government agencies. All reports will be posted on the DRI Internet site (www.dot.ca.gov/hq/research/).

The TAC members will decide if the lead agency should distribute the project report and deliverables beyond the project partners. They will consider the nature of the project and if a broader based distribution is advisable. They will also consider if a broad implementation plan is desirable in accordance with the implementation plan.

Project products should be sent to the relevant AASHTO Standing Committee and to the relevant TRB committee or subcommittee. Whenever possible, the full text of all reports should be posted on the web and should be linked to Online-Transportation Research Information Service (TRIS). These reports should be in an accessible format, such as html or Adobe Acrobat. (The cost of putting the full text of the report online should be borne by the lead agency.)

Research Deployment

The TPF Program is primarily an applied research, planning, and technology innovation funding and contracting mechanism. Definable and measurable deployment is crucial to the program's overall viability. Therefore, the pooled-fund program includes a deployment plan that should be published on the web and fulfilled as part of the pooled-fund project. Follow-up deployment strategy should identify deployment at the end of the research. The TAC will also consider if a broad deployment plan is warranted to measure the long-term (three to five years) effects of program investments.

6.5 Project Participation (Partner Agency)

Caltrans' Response to an Invitation to Participate

The DRI Office of National Liaison notifies the relevant TAP, DRI Technical Representatives in the appropriate program area, and Program Steering Committees (PSCs), and asks the TAP, PSC, and DRI technical representatives to review, evaluate, and recommend participating or not in this pooled-fund project.

If the PSC recommends participating, they will recommend the Caltrans funding commitment and nominate a Caltrans technical representative for the pooled-fund project, whose job it is to represent Caltrans' best interests by providing technical and day-to-day support, and if appropriate, to champion the project results for implementation by Caltrans. The DRI must also confirm the technical representative nominated by the PSC.

If the PSC recommends participation, the DRI Office of National Liaison will ask the DRI Division Chief to commit funds to the study. The Division Chief submits the project to the off-cycle process for approval by the RDSC *(See Sections 1 and 2, Overview and Program Development, respectively).*

Decision to Participate in the Pooled-Fund Project

The RDSC will make the decision to participate, or not. If approved, the DRI will commit funds.

Commitment of Funds

Funding commitments are made online at the TPF web site. A study partner makes a commitment of

funds to the sponsor agency to acknowledge that they will formally obligate funding to the pooled-fund study when the FHWA requests it.

A commitment does not obligate funds. When the study has enough funds committed, the FHWA will assign a pooled-fund number to the project. Then, the FHWA will notify the sponsors and partners that they should obligate the funds committed for that year. The partners then execute the documents to obligate the SPR funds to this study.

The FHWA is the broker of funds that have been obligated to pooled-fund projects. Its responsibility includes:

- The authority to approve the use of 100 percent of the SPR Part II funds.
- Assignment of project numbers and an FHWA technical liaison.
- Processing the obligation forms.
- Notifying the project partners about the financial issues related to the study.

Obligation of Funds

Obligation of funds is discussed in Section 2.9 State Planning and Research Part II Annual Work Program.

The obligation of private funds will be considered on a case-by-case basis for private industry, foundations, and universities, or any other participants. Contact the DRI Office of National Liaison for information on how to handle private funds. Non-state SPR funds forwarded to the FHWA for pooled-funds needs an agreement between the FHWA and Caltrans.

Appendix A: Development of the Strategic Research Plan

Concurrent with development of the FY 07-08 Research Program, the Department is developing a Strategic Research Plan, which will be used to guide selection of annual and off-cycle research projects. Key elements of the plan development process are the following. See Figure A-1 for a graphic presentation of the process.

- Research Roadmaps for Continuing Research. DRI is developing roadmaps that present all research that is currently being conducted. Figure A-2 shows a sample roadmap at the program level. At the project level (Figure A -3), the roadmap identifies all phases of a project that will be needed to achieve a desired outcome.

- Research Outcomes and Funding Levels. Each of the Program Steering Committees (PSCs) will be asked to identify key program, family and project outcomes. Identification of outcomes facilitates asking if the program is really doing the right program activities to bring about the outcomes it believes is needed by its customers. Defining family (major sub-program) and project-level outcomes insures that project selection is linked to program outcomes. District representatives will be given the opportunity to suggest additional outcomes. Input from PSCs and Districts will be consolidated and presented to the RDSC. The RDSC will adopt a set of outcomes to guide further development of the Strategic Research Plan. At the same meeting, the RDSC will adopt preliminary funding levels, by Department goal, for the FY 07-08 research program.

- Research Gaps. DRI will work with the TAPs and PSCs to identify new research projects needed to achieve adopted outcomes, and to develop a problem statement for each new project that is proposed.

- Leveraging Resources. DRI will coordinate roadmaps with other agencies.

- Research Project Priorities. DRI will work with the TAPs and PSCs to identify current projects (as represented in the research roadmaps for continuing research) that are most directly aligned with adopted outcomes. The RDAC will consider both existing projects and proposed new projects, and will score and rank projects by Department goal. Based on the resulting ranking, RDAC will recommend a program of projects to the RDSC. RDSC will approve the final program of projects.

- Strategic Research Roadmaps. A final set of research roadmaps will be developed that reflects the program of projects adopted by the RDSC. These roadmaps will comprise the Strategic Research Plan.

- Research Program. Once the final program of projects has been approved, DRI will identify research needing funding in FY 07-08 for inclusion in the Research Program.

Figure A-1
Annual Research Program Development Process (FY 07/08)

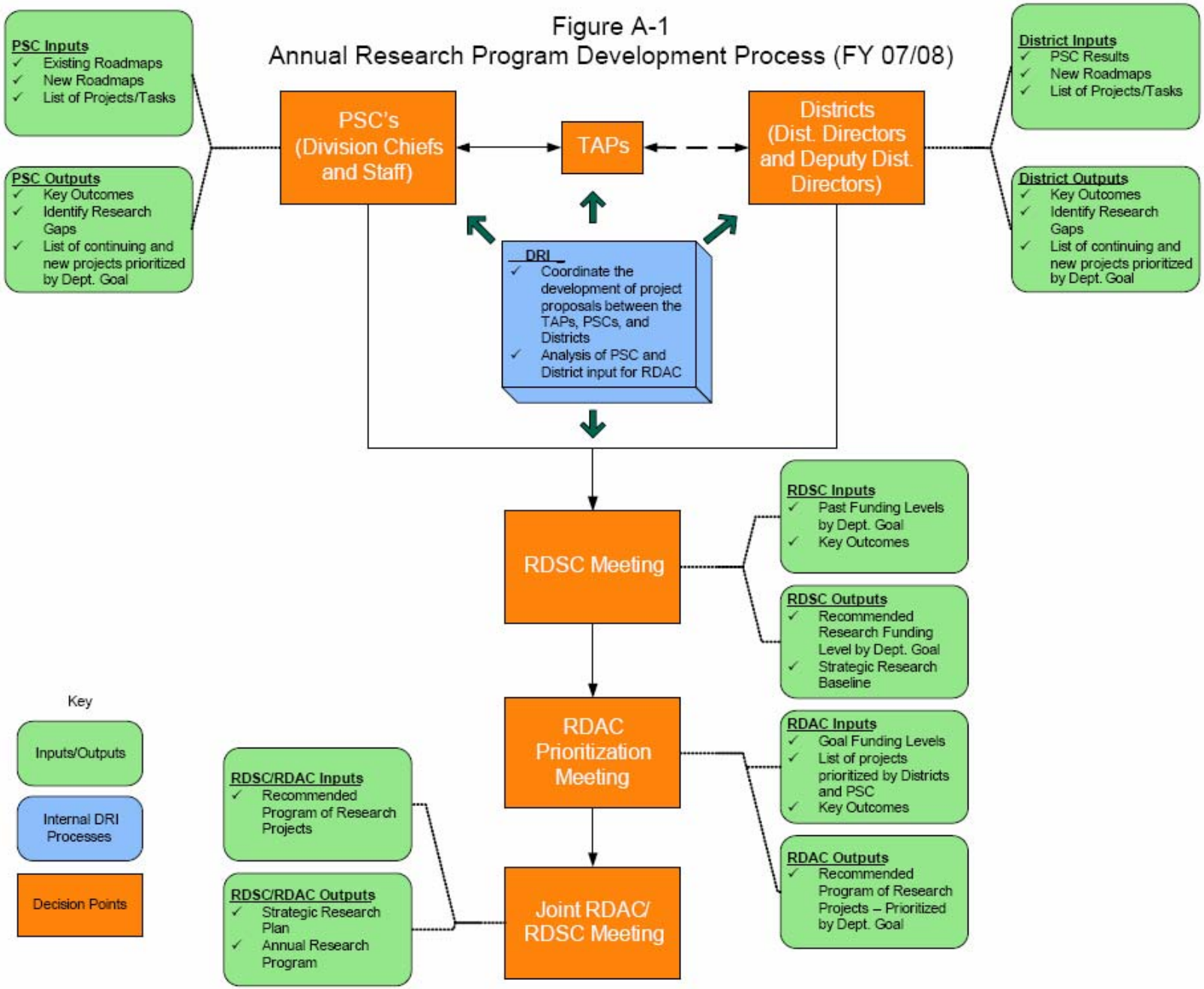
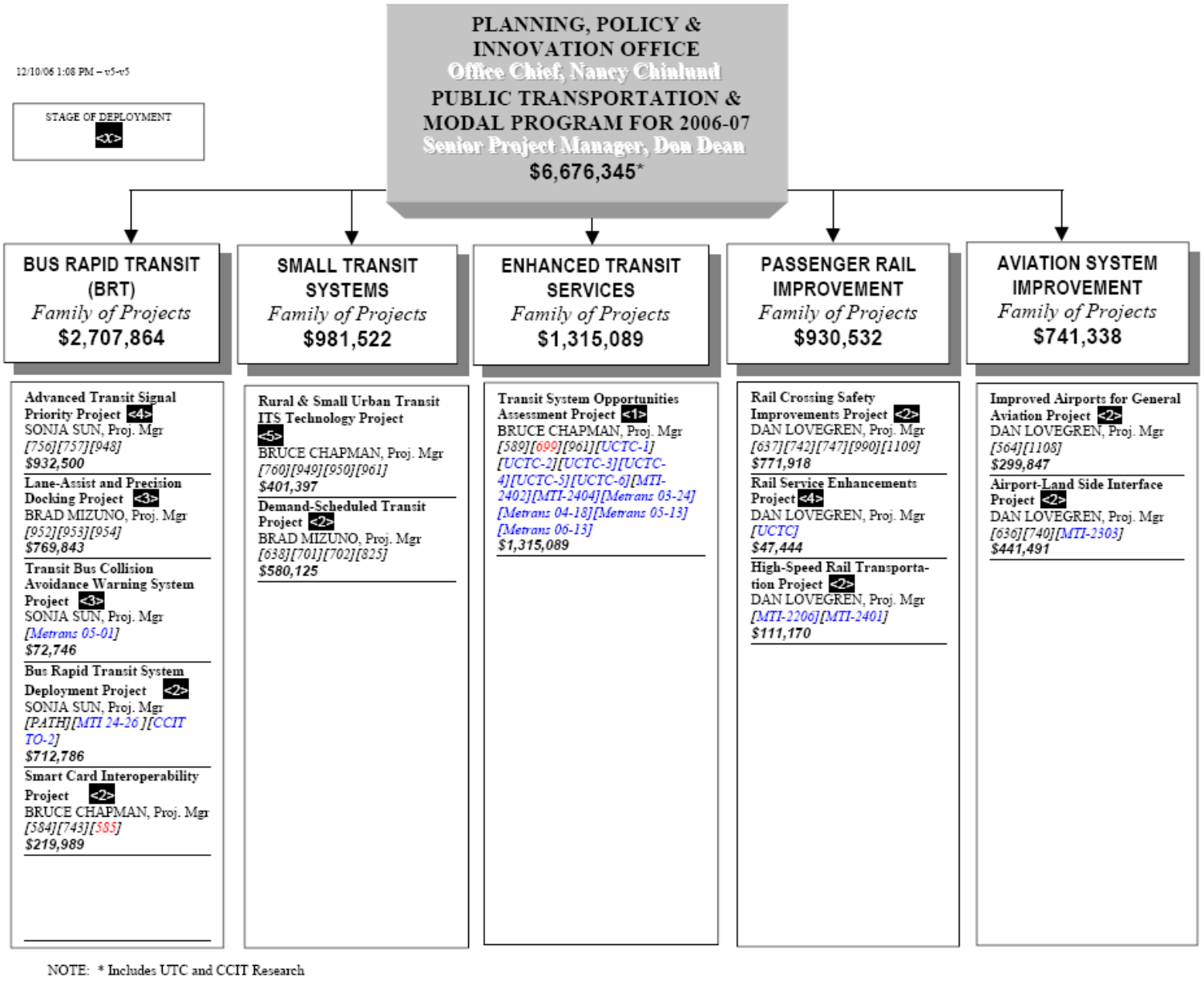
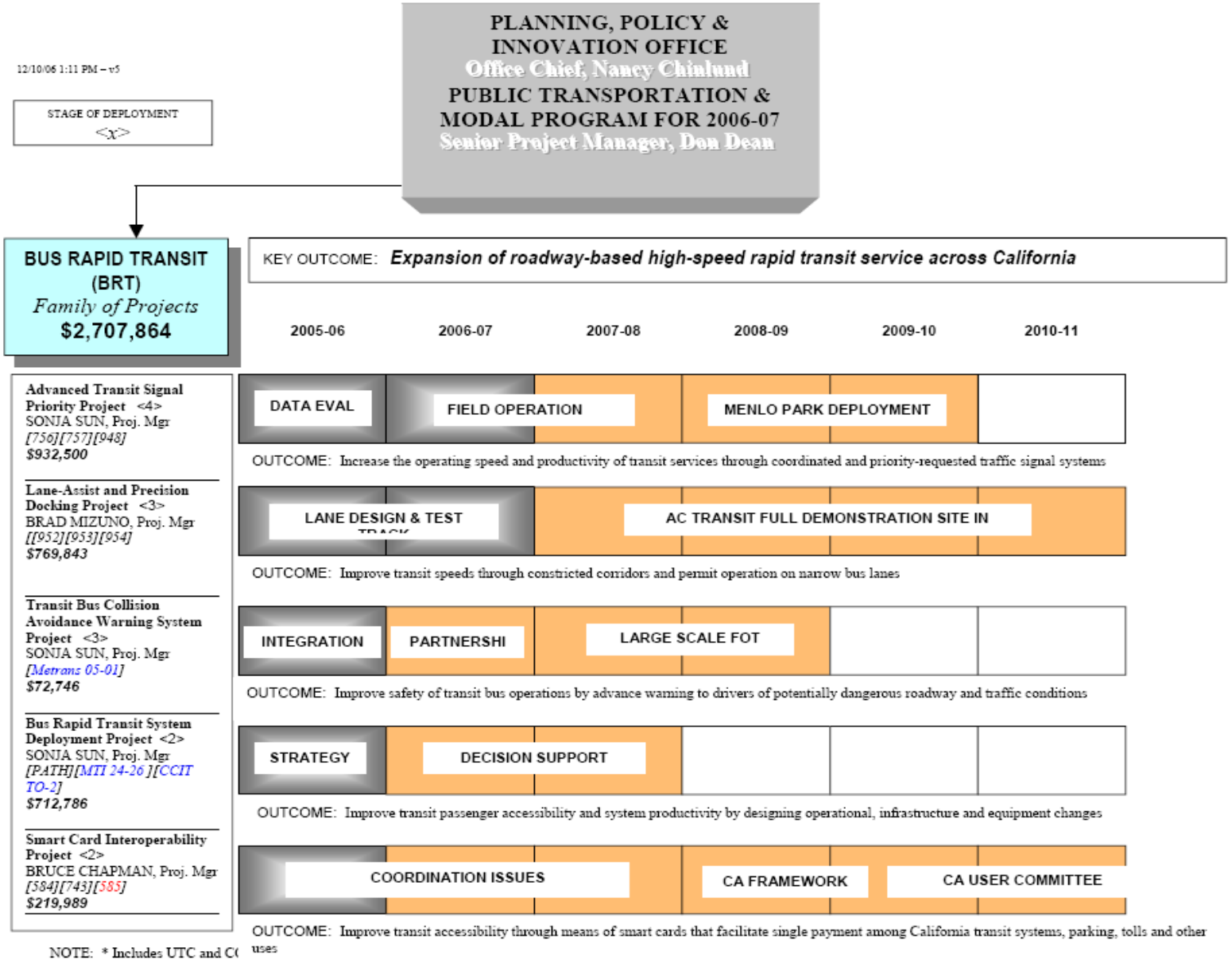


Figure A-2: Program Level Roadmap

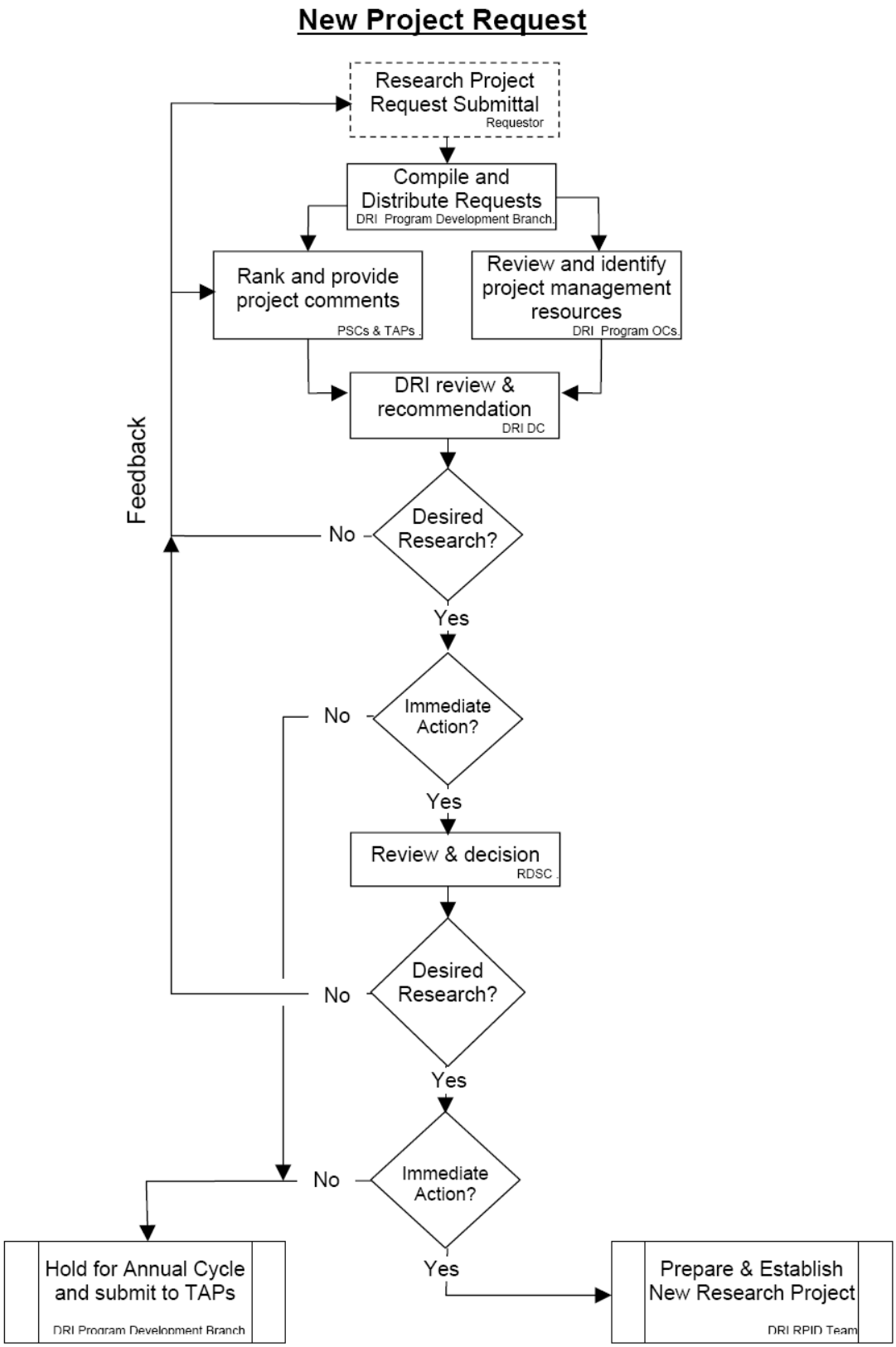


NOTE: * Includes UTC and CCIT Research

Figure A-3: Project Level Roadmap



Appendix B: Graphic Off-Cycle Process



Appendix C : Abbreviations/Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACRP	Airport Cooperative Research Program
AWP	Annual Work Program
CALTRANS	California Department of Transportation
CFR	Code of Federal Regulations
CFS	Call for Submissions
DOT	Department of Transportation
DRI	Division of Research and Innovation
FHWA	Federal Highway Administration
FMIS	Fiscal Management Information System
FTA	Federal Transit Administration
ITS	Intelligent Transportation System(s)
JIC	Joint Implementation Committee
LTAP	Local Technical Assistance Program
MSA	Master Services Agreement
NCB	Non-Competitive Bid
NCHRP	National Cooperative Highway Research Program
OCLC	On-line Computer Library Center
OMS	Office of Management Support
OPPI	Office of Planning, Policy & Innovation
OTOR	Office of Traffic Operation Research
PATH	Partners for Advanced Transit and Highways
PI	Principal Investigator
PM	Project Manager
PSC	Program Steering Committee
RDAC	Research and Deployment Advisory Committee
RDSC	Research and Deployment Steering Committee
RFP	Request for Proposals
RPID	Research Project Input Document
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (2005)
SPR Part I, II	State Planning and Research: Part I – Planning, Part II – Research (A federal program)
STEP	Surface Transportation Environmental Programs
T2	Technology Transfer
TAC	Technical Advisory Committee
TAP	Technical Advisory Panel
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century
TPF	Transportation Pooled Fund
TRB	Transportation Research Board of the National Research Council
TRAMS	Transportation Accounting Management System
TRIS	Transportation Research Information Service
UC	University of California
USC	United States Code
US DOT	United States Department of Transportation
UTC	University Transportation Center

Appendix D: Definitions

Agreements/Contracts:

Interagency Agreement (IA): Used between State agencies, including the University of California and the California State University system, as the basis for securing interagency services and for reimbursement for such services. An IA constitutes the complete understanding between both parties. It must include the following:

- A clear and complete statement of the work, service, or product to be performed, rendered, or provided,
- A complete delineation of the responsibility of each party in the performance of such work,
- The basis upon which payments for such services are to be made, and
- The period of performance.

Master Agreement: A generic term for a certain kind of research agreement between Caltrans and academic institutions (Interagency Agreements with the University of California and other public entities and Standard Agreements with private entities). The Master Agreement sets the general terms, conditions, and spending authority of the agreement between the parties. It also provides for a supplemental contracting mechanism that, upon execution, specifies services, materials, equipment to be furnished, or work to be performed; by whom; the time for performance, including the terms, date of commencement and date of completion; and, the payment provision. The intent of the Master Agreement is to save time and resources because the general terms, conditions and spending authority have already been established. Currently, there are two supplemental contract methods: the Research Technical Agreement (RTA) and Task Order.

Master Services Agreement (MSA): Generally statewide agreements executed by the Department of General Services that have been competitively bid and allow State agencies the option of placing orders directly with contractors.

Research Technical Agreement (RTA): A supplemental contract to the Transportation Research Master Agreement with the University of California specifying the funding and performance requirements to be met while under contract for a specific research project.

Standard Agreement: A contract with private consultants or laboratories, other governmental agencies, educational institutions (other than the University of California), or foundations supporting units of the California State University system for the performance of specific research work for Caltrans.

Task Order: 1) A cost-reimbursement or cost-sharing type of contract with FHWA permitting Caltrans to conduct a specific research project or implementation study, or 2) a supplemental contract with a university under an Interagency Agreement or Standard Agreement. The Task Order for FHWA supplements a Basic Agreement. The Task Order with universities enables the Department and academic researchers to focus only on a statement of work, schedule, budget, and research team to get a particular research project done.

Transportation Master Research Agreement: An Interagency Agreement with the University of California providing for the execution of RTAs. The Transportation Master Research Agreement establishes the basic terms and conditions of contracting between Caltrans and the University, thereby enabling the two parties to enter into RTAs more quickly than if they entered into a full Interagency Agreement for every research project.

Annual Research Process

The Department's annual process for planning, selecting and funding transportation research projects for a specific fiscal year. See Off-Cycle below.

Annual Work Program

The Caltrans SP&R, Part II Annual Work Program (AWP) consists of the current and proposed research efforts to be financed in part with federal aid funds through the Federal Highway Administration. The AWP contains an organized listing of the participating research and development projects, both current and proposed, giving an account of program status, proposed work, and estimated costs.

Caltrans

The California Department of Transportation

Consultant

A qualified individual, group, or firm able to perform specialized research or to provide technical advice to a responsible department unit performing research. A consultant engaged by Caltrans is usually termed "contractor" in the agreement.

Contract Manager

A contract manager is the Caltrans person responsible for administering a contract and monitoring the contractor's performance. The contract manager serves as a liaison with the contractor and may perform administrative tasks ranging from the request of contract services through the performance and final payment for completed services.

Department

The California Department of Transportation (Caltrans)

Deployment

Deployment is the last stage in the research process. Deployment is the incorporation of the results into the everyday practices of the organization. Deployment may include a new or revised policy, procedure, standard, design, specification, test method, computer program, or manual change. It may also include the development, marketing and use of new products, including new kinds of equipment. Caltrans defines deployment in 5 stages. See Figure 5-1.

Disclaimer Clause

The standard clause that must appear verbatim in all published research reports involving FHWA participation is shown below:

"The contents of this report reflect the views of the author(s) who is (are) responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the state of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation."

Dissemination

The distribution of research facts or findings to appropriate programs, offices, districts, and/or parties for review and possible implementation.

Fiscal Year

For the state of California, a 12-month budgeting period from July 1 through June 30 of the next year (e.g., Fiscal Year 1996 is from July 1, 1995 through June 30, 1996). For the federal government, a 12-month period budgeting period from October 1 through September 30 of the next year.

Off-Cycle

The off-cycle process provides an opportunity for the research committees to consider research problem statements or project proposals that cannot wait for the next annual cycle. The approval process is accelerated, because of the urgent nature of the request.

The off-cycle process also provides a flexible way to respond to solicitations that are received through the year (e.g., pooled-fund projects, grants, etc.).

Peer Review or Peer Exchange

An information exchange meeting among persons who are knowledgeable of the management and operation of research programs. These persons may include representatives from other state DOTs, the Federal Highway Administration, Transportation Research Board, universities, and the private sector. This activity is required every three years by 23 CFR 420.

Principal Investigator (PI)

The person (or persons) bearing the primary technical and administrative responsibility for the design and completion of a research study and for the day-to-day control and direction of the work (when using a research team approach, there may be more than one principal investigator).

Project Manager (PM)

The Caltrans person with full authority and responsibility, delegated by the appropriate Division Chief, to produce the intended results, on schedule and within budget, and to keep the project sponsors, customers and end users satisfied by managing all aspects of an approved project, from the initial Problem Statement to a Deployed Product. Also called the Research Project Manager.

Quarter

A time period within one year that is divided into four three-month segments for ease of reporting and monitoring progress. According to the fiscal year for the State of California, the first quarter begins July 1 and ends September 30. The second quarter begins October 1 and ends December 31; the third quarter begins January 1 and ends March 31; and, the fourth quarter begins April 1 and ends June 30 (the end of the fiscal year).

Research Problem Statement

A formal description of need for research based on a difficulty or crisis that requires new facts, policies, techniques, methods, etc. The Department prioritizes the problem statements and may approve some for solicitation of full research proposals.

Research Project Manager

See definition of Project Manager.

Research Proposals/ Solicitations:

Research Proposal: A detailed research plan with substantiating data submitted for approval to conduct a research project. The research project proposal typically includes a title, justification,

background data, a review of previous research and pertinent literature, objectives, a budget, and a work plan.

Unsolicited Proposal: An offer (usually accompanied by a proposal) from a university, a consultant, private laboratory, independent researchers, or others to perform research work not specifically requested by Caltrans.

Work plan: The section of the research proposal outlining the procedures and timeframe that the researcher plans to follow to conduct the research project.

Types of Proposals/Methods of Solicitation

Call for Submission (CFS): A method to openly solicit proposals from interested parties without committing to a contractual relationship in the initial phase. Information provided in a CFS is similar to that of an RFP. If the Department decides to proceed after receiving all proposals, the Department and the submitter must first enter into a contractual agreement before any work can be performed. Only public entities are eligible to submit proposals in response to DRI's CFS.

Request for Offer (RFO): An RFO is the method by which the Department solicits offers from contractors who are on a Department of General Services' Master Services Agreement (MSA) list. The contractor must provide all information that DRI deems necessary to evaluate the offer. The RFO submittal must provide enough information for DRI to be able to determine and verify the contractor's ability to perform the tasks and activities defined in the Statement of Work.

Request for Proposals (RFP): A procedure whereby the Department solicits proposals to perform research from qualified parties.

Transportation Pooled Fund Project: When DRI identifies a project that may be of interest to other states, the Department works with FHWA to initiate a pooled fund project and solicit participation by other states.

TRB's Cooperative Research Programs: When DRI identifies problem statements that may be of national interest the Department submits the problem statements to the appropriate TRB Cooperative Research Program.

Reports

Annual Accomplishment Report: A report required by the Federal Highway Administration that is an accounting of the accomplishments, savings, and cost of all research projects completed during the fiscal year period immediately preceding the Annual Accomplishment Report date (September). The report also includes the continuing projects for which resulting benefits have been implemented.

Final Report: A research report that documents the data gathered, the analysis performed, conclusions, the significance of the results to Caltrans operations, and recommendations on the means by which the research results may be implemented. It should not simply repeat information given in an interim report.

Progress Report: A report of progress, usually monthly, in addition to the quarterly report. Its contents and frequency are specified in the research agreement.

Biannual Report: A report that provides information on the status of an individual research project on a quarterly basis. This report enables research administrators and participating funding partners to periodically evaluate the progress of a particular research project to determine if the potential for producing significant results is strong enough to warrant project continuation.

Termination Request: A report by the Project Manager documenting the Department's determination that further research in a given area may not be productive or the desired outcome may not be

achieved. The Project Manager subsequently requests the researcher to terminate the project and prepare a Termination Report.

Termination Report: A report prepared by the researcher in response to a termination request. The researcher must submit a final report that addresses work and deliverables produced up to the time of termination, and it must discuss the reasons for the termination.

Research

Applied Research: A systematic, analytical, and experimental investigation of natural phenomena to gain specific new knowledge that answers a specific question or solves a problem. Applied research is needed to improve the functional characteristics of a system—usually resulting in direct application of results.

Basic Research: A systematic analytical and experimental investigation to increase knowledge of fundamental phenomena. Specific applications have not usually been identified.

Research: The scientific investigation, including analytical and/or experimental activities, to discover or apply new facts, techniques, methods, and natural laws.

Advanced Research (previously called Out of the Box)

Innovative, non-traditional or high risk research that has the potential for high payoff results that would serve the long-term needs of the Department.

Research Project Input Document (RPID)

An internal DRI form that the Project Manager completes to launch a project that has been approved by the RDSC. It is also used to help populate DRI's financial database.

Research Roadmap

A document that identifies all the research that will be needed to deliver Research Outcomes that support one or more Department Goals. The Roadmaps are used to organize projects by goals and outcomes. The baseline roadmaps are compared to the desired outcomes for a gap analysis and organize. The Roadmaps allow decision-makers to pursue the highest priority research. The roadmaps also show how various research projects work together to accomplish the stated outcomes.

Technology Transfer

A systematic process by which the existing research knowledge of others is transferred operationally by Caltrans into useful processes, products, or procedures. Technology Transfer includes those activities that lead to the adoption of a new technique or product, and can involve dissemination, demonstration, and training.

Transportation Pooled Fund Program (TPF)

A means for FHWA to partner with state agencies and other organizations when there is mutual interest in solving transportation-related problems. Partners may pool funds and other resources to solve these problems through research, planning, and technology transfer.

University Transportation Center

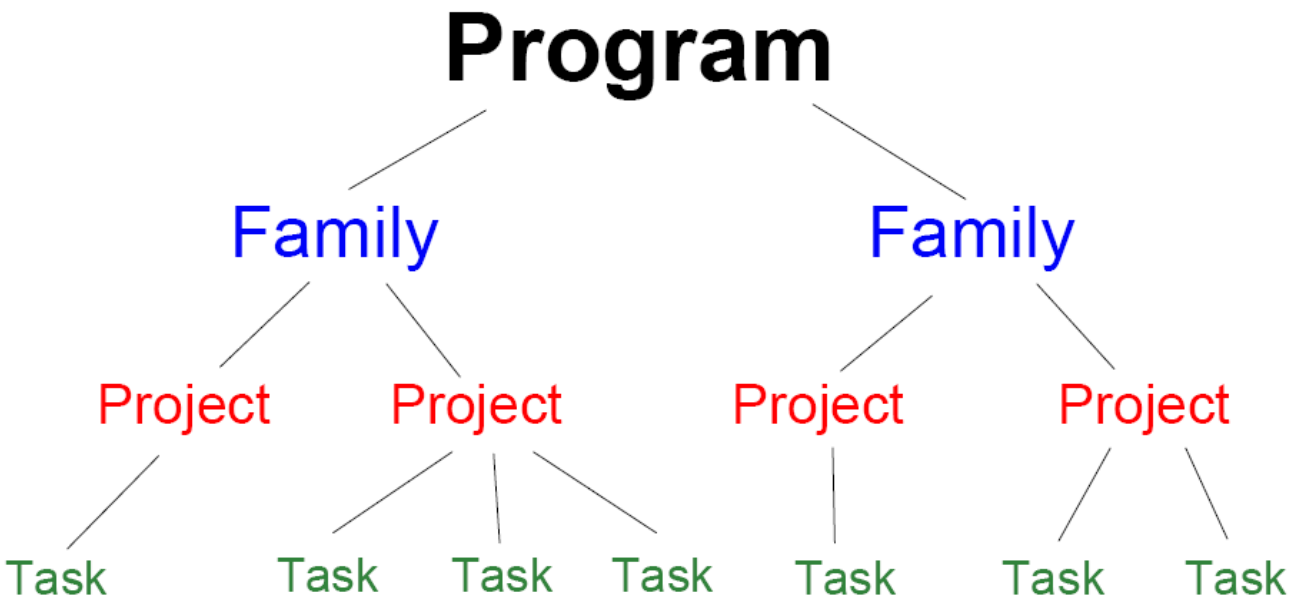
University Transportation Centers are non-profit institutions of higher learning listed in SAFETEA-LU Section 5402. University Transportation Centers advance significantly state-of-the-art transportation research and expand the workforce of transportation professionals through:

Research: Basic and applied research, the products of which are judged by peers or other experts in the field of transportation to advance the body of knowledge in transportation.

Education: An education program relating to transportation that includes multidisciplinary course work and participation in research.

Technology Transfer: An ongoing program of technology transfer that makes transportation research results available to potential users in a form that can be implemented, utilized, or otherwise applied.

Appendix E: Project Family



A Project has Deployable Products.
A Task has Deliverables.
A Project can be made up of a number of Tasks that can occur either sequentially or in parallel.
A Family is a grouping of related Projects.

Appendix F: Research Progress Report

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

RESEARCH QUARTERLY PROGRESS REPORT

MR-6068 (REV. 2/93)

1. TITLE	2. FEDERAL STUDY NUMBER
3. OBJECTIVE	2a. CONTRACT NUMBER
	4. EA *(DIV-UNIT-EA)*

5. PRESENT WORK PLAN APPROVED ON:	6. ORIGINAL START	7. ESTIMATED COMPLETION	8. TIME ELAPSED %	9. PROJECT COMPLETED TO DATE %

10. List specific major steps or phases to accomplish the objective.
Use the following symbols to indicate planned progress.3
Circle symbol when actually accomplished.
S = Starting Date, **C** = Estimated Completion Date
List of Tasks:

	FISCAL YEAR												
Qtr.	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	Beyond
Prior	Jul Sep	Oct Dec	Jan Mar	Apr Jun	Jul Sep	Oct Dec	Jan Mar	Apr Jun	Jul Sep	Oct Dec	Jan Mar	Apr Jun	

11. EXPLAIN WHAT WAS DONE THIS QUARTER AND HOW IT COMPARES WITH WHAT WAS PROPOSED IN BLOCK **12** OF THE LAST QUARTERLY REPORT.
DESCRIBE ANY UNANTICIPATED PROBLEMS THAT AROSE THIS QUARTER OR ANY RECENT IMPLEMENTATION.

12. BRIEFLY DESCRIBE THE WORK PLANNED FOR THE NEXT QUARTER ALONG WITH ANY PROJECTED DEVIATIONS FROM THE WORK PLAN OR ANTICIPATED MODIFICATIONS TO THE COST ESTIMATE OR THE WORK SCHEDULE.

13.		THIS FISCAL YEAR	TOTAL PROJECT	% EXPENDED TO DATE	14. Contractor Name	
Approved Total Funding	$	$	$			
Funds Expended To	Date	$	$	%	15. Responsible Unit	
Approved Caltrans PY's	Date	PY'S	$		16. Date	Quarter
PY's Expended To	Date	PY'S		%	17. PI Signature *(and Contract Monitor Initials)*	

FM 93 1759 M

Appendix G: Contents of the Final Report

1. Cover Page

- Identify the title of the research project
- Identify the federal report number
- Identify the report type (i.e. draft/interim/final)
- Identify the ownership of the report
  Example: State of California
  Department of Transportation
  Division Name
  Office Name (if applicable)
- Include a graphic, if desired
- Identify the report date, e.g., August 2005

2. Title Page

- Identify the ownership of the report
  Example: State of California
  Department of Transportation
  Division Name
  Office Name (if applicable)
- Identify the title of the research project
- Identify the report type (draft, interim, or final)
- Identify the author(s) of the report
- You may also identify the researcher and the individual(s) who prepared the report

3. Technical Report Documentation Page

Federal form DOT-F-1700.7 needs to be completed if the research was federally funded. For the most updated version of and instructions to prepare the Technical Report Documentation Page, refer to DRI Internal website: http://onramp.dot.ca.gov/newtech/research_process_policy/research_manual/manual_8_18_section_5000.doc).

4. Table of Contents

- Include an organized list of important report sections in outline form with beginning, but not inclusive, page numbers
- Include numbers or letters only before main items
- Use column heads (such as “Chapter” or “Section” on the left and “Page” on the right) and Department of Transportation (DOT) headers if desired
- Include a list of “Appendices,” at the end of the outline, with the heading centered but without a dividing line above it if desired

5. Illustrations and Tables

- List “Tables and Illustrations” at the foot of the “Contents” or on a separate page behind the “Table of Contents”
- List the titles of all illustrations, which may include tables, drawings, diagrams, maps, charts, graphs and photographs
- The illustrations, except tables and photographs, are called “Figures.” Photographs may be called “plates” if they are grouped on one page or printed singly on special paper

- Number the illustrations consecutively as they appear in the text. Within the text of the heading, "Figure" should be placed below the illustration and before or above its title in initial caps. It is usual to use column headings "Figure" or "Table" on the left and "Page" on the right.

Note: The contractor is free to copyright material, including Interim Reports and Final Reports, developed under contract, with the provision that Caltrans and FHWA reserve a royalty-free, non-exclusive and irrevocable license to reproduce, publish or otherwise use and authorize others to use the work for government purposes.

6. Disclaimer Statement

All reports must include a disclaimer statement before the introduction. For research reports involving FHWA participation, the disclaimer statement must say:

"The contents of this report reflect the views of the author(s) who is (are) responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification or regulation."

The United States Government does not endorse products or manufacturers. Trade and manufacturers' names appear in this report only because they are considered essential to the object of the document.

7. Foreword, Preface and Acknowledgments

- The Foreword must appear on a separate page. The Preface and Acknowledgments may be combined on one page or appear on separate pages
- Present these items in the initial pages of the report
- Acknowledge financial support using this phrasing: *"This work was supported by …"*

8. Executive Summary[1]

An executive summary is a report, proposal, or portfolio, etc in miniature (usually one page or shorter). That is, the executive summary contains enough information for the readers to become acquainted with the full document without reading it. Usually, it contains a statement of the problem, some background information, a description of any alternatives, and the major conclusions. Someone reading an executive summary should get a good idea of main points of the document without becoming bogged down with details. Covering no more than a page in length, the executive summary is Longer and is a highly condensed version of the most important information the full document contains.

(Source: Technical Writing: A Reader-Centered Approach. 2"J ed. By Paul V. Anderson, Harcourt, Brace, Jovanovich Publishers, 1991)

With the possible exception of the conclusion and recommendation, the executive summary is the most important part of a report. As such, it should be the best-written and most polished piece of the document. This is because many readers may only look at the executive summary when deciding whether or not to read the entire document. In some companies, the executive summaries are distributed so that employees are informed as to what information is available, and interested readers may request the entire document. In short, you may expect that an executive summary will be read more frequently and by more people than will your entire document.

When writing your executive summary, ask yourself if those who read the summary will be those who will read the entire report. If you are dealing with two different groups of people, you will have to decide how much technical detail to include in the summary. If it is likely that some who read only the executive summary will not have the technical background of the writer or final reader, keep the technical information and vocabulary to a minimum. You might have three types of readers: those

who want a full picture but won't check the details (they might read the executive summary, some of the body, the conclusions, and the recommendations), those who read everything (they read the appendixes, all the data, the calculations, etc.), and those who are in executive positions, wish to be kept informed on what is going on in the company, and will say "yes" or "no" to a project (they will read the executive summary, the conclusions, and the recommendations). Your executive summary must address all three types of readers.

Since the executive summary is a condensation, when creating it, you omit any preliminaries, details, and illustrative examples. You do include the main ideas, the facts, the necessary background to understand the problem, the alternatives, and the major conclusions. Brevity and conciseness are the keys to a well-written summary. Do not take a few sentences from key sections of the document and string them together. Rather, go over the entire document and make notes of the elements you consider important. From your notes, create a rough draft of the summary. Then, polish what you have written until it is smooth and seamless without unnecessary wordiness. Do not include any introductory or transitional material. Finally, ensure that your executive summary is accurate and representative of your full document.

9. Introduction

The author must, at the outset of the introduction clearly identify the exact subject of the report and its organization. The text in this section is concise. It should not contain details of any state-of-the-art survey, test procedure or mathematical analysis.

It must, however:

- Identify the problem that led to the research project and how it relates to other prior and current research
- Indicate the research project's objectives as stated in the research proposal and any later supplements
- Briefly summarize how the research findings address each specific research objective, and
- Relate the significance of the research findings to the overall operations of Caltrans

10. Background

This section provides background data, a review of previous research, and pertinent literature and the objectives and support for the research project.

11. Body

In general, the body of the report should:

- State the research procedure(s) in sufficient detail to permit the research to be replicated
- Describe any problems encountered during the progress of the research
- Include a description of the data recorded, a detailed statement of how the data was analyzed and a summary of the analyses (with the raw data either included in an appendix or not presented), and
- Discuss the meaning of the relationships observed or derived from the research

12. Conclusions and Recommendations

The authors must provide detailed quantitative statements about the relationships that were found. They must also provide a description of the tests used for significance and the degree of confidence one may have in the stated findings.

13. Deployment

IMPORTANT NOTE: All research must have clearly defined plans for deploying the research findings. Such plans must clearly identify "customers" of the research findings from the earliest stages of the research, i.e., at the "Problem Statement" development phase.

This statement should point out any immediate practical application of the research findings. It should be prepared cooperatively by the researcher from potential deployment offices. Also, it should provide answers to the following questions.

Did the findings warrant or assist in:

- The application of new procedures?
- The issuance of new specifications, standards, or designs?
- The use of new materials?
- The development of new equipment?
- The rejection of a proposed new procedure?
- A determination that no problem exists?
- Other positive benefits?
- No conclusions, but the determination that additional research is needed? Why?

The report shall include a recommended procedure for deployment and describe the methods used to translate the research product into practical implementations. Describe any potential benefits from deploying the research findings:

- Savings in time, money and lives
- Increased safety
- Better service
- Improved aesthetics
- Improved environment
- Increased energy efficiency
- Enhanced capability for solving transportation problems that may become available to the engineering, planning or related professions, and
- Other user and nonuser benefits

When savings can be expressed in terms of dollar amounts, the PI shall estimate the first year savings and the subsequent average annual savings anticipated upon application of the research results. If the findings are positive, but not suitable for immediate application, the report shall indicate the extent of additional work needed to produce results suitable for deployment, e.g., testing for verification, combining, correlating and interpreting additional research, etc.

Also, the report shall state whether significant deployment is proposed that could be profitably shared or if an implementation plan needs to be prepared. *(For more information, see Section 6000 Deployment and Technology Transfer.)*

14. Appendices

Appendices shall include information such as supporting data, substantiation of evidence, documentation, charts, photographs, and other details referred to in the text (usually by footnotes), which are not appropriate for the body of the report. Identify appendices with A, B, C; 1, 2, 3; or I, II, III, if Roman numerals have not been used for chapters.

15. References and Bibliography

The References list books or other authoritative writings that have been cited ("called out") in the text as "stated by Lee (1968, p.l2)" or "(Ref. 6)" or just "(3)" and that have not been listed in footnotes or

at the end of each chapter. It may be arranged alphabetically or numerically to correspond to the citation numbers in the text.

Appendix H: Technical Report Documentation Page

1 . Report No. FHWA/CA/TL-	2. Government Accession No.	3. Recipient's Catalogue No.
4. Title and subtitle		5. Report Date
		6. Performing Organization code
7. Authors		8. Performing Organization Report No.
9. Performing Organization Name and Address California Department of Transportation Division of Research & Innovation 1227 O St Sacramento, CA 95814		10. Work Unit Number
		1 1 . Contract or Grant No.
12 Sponsoring Agency Name and Address California Department of Transportation Sacramento, C A 95819		13. Type of Report and Period Covered
		14. Sponsoring Agency Code
15. Supplementary Notes		
16. Abstract		
17. Keywords		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161
19. Security Classif. (of this report) Unclassified 20. Security Classif. (of this page)		21 . No. of Pages 22. Page

Appendix I: Format for The Content of Termination Report

Title

Indicate that this is a Termination Report, and identify the project.

Objectives

List the objectives of the research project as stated in the proposal.

Objectives Achieved

List the objectives achieved prior to termination of the project, and describe how they were met.

Objectives Unattained

List the objectives not achieved at the time the project was terminated, and indicate why.

Accomplishments

Inform other researchers who wish to continue or to conduct new research in the same subject area what has already been accomplished.

Reasons For Termination

Indicate the reason(s) for terminating the project.

Expenditures

Specify the dollar amounts expended under the following four categories: personnel, (including consultants), materials, equipment and travel.

Nonexpendable Equipment

- Indicate whether any non-expendable equipment was purchased or assigned to the project.
- Identify the non-expendable equipment, when it was purchased or assigned and its purchase price or value when it was assigned to the project.
- List the current depreciated value of the equipment and how that value was determined.
- Indicate when authority was granted to purchase non-expendable equipment (for example, upon proposal approval or later, as a separate request.)
- Give the disposition of the equipment.

Appendix J: Stages of Research Deployment

CONCEPT - STAGE 1

- First steps following Problem Statement and Proposal.
- Includes detailed literature search.
- Involves experimental design, data collection, analysis, and reporting.
- Assesses results of research.
- Defines barriers to implementation (e.g., policies, specifications, standards).
- Submits a Final Report and outlines a recommended implementation plan.

LABORATORY PROTOTYPE - STAGE 2

- Develops prototype product, such as a breadboard circuit or computer system model.
- Demonstrates operation in laboratory setting.
- May incorporate customized or one-of-a-kind components.
- Assesses results.
- Submits Final Report and recommends design of full-scale demonstration.

CONTROLLED FIELD DEMONSTRATION - STAGE 3

- Prepares for full-scale testing of demonstration project.
- Includes collaboration with outside agencies or other state departments of transportation and the U.S. Department of Transportation.
- Controlled tests at specialized facilities are observed and supported by cooperating agencies, industry, and technical associations.
- Potential end-users are enlisted to support the field pilot stage.
- Assesses results.
- Submits Final Report and recommends site/conditions for first application pilot stage.

FIRST APPLICATION (CONTRACT) FIELD PILOT - STAGE 4

- Works with potential end-users to select site and to conduct pilot testing under real-world operating conditions.
- Test specifications and standards are developed.
- Research assistance given to assure proper installation and operation.
- Problems are corrected and adjustments made, as necessary, to complete pilot testing.
- To the extent possible, potential end-users operate the project under careful research surveillance.
- Assesses results.
- Submits Final Report and recommends initial sites for full corporate deployment.

SPECIFICATION AND STANDARDS WITH FULL DEPLOYMENT - STAGE 5

- End-user(s) select site(s) and deploy the method/process/equipment using resident management, supervision, staff and contracting forces (where applicable).
- Deployment is without research supervision or direction.
- On-call assistance is available upon request.
- Assesses results.
- Submits Final Report and recommends adoption of specifications and standards.