Research, Development and Technology Transfer

PROCEDURES MANUAL

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RESEARCH, DEVELOPMENT, AND TECHNOLOGY TRANSFER

PROCEDURES MANUAL

The mission of the Research, Development, and Technology Transfer (RD&T) program is to save Colorado citizen's money, time, and lives while preserving the environment and quality of life through the development and deployment of innovative products, materials, and methods in transportation.

I.   PURPOSE OF MANUAL

This manual describes the formal procedures under which research will be funded and/or conducted by the Colorado Department of Transportation (CDOT). It is intended to meet the requirements as specified in 23 CFR Part 420, Subpart B, Research, Development, and Technology Transfer Program Management.

 The objectives of the processes are to assure that:

A. Priority and strategic issues are addressed by research; and that
B. Research findings are useful and implementable in Colorado transportation programs. This objective requires that implementation be considered during selection, development, execution, completion, and in the follow-up of research projects.

II.   DEFINITIONS

AASHTO - American Association of State Highway and Transportation Officials.
AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail and water. Its primary goal is to foster the development, operation and maintenance of an integrated national transportation system.

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Applied Research. The study of phenomena to gain knowledge or understanding necessary for determining the means by which a recognized need may be met; the primary purpose of this kind of research is to answer a question or solve a problem.

Basic research. The study of phenomena, and of observable facts, without specific applications toward processes or products in mind; the primary purpose of this kind of research is to increase knowledge.

Development. The systematic use of the knowledge or understanding gained from research, directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes.

DDTD - Director of the Division of Transportation Development. The person in charge of the Division and responsible for the administration of the SP&R Work Program and other related programs.

Experimental Feature. A method, material, or practice which is not a state or industry standard.

FHWA - Federal Highway Administration. The FHWA is a part of the Department of Transportation and is headquartered in Washington, D.C., with field offices across the United States. They provide expertise, resources, and information to continually improve the quality of our nation's highway system and its intermodal connections.

Final Report. A report documenting the scope of the research, approach, analysis, findings, and recommendations.

HITEC - Highway Innovative Technology Evaluation Center. A program conducted by the Civil Engineers Research Foundation with support from FHWA to investigate transportation applications of new technology developed by the private sector.

Implementation. The completion of activities necessary for research findings to be incorporated into standard practices.

NCHRP - National Cooperative Highway Research Program. A pooled-fund program directed toward problems of national significance sponsored by the state highway agencies and the FHWA, and administered by the TRB of the National Academy of Sciences under the direction of AASHTO.

NTPEP - National Transportation Product Evaluation Program. An AASHTO program established to test, evaluate, and report on transportation-related products purchased and specified by state DOTs.

Non-Expendable Equipment. Equipment having a useful life of more than one year and an acquisition cost of more than $5,000 per unit.

OT - Oversight Team. A team established to provide technical guidance and oversight for the RD&T program in specific subject areas.

OTM- Oversight Team Manager. Provides analysis, documentation, and scheduling for oversight team members.

Peer Exchange. "Peer exchange means a periodic review of a State DOT's RD&T program, or portion thereof, by representatives of other State DOT's, for the purpose of exchange of information or best practices. The State DOT may also invite the participation of the FHWA, other Federal, State, regional or local transportation agencies, the Transportation Research Board, academic institutions, foundations, or private firms that support transportation research development or technology transfer activities." 23 CFR 420.203

Pooled-Fund Projects. The cooperative funding of a study or program by two or more transportation agencies.

PI - Principal Investigator. The person with the primary responsibility for conducting and documenting a research study.

Problem Statement. A brief description of an existing problem and a potential resolution for review by the Research and Implementation Council. *(Form is included in Appendix C "CDOT Research Problem Statement Format.")*

Proposal. A detailed Scope of Work, to include objective(s), work plan, cost estimates, and a time schedule for the completion of activities.

RCE - Research Coordination Engineer. The person who is in charge of the Research Branch and is responsible for the coordination of all research activities funded through CDOT. The person named to control the Federal-Aid Research program. The RCE reports directly to the DDTD.

RD&T Work Program - Research, Development, and Technology Transfer Work Program. An annual or biennial listing of proposed work and the estimated cost of providing branch activities.

Research. A systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research can be basic or applied.

Quick Study. A short study performed primarily by Research Branch personnel to make recommendations on standard practice. *(See Appendix A "Quick Study Program.")* Examples are:

A. A paper study (literature search) which reviews research reports in a specific area in order to develop recommendations; or
B. A brief evaluation of a method, material, or product to establish recommendations; or
C. A preliminary evaluation needed prior to approval of normal study.

RFP - Request for Proposals. A process to be utilized in acquiring both services and specialized products when objective bid specifications cannot be used.

RIC - Research Implementation Council.   The RIC is composed of several high-level CDOT department managers who are appointed to the council by the Executive Director and a representative from the FHWA. The RIC reviews transportation research and development needs and recommends an RD&T program to meet these needs.

Scope of Work. A detailed description of the research activity to be performed.

Study Manager. A CDOT employee, usually from the Research Branch, responsible for initiating and overseeing the research study and coordinating activities with the study panel. The study manager and PI are normally the same person when the PI is an employee within the Research Branch.

Study Panel. An ad hoc committee established to oversee a research study. It establishes the direction of the study which best meets the needs of CDOT, reviews the work and reports of the PI during study panel meetings, and makes implementation recommendations.

SP&R - State Planning and Research. National transportation legislation requires that two percent of Interstate Maintenance, National Highway System, Surface Transportation, Congestion Mitigation and Air Quality Improvements, Highway Bridge Replacement and Rehabilitation and Minimum Guarantee monies that go to each state be available for planning and research. These funds are designated SP&R funds and must be matched by the state based on the matching ratio established by federal law.

Subject Matter Expert. A person recognized statewide by peers to be an expert in a specific, significant area of the transportation program. New technology or innovations suggested by a subject matter expert would command serious consideration by peers simply because of their reputation.

Technology Transfer. Those activities that lead to the adoption of a new technique or product by users and involves dissemination, demonstration, training, and other activities that lead to eventual innovation.

TRB - Transportation Research Board.   TRB is a unit of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information and encouraging the implementation of research results.

TRIS - Transportation Research Information Service. A computerized storage and retrieval system developed and maintained by TRB for two types of information:

A. Progress of ongoing R&D studies; and

B. Abstracts of completed R&D reports and articles.

III.   FUNDING OF RESEARCH

The following are various categories of funding used to finance CDOT research activities:

A. SP&R Funds

Most of CDOTs research effort is financed by SP&R funds. Current federal legislation requires that not less than 25 percent of the states total apportioned SP&R funds shall be spent on RD&T activities. Except for specific projects such as pooled-fund studies approved by FHWA for 100% federal funds, this program requires a 20% state match.

B. State Funds

Certain studies, because of limited scope, local interest, or shortage of federal funds, are financed with state funds and not submitted for federal participation. Monies in this category originate from the Highway Users Tax Fund and are approved through the State Transportation Commission review process.

C. Public-Private Partnerships

Public-private partnerships that will leverage research funding and enhance implementation opportunities are also pursued. Such relationships should be of benefit to Colorado's transportation program and in compliance with state and federal laws.

D. Other Funding Sources

The RCE may utilize other funding sources that may be available. Research performed by the CDOT staff with these funds, however, must still be consistent with the mission and goals of the department. The RCE does not accept funding from other sources that may put in question the impartiality of the research results.

IV.   WHO'S WHO IN RESEARCH
Research Implementation Council (RIC)

A. Functions of the RIC
RIC reviews Colorado transportation research and development needs and recommends an RD&T program to meet these needs. Research projects are selected and prioritized annually by the RIC through a process that insures that broad-based, strategic, priority issues are addressed.

The 8 to 10 members of the RIC are appointed by the Executive Director of CDOT with the objective of maintaining a proactive RIC that represents the broad needs of the

transportation program. A representative from the Colorado Division of FHWA also participates on the council. Because members are selected from a pool of higher-level managers to incorporate their broad knowledge, perspective, and objectivity with respect to transportation issues, the Executive Director must approve any delegation of responsibility by appointed members. RIC members from the Regions are rotated every three years. The RCE chairs the RIC meeting, which is held twice a year, in August and December, or as needed.

1. Identify strategic direction for the CDOT RD&T program with input from the oversight teams. (Solicitations for research problem statements are based on this strategic direction. Oversight teams review these problem statements and make recommendations to the RIC.)

2. Review proposed subject area recommendations presented by each of the oversight teams.

3. Consider oversight team recommendations and the strategic needs and priorities of CDOT, in developing a prioritized list of research projects.

4. Provide guidance to oversight teams.

5. Prioritize research project recommendations for funding.

6. Recommend funding levels or a percentage of available funding to address ongoing activities, subject areas activities, and strategic area activities.

7. Review ongoing RD&T activities.

8. Identify implementation priorities and assign responsibility for implementation of specific research recommendations to organizational units in CDOT.

9. Approve all final implementation plans, via email.
   Recommend organizational changes, budget actions, policy changes, or legislative changes necessary to implement research findings.

B. Functions of the RIC Members

Each research subject area will have an appropriate RIC member who has the authority in a subject area within CDOT and will serve as champion for research in that subject area.

1. Provide guidance to research oversight teams.

2. Appropriate RIC member will approve problem statements recommended by the oversight team for consideration by the council. Without this support, the council will not approve the problem statement.

3. At a minimum, the appropriate RIC member will approve the Scope of Work, study panel membership, the RFP, the PI, the final report and the implementation plan.

4. Appropriate RIC member will validate implementation recommendations of the study panel.

5. Upon completion of the study, the appropriate RIC member will be responsible for implementation and the transfer of the research product to CDOT committees (e.g., Spec. Committee) or the referral of the research product to the appropriate division head within CDOT.

Oversight Teams

A. Functions of the Oversight Teams

The Oversight teams review and prioritize the proposals submitted for research study and determine whether the proposals comply with the strategic direction set by the RIC.

1. Review all research problem statements, except experimental feature evaluations and Quick Studies. Problem statements must demonstrate how the department, upon completion, will use the research.

2. Working with the appropriate RIC sponsor, oversight team members will decide whether to support, enhance, combine, modify, or reject the problem statements.

3. Create additional problem statements, especially when needed to address strategic direction in subject area.

4. Make research funding recommendations.

5. Provide guidance to RIC members.

B. Functions of the Oversight Team Manager

1. Analyze problem statements or ideas received in OT subject area considering previous or ongoing research.

2. Call OT meetings as needed.

3. Document decisions of the OT by preparing recommendations to the RIC and modifying problems statements, when needed.

4. Verify RIC sponsor concurrence of OT recommendations before RIC meeting.

Study Personnel consists of a Study Manager, a Study Panel, and a Principal Investigator

These personnel are responsible for insuring the study quality, timeliness, and implementation of the research product.

A. Functions of the Study Manager

1. Become familiar with the research project and related issues through literature reviews, discussions with other knowledgeable people on the subject, and consultation with the problem statement's author.

2. In cooperation with the RIC member sponsor assemble a study panel composed of at least two people from CDOT that are outside the Research Branch and have an interest in the defined problem. One of the members of the study panel should be the appropriate departmental subject matter expert. FHWA participation should also be solicited.

3. Organize, manage, and document the PI selection and hiring process. This includes drafting the RFP, working with the DTD Business Office to complete appropriate forms, soliciting for proposals, coordinating PI selection with study panel, negotiating the agreement with the PI and finalizing contract documents.

4. Keep the research project on schedule and track budget. Review thoroughly the project's activities and adherence to milestones.

5. Keep in contact with PI and relate any issues of concern to the study panel and RIC sponsor.

6. Consult with the appropriate RIC sponsor throughout the study. At a minimum, the appropriate RIC member will approve the study panel membership, the RFP, the PI, the final report and the implementation plan.

7. Conduct study panel meetings as needed.

8. Maintain study panel member information.

9. Review and approve related project billings, as appropriate.

10. Remind PI two weeks before end of each quarter to provide progress report.

11. Review, revise as needed, and forward progress reports to DTD administrative assistants.

12. Inform panel members when new progress reports are available on the web site.

13. Coordinate and manage final report review, publication, and distribution.

14. Distribute QUICK STUDY(ies) summaries to the Regions, when appropriate.

15. Coordinate the development, updating and finalizing of the implementation plan.

16. Finalize all financial records and reports.

17. Close out projects, especially pooled-fund projects.

B. Functions of the Principal Investigator

1. Complete the research according to the Scope of Work, as scheduled and within budget.

2. Identify immediately to the study manager any issue that could impact the Scope of Work, expected outcome, schedule, or cost of the project.

3. Attend all panel meetings.

4. Provide progress reports at the end of each calendar quarter to the study manager.

   a. Progress reports should be spell checked.

   b. Make sure you change the dates of the reports.

   c. The completed progress report should not be more than 2 pages. Detailed information that exceeds this limit should be kept in the project file.

5. Provide draft final report to study manager at least two months before the project is expected to conclude. <u>This draft report should be completely edited and not contain any grammatical or spelling errors.</u>

6. Address all comments made by the study panel on the draft report.

7. Provide a final report that follows the required report format for editorial review. *(See Appendix B "Research Report Format.")*

8. Make editorial corrections and submit final report electronically. A black and white reproducible copy, ready for printing, must also be submitted. Any graphics included in the report need to be distinctive, and understandable, without the use of color.

C. Functions of the Study Panel Members

1. Attend and participate in panel meetings and provide technical expertise.

2. Review and approve final Scope of Work and RFP.

3. Select PI.

4. Review progress reports and notify study manager of emerging concerns.

5. Review research reports for your study and provide comments in a timely fashion.

6. Provide input and approval for final implementation plans that go to the RIC sponsor for approval.

D. Functions of the Research Coordination Engineer

The Research Coordination Engineer (RCE) is responsible for the RD&T program for CDOT and is the person that controls the Federal-wide RD&T program as defined and required by Federal guidelines.

1. Make recommendations to the CDOT Executive Director regarding RIC membership.
2. Poll RIC membership and executive management regarding changes to the Research strategic direction and call for a RIC meeting if changes are needed.
3. Provide information as needed to executive management and the RIC to facilitate their decision-making.
4. With the Research strategic direction as a guide, solicit problem statements from all CDOT employees, Colorado universities, MPOs, and the FHWA prior to annual RIC meeting.
5. Assign the received problem statements to appropriate research oversight teams.
6. Review research oversight team recommendations for completeness and distribute to RIC members.
7. Call and chair RIC meeting to review and prioritize research oversight team recommendations.
8. Call and chair additional RIC meetings, if needed.
9. Compile RIC recommendations and review with the Director of DTD and the Chief Engineer.
10. Develop annual RD&T work program based on RIC recommendations and present to DTD management.
11. Assign funded RIC approved projects and experimental feature projects to study managers based on expertise and workload.
12. Approve final study plan for each project.
13. Amend current RD&T work program as needed.
14. Review implementation plans and forward to RIC after they are approved by the study panel and the implementing office.
15. Provide overall management of RD&T program and staff.

16. Coordinate CDOT research activities with other state DOTs, FHWA, TRB, and AASHTO.

17. Manage research projects of special significance to CDOT executive management.

18. Close out projects, especially pooled-fund projects.

E. Functions of DTD Leadership Team as Related to the RD&T program

1. Review proposed RD&T work program and provide comments for consideration by the Research Coordination Engineer and the Director of DTD.

2. Develop an annual SP&R work program with the RD&T work program as an integral part.

F. Functions of the Chief Engineer as Related to the RD&T Program

1. Participate in the development of the research strategic direction.

2. Review the RIC recommendations.

3. Provide general oversight regarding the implementation of research findings that are the responsibility of the Chief Engineer.

4. The Chief Engineer is available to support the implementation of research when it involves a major change or is perceived as high-risk.

5. The Chief Engineer's Meeting can also be used to announce the availability of new design or construction options developed through research.

G. Functions of the Director of DTD as Related to the RD&T Program

1. Participate in the development of the research strategic direction.

2. In cooperation with the Chief Engineer, review RIC recommendations and make necessary adjustments.

3. Review and approve the overall SP&R Work Program including the RD&T part.

4. In cooperation with the CDOT Executive Director and the Transportation Commission, submit the SP&R Work Program to the FHWA Division Office for approval.

5. Review and approve contract, task orders and purchase orders for research projects.

V.   SP&R RD&T WORK PROGRAM OVERVIEW

The purpose of the RD&T program is to conduct research that has a direct application to planning, design, construction, maintenance, safety, environment, public transportation, and

intermodal transportation systems or operations at CDOT. The RD&T program also facilitates the implementation of the research through knowledge sharing, specification changes, and changes in practice.

Research projects are selected annually through a process that insures that broad-based, priority issues are addressed. Research problem statements are solicited and the oversight teams review these problem statements and make recommendations to the RIC. The RIC then makes prioritized recommendations for funding based on the strategic direction. Experimental feature evaluations are not subject to this process and are funded throughout the year. These requests from the staff and Region offices are approved for funding by the RCE.

DTD Management will use the research study priority list together with the ongoing RD&T activity funding needs to develop a RD&T annual work program. In addition to funds for professional services for projects identified in the RIC priority list, appropriate funding for the following is also considered:

- Local Technical Assistance Program (LTAP) match, 25% of total program costs
- NCHRP contribution
- TRB membership
- Set-aside for professional services for experimental feature evaluations, contingencies for pooled-fund studies and implementation

A. Experimental Features on Construction Projects

In accordance with Procedural Directive 3.1, all experimental features incorporated into Federal-Aid projects will be evaluated. The following steps will be followed in developing evaluation plans for experimental features.

1. The evaluation of an experimental feature will need to be requested in writing by staff or the Region.
2. Upon the receipt of a written request, the RCE will assign a study manager from the Research Branch to develop a study plan.
3. Funding to incorporate an experimental feature into a project is normally provided by the construction project account. Evaluations during construction are normally funded with SPR research program funds.

B. Pooled-Fund Projects

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 (contractors, universities, etc.). These studies may be conducted using SP&R funds without state matched funds, if approved by the FHWA Administrator.

Generally, a lead state will act as the contracting agency for all of the participants. On some occasions, the FHWA or TRB will also act as the contracting agency. An advisory committee composed of representatives of each participating state and the FHWA will be established to provide overall project direction and permit consideration of the cooperating states' views. FHWA or TRB management is also an option.

Requests for CDOT to participate in pooled-fund studies are received throughout the year from other states and FHWA. The following process will be used to determine participation by CDOT.

1. A RIC member sponsor will be required for each pooled-fund study.
2. Research staff will track the pooled-fund study performance and benefits.
3. Pooled-fund solicitations will be sorted into Type A, B, or C. *
4. Decisions will be withheld on Type B and C studies until annual priority setting meeting.
5. CDOT will consider using set-aside funds to join type A studies early enough to enable participation in the project scoping and PI selection (with a small dollar commitment). The decision to participate will be based on whether or not the pooled-fund study is of a higher priority than the highest priority unfunded research study.
6. Type A studies will be considered for funding at the next annual meeting through the normal problem statement prioritization process.

   *Type A, B, and C definitions
   - Type A - General Scope of Work with final scope and PI selection pending
   - Type B - Scope and PI predetermined
   - Type C - General subject area for research identified specific studies to be identified by state representatives

C. National Cooperative Highway Research Program (NCHRP)

NCHRP is an AASHTO pooled-fund research program where states and the FHWA pool their funds together to address transportation research of national interest. Each state participates by contributing 5 1/2% of their SP&R. No state match is required. Managed by TRB, the program begins by soliciting for problem statements from state transportation agencies and the FHWA. Due in September, the problem statements are reviewed by subject matter experts from TRB, FHWA, and AASHTO committees. All reviews, responses and problem statements are submitted back to state transportation agencies for balloting in January. Based on this balloting the AASHTO Standing Committee on Research meets in March to establish the annual program of projects. The RCE encourages problem statement submission, prepares the CDOT ballot based on input from CDOT experts and nominates CDOT staff to serve on the study panels. Based upon these recommendations and available funding, the RCE will prepare an annual RD&T work program and the DDTD will submit it, as part the overall annual SP&R Work Program to the FHWA. Any major changes will need to be submitted to the FHWA for approval, otherwise an informational copy of the updated work program will be provided to the FHWA quarterly or upon request.

VI.   EQUIPMENT

Cost of non-expendable equipment shall be managed in such a manner that only those equipment costs reasonably attributable to the SP&R RD&T program are charged to it.

- Purchase of non-expendable equipment with federal funds greater than $5,000 must be approved by FHWA.
- Inventory records for each piece of non-expendable equipment purchased or built under the RD&T program including equipment acquired by a contractor with Research funding will be incorporated into the CDOT inventory system.
- When non-expendable property is acquired with research funds the equipment title shall rest with CDOT unless the funding source specifies otherwise.
- Non-expendable equipment costing over $5,000 purchased with SP&R RD&T funds which has no further use in the CDOT RD&T program shall be properly disposed of and the residual value credited to the SP&R RD&T work program.

VII.   RESEARCH STUDY IDENTIFICATION AND DEVELOPMENT SCHEDULE

Research studies are generally started through the solicitation of problem statements. Evaluations of experimental features on construction projects are started by formal written requests from the corresponding Region office and staff. Other studies funded through FHWA work orders may be proposed and requested by the RCE based on interest from CDOT personnel or FHWA personnel.

Research Program Development Schedule (Dates are approximate.)

- **8/1** The RIC will review strategic research direction and update as appropriate.

- **8/15** The official request for research problem statements will be issued. Note however, that research staff will accept research ideas/problem statements throughout the year. *(See Appendix E, "Research Problem Statement Form.")*

- **9/15** Deadline for submitting problem statements for consideration at the 12/15 RIC meeting. A database search for other completed or ongoing research related to the problem will be performed by the Research Staff Librarian using the TRB TRIS system. If the search results do not provide a solution(s) for the problem, the submitter of the problem statement will be asked to develop a complete problem statement.

- **11/15** Oversight teams will complete an analysis of each problem statement (previous research, TRIS search results, feasibility, and application). Only problem statements that are not currently being studied, either by CDOT or another agency, will be considered. The oversight team will then develop a prioritized list of the accepted problem statements for presentation to the RIC.

- **12/1** With the approval of the appropriate RIC member, oversight teams will submit recommendations to the RIC. For appropriate oversight teams, recommendations will include research to address the strategic direction.

- **12/15** The RIC will meet and prioritize the recommended problem statements.

- **12/31** Recommended problem statements will be finalized by the Chief Engineer, the Director of the Division of Transportation Development, and the Research Coordination Engineer.

- **1/15** Recommended problem statements that will undergo research study will also be announced to state universities and consultants that are under task order agreements. A letter of interest to the RCE will be requested from interested organizations or individuals for each project they would be interested in submitting a proposal.

- **1/31** The study manager will organize a study panel for each new research study. Research staff and the study panel will start developing the final scopes of work and RFP's for the recommended research studies.
- **7/1** Pending incorporation of projects in the work program and subsequent approval, funding becomes available.

VIII. THE RESEARCH PROCESS
A. Assigning a Study Manager

Once an experimental feature or a problem statement has been identified as a research project the RCE will assign a study manager from the Research staff or a subject matter expert within the department as appropriate.

It is expected that the study manager will stay involved with the research project and related issues through literature reviews, discussions with other knowledgeable people on the subject, and consultation with the problem statement author.

B. Assembling a Study Panel

With input from the RIC sponsor, the study manager will assemble a study panel composed of at least two people from CDOT that are outside the Research Branch and have an interest in the problem.   One of the members of the panel should be the appropriate departmental subject matter expert. FHWA participation will also be solicited.

C. Study Panel Responsibilities in the Research Study Development Process

1. Review the problem statement and refine or modify the objective, if necessary, of the research.
2. Develop the Scope of Work. (Significant deviation from the problem statement or increase in funding is subject to RCE and RIC approval and funds being available.)
3. Review and/or refine the implementation plan.
4. Determine the domain of the PI. Possible domains include:
    - CDOT staff
    - State universities
    - Consultants with task order agreements with CDOT
    - All universities, private research groups, and consultants
5. Develop the RFP or in-house proposal as needed. The appropriate RIC sponsor must give approval to the RFP.

6. Develop the selection criteria to use in evaluating the proposals and in selecting the PI. Criteria should include the ability and commitment of the PI to produce an implementable product on schedule.

7. Issue the RFP to the selected domain. Except for a CDOT staff PI, a competitive process for selecting the PI is required. If the study panel desires to include potential PIs that are not part of the task order contracts or Colorado universities, a formal RFP process through the Procurement Office is required.

8. Select the PI based on the proposals received and the selection criteria.

9. An implementation plan needs to be prepared and forwarded by the study manager to the Technology Transfer Program Manager as the research contract/task order is executed. *(See Appendix D, "Implementation Plan Form" and Appendix E, "Implementation Plan Instructions.")*

D. PI Contract Negotiations

The study manager shall negotiate or review the final agreement with the PI. This agreement should require:

- Submitting progress reports in CDOT format at the end of each calendar quarter at a minimum.
- Providing the final report in both electronic form and a black and white reproducible hard copy in the CDOT report format.
- Providing a concise, one-page executive summary of the final research report including a brief recommendation of implementation.
- Submitting a recommendation for implementation.

E. Contract Processing

The study manager should do the appropriate follow-up to insure that the agreements get processed in a timely manner. Contracts and task orders must require a final report in the *"Research Report Format,"* see Appendix B.

F. RIC Sponsorship

The study manager shall consult with the RIC sponsor throughout the study. At a minimum the RIC sponsor will approve the study panel membership, the RFP, the PI, the final report, and the implementation plan.

IX.   CONDUCTING A RESEARCH STUDY
A. Contract Start

Once the proposal is approved and necessary contracts needed are signed, the PI will proceed with the study as outlined in the proposal upon receiving a Notice to Proceed from the study manager.

B. Progress Reports

Progress reports are required of each study at the end of each calendar quarter.

1. The study manager will follow-up with PI to insure the timely submission of these reports in CDOT format. *(See Appendix B "Research Report Format.")*

2. DTD administrative assistants will collect the quarterly progress reports and pass them on to the Research Staff Librarian. The Staff Librarian will post the progress reports on the Research web site. The DTD administrative assistants will also make hard-copy distribution of the reports to:
   - FHWA, Colorado Office; and the
   - DTD Director.

3. The Research Staff Librarian will use these progress reports to update the TRB Research-In-Progress database.

4. The study manager will review the progress reports and consult with the RCE or when appropriate, the study panel members, and the PI if the study appears to be behind schedule or not following in the direction dictated by the study proposal.

5. The Research Staff Librarian adds progress reports to the Research web site. Once added, the study managers will be informed of their availability on the web site and the study managers will, in turn, inform the project stakeholders.

C. Tracking the Study

The study manager will use progress reports and other information to monitor the progress of the study and determine if the PI is following the Scope of Work and is within the budget. The study manager will work with the PI to correct and/or clarify any deficiencies informing the study panel and the RCE of any problems.

D. Payments

The study manager will approve invoices for payment that are consistent with the progress reported.

E. Changes to the Study

    1. If changes in the schedule, budget, or work plan are deemed necessary, it is the responsibility of the PIs to submit an amendment in writing to the study manager following the time frame and conditions for the changes as directed by the contract. Allow a minimum of one month when requesting an amendment to an agreement.

    2. The study manager should consult with the study panel members about any changes to the study. The study manager need not get approval from each panel member but should consult with each member before approving or disapproving.

    3. Approval of the change from the RCE is mandatory.

    4. The custodian of the task orders must be notified of any amendments to an agreement.

    5. Subsequent to the RCE's approval, the study manager should work with the DTD Business Office to execute the appropriate legal documents for the change.

    6. Changes on non-SP&R, or non-state-funded research, must follow the approval process of the funding source.

F. Final Report Review

The PI should submit a draft final report two months before the end of the project. The study panel members are responsible for reviewing the final report. The study manager may also request that other subject matter experts, from both inside and outside the department, review the report. This review should not only address the technical merits of the reports but spelling and grammar also. All comments from the reviewers need to be addressed by the study manager and the PI prior to the publishing of the report.

After the PI has addressed all comments, and has completed another spelling and grammatical check, the revised report should be given to the Staff Librarian for a final review.

The Staff Librarian will review the cover, the front matter, the executive summary and conclusions only for grammatical and spelling errors and conformance to established guidelines. The Staff Librarian will not review the body of the report. **The Staff Librarian must review the above listed sections of all reports, including those written by**

consultants and university staff prior to publishing.

G. Final Report

1. Final reports should be prepared in a timely manner for each research project and must follow the *"Research Report Format" found in Appendix B*. A completed *Appendix G "Technical Report Documentation Page"* must also be included in the report. <u>Reports submitted in other formats will be rejected.</u>

2. Conclusions should be well justified and research findings by others should be referenced appropriately.

H. Copies of the Report

The PI should submit a black and white reproducible copy of the final report to the study manager, who will insure that sufficient copies are printed and distributed. The PI must also provide Research an electronic version of the report. The electronic version of the report will be put on the Research web site and emailed to people on the electronic report distribution list.

I. Copyright Authorization

Any author will be free to copyright material developed under the contract with the provision that CDOT and FHWA (if the research is funded by Federal-Aid) reserve a royalty-free, non-exclusive, and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use the work for government purposes.

J. Distribution of the Final Report

The librarian will post an electronic version of the report on the on the Research web site and email it to people on the generic electronic report distribution list. The study manager will get a link to the report and is responsible for distributing the link to the study panel and other interested parties.

X.   IMPLEMENTATION OF RESEARCH

Implementation of research findings is an essential element of the research process and each research project has a dynamic implementation plan. This plan is required for each research recommendation that is submitted to the RIC. For approved projects, the plan is revised and expanded throughout the study as the specifics and findings of the study evolve. Although somewhat speculative at first, the plan identifies the expected implementation product, the steps needed to put the findings into standard practice at CDOT, and who in the department will be responsible for each of these steps. These steps typically include an effort to

communicate the findings to appropriate staff (presentation or training), pilot projects, approvals, and incorporating the findings into CDOT operating documents (Standard Specifications, Design Manual, Materials Manual, etc.). These plans will be available for recently completed projects, studies proposed, and ongoing projects.

The implementation program contains several elements to facilitate putting research findings into standard practice. *See Appendix D, "Implementation Plan Format," Appendix E, "Implementation Plan Instructions" and Appendix G, "Chief Engineer's Procedure for Implementing Research Findings."*

Annually the RIC will review completed research and identify appropriate units at CDOT to implement research findings of completed research studies and request management to formally direct the organizational unit in this effort.

The Technology Transfer Program Manager is responsible for tracking the progress and implementation of research as it progresses from start to completion. A status table will be provided to the Chief Engineer and division directors every calendar quarter. Two years after the implementation effort on a project has been completed, the actual use of the product will be reviewed.

XI. TECHNOLOGY TRANSFER PROGRAM

Technology Transfer (TT) is the exchange of research and technological information. The Technology Transfer Program provides members of CDOT and other agencies in Colorado with the technical knowledge necessary to carry out planning, design, construction, maintenance, and traffic operations according to the most efficient and latest state-of-the-art. The section's responsibilities include overseeing various implementation activities.

A. Local Technical Assistance Program (LTAP)

LTAP is a statewide transportation-training program for local governments across Colorado. The program provides about 50 training classes per year including the Roads Scholar Program and the Supervisory Skills and Development program to about 1500 participants. They also publish a quarterly newsletter and provide reference assistance to cities and counties.

B. Tracking Deployed Research

This is a process to track research products that have been completed and their use, or non-use, by the department.

C. Research Implementation Coordination

Technology Transfer coordinates the various aspects of the Research implementation program by meeting with study managers and principal investigators, reviewing implementation plans, tracking implementation plan progress, producing information brochures on new research, and assistance on implementation projects.

D. Management of CDOT Research Library

The CDOT Library, located in the Staff Materials building, has the most comprehensive collection of transportation materials in Colorado. It has a database of 18,000 holdings and is available to the department online through CDOTs network. The Staff Librarian can perform online searches of databases including TRIS (Transportation Research Information Service.) The library also has several special collections including: AASHTO, TRB, CDs, videotapes, and career development. The library is open to the public.

E. Research Publications

The Technology Transfer Program coordinates and edits the Research Status Report, the Research Newsletter, and the final research reports.

F. CDOT Research Web Site

The URL for the CDOT Research web site is http://www.dot.state.co.us/Research/ It contains information on staff responsibilities, research reports available, research study progress reports and the current copies of the Research Newsletter and the status report.

XII.   RESEARCH MANAGEMENT REVIEW PROCESS

Quality in any process is not static, one-time accomplishment, but a striving for continuous improvement. Such a continuous improvement must be accomplished by a periodic review of the practices. One technique designed to improve the quality of the program is a Peer Exchange examination of the deliverables of the research program through the management process.

A. Peer Exchange Panel

A panel, with knowledge of state research programs, will be utilized to examine the RD&T management process and identify areas for potential improvement. A comprehensive review of the research management process will be conducted once every three years by a team external to CDOT. The team may include the following:

- A research manager(s) from another state DOT;

- A representative from the FHWA;

- A representative from other Federal, State, regional or local transportation agencies;

- A representative from the Transportation Research Board, or

- A representative with research management responsibilities from a private consulting company, a government laboratory, or a university.

B. Peer Exchange Discussion Items

- Discussion of the research program's management system as described in this manual with the RIC and other research staff.

- Discussion of the strategic plan for research and its relationship to the strategic plan for the department and the scope of the research program, including all the activities in the work program with executive management.

- A review of example projects as they advance through the system, including the solicitation, selection, choice of principal investigator, project progress, and technology transfer activities.

- Discussion with suppliers and customers of the RD&T program, which may include any of the following: RIC members, OT members, study panel members, CDOT researchers, past or ongoing research contractors, and CDOT planning, design, maintenance, or operations personnel.

C. Peer Exchange Panel Report

The review team will prepare a draft report that addresses the efficiency and effectiveness of the management process in meeting the RD&T program's overall mission. Issues such as:

- The ability to recognize and respond to future research needs;

- The ability to focus on priority issues;

- Timeliness;

- Objectivity;

- Appropriateness and accuracy of documentation;

- Impartiality;

- Training of staff;

- Technology transfer effectiveness;

- Incorporation of results into standard plans; and
- Comparison to other similar programs.

After discussing their findings and recommendations with CDOT staff, the reviewers will finalize the report and submit it to FHWA. CDOT may accept the panel's reporting as it would any other report that is designed to improve management processes.

D. Participation in Reviews with other state DOTs

CDOT research staff will participate in reviews of other state DOT research programs provided travel expenses are paid by others. This should be a valuable experience to those that act as reviewers, bringing back new ideas, insights, and new perspectives to the Colorado program.

APPENDIX A   QUICK STUDY PROGRAM

- The QUICK STUDY program was established to provide fast response to CDOT issues related to implementation of new technologies. A QUICK STUDY may be a "paper study" where Research Branch personnel review research reports in a specific area and prepare recommendations for engineering, construction, maintenance, or planning personnel. A QUICK STUDY may also be an evaluation of a new material, method, or product, which represents a significant change over standard practice.

- All QUICK STUDY(ies) will culminate in a one-page summary similar to that in the Appendix D, "Colorado DOT Research Implementation Plan Form." Other documentation, such as field notes, review notes, or a bibliography, may also be developed and kept on file unless the QUICK STUDY results in a formal report. Summary sheets will be kept in a notebook at the library and logged into the library database.

- QUICK STUDY(ies) will be sent by the study manager to all region offices.

- The RCE will maintain a list of these QUICK STUDY(ies) and the progress on each will be reported on the semi-annual progress report for QUICK STUDIES.

- A QUICK STUDY will normally last less than 12 months. Literature reviews and construction evaluations are expected to take much less time. Progress reports should be prepared and submitted on QUICK studies that have not been completed upon by the due date of the semi-annual progress reports.

- QUICK STUDIES active during the annual program development process and expecting to be ongoing into the next program year should be incorporated into the technical research oversight team recommendations.

APPENDIX B   CDOT RESEARCH REPORT FORMAT

Provide word file to Research. The Librarian will review, convert to PDF, and post online. Reports are published exclusively in electronic format.

Format and Content
- Use full justification
- Spacing
  - 1 1/2 spaces between lines and after headings
  - triple space between paragraphs
- Fonts
  - use Times New Roman font, size 12 for text, size 14 for headings
- Pagination
  - use lower-case Roman numerals for front matter
  - use stand-alone Arabic numbers for body of report (no italics or dashes)
  - number pages of appendices A-1, B-1, etc.
  - center page numbers 0.5 inches up from the bottom edge of the page
- Chapters
  - insert 1 1/2 spaces between headings and text - do not underscore headings or use horizontal lines
  - left-justify chapter headings and headings for front matter, capital letters, bold type, one inch from top of page
  - left-justify second-level headings, initial capitals, bold type
  - left-justify third-level headings, initial capitals, italics - do not bold (place on first line of paragraph)
- Tables and Figures
  - number figures consecutively and label with unique captions centered at the bottom, bold type (note: they should be called figures, not photos)
    - ➢ **Figure 1. This is how the captions should look.**
  - number tables alphabetically and label with unique captions centered at the top, bold
  - place figures and tables as close as practical to textual references
  - place graphics so that they can be viewed without turning the page sidewise (if a graphic must be placed sideways, the top should be on the left side of the page)
  - tables should supplement, not duplicate, the text
- Abbreviations, Acronyms and Symbols
  - define the first time they are used
  - include list of acronyms if warranted
- Numbers
  - spell out numbers from one through nine
  - use numerals for numbers 10 and above, unless they are the first word of a sentence
  - if a number 10 or above is in the same sentence as a lower number, use all numerals
  - use numerals for units of money, measurement, and time
- Widows and orphans
  - avoid leaving a single line of text at the top or bottom of a page
  - do not leave a header without text at the bottom of a page

Report Cover (use template)
- Left-justify all information on cover, bold type
- Type "Report No. xxxx" in the top corner (upper/lower case, font size 14)
- Type "Final Report," "Construction Report," etc., directly under Report No. (upper/lower case, font size 14)
- Type report title (all caps, font size 20)
- Type author's name(s) (upper/lower case, font size 14)
- Type publication date (upper/lower case, font size 16)
- Type the following information in the bottom left corner (all caps, font size 14):

   COLORADO DEPARTMENT OF TRANSPORTATION
   DTD APPLIED RESEARCH AND INNOVATION BRANCH

Disclaimer (use template)
- Place on inside of front cover

Technical Report Documentation Page (use template)
- Use font size 10
- Type report title in all caps
- Report title should be an exact match of title on report cover
- Key words
  - should supplement, not duplicate, words from the title
  - do not capitalize unless they are proper nouns
  - type in continuous line with commas separating key words
- Include front matter in the page count
- Number documentation page as page i.

Title Page
Include the following information: (centered, upper/lower case, font size 12 except for title):

   Title (all caps, font size 18)
   by Author(s) include job title(s)
   Report No.
   Prepared by/ (if prepared by a consulting firm or university - include address)

   Sponsored by the
   Colorado Department of Transportation
   In Cooperation with the
   U.S. Department of Transportation
   Federal Highway Administration

   Date (month and year)

   Colorado Department of Transportation
   DTD Applied Research and Innovation Branch
   4201 E. Arkansas Ave.
   Denver, CO 80222
   (303) 757-9506

Acknowledgements
- Include list of study panel members on all reports, interim and construction

Executive Summary
- Place after acknowledgements page
- Should be approximately one-two pages long
- Discuss why research was needed
- Discuss how research was completed
- Compare actual research results with expectations
- Discuss how the research can be used by CDOT
- Include recommendations for action or further research
- Outline cost benefits

Implementation Statement
- Should be subheading under Executive Summary (on same page)
- Identify recommendations to be implemented at CDOT
- Include one or two paragraphs with a specific CDOT implementation strategy
- Discuss who could benefit from this research

Table of Contents
- Place after executive summary
- Do not include front matter in table of contents
- Consecutively number chapters and break down into numbered sections
- Number appendices A, B, etc.
- Wording and punctuation should exactly match headings in report
- Include List of Figures and List of Tables

Introduction
- Include background, study objectives and scope of study

Conclusion and Recommendations
- Conclusions and recommendations should be separate sections of chapter
- Both conclusions and recommendations should be valid, appropriate, and properly supported
- Discuss how research findings should be used

References
- Give credit for all information taken from other sources
- Include author, title, volume and issue or report number, page number, publisher or issuing agency, publication date.

Example:
Scheinberg, Phyllis. "Prospects for Innovation Through Research, Intelligent Transportation Systems, State Infrastructure Banks, and Design-Build Contracting." GAO/T-RCED-97-83. General Accounting Office, March 6, 1997.

- To cite files from the Internet, provide the following information:
  - the author's name (if known)

- the full title of the document in quotation marks
- the title of the complete work if applicable in italics
- the date of publication or last revision (if available)
- the full http address (URL) enclosed within angle brackets
- the date of visit in parentheses

Example:
Burka, Lauren P. "A Hypertext History of Multi-User Dimensions." *MUD History,* **1993. <http://www.ccs.neu.edu/home/1pb/mud-history.html> (5 Dec. 1994).**

Report Preparation Checklist
- Make sure title, report # and date are the same on cover and documentation page
- Make sure keywords are included in documentation page
- Make sure font sizes and types are consistent
- Have all members of study panel review report
- Have at least one person review entire report for clarity and grammar
- Spell check report after all editorial changes have been made

APPENDIX C   CDOT Research Problem Statement Format

1. **Problem title-full, problem title-short**   Please supply the full working title of the study and a short unique title that can be used to reference the study

2. **Subject area**   Pavements, Structures/Geotech, Environmental or Maintenance, Safety, Multi-Modal/Planning, Asset Management.

3. **RIC Sponsor** Identify the RIC committee member who supporting the project

4. **Description of Problem** Describe the problem or issue that the research can address. Remember this is not a research proposal. Details about the research approach should be limited. This will be sorted our by the study panel assigned to the research later.

5. **Author of Problem Statement**

6. **Background** Give a background of the issue. Describe any previous research by yourself or others. Why is previous research not adequate and how will it enhance the proposed research? Problem statements forwarded to the RIC must have as a minimum of a TRIS data base search conducted and discussed.

7. **Product of Research** Describe the expected product of the research tha can be used for planning, designing, building, or operating transportation infrastructure in Colorado?

8. **Benefits of Research** Describe the expected benefits of the research. When will they be realized? How can they be measured and tracked?

9. **Implementation Plan Sections F, G & H** Describe how the results of the research can be used. How will the potential users learn about the research products and how will they learn how to use them?

10. **Champion** Who at CDOT should be the "champion" for the research and have a major influence on its ultimate use?

11. **Leverage** Would others (states, local governments, etc.) be interested in this research? Are there or should CDOT pursue funding partners? How much time and control should be sacrificed for developing such a partnership?

12. **Cost for Research**

13. **Cost for Implementation**

14. **Time to complete research** Discuss other factors that may affect completion time: season of year, school year, etc.

APPENDIX D   Colorado DOT Research Implementation Plan Form

A. Study number/Report Number (if published):

B. Study name:

C. Principal Investigator:

D. Study Manager:

E. Date:

F. Category of implementation product:

G. Further description of implementation product:

H. Implementation steps and person/organization responsible for each:

I. Approvals:

   a. Date study panel approved:

   b. Date implementing office approved:

   c. Date RIC approved:

J. Study panel members making the recommendation:

K. Report Summary:

L. Findings to be implemented:

M. Estimated cost of implementation:

N. Benefits:

O. Barriers:

P. Method to Measure Benefits:

APPENDIX E   Implementation Plan Instructions 3/18/02

Please put your implementation plans into the attached standardized format. If you cannot fill in the information requested for a letter, leave it blank. A-F should be completed at beginning of study. Copies of any updates should be sent to Beth Moore, kept in project file, and shared with PI and study panel.

A. Study number

B. Study name

C. Principal investigator

D. Study Manager

E. Date of plan

F. Category name of implementation product, use one of these terms showing both number and name

      1. New Design Option

      2. Design Methodology Change

      3. Design Standard Change

      4. Assessment Methodology Change

      5. Materials Specification Change

      6. Construction Specification Change

      7. Planning Process Change

      8. Maintenance Practice Change

      9. Manual

      10. New Program

      11. New Technology

G. Further description of implementation product

H. Describe implementation steps, what needs to happen - in the order it needs to happen, and the person(s) and/or organization with primary responsibility for each step

At the conclusion of the study and prior to the report's publication complete the following.

I. What is the appropriate approval level for this product? None, implementing office, study panel, or RIC?

      1. Date study panel approved

      2. Date implementing office approved

      3. Date RIC approved

J. Provide a list of the study panel members making the recommendation

K. Provide a brief summary of the report

L. What are the findings that should be implemented? Also note what findings have already been implemented. If no implementation is recommended, provide justification for that decision and stop here.

M. Provide an estimation of the expenses of implementation

N. What are the benefits of implementation

O. Explain any barriers to implementation

P. What method are you going to use to measure benefits

APPENDIX F

1. Report No. CDOT-	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle		5. Report Date
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Colorado Department of Transportation - Research 4201 E. Arkansas Ave. Denver, CO 80222		13. Type of Report and Period Covered
		14. Sponsoring Agency Code
15. Supplementary Notes Prepared in cooperation with the US Department of Transportation, Federal Highway Administration		
16. Abstract Implementation:		
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) None	20. Security Classif. (of this page) None	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

APPENDIX G CHIEF ENGINEER'S PROCEDURE FOR IMPLEMENTING RESEARCH FINDINGS

As part of the effort for implementation of research findings for new applications under the authority of the Chief Engineer's Office, the following process will be followed:

1. **Results Validation** - The appropriate RIC member should consider the application and be willing to support its validity and the reasonableness of its risk versus potential benefit for projects. A risk assessment should be completed under the direction of the RIC member. The product should only move forward with appropriate RIC member support.

2. **Results of General Application** - For research findings with general application, the RIC member, with support from Research staff as desired, should work through the appropriate committee (e.g. Specification Committee, Materials Advisory Committee, etc.) to make changes in the appropriate document (e.g. Standard Special Provisions, Materials Manual, Construction Manual, Design Manual, etc.) Review of these changes will be incorporated into the normal process for modifying these documents.

3. **New Design/Construction Options** - New options (6 to 8 per year) developed and supported by the appropriate RIC member will be reviewed by the Chief Engineer and presented at the Chief Engineer meetings. Recognizing that the RE's may be reluctant to take risks when options significantly deviate from current practice, the Chief Engineer is willing to support them in trying proven research.

   For design/construction options, under the direction of the RIC member, the Research Branch should develop a brochure/fact sheet for the design/construction option that describes the option, its application, its risks, and its benefits. This brochure/fact sheet should be one page and definitely not more that two pages (one sheet front and back).
   This RIC member should review STIPed projects for potential application. Research resources are available for this effort and to monitor the performance of the application of the research findings.

4. **Tracking** - The Research Branch will track the progress on each new product and provide a report to the Chief Engineer every calendar quarter.