COLORADO
Department of Transportation
Division of Transportation Development

Research Manual

Office of Applied Research

Revised March 2025

Contents

1. Introduction

The Colorado Department of Transportation (CDOT[1]) Office of Applied Research (OAR), within the Division of Transportation Development, also referred to as the Research Office , manages a program to address research needs across CDOT. Research can provide solutions to many problems facing today's transportation practitioners. Through OAR, CDOT leads, participates in, and applies transportation research that takes place locally through research conducted and managed directly by CDOT, regionally through research collaboratively conducted by multiple states through Transportation Pooled Fund (TPF) projects, and nationally through the research conducted by the National Cooperative Highway Research Program (NCHRP). Research addresses methods, materials, technologies, and planning to enable CDOT to promote safety, enhance mobility and sustainability, save money, plan for future technologies, and protect the public investment in transportation infrastructure. At all levels, OAR brings to bear knowledge and solutions that improve Colorado's transportation system. A brief history of OAR is presented in Appendix G.

This research manual is intended for researchers, CDOT staff, academic partners, and others interested in the CDOT research program. It provides information on the research cycle including developing, selecting, funding, performing, managing, and implementing research that benefits the traveling public in Colorado. This research manual also fulfills the United States Department of Transportation (US DOT) requirements specified in 23 CFR Part 420, Subpart B, Research, Development, and Technology Transfer (RD&T) Program Management, to describe CDOT's management process and procedures for selecting and implementing Subpart B RD&T activities. In this manual SPR refers to state planning and research, and more specifically SPR Part B applies to RD&T activities and funding. OAR reviews this manual for major and minor updates at least every two years. At least every 5 years, or whenever major updates are made, it will be resubmitted to FHWA for approval.

Figure 1. CDOT bridge inspection test with a Small Unmanned Aircraft System (sUAS)

[1] See Appendix A for Acronyms and Definitions.

2. Organizational Structure and Guiding Mission and Vision

The CDOT RD&T program is conducted by the Office of Applied Research, one of 7 offices of CDOT's Division of Transportation Development (DTD).

OAR staff have broad internal expertise, and we leverage subject matter experts (SME) throughout CDOT. The Office encourages risk-taking and innovative approaches to investigate research questions, implement results, and study new technology. Most projects lead to recommendations that can change CDOT practices, but some do not. This is the nature of research, and a negative result is as valid and can be as valuable as an actionable outcome. OAR maintains close interactions within DTD and with throughout CDOT. The visible support and endorsement of CDOT executives, managers, and group leaders is also important to successful research and implementation.

The overall direction of CDOT is set by organizational mission and vision statements. These guide research strategies and project selection. The current organization charts, and current mission and vision statements of CDOT, DTD, and OAR are presented in Appendix B. CDOT's Strategic Policy Initiatives change more frequently than vision and mission and also provide guidance. These are also in Appendix B.

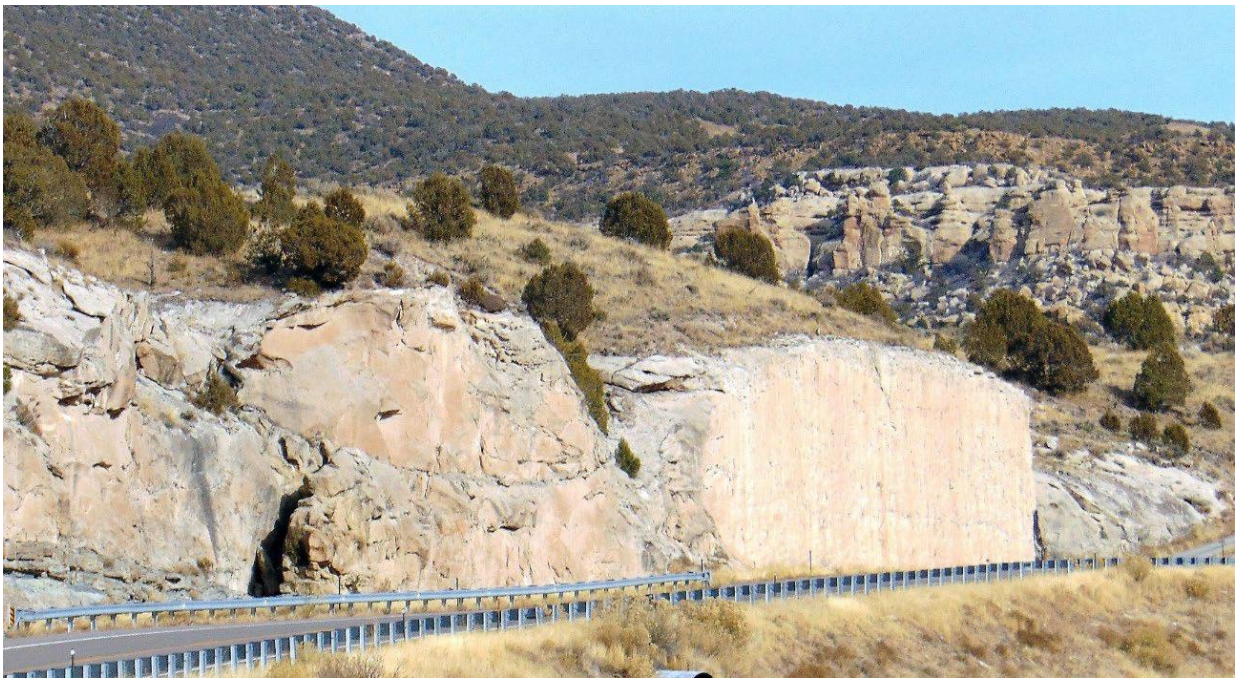

Figure 2. Example from the Rock Cut catalog (State Highway 65, milepost 55) developed as part of research into best management practices for rock blasting aesthetics.

3. Office of Applied Research Program Areas

Research and development can be defined as "creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge."[2]

Applied research is "original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective."

Basic research is "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view."

The OAR research program focuses on applied research, with an emphasis on uncovering knowledge that is actionable and that CDOT can implement or use for future planning.

Core Research Program Areas

OAR is structured with the following areas of specialty. Each is considered a research program area which encompasses a set of research projects. For each program area, an OAR research program manager identifies needs and their scope and organizes in-house research or selects consultants to perform research. In all cases, scientific research methods are used.

Environmental and Planning

This area encompasses air and water quality, cultural and natural resources, landscape and vegetation management, noise abatement, NEPA[3] processes, and sustainability. It also includes transportation planning. Often pursuing an interdisciplinary approach, research in this area will identify value-added opportunities to minimize the environmental impact of building and maintaining transportation infrastructure, and to ensure the effectiveness of the planning process.

Structures, Hydrology/Hydraulics, Geotechnical, and Geohazards

This area encompasses bridge and retaining wall design, slope stability and foundations, geology, hydrology/hydraulics, and geohazards. Research goals often focus on ways to improve the structural integrity of bridges, foundations, structures maintenance, cost-effectiveness of structural design, effectiveness of hydrological analysis, and hydraulic design of culverts and bridges.

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[2] The definitions of this section follow [OECD (2015) Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development. The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris]

[3] NEPA refers to the National Environmental Policy Act (NEPA) signed into law on January 1, 1970

Safety, Maintenance, and Operations

This area encompasses highway safety, worker safety, traffic operations, geometric design, maintenance, and Intelligent Transportation Systems. Research goals often focus on opportunities to improve safety and mobility, and to optimize how highways are maintained in both summer and winter.

Pavement and Materials

This area encompasses materials, pavement management systems, and pavement design. Research focuses on aspects of design, construction, and preservation of asphalt and concrete pavements, and the use of binders, aggregates, fillers, emulsions, sealants, additives, geotextiles, reclaimed materials, supplementary cementitious materials, and other materials to improve the workability, performance, durability, safety, and environmental impact of pavement structures.

Research Program Areas of Emphasis

As an overlay to the core research program areas, OAR develops Areas of Emphasis which are topics of special interest to CDOT. They are topics where focused research has the potential to result in substantial near-term and long-term benefits to Colorado, and where local factors make Colorado a logical choice to lead this research. Examples of local factors are Colorado's natural features (for example, terrain, climate, the built environment, or state government policy), and relevant research strengths within Colorado's universities, consulting firms, or national laboratories. Areas of Emphasis are selected by OAR following consideration and advice from the Research Implementation Council (RIC) and CDOT Management. Current Areas of Emphasis can be found on the OAR website.

Research Management and Participation at the National Level

OAR pursues results that meet the practical needs of CDOT. Research conducted at the national level produces knowledge relevant to many states. Colorado supports and benefits from national participation through its activities with the Transportation Research Board (TRB), The American Association of State Highway and Transportation Officials (AASHTO), The Federal Highway Administration (FHWA), and the National Highway Traffic Safety Administration (NHTSA). National level activities are further described in Chapter 5.

4. Research Funding Sources

DTD's primary program funding source is FHWA SPR funds. Federal law requires that two percent of federal-aid funds be apportioned for certain surface transportation categories and be spent on planning and research activities. Of these funds, a minimum of twenty-five percent must be allocated for research-related activities as specified in 23 CFR Part 420, Subpart B. This SPR Part B allocation, together with a required state match, provides the main funding for OAR's research activities.

To the greatest extent possible, this budget is applied to research benefiting CDOT activities and management of the research program. National projects include the research of the NCHRP and Transportation Pooled Fund (TPF) programs. State research projects are conducted by our university partners, contracted consultants, and staff within CDOT. Only research activities eligible for federal participation per 23 CFR 420.113 will be funded with S&R Part B funds through the DTD SPR Work Program.

Other than SPR Part B funds, on occasion OAR will apply funds from other sources such as

- Funds from federal government agencies other than FHWA, for example the United States Geological Survey. Such funds may substitute for the state match or simply provide enhanced resources to pursue research goals.

- Certain studies of limited scope or local interest can be financed with state funds.

- Public-private partnerships that leverage research funding and enhance implementation opportunities are also pursued. Such relationships should benefit Colorado's transportation program and must comply with state and federal laws.

- OAR may use other funding sources. Research performed by CDOT staff with these funds must still be consistent with the mission and goals of the department. OAR does not accept funding that could put in question the impartiality of research results.

Figure 3. I-270 air quality sensor for research into the air quality impacts of construction activities.

5. RD&T Program Overview

RD&T program activities lead to high-quality, implementable research results to improve CDOT's current practices and to prepare for the increasingly complex needs of Colorado's transportation future. The research program includes directed research projects to solve problems identified by CDOT, as well as multi-state (TPF) and national (NCHRP and TRB) research that CDOT staff help guide and whose results benefit Colorado. It also includes knowledge curation and exchange by the Research Library, participation in regional and national meetings of AASHTO, TRB, and others, and monitoring of research results from other states. The Program emphasizes the implementation of research. This includes the implementation of results from local research projects, and participation in the State Transportation Innovation Council (STIC).

Research projects directly managed by OAR are selected twice each fiscal year through a process that ensures broad input and directs resources to projects that address priority topics. Research problem statements are solicited from within and outside CDOT. Oversight Teams (OT) comprised of subject matter experts review and sometimes improve these problem statements for their potential to help CDOT and for their tractability. The Research Implementation Council (RIC) then makes prioritized recommendations consistent with CDOT strategic directions. DTD and CDOT leadership incorporate a final set of projects into the DTD Work Program.

The following sections describe the components of the RD&T program.

Management of Local Research Projects

Managing local research projects is the largest component of the RD&T program. These projects directly address ideas affecting CDOT operations and advance CDOT approaches and practices as knowledge, technology, and needs change. Chapters 7, 8, and 9 describe the steps for local research project identification, development, and implementation of recommendations.

Transportation Pooled Fund Projects

The Transportation Pooled Fund (TPF) program provides a way for two or more states, the FHWA, and third parties (contractors, universities, other government agencies, etc.) to combine resources and achieve common research goals. Each participating member of a pooled fund project contributes both financial and staff support. If approved by the FHWA administrator, these studies may use 100% SPR funds without the usual requirement that states contribute a 20% match. OAR's process for leading and participating in TPF projects is outlined in Appendix F.

Contributions to National Programs

OAR leads, contributes to, and benefits from CDOT's interactions with the Transportation Research Board (TRB) and the American Association of Highway Transportation Officials

(AASHTO). Relevant programs are the TRB Research Innovation Implementation Management (RIIM) Committee (AJE35), the National Cooperative Highway Research Program (NCHRP) and the AASHTO Special Committee on Research and Innovation (R&I).

The Transportation Research Board (TRB)
The TRB is one of seven programs within the National Academies of Sciences, Engineering, and Medicine. It's activities solve complex problems and inform public policy decisions, and it provides independent and objective analysis and advice to the nation. The TRB'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. CDOT contributes funds to support the TRB through the DTD Work Program.

The TRB has several hundred standing committees and task forces, consisting largely of volunteers. Among its activities are the publication of peer-reviewed reports and research papers, management of cooperative research including the NCHRP, operation of the Transportation Research Information Services (TRIS) and the Transportation Research International Documentation (TRID), and hosting the TRB Annual Meeting as well as many topical conferences and symposia each year. CDOT and OAR subject matter experts serve on numerous TRB committees and participate in many services provided by the Board. See the TRB website for further information.

OAR organizes most of CDOT's interactions with the TRB. The DTD Assistant Director for Research, also known as the OAR Director, is the State of Colorado's representative to the TRB. Responsibilities include

- Keeping the TRB informed of challenges facing CDOT and our research activities.
- Updating CDOT on TRB activities and national research efforts
- Identifying qualified people to serve as TRB committee and panel members.
- Working with TRB to schedule the annual TRB State Partnership Visit

CDOT supports and relies on the TRB's TRID database. Each of our research reports is submitted to this database, adding to the common body of knowledge so other states and other research organizations can access them. The TRID database is also one of the most important sources when our CDOT Research Library conducts a literature review.

Each year, the TRB Annual Meeting provides an opportunity for CDOT research staff and subject matter experts throughout CDOT to learn about the latest transportation research results, as well as research in progress. It is also a venue to present and share CDOT ideas and solutions, to develop relationships with peers at other state DOTs, and to visit with industry representatives and view their latest products. Many TRB topical meetings and workshops also occur throughout the year, providing CDOT specialists opportunities to work with colleagues and researchers on transportation problems in their area of expertise.

The National Cooperative Highway Research Program (NCHRP)
NCHRP is an AASHTO program, managed by the TRB, where states and the FHWA contribute funds to address transportation research problems of national interest. Each state contributes 5.5% of their SPR funds. No state match is required.

Like research management at the state level, NCHRP research begins by soliciting problem statements. These are invited from state transportation agencies and the FHWA. They are reviewed by subject matter experts from TRB, FHWA, and AASHTO committees. State transportation agencies are then provided with all problem statements, reviews, and author's responses to the reviews, and are asked to rate each problem statement. Considering all states input and all reviews, the AASHTO Special Committee on Research and Innovation then meets to recommend an annual program of NCHRP research projects which is voted on by the CDOT Executive Director and their counterpart in all states.

CDOT supports this NCHRP process at several stages. The OAR Director encourages NCHRP problem statement submissions, gathers advice from within CDOT to rate problem statements, and nominates experts and staff to serve on NCHRP study panels.

The American Association of State Highway Transportation Officials (AASHTO)
AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments throughout the U.S. One of the organization's roles is to serve as a liaison between state departments of transportation and the federal government. AASHTO operates the NCHRP. The AASHTO Special Committee on Research and Innovation organizes activities within the transportation research community and develops research priorities for NCHRP. Within this Special Committee, the Research Advisory Committee (RAC) includes research managers from each state DOT and provides input on needs and priorities. The RAC has four regions, with Colorado participating with the western states in RAC Region 4 (RAC4). An important function of the AASHTO-RAC is to facilitate information exchange through surveys that support research and provide a link between research managers. The OAR Director represents Colorado on the RAC and OAR coordinates input to AASHTO surveys from subject matter experts within CDOT. In 2024 RAC Region 4 formed the Western Transportation Research Consortium as a forum for RAC4 states to collaborate and coordinate activities.

Local Technical Assistance Program (LTAP)

The Local Technical Assistance Program (LTAP) is an FHWA technology transfer program that provides technical assistance and training to local transportation departments. OAR has operated the Colorado LTAP program since 1986. It is currently run as a cooperative effort between the FHWA, CDOT, and Front Range Community College.

LTAP strives to bridge the gap between research and practice by conducting training sessions and demonstrations and by serving as a clearinghouse for information related to state-of-the-art technology in the construction and maintenance of roads and bridges.

Colorado LTAP manages three training programs offering dozens of courses each year.

- The **Roads Scholar I** program provides participants with the training necessary to increase their knowledge of transportation safety, as well as local road maintenance and construction procedures, and to improve their technical skills. Four required courses and 5 elective courses are needed for graduation.

- The **Roads Scholar II: Road Master** program is an advanced training program for experienced maintenance workers, equipment operators, and managers. The program includes courses in four focus areas: safety, environment, transportation management, and technical skills. It provides Colorado's municipal highway personnel with knowledge of modern road maintenance management procedures and techniques. Graduation requires prior completion of Roads Scholar I as well as 14 hours of coursework in each of the focus areas.

- The **Supervisory Skills and Development Program** educates, prepares, and provides public works employees with the background necessary to confidently perform in a supervisory position. The courses provide a fundamental understanding of the roles and responsibilities of a supervisor and help students develop tools for succeeding in management. Each of the 9 required classes includes 7 hours of training.

In addition to the three training programs, Colorado LTAP provides many in-person classes and on-demand and online resources through a training database, recorded training, and webinars. It also operates an equipment loan program to give local transportation practitioners short-term access to needed tools, and a lending library which shares reference materials.

Finally, Colorado LTAP connects CDOT to Colorado's local agencies and the agencies to each other via a newsletter, Google Group, and a strong social media presence.

The CDOT Research Library

The CDOT Research Library, operated by OAR, provides transportation-related resources and services to CDOT employees, CDOT partners, and the public. The library contains digital and print materials including research reports, agency publications, books, eBooks, Audiobooks, archival materials, journals, environmental reports, newsletters, and historical information about Colorado's highways and bridges. Unrestricted access to the collections is available through the online catalog.

Located in the CDOT Headquarters building in Denver, employees are welcome to browse the shelves at headquarters on any working day. Members of the public can use library materials on-site by request or appointment.

CDOT research library activities include

- **Research Assistance:** The library staff helps locate needed information. CDOT employees may request any library publications or resources. The CDOT Librarian can deliver materials electronically or via inter-office mail. A ***Library Request Form*** is available if further assistance is needed.
- **Literature Searches:** The Librarian can conduct searches of catalogs and databases related to any specific topic. A more detailed Literature Search or Literature Review can be arranged for current or potential research topics.
- **Online Catalog:** The library collection can be searched using the online library catalog. CDOT reports and NEPA documents found through the catalog are

available digitally 24/7. For further assistance, the Research Librarian is available to help.

- **OAR Newsletter:** The OAR newsletter is distributed to subscribers quarterly and informs stakeholders of Problem Statement deadlines, research opportunities and announcements, library updates, recent projects, and other topics.
- **Transportation Databases:** The library provides access to transportation databases for research and information gathering.
- **Online Journals:** CDOT employees have access to selected newspapers and journals through institutional subscriptions and can request articles from other journals. Contact the librarian for an institutional login.
- **Subject Guides:** Subject guides (LibGuides) are collections of library resources on a particular topic compiled by the CDOT Research Librarian. They help users explore topics through hand-picked resources such as databases, journals, and websites.
- **Book/Author Series:** The CDOT library organizes a transportation book series to introduce and engage staff to innovative ideas and new topics. Each quarter the library features a new book, provides a list of related resources, and organizes an event where the book is discussed, sometimes with its author present.

Other RD&T Activities

OAR and the STIC manages the Technology Deployment Funds (T2) process for CDOT. T2 is a set of Technology Transfer activities required of all federal departments by Congress. FHWA partners with state DOTs in the identification and development of innovative technologies and practices, and the implementation of innovations. Applications for T2 funds are reviewed and prioritized by OAR and the STIC before submission to FHWA. These applications compete nationally for funds and winning applications typically receive $5,000 - $7,500. T2 funds are used for outreach activities related to research, development, technology, and innovation. Examples of eligible activities are peer exchanges, scan tours, brochures, trainings, workshops, demonstration projects, production of graphics or audio-visuals, and other outreach. OAR also facilitates technology transfer in other ways including its operation of the Research Library and LTAP, participation in the STIC and other CDOT committees, professional conferences, outreach related to local and national research, and tracking and encouragement of research implementation.

OAR participates in and sometimes manages the STIC. This council facilitates the rapid implementation of technology, processes, procedures, and techniques among transportation professionals to ensure smart and efficient investment in Colorado's transportation infrastructure. The STIC Incentive Program provides funding and resources to foster a culture of innovation and to move innovations into standard practice. OAR has a seat on the STIC and in some years has coordinated its activities, including applications for and distribution of funds from the Incentive Program. Through the program, funding up to $125,000 per federal fiscal year is available to support the costs of standardizing innovative practices in Colorado.

6. Research Roles and Functions

All CDOT staff have a role in identifying research needs. They may also submit problem statements or seek subject matter experts to help shape a need into a problem statement. This chapter describes roles and their responsibilities at each step of the research cycle. In addition to these functions, CDOT and OAR staff have other duties that support the overall health and operation of the CDOT RD&T program.

DTD Assistant Director for Research (OAR Director)

The OAR Director is responsible for oversight of the CDOT RD&T program and for CDOT's participation in the federal RD&T program. Responsibilities include:

1. Provide overall management of the RD&T program and staff.
2. Research Problem Statement solicitation, evaluation, and selection responsibilities.
    a. With broad CDOT and State of Colorado goals as a guide, solicit problem statements from CDOT employees, Colorado universities, and others.
    b. Distribute problem statements to the appropriate OAR research project manager for evaluation by oversight teams (OT). In coordination with the research project manager, review OT recommendations.
    c. Organize meetings of the Research Implementation Council (RIC) to review and prioritize the problem statements and recommendations forwarded from the research oversight teams.
    d. Compile RIC recommendations and review them with the DTD Director and the Chief Engineer. Provide information as needed to facilitate final CDOT selections. Ensure selected projects are entered into the DTD Work Program for approval by FHWA.
    e. Ensure active and completed project status is included in the CDOT DTD Annual SPR Accomplishments Report, which is submitted by DTD to FHWA within 90 days after the ending of a Work Program.
    f. Distribute fully approved projects to research project managers based on expertise and workload. Review the final study plan (typically the Scope-of-Work, SOW) for each project, including the plan for implementation.
    g. Manage research projects of special significance to CDOT executive management; and
    h. Monitor and track the implementation and impacts of research project results to ensure the RD&T program is effective.
3. Chair and ensure good function of the RIC.
    a. Ensure the RIC membership is balanced and encompasses broad knowledge of CDOT needs.
    b. Together with the DTD Director and Chief Engineer, nominate and promote candidates to RIC membership.
4. Work with CDOT to set the research program's strategic direction.
    a. Engage RIC members and executive management to set and adjust strategic research priorities and call a RIC meeting if discussion is needed.

b. Develop the annual RD&T Work Program based on RIC recommendations and present it to DTD management. Amend the current RD&T Work Program throughout the year as needed.

5. Coordinate CDOT research activities with other state's research programs, FHWA, TRB, and AASHTO, and represent CDOT on national level including the Research Advisory Committee (RAC) to the AASHTO Special Committee on Research and Innovation.

Research Project Manager and Study Manager

Each research project manager is responsible for forming a program of research that advances their areas of responsibility. The research project manager is usually the study manager of their projects and is directly responsible for the project. They are central to its steps and activities from cradle to grave. The study manager guides the problem statement through the screening and evaluation steps of the OT and RIC. For problem statements that are selected for funding, they coordinate the selection of a research team, and they manage and support the research from its kick-off to its conclusion. They also work with the study champion to track implementation and impacts after the research. Responsibilities of the study manager include:

1. Building and maintaining a program of research
    a. Maintain current knowledge of the problems and opportunities that CDOT encounters.
    b. Manage the selection of OT members and facilitate OT meetings.
    c. Continuously review ongoing and recently completed research and innovations outside Colorado, including through Research-In-Progress reports, final reports in the TRID database from other agencies, and pooled fund final reports.
    d. Convey relevant information to CDOT practitioners.
2. Research Problem Statement Solicitation, Evaluation, Selection Cycle responsibilities.
    a. Encourage the submission of relevant problem statements. Work with subject matter experts to form well-posed problem statements.
    b. Assemble the Oversight Team to provide advice on Problem Statements. This should include its practicality, priority, and timeliness. OT advice should include a recommendation whether to forward a Problem Statement to the RIC.
    c. In coordination with the OAR Director, review research oversight team recommendations and prepare them for presentation to the RIC.
3. Research Project initiation and execution. This applies to the set of problem statements selected by CDOT and in the approved DTD SPR Work Program.
    a. Become familiar with the research project and related issues through literature reviews and discussions with other knowledgeable people on the subject.
    b. In consultation with the RIC sponsor and Study Champion, assemble a study panel composed of at least two people from CDOT who are outside of OAR. At least one member of the study panel should be the appropriate departmental subject matter expert. FHWA participation should also be solicited.
    c. With the study panel, develop a Scope of Work (SOW) that translates the Problem Statement into a project plan intended to lead to beneficial outcomes for CDOT. Work with the DTD Administration Office to initiate the solicitation

and selection of a principal investigator through division and CDOT fiscal processes.

d. Manage and document the Principal Investigator (PI) selection process. This includes working with the CDOT Business Office to complete appropriate forms, soliciting proposals, coordinating PI selection with study panel input, negotiating the agreement with the PI, and finalizing contract documents.
e. Provide the PI with an official notice to proceed letter when the expenditure of funds has been authorized by the CDOT Division of Accounting and Finance.
f. In coordination with the study panel leader (typically the Study Champion), keep the research project on schedule and track the budget. Review the project's progress and adherence to milestones. With the Study Panel leader, communicate regularly with the PI and relate any issues of concern to the study panel and RIC sponsor. Conduct study panel meetings and keep the study panel informed, as needed.
g. Review, approve, and forward for payment vendor-submitted project invoices.
h. Maintain documentation and records, including study panel contact information, contract amendments, billing and payment status, etc.
i. Ensure deliverables including required progress reports are received on time.
j. Review and ensure that project Research Briefs and Final Reports meet CDOT and FHWA accessibility requirements. Coordinate the review of project final reports and their publication and distribution by the research librarian.
k. Prepare a short description of the status of the project annually for inclusion in the annual DTD Work Program Accomplishment Report.
l. Coordinate the development of the Research Outcomes Implementation Plan. Track and update the impacts and implementation of completed projects over time to ensure the research program is effective.
m. Finalize financial records and reports and work with DTD's Administration Office on project and purchasing close out process, per division and CDOT procedures.

4. Any other activities necessary to lead the research project to a successful conclusion.

Study Champion

Every major research project undertaken by OAR requires a dedicated champion. The champion has a strong impact on the chance for successful completion and implementation of the project results. The champion fills an important and substantial role and must be committed to the tasks needed for a successful project. They are often a subject matter expert knowledgeable about the technical aspects of the topic. The champion commits to dedicate the time and resources needed to help the PI and research project manager successfully complete the research and has a critical role in the implementation of its results. The Study Champion is typically also the Study Panel leader.

Responsibilities of the study champion include, but are not limited to:

1. As needed, work with the individual initiating a problem statement to develop the idea and propose how research could address the problem. In preparation for the OT and RIC meetings, provide a clear rationale for the value of solving the problem.
2. For problem statements selected by CDOT and in the approved DTD SPR Work Program, work with the study manager to form a study panel, create the SOW, and select a PI.
3. Work with the Study Manager to create the study panel and in most cases lead this panel. Work with the panel members to monitor and guide progress of the research.
4. Support the PI and act as a liaison to CDOT resources.
5. Critically review all project deliverables including Quarterly Progress Reports (QPRs) and the draft and final reports, along with other study panel members
6. Following the project completion, actively promote and track implementation of actionable research findings within CDOT groups. Periodically update status, progress, and impacts using the Research Outcomes Implementation Plan Form.

RIC Sponsor

Every major research project undertaken by OAR requires a RIC sponsor. This is to ensure there is management support for the project and strong follow through to implement results once the project is complete. The RIC sponsor can be a CDOT DTD Unit Manager or a RIC member. A RIC sponsor is also required for CDOT participation in TPF studies.

Responsibilities of the RIC sponsor include supporting OAR and the study champion, and

1. Participate in assembly of the study panel, if needed
2. Monitor the progress of the research to help ensure it will meet a CDOT need.
3. Review and approve the detailed project plan/SOW or in-house proposal drafted by the study panel, if needed
4. Review the research project's final report and implementation plan.
5. Strongly promote the implementation of the research findings throughout CDOT.

Oversight Teams

The oversight teams (OTs) are composed primarily of CDOT subject matter experts qualified to review and provide advice on submitted problem statements. OTs may address the need for the research, the likelihood that it will result in conclusions that can be applied within CDOT, and its alignment with CDOT's mission, vision, and strategic goals. The OT's responsibilities include

1. Review all research problem statements assigned.
2. Recommend whether to endorse, enhance, combine, modify, or reject the problem statements, and whether to forward them to the RIC for further consideration.
3. Actively consider CDOT strategic needs and, when needed, create or motivate problem statements to address them.

Research Implementation Council (RIC)

RIC members bring a broad knowledge of Colorado and CDOT transportation research and development needs. The RIC recommends an RD&T program to meet these needs. Research projects are prioritized by the RIC through a process that ensures the CDOT mission, vision, and strategic goals are considered.

The members of the RIC are selected by the OAR Director and approved by the DTD Director and Chief Engineer with the objective of maintaining a proactive RIC that broadly represents the transportation program. A representative from the Colorado Division of the FHWA is invited to attend and participate in RIC meetings but is not a member and does not have formal duties. For many project areas, the RIC will include a member who has the subject area authority within CDOT and will serve as the RIC Sponsor for research projects in that subject area.

RIC members' activities include,

1. Advocate for, maintain, and enhance the engagement of CDOT staff with OAR activities.
2. Review problem statements that are supported by the OTs, participate in discussions at RIC problem statement evaluation meetings (2 each year), and provide recommendations and prioritization for funding.
3. Help identify CDOT champions and subject matter experts for studies.
4. Sponsor research projects that fall in their area of responsibility.
5. Participate in meetings with OAR to exchange information and updates, and to provide advice on future directions for CDOT research and OAR research administration.
6. Raise broad CDOT research needs, and support implementation of research results.

Study Panel

Each research project has a study panel formed by the Study Manager, Study Champion, and RIC Sponsor to guide and support the research. Study panel members bring subject matter expertise and relevant knowledge, and often are stakeholders in the research outcome.

The functions of the study panel are to

1. Assist the study manager with the project definition and contracting steps. This includes assisting with
    a. Development and review of the SOW. Note that significant change to the approved problem statement requires approval of the OAR Director. Funding changes also require FHWA approval through a DTD Work Program amendment.
    b. Advice on strategy for identifying qualified researchers. For example, projects may be undertaken by researchers at local public universities and state agencies, researchers found through a broad search of all universities, consultants, private research groups, or CDOT staff.
    c. Review of criteria used to evaluate proposals, including the ability of the PI to produce an implementable product on schedule and within budget.

    d. Selection of the PI based on the proposals received and selection criteria.
2. Participate in overseeing and guiding the research.
    a. Participate in panel meetings and provide technical advice.
    b. Review progress reports and notify the study manager of emerging concerns. Review deliverables, including draft and final reports; and
    c. Provide advice on implementation paths and review the implementation plan.
3. Implement usable results when they will benefit CDOT.

Principal Investigator (PI)

The functions of the PI include

1. Complete the research according to the contract SOW, as scheduled and within budget.
2. Identify any issue that could impact the SOW, expected outcome, schedule, or cost of the project and promptly communicate it to the study manager.
3. Fully and proactively participate in all panel meetings.
4. Ensure deliverables and invoices are submitted on time and follow CDOT requirements, including meeting accessibility requirements where applicable.
5. Provide progress reports to the study manager at the end of each calendar quarter or other agreed interval. This should include whether the project is on time or if extension of the performance period is needed. Changes must adhere to CDOT fiscal rules and continued authorization for funds expenditure by FHWA.
6. Throughout the research, consider how results and conclusions can be implemented.
7. Provide Research Briefs using the provided template.
8. Provide a draft final report to the study manager at least two months before the project is expected to conclude, address all study panel and editorial comments on the draft report, and submit a final report in required report format. The PI shall closely check the final report for editorial errors and ensure it is in compliance with federal and Colorado requirements of accessibility (Section 508 of the Rehabilitation Act (29 U.S.C. § 794d, as amended by the Workforce Investment Act of 1998 (P.L. 105-220)) and the State requirement to comply with Web Content Accessibility Guidelines (WCAG)). The final report should be submitted as a digital file in both Microsoft Word and PDF formats to the project manager. It should conform to the required research report formatting (see Appendix C).
9. At the end of the contract, provide a final invoice and notice that all deliverables have been completed.

Director of the Division of Transportation Development (DTD)

Functions of the Director of DTD as they relate to the RD&T Program are to

1. Participate in the development of strategic directions for research.
2. Review project recommendations of the RIC and make necessary adjustments in cooperation with the OAR Director and Chief Engineer
3. Review and approve the RD&T section of the DTD SPR Work Program

4. Submit the DTD SPR Work Program, in cooperation with the CDOT Executive Director, to the FHWA Division Office for approval.

Chief Engineer

Functions of the CDOT Chief Engineer as they relate to the RD&T Program are to

1. Encourage and support the participation of CDOT engineering and technical staff in all aspects of research.
2. Support and advocate for the implementation of research, especially for major changes to current practices.
3. Participate in the development of strategic directions for research.
4. Review and approve project recommendations of the RIC, making necessary adjustments in cooperation with the OAR Director and DTD Director, and
5. Communicate relevant research findings to the Division of Engineering staff.

CDOT Research Librarian

The CDOT research librarian is responsible for the CDOT library, which houses the most comprehensive collection of transportation reference materials in Colorado. The librarian has access to national and international transportation reference resources. The library is open to CDOT employees and to the public, and its catalog is accessible online. Library staff perform customized literature searches on request.

The librarian supports research by

1. Overseeing the good function of the CDOT Research Library, including providing outreach and library services throughout CDOT and beyond.
2. Maintaining an up-to-date, accessible inventory of transportation reference materials
3. Maintaining the OAR portion of the CDOT website, at the CDOT library website.
4. Ensuring CDOT research final reports are properly formatted and meet accessibility requirements, are published online, and are submitted to national databases, and
5. Conducting literature searches for OAR projects either directly or through contract services

Figure 4. Autonomous attenuator truck testing. CDOT leads the Autonomous Maintenance Technology pooled fund study

7. Research Project Identification

Research project ideas are gathered through the solicitation of problem statements. Studies may also be proposed and requested by the OAR Director based on interest from CDOT management, CDOT staff, or FHWA personnel.

The three stages in a research project's life cycle are (1) the review and selection steps, which occur between problem statement submission and the incorporation of the project into the DTD Work Program (this chapter), (2) the research project management steps, which occur from project approval through publication of a final report, as described in Chapter 8, and (3) implementation of results following the project, as described in Chapter 9.

Steps for study identification and development are (dates are approximate):

1. OAR accepts research problem statements throughout the year and conducts an evaluation and selection process twice each fiscal year. Colorado's fiscal year begins on July 1. Problem statements are submitted via the OAR Research Problem Statement web page. Deadlines are set for approximately the second Monday of February (the Spring cycle) and the second Monday of August (the Fall Cycle), and problem statements submitted by the deadline enter the review process. Approximately 2 months before the deadlines OAR will publicize the submission opportunity. The required forms (see Appendix C) consist of basic information in an intake form, the problem statement form, and a short summary (presentation slides) to aid in the review. Templates are provided.
2. Each problem statement must have an identified CDOT champion. If requested by the champion or the OAR Director, a preliminary literature search will be performed through the CDOT Research Library.
3. In consultation with OAR staff, the OAR Director may elect to decline submissions that are not practical. Submissions may also be deferred to a future evaluation cycle, with recommendations for further development.
4. The OAR Director distributes each problem statement to the appropriate OAR research program manager. Oversight Teams will consider and discuss each problem statement (its relation to previous research, need, timeliness, feasibility, application, and relation to strategic directions of CDOT), and provide OAR with opinions.
5. OAR will consider the views of each oversight team and determine the subset of problem statements to be evaluated by the RIC. This subset will be passed to the RIC prior to the RIC evaluation meeting.
6. RIC meetings will be scheduled approximately 6 weeks after the problem statement deadlines. The RIC will meet and provide recommendations on the priority of the problem statements, as well as provide comments supporting their recommendation.
7. A final set of Problem Statements are determined by the OAR Director in consultation with and approval by the DTD Director and the Chief Engineer. Approval determinations will be finalized through a joint memorandum including the OAR Director, DTD Director and Chief Engineer. For the Spring cycle, decisions will be entered into the following fiscal year's proposed DTD SPR Work Program for consideration and approval by FHWA. Once in the approved Work Program, Spring cycle projects can become active on July 1. Fall cycle problem statements are

submitted for inclusion through an Amendment to the current fiscal year Work Program.

8. Sometimes there is a compelling need for a research project to be undertaken sooner than the next RIC evaluation cycle allows. In this situation, a decision may be made jointly by the OAR Director, DTD Director, and Chief Engineer. Also, the OAR Director may make decisions about supplements to funding for projects that have been previously approved by the RIC, as well as for smaller new projects. These are rare occurrences. FHWA approval, through an amendment to the SPR Work Program, is required for new projects or funding above already approved amounts.

In evaluating projects for the Work Program, the OTs, RIC, and those in the approval chain will evaluate the problem statements based on research need and importance and implementation potential, using organizational strategic priorities as context. The potential to implement results in a way that will have a clear positive impact for CDOT is always a central consideration.

Figure 5. Debris flow damage to Interstate 70 through Glenwood Canyon, CO following heavy rain on the Grizzly Creek fire burn scar.

8. Active Research Project Steps

Research project management steps take place following approval of the projects in the SPR Work Program and end with the publication of a final report. Throughout this active phase, implementation of results remains an important consideration.

Once projects are fully approved and in the Work Program, OAR staff and CDOT subject matter experts develop the problem statements into well-defined research projects. Generally, a SOW is developed for use in an RFP. State procurement processes are followed to engage the best qualified researcher (see Appendix E). A research project is rarely completed within the same fiscal year it is budgeted. The research program consists of both new studies budgeted in the current fiscal year and ongoing studies still in progress.

The following are key steps when undertaking a research project

Assign a Study Manager
For each approved research project, the OAR Director designates a study manager from the OAR staff. Typically, this is the person who led the problem statement through the OT evaluation, and the study manager remains involved with the research project to completion.

Assemble a Study Panel
The study manager and study champion assemble a study panel composed of at least two people from CDOT who are outside the OAR and have relevant expertise. One study panel member should be an appropriate subject matter expert. Most often, the champion is also the study panel leader. Study panel members and the study manager develop a SOW based on the problem statement. (See also Functions of the Study Panel in Ch 6. Research Roles and Functions).

Initiate the Procurement Process
Working with the DTD Administration Office and CDOT Procurement and Contract Services Office the study manager determines the best procurement method for the research project. Appendix E outlines common procurement methods for research projects. Following procurement rules, the study panel will review proposals and recommend a PI.

Negotiate the PI Contract
The study manager and CDOT Procurement and Contract Services office negotiates the final agreement with the PI. Along with work specific to conducting the research, this agreement will require a standard set of deliverables including

- Quarterly progress reports (or another period as agreed) using the required format (see Appendix C).
- A Data Management Plan. This should be provided early in the project. It is intended to be a living document to be updated as needed throughout the project.
- A final presentation to the study panel.
- The final report in the required format (see Appendix C), including a written implementation plan. This includes a concise executive summary.

- Participation in a focused meeting with the CDOT Study Manager, Project Manager, and others to discuss implementation of results.
- Annual research briefs suitable to convey the project goals and status or results to a broad audience. A recommended format is provided (see Appendix C).

Contract Start
Once the contract is in force, the study manager will issue a Notice to Proceed to the PI. The PI will begin the study, generally with a study panel kickoff meeting.

Progress Reports and Budget Tracking
The study manager and study champion are the primary points of contact between the PI and CDOT. Together they have the responsibility for reviewing progress reports and invoices to ensure the project stays on track both in its progress and its use of funds. Periodic progress reports are required for each study. The study manager will follow-up with the PI to ensure the timely submission of these reports in CDOT format (Appendix C). Progress reports also support the study manager's verification of work done when approving submitted invoices.

The study manager will track the progress of the study and determine if the PI is following the scope of work and is within the budget. If necessary, the study manager will work with the PI to correct or clarify any variances, informing the study panel and the OAR Director if the study is behind schedule or is not following the direction and budget of the contract.

Payments
The study manager will certify invoices for payment that are consistent with the progress reported and ensure invoices are submitted through the invoice processing system, financially coded properly, and forwarded to the DTD Administration Office for second-level approval. The study champion will also review invoices to verify goods received.

Changes to the Study
If changes in the schedule, budget, or Work Program are necessary, it is the responsibility of the PI to submit a request in writing to the study manager following the terms of the contract. If an amendment to the contract is needed, the study manager will work with the DTD Administration Office to submit an amendment to the current contracting/purchasing authorization document through the CDOT Procurement and Contract Services Office to enact the changes following state fiscal rules. If an amendment to the SPR Work Program is needed, it must be approved by FHWA. Requested changes should be in consultation with the study panel and require the approval of the OAR Director. Contracting can take several months so it is important to anticipate changes that will require a contract amendment well in advance.

Final Report Review
The PI shall submit a draft final report no less than two months before the end of the project. This draft must be in good form, including its spelling and grammar. The study panel members review the draft final report and provide any necessary feedback. The study manager may also request that other subject matter experts from inside or outside the department review the report. This review should address the technical merits of the report, as well as an editorial review. All comments from the reviewers must be addressed by the PI to the satisfaction of the study manager before the report is accepted and published.

Presentation of the Research to the Study Panel and Interested Parties
The PI will present the findings and recommendations of the research, typically through a PowerPoint presentation, to the study panel members and other interested parties invited by the project manager. The PI will incorporate comments and suggestions received during the presentation into the final report.

Final Report
Final reports shall be prepared promptly for each research project and must follow the OAR research report format (Appendix C) and meet accessibility requirements. A completed "Technical Report Documentation Page" must be included in the report. Conclusions shall be well justified, and research findings by others shall be referenced appropriately. The PI shall closely check the final report for editorial errors and ensure it is in compliance with federal and Colorado requirements of accessibility (Section 508 of the Rehabilitation Act (29 U.S.C. § 794d, as amended by the Workforce Investment Act of 1998 (P.L. 105-220)) and the State requirement to comply with Web Content Accessibility Guidelines (WCAG)). Once complete, the PI shall submit an electronic Microsoft Word file and a PDF file to the project manager. The PDF report will undergo a final review by the research librarian and project manager. The librarian will review the cover, front matter, executive summary, and conclusions for grammatical and spelling errors and conformance to accessibility requirements. Once accepted by CDOT, the report will be published on the OAR web site and submitted to the TRID database, and a link will be made available on the next scheduled DTD Work Program Accomplishment Report with the approved task that is being closed out.

Data Management and Curation
Following the accepted Data Management Plan, documented data sets should be placed in a permanent repository and remain available for future requests and use. Some datasets may be archived and curated within the CDOT Office of Data Management's Advanced Data Analytics Platform (ADAP).

Project Closeout
Once the final report is accepted as complete, the project manager and research librarian will ensure closeout steps are completed. These include

- Publishing the report to the CDOT OAR website, its intake to the CDOT Research Library, and forwarding it for inclusion in the TRID database and other transportation libraries.
- Forwarding the report to Study Panel members and other interested stakeholders.
- Checking that all contract deliverables are received, that all invoices have been paid, and working with the DTD Administration Office on financial closeout procedures to close the project subaccount.
- Archiving key project information and files on the OAR internal shared space.
- Conduct an implementation planning meeting with the Study Manager, Study Champion, RIC Sponsor, and with the PI if available. Develop the CDOT Implementation Plan to translate research recommendations into a practical strategy.

9. Research Project Implementation

Although implementation occurs after the research is complete, it is considered throughout the research process. Because of its importance, it is a responsibility of nearly all roles outlined in Chapter 6.

Implementation Focus During the Project Formation and During the Research

Consideration of how the research will be used by CDOT, or implemented, is present as early as Problem Statement submission. A question on the Problem Statement submission form asks how the research findings may be used in the planning, design, construction, maintenance or operation, and safety improvement of Colorado's transportation system. Because each submission requires a CDOT study champion, even ideas that originate outside CDOT will have a CDOT subject matter expert thinking about how the research will be used.

The feasibility and potential impacts of the research idea are considered by the OT and the RIC as part of their evaluation, and if the idea progresses this is also considered during approval by the OAR Director, DTD Director, and Chief Engineer.

The project SOW developed by the study panel will include contractual requirements for consideration of implementation. The Final Report must include an Implementation Statement that identifies which recommendations should be implemented by CDOT, describes an implementation strategy, and discusses how CDOT would benefit. This information should also be included in the final presentation by the PI to the study panel.

As a final step in the research phase of the project, the study manager and champion work with the study panel, PI, and others to develop the Implementation Plan (the implementation plan format can be found in Appendix C). The plan identifies the expected implementation product and the steps needed to put the findings into standard practice at CDOT.

It is the nature of research to uncover new knowledge or understanding. Not every project will end with implementable results. However, most funded projects do produce results that can be considered for implementation.

Implementation Following Completion of the Research

Once the research is complete, the Study Champion and RIC Sponsor have the primary responsibility for implementation. When applicable, the Chief Engineer should support the spread of its implementation throughout CDOT.

Implementation typically includes an effort to communicate findings to appropriate staff (through presentations or training) and incorporating the findings into CDOT operating documents (Standards specifications, Design Manual, Materials Manual, etc.). It can sometimes include pilot projects and steps to formally approve changes. Typically, implementing research outcomes will improve or impact design and construction methods, design and construction specifications, planning processes, maintenance practice, and/or content of manuals. They may also lead to the initiation of new programs or may provide new

technology. In some cases, such as research projects with negative results, no implementation will be appropriate.

Following the creation of the Implementation Plan, the Project Manager coordinates tracking the progress of the project's implementation to evaluate its benefit for CDOT. The Project Manager requests that the champion report implementation status and progress each year. This can be an update of the "Research Outcomes Implementation Plan" (Appendix C).

Finally, OAR conducts activities that, while not applicable to every project, can promote implementation. These include communicating research findings through the Research Brief, participation on the State Transportation Innovation Council incentive program (STIC), and managing the Technology Transfer program (T2). OAR also highlights recently completed projects in the quarterly Research Newsletter.

Figure 6. Mule deer approaching the new wildlife underpass for State Highway 9. CDOT research documented a 92% reduction in wildlife-vehicle crashes following the addition of wildlife crossings, fencing, escape ramps, and other treatments at key locations along SH9.

10. Peer Exchange Process

Exchange of knowledge and practices with peer research programs helps to maintain the good performance of state DOT research. This external review process provides new ideas, ensures information exchange with similar programs, and generates recommendations to enhance OAR's performance. 23 CFR 420.209 requires that a peer exchange be completed periodically. FHWA interprets that to mean that a peer exchange shall be completed approximately every 5 years. CDOT is now a member of the Western Transportation Research Consortium which integrates state research peer exchanges with WTRC meetings. In the future CDOT may take advantage of this venue for its peer exchange.

Peer Exchange Panel
A panel with knowledge of state research programs is invited to learn about the CDOT RD&T management process, present their processes, and recommend improvements. The peer exchange may take place virtually or in person. OAR will budget SPR-B funds for contracted support and travel expenses if needed. The external panel may consist of

- Research managers and staff from other state DOTs and representatives from the FHWA
- Representatives from other federal, state, regional, or local transportation agencies
- Representatives with research management responsibilities from private consulting companies, government laboratories, or universities
- Other participants that the OAR Director believes will be valuable

The OAR Director and OAR staff will participate and interact with the panel. Other CDOT staff will be invited to learn and to present as appropriate.

Agenda
The peer exchange panel typically spends about two days with OAR staff and research program stakeholders. The focus of a peer exchange is at the discretion of the host program, but it must address management practices. A non-exhaustive list of Research Peer Exchange topics is available from the AASHTO Special Committee on Research and Innovation.

Peer Exchange Panel Report
The panel will prepare a draft report that summarizes the meeting and its recommendations and actions addressing the efficiency and effectiveness of the RD&T program. After discussing their findings and recommendations with CDOT staff, the panel will finalize the report. The written report is shared on the AASHTO Research and Innovation website, and a copy is forwarded to the FHWA Colorado Division.

Participation in Reviews with other state DOTs
CDOT research staff participate in reviews of other state DOT research programs. As well as supporting these programs, reviewers should bring back new ideas, insights, and new perspectives to the Colorado research program.

- ## Appendix A – Definitions and Acronyms[4]

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 transportation modes, including air, highways, public transportation, active transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system.

Areas of Emphasis
Areas of Emphasis are topical areas of special interest for research at CDOT. They are areas where focused research has the potential to result in substantial near-term and long-term benefits to Colorado, and where local factors make Colorado a logical choice to lead this research.

OAR – Office of Applied Research
OAR manages the Research, Development and Technology (RD&T) program to address research needs across CDOT. Research addresses methods, materials, technologies, and planning to enable CDOT to promote safety, enhance mobility and sustainability, save money, plan for future technologies, and protect the public investment in transportation infrastructure. OAR is sometimes referred to as the Research Branch because of its historical name (the Applied Research and Innovation Branch).

Applied Research
Applied research is original research undertaken to acquire new knowledge. Unlike basic research, it is directed primarily towards a specific, practical aim or objective.

CDOT – The Colorado Department of Transportation
The Colorado Department of Transportation (CDOT) exists to ensure that Colorado has a safe and efficient highway system by building and maintaining interstates, U.S. highways, and state highways.

DTD – Division of Transportation Development
The Office of Applied Research is one of 7 offices within the CDOT Division of Transportation Development.

FHWA - Federal Highway Administration
FHWA is an agency within the U.S. Department of Transportation that supports state and local governments in the design, construction, and maintenance of the Nation's highway system (Federal Aid Highway Program) and various federally and tribal-owned lands (Federal Lands Highway Program). FHWA provides stewardship over the construction, maintenance, and preservation of the Nation's highways, bridges, and tunnels. FHWA also conducts research and provides technical assistance to state and local agencies to improve safety, and mobility, and to encourage innovation.

[4] Acronyms used only in appendices are not included here.

Final Report
Research project Final Reports document all technical data, analyses, and findings for an entire project and demonstrate fulfillment of the conditions of the contract.

Implementation
Implementation is the process of putting research recommendations into practice. It is the adoption of a product for use and includes Technology Transfer activities that promote adoption, such as information dissemination, training, demonstration, and deployment.

LTAP – Local Technical Assistance Program
The Local Technical Assistance Program (LTAP) is a Federal Highway Administration (FHWA) technology transfer program that provides technical assistance and training to local transportation departments across the nation. LTAP strives to bridge the gap between research and practice by conducting training sessions and demonstrations and by serving as a clearinghouse for information related to state-of-the-art technology in the construction and maintenance of roads and bridges. LTAP is funded by the FHWA, with matching funds from state governments, universities, state highway agencies, and other organizations.

NCHRP - National Cooperative Highway Research Program
NCHRP is a transportation pooled fund program directed toward the study of problems of national significance that affect highway planning, design, construction, operation, and maintenance nationwide. NCHRP is administered by TRB and voluntarily sponsored by the state DOTs and other member departments of AASHTO. Each state's contribution amounts to 5.5 percent of its SPR apportionment. These funds can be spent only for the administration of problems approved by at least two-thirds of the states.

OT - Oversight Team
Oversight teams of experts and stakeholders established by OAR provide technical guidance and oversight for research in specific subject areas (refer to Chapter 5, “Research Roles and Functions”)

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

PI - Principal Investigator
The PI is the lead researcher who is responsible for the technical direction of the work on a research project. The PI has the primary responsibility and is expected to be available and actively involved in the research efforts for the full duration of the project. In some research studies, more than one person shares responsibility for research as Co-Principal Investigator(s).

Proposal
A Proposal is a document submitted by a prospective researcher to CDOT in response to the RFP (see below). It defines the scope of work, budget, project schedule, deliverables, and qualifications of the research team.

Problem Statement
The problem statement is a concise description of a problem or innovative idea that needs to be addressed through research. It must include the potential benefits of performing the research and implementation methods for the results. (Refer to Appendix C)

RFA – Request for Application
An RFA refers to the general process CDOT sometimes uses to select a PI to conduct a research project and write a final report. It refers to the informal process available only with Colorado public universities or government agencies. An application is not a proposal. It is a document similar to a proposal, submitted by a prospective researcher to CDOT in response to the RFA. It defines the scope of work, budget, project schedule, deliverables, and qualifications of the research team. A more formal process managed by the procurement office is called Request for Proposal (RFP).

RFP – Request for Proposal
An RFP refers to the general process CDOT uses to select a PI to conduct a research project and write a final report. It refers to the formal process managed by the procurement office where a panel of experts and stakeholders review proposals and select the one that is most beneficial to the state. OAR sometimes uses a less formal process to solicit public university proposals to select the best PI. The less formal process is sometimes called a Request for Application (RFA). Additional details are in Appendix E.

RD&T – Research, Development & Technology
RD&T activity means a basic or applied research project or study, development, or technology transfer activity (CFR 23 420.203). The state's RD&T program is funded through SPR Subpart B funding.

RIC – Research Implementation Council
The RIC is composed of CDOT senior managers selected jointly by OAR Director, DTD Director, and Chief Engineer. The RIC reviews, evaluates, and provides recommendations of research projects for funding based on CDOT's mission, strategy, and strategic goals. RIC members also provide advice on future directions for CDOT research and OAR research administration. A representative from the Colorado Division of the FHWA is invited to attend and participate in RIC meetings but is not a member and does not have formal duties.

SME - Subject Matter Expert
The SME is recognized statewide by peers to be an expert in a specific area of the transportation program.

SOW – Statement of Work (sometimes Scope of Work)
The SOW is a formal document that describes and defines the research work activities, deliverables, cost estimate, and schedule needed to address the problem statement or research idea.

SPR - State Planning and Research
SPR funding is the major source of funding for state transportation research. Federal law requires that two percent of the federal-aid funds given to states be apportioned for SPR activities. Of these funds, a minimum of twenty-five percent must be allocated for research, development, and technology (RD&T). RD&T activities involve research on new areas of knowledge; adapting findings to practical applications by developing new technologies; and the transfer of these technologies, including the process of dissemination, demonstration, training, and adoption of innovations by users.

Study Champion
The study champion, usually a subject matter expert with a strong interest in application of the expected research results, is responsible for leading the study team, overseeing and facilitating the successful technical conduct of the study, and strongly pursuing and advocating for implementation of the findings. (Refer to Chapter 5, "Research Roles and Functions")

Study Manager, also known as Project Manager
The study manager, usually a staff member from the OAR, is responsible for overseeing the research project and coordinating activities with the study panel, the PI, and various institutions. (Refer to Chapter 5, "Research Roles and Functions")

Study Panel
The study panel is an ad hoc committee consisting of experts and stakeholders, established to oversee a research project. It develops the directions of the study to best meets the needs of CDOT, reviews study progress, products, and reports, and develops the implementation plan for research findings. (Refer to Chapter 5, "Research Roles and Functions")

Technology Transfer
Technology transfer consists of activities that promote adoption of a new technique or product by users, often involving information dissemination, demonstration, deployment, training, and other activities.

TAC – Technical Advisory Committee
Each Transportation Pooled Fund project has a TAC to provide overall project direction and oversight. The TAC includes a technical representative from each participating agency and is chaired by the lead state representative.

TRB - Transportation Research Board
The TRB is one of seven programs within the National Academies of Sciences, Engineering, and Medicine. It conducts activities to solve complex problems and inform public policy decisions, and it provides independent and objective analysis and advice to the Nation. The TRB'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.

Transportation Pooled-Fund Studies
The Transportation Pooled Fund (TPF) Program, administered by FHWA, is a means for interested states, FHWA, and other organizations to partner when significant or widespread interest is shown in solving transportation-related problems. Partners may pool funds and other resources to solve these problems through research, planning, and technology transfer activities. (Refer to Chapter 6, "RD&T Program Overview" in this manual).

TRID - Transport Research International Documentation
The TRID database is an integrated database that combines the records from TRB's Transportation Research Information Services (TRIS) Database and the Organization for Economic Cooperation and Development (OECD) Joint Transport Research Centre's International Transport Research Documentation (ITRD) Database. The TRID database provides access to more than 1.3 million records of transportation research worldwide.

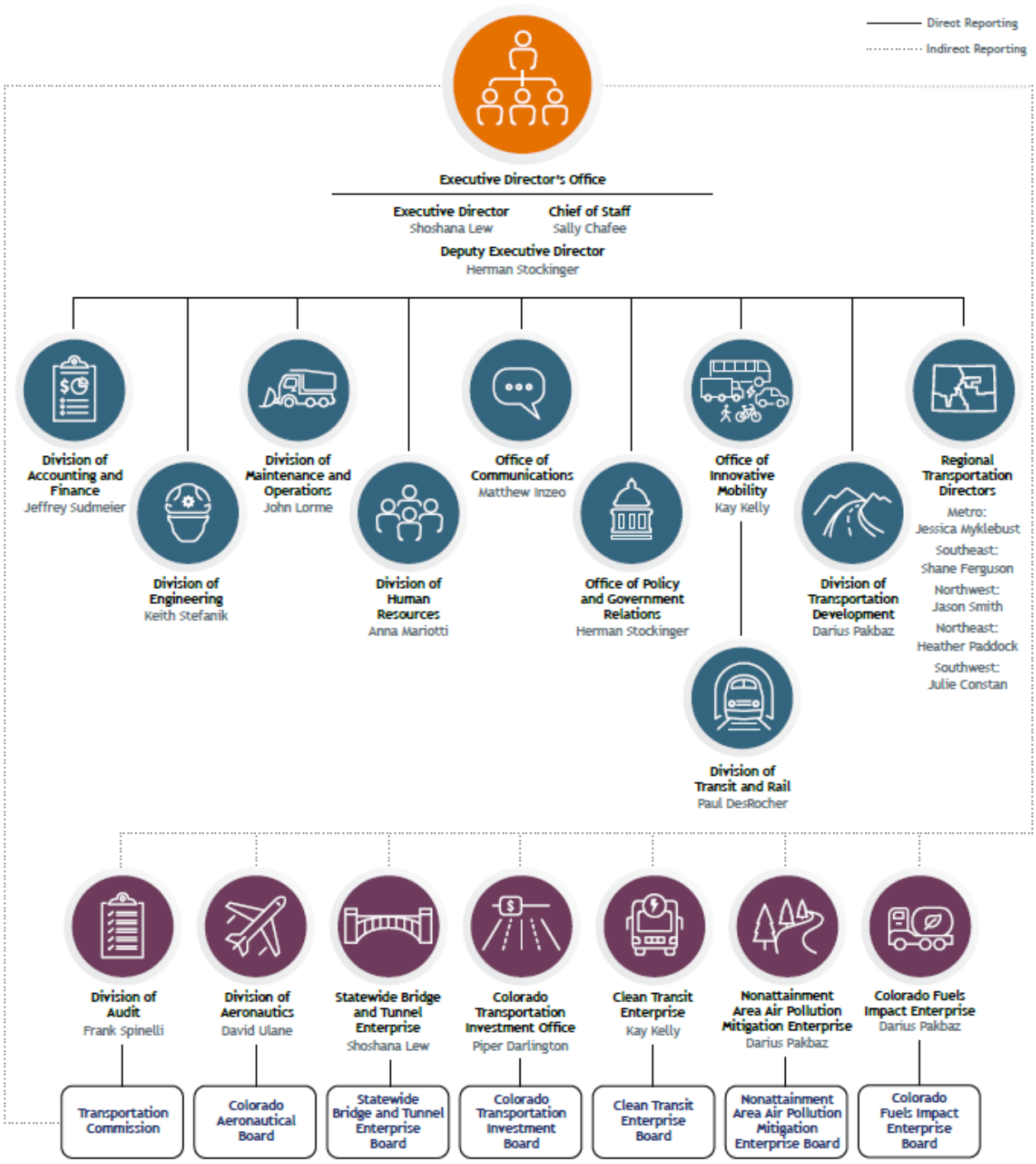
TRIS - Transport Research Information Services
TRB's Transportation Research Information Services (TRIS) includes the TRB Library and the TRB Databases which are available on the TRB website.

Work Program
The DTD SPR Work Program is a document that describes the budget and projects undertaken in each state fiscal year. The OAR part of the Work Program includes each research project. The Work Program is updated and approved by CDOT and FHWA annually.

Figure 7. Participants in the CDOT Research Peer Exchange, February-March 2023.

- **Appendix B – Organizational Structure, Mission, Vision, and Initiatives**

CDOT Organization Structure



Colorado Department of Transportation (CDOT) Organization Structure (FY2024-2025)

CDOT Mission and Vision

Mission: "To provide the best multi-modal transportation system for Colorado that most effectively and safely moves people, goods, and information."

Vision: "To enhance the quality of life and the environment of the citizens of Colorado by creating an integrated transportation system that focuses on safely moving people and goods by offering convenient linkages among modal choices."

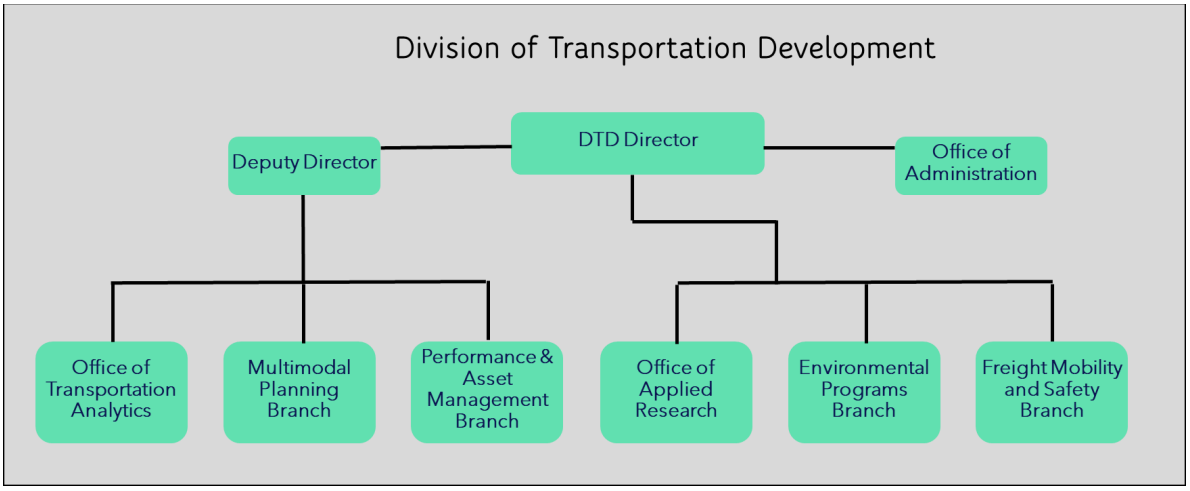
CDOT FISCAL YEAR 2024-2025 STRATEGIC POLICY INITIATIVES

Advancing Transportation Safety: Advance the safety of Colorado's Transportation System so all travelers arrive safely at their destination.

Clean Transportation: Reduce air pollution from the transportation sector.

Statewide Transit: Expand statewide transit

Colorado Department of Transportation (CDOT) Mission and Vision, and Strategic Policy Initiatives (FY2024-2025) (updated annually)

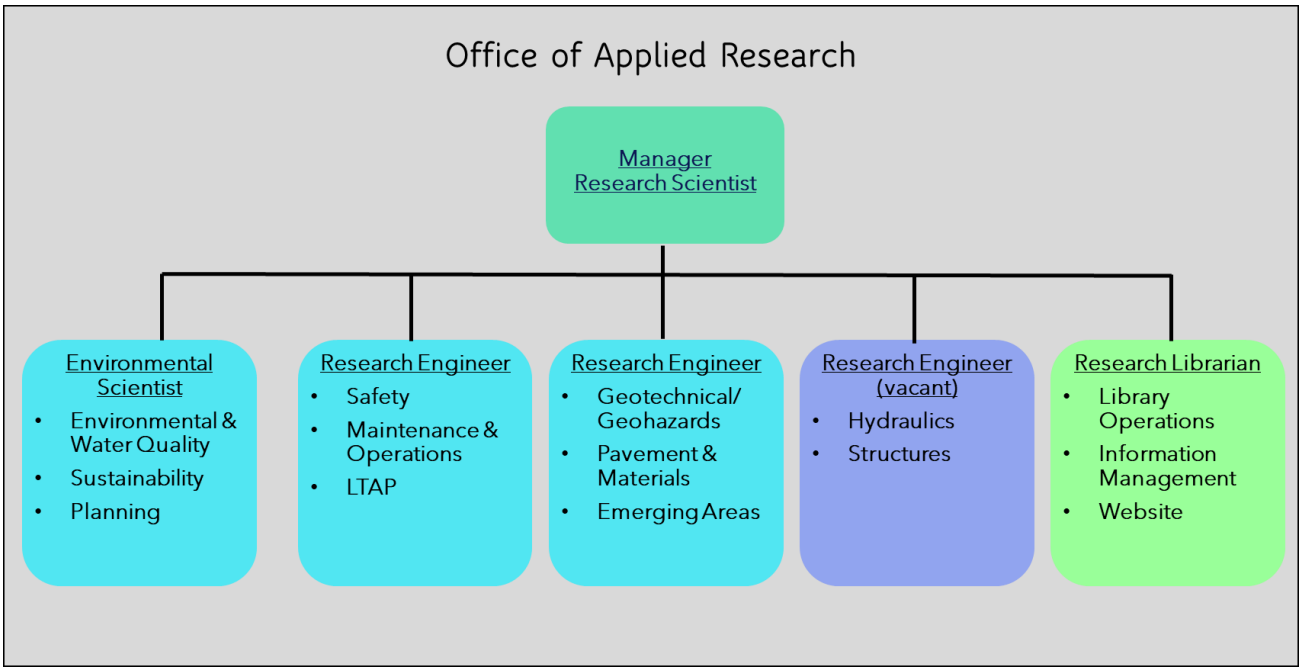


DTD Mission and Vision

Mission: "DTD is dedicated to preparing Colorado's transportation system for the future through planning, analysis, and innovation."

Vision: "Transforming Colorado with BIG IDEAS to create a sustainable, equitable, and connected transportation system."

Division of Transportation Development (DTD) Organization Structure, Mission, and Vision (2024-2025)



OAR Mission

Mission: "To conduct a program of high-quality, applied research, advancing solutions to the increasingly complex needs confronting Colorado's transportation future."

Office of Applied Research (OAR) Organization Structure and Mission

- ## Appendix C – Forms and Templates, the OAR Guidance for Researchers

Forms and templates, along with other guidance for researchers can be found on the OAR website in the Guidance for Researchers

This appendix describes key forms.

Problem Statement Form
A Problem Statement is a concise description of a problem or innovative idea that can be addressed through research. A good research problem statement should identify an existing gap in knowledge in the field. CDOT accepts problem statements from CDOT staff, universities, and other stakeholders to develop its annual research program. The problem statement is not a grant application or a contract document. Submitted problem statements may be publicly shared and may be the basis for an open competition through an RFP process.

Input consists of the completion of a short Google form with basic intake information, and the upload of both a Microsoft Word document and a PowerPoint document. Templates for these two documents can be downloaded using the Problem Statement and the presentation links.

Quarterly Progress Report Template
The Quarterly Progress Report (QPR) is a description of progress made on a study during a calendar quarter or other designated period. QPRs are written by the PI and submitted to the CDOT Study Manager. They are required for every calendar quarter after the Notice to Proceed through study completion. In some cases, monthly progress reports or another interval may be used with the approval of the study manager.

QPRs will be shared with external parties, including but not necessarily limited to the study panel, FHWA, and other stakeholders. They are used to keep the study manager and study panel apprised of progress toward deliverables and tasks, significant events, anticipated events, schedule changes, preliminary observations, or other elements. In some cases, QPRs may be used to track progress tied to invoicing.

The first part of the form contains basic project information unlikely to change over the course of the study, such as contracting information, budget, description, and a list of study panel members. The PI can request this information from the study manager if needed. The latter part of the form contains entries tracking progress toward notable milestones, tasks, and deliverables. Entries should be listed with the most recent events first.

When submitting the Quarterly Progress Report, files should be named following this convention:

> RXX-X.XX Study Title_YYYYQN
>
> Example: **R25-1.01 Understanding Bat Use of CDOT Strutcures_2025Q1**

A QPR template can be found on the Guidance for Researchers website.

Research Report Formatting Instructions
Research Project final reports must conform to a strict format. Instructions for this format can be found in the Guidance for Researchers section of the website. Among the requirements, it is extremely important to ensure the document meets accessibility rules (Section 508 of the Rehabilitation Act (29 U.S.C. § 794d, as amended by the Workforce Investment Act of 1998 (P.L. 105-220)) and the State requirement to comply with Web Content Accessibility Guidelines (WCAG)). Reports will be submitted to national databases and be available on state websites and risk rejection if these requirements are not met.

Research Report Front Matter Instructions
In addition to formatting instructions, Research Project final reports must use a uniform format for the Front Matter (Cover Page, General Statement Page, and Technical Documentation Page). Instructions and a template for these pages are also on the website.

Implementation Plan Form
At the conclusion of the research project, the Implementation Plan Form is used to identify recommendations that can lead to specific implementation products, and the steps to put findings into standard practice at CDOT. This form can be referenced over time to track the progress of implementing recommendations. The form can be found on the website.

Research Brief
The Research Brief is a one to two-page "brochure" designed as a stand-alone synopsis of the study for distribution to CDOT leadership and other interested parties. It should be written for a public, non-specialist audience, and should summarize the project approach, goals, and findings in a visually appealing format. PIs are asked to complete a Research Brief near the start of the project focusing on study goals and methods, an updated Research Brief annually during the project, and a Final Research Brief at the project completion focusing on results and recommendations.

We encourage PIs to use the OAR template for this Brief to help ensure it meets accessibility requirements but will accept style and formatting modifications suitable for the project. Modifications to the template must be approved by the research project manager and all submissions must meet accessibility requirements. The Research Brief template can be found on the website.

Data Management Plan
There is no CDOT template for the required Data Management Plan. CDOT OAR is still developing our expectations and requirements for this document. However, in general the plan should follow the Creating Data Management Plans for Extramural Research guidance provided by the National Transportation Library, Bureau of Transportation Statistics. In some situations, CDOT can assist with archiving and preservation (data storage and perpetual access) through our Advanced Data Analytics Platform (ADAP).

- ## Appendix D – CDOT OAR Study Number Procedure

The OAR will assign Study Numbers to identify projects according to the general subject area and the fiscal year. Subject areas are coded to match our SPR Work Program numbering following the format RYY-ANN, where **YY** is the last two digits of the state fiscal year
A is the subject area code (1 – 4) defined below, and
NN is a sequential number assigned by OAR

Environmental and Planning: Code = 1
Structures, Hydraulics, Soils, and Geotechnical/Geohazards: Code = 2
Safety, Maintenance, and Operations: Code = 3
Pavements and Materials: Code = 4

For example, the fourth study (04) within the Safety, Maintenance, and Operations area (Subject Area code = 3) in Fiscal year 2026 (26) will be assigned: R26-3.04

Figure 8. CDOT has a long history of avalanche research. A 2020 research report examined the design and use of snow sheds to protect traffic, such as this one near Rogers Pass in British Columbia.

- ## Appendix E – Procurement Methods

This appendix summarizes the CDOT/State of Colorado procurement methods that a research project manager typically uses to get a research project underway. The requirements are fully described within the CDOT Procurement and Contract Services CDOT Procurement and Contract Services Purchasing Toolkit which supersedes guidance in this research manual.

In all situations, the research project manager must act in the best interests of CDOT and the State of Colorado.

Public University or Government Agency:

Contracting directly with any public university[5] or government agency in the United States follows a different process than with private universities or non-profit research institutes which follow the same procedures as a private consultant (see next section). With CDOT approval, universities may hire subcontractors following their procurement method and will be responsible for managing that process.

Solicitation method via email - If the research project manager believes the research is best done by a public university or government agency, they can solicit proposals from one or more of these entities. In some cases, they will request a detailed project plan from the institution where the problem statement originated. The research project manager can do this via email, sending a request with a Statement of Work (SOW) based on the Problem Statement. The SOW will clearly describe all requirements including the minimum set of deliverables. Since this process happens outside of procurement, OAR uses the term Request for Application (RFA) so as not to confuse this method with specific procurement methods such as RFP (Request for Proposal), or IFB (Invitation to Bid).

Once CDOT has a project plan that addresses all aspects of the SOW, the CDOT Procurement and Contract Services Office will decide on the best contracting mechanism. Options are:

1. A standard Purchase Order (PO[6]). This will apply Purchase Order Terms and Conditions that generally cannot be modified. The benefit of a standard PO is that it can be enacted quickly and is easy to manage. Services over $250,000 require a contract. However, often universities will not accept this method.

2. An Inter-Agency Agreement (IAA) or Inter-Governmental Agreement (IGA). A customized IAA can be used for agreements with entities that are part of the State of Colorado government. These are generally used with public universities in Colorado and Colorado state agencies. For contracts with other government agencies an IGA will be used.

[5] Although this Manual refers to Universities, the rules described will apply to all Institutes of Higher Education (IHE).
[6] Procurement acronyms used only in this appendix do not appear in Appendix A.

Private Consultant (including Private University):

If the research project manager decides that hiring a private consultant or private university is in CDOT's best interest, then the contracting process uses a competitive solicitation. This does not exclude public universities or government agencies from participating. The solicitation process follows the procurement steps described in the Purchasing Toolkit. This list summarizes the pathways most commonly used by the OAR.

1. Agreements under $10,000 can be entered into without a competitive bid. A valid quote is needed and contracting uses statistical PO (preferred) or a card (CDOT's commercial card) if requested by CDOT Headquarters Business Office.

2. Discretionary Funding agreements are used to purchase services between $10K – $50K. No cooperative agreement needs to be in place. A proposal can be solicited directly from the vendor via email rather than through procurement to get a valid quote that includes a description of the services to be performed along with a clear set of deliverables. An RFA (Request for Application) should be used because we are working outside of the procurement system to solicit proposals. The work must be a one-time task. If there is any possibility of funding future work of the same type or expanding the project so that the cost may increase above the agreed amount, then a different process should be followed.

3. Agreements up to $250K may follow one of several paths. A standard PO may be used if parties agree.

   Documented Quotes (DQ) – This is for services from $50k up to $250k.

   Invitation for Bid (IFB) – this is a competitive solicitation and can follow a one-step or two-step process.

   Non-Project-Specific (NPS) Services $10k-250k – This procurement method can be used when an NPS agreement is already in place between CDOT and the vendor.

4. Agreements greater than $250K require a formal Request for Proposal (RFP) process. The RFP process is more involved than the IFB process.

5. Sole Source procurement is used when there is only a single vendor that can reasonably meet the project requirements. This method is rarely used and takes considerable justification.

There are additional procurement solicitation methods such as Request for Information (RFI), and Invitation to Negotiate (ITN). They are seldom used in the research process and are not described here.

- # Appendix F – Transportation Pooled Fund Procedures

1. Introduction

OAR processes for leading Transportation Pooled Fund projects, as well as for being a partner in Pooled Funds led by other States, follows the guidance available at the FHWA Transportation Pooled Fund (TPF) program website and in particular the processes and templates available in its Frequently Used Resources area. Internal CDOT financial processes are described in DTD-S-2412-02 which outlines the DTD financial processes for initiating, managing and closing out Pooled Funds.

2. OAR Process for CDOT-led Pooled Funds

Leading a Pooled Fund is a big commitment and requires joint leadership from a CDOT Champion and an OAR Program Manager. As the lead state CDOT will develop a problem statement and discuss it with potential partner states to gauge the likelihood of a successful solicitation. If OAR pursues the Pooled Fund, the Problem Statement is evaluated by the same RIC process as a research Problem Statement, and our funding commitment must be in the approved SPR Work Program.

Subsequent steps to set up pooled fund activities follow the pooled fund guidance. See the TPF Flow Chart for State Led pooled funds projects:

- OAR requests the FHWA division office to establish a new pooled fund project and the division office checks for compliance with the SPR Program.
- OAR enters the solicitation into the TPF Program website where it is assigned a PFS number (Pooled Fund Solicitation), and begins to request commitments from partners. Commitments are pledges to transfer funds once the minimum funding level is met. It is not yet a legal obligation of funds.
- Partners that are non-DOTs must work with FHWA TPF Program Manager to set up an account for their agency.
- OAR submits a match waiver request letter, requesting to use 100% SPR funds, to the local FHWA division office. If approved, OAR uploads the match waiver approval memo to the TPF study webpage.
- Once the minimum funding level is met, FHWA replaces the PFS number with a newly assigned TPF number.
- The OAR PM, in coordination with the project Champion, then establishes the technical advisory committee (TAC) to provide guidance and technical support to the project. Usually, each contributing partner provides one TAC member. FHWA assigns a technical liaison to the project.

Once established, the pooled fund project is managed by the OAR PM and Champion. Financial activities are described in DTD-S-2412-02, including creating an acceptance memo

and various FMIS activities. During the project, the OAR PM ensures that CDOT awards contracts, obligates funds, pays contract invoices, and tracks funds. The study Champion (usually the CDOT TAC member but sometimes a TAC member from a partner agency) will work with the OAR PM and the DTD Office of Administration to initiate the SOW (or sometimes more than one SOW) to be contracted and work with the CDOT procurement office to select a vendor and put an agreement in place.

Throughout the project, the OAR PM submits quarterly progress reports and final deliverables to the TPF Program website.

Once the Pooled Fund activities are completed, required close out activities are as described in DTD-S-2412-02, including finalizing deliverables and contracts, submitting the closeout funding spreadsheet for FHWA, and returning unspent funds to partners. Helpful information is at the Pooled Fund website.

3. OAR Process as a Partner in Pooled Funds led by other Agencies

To participate as a partner in a pooled fund project, a CDOT Champion must first submit a CDOT Research problem statement form. The problem statement is evaluated with the same steps as are used for submitted CDOT research projects. If approved in the DTD Work Program, the assigned OAR PM makes funding commitments on the TPF Program website. Administration of CDOT's participation, including making and tracking subsequent financial transfers, is described in DTD-S-2412-02. Technical participation is led by the CDOT TAC member.

4. Role of CDOT TAC Member

The CDOT TAC member has the primary responsibility to ensure the Pooled Fund activities meet CDOT's needs.

- For each Pooled Fund project, the CDOT TAC member is the CDOT point of contact, represents CDOT's interests, and votes on TAC decisions.
- The CDOT TAC member will update OAR annually on progress and significant events over the previous year, and on plans for future activities. They will work with the OAR Program Manager to ensure CDOT's information on PooledFund.org is correct, including the commitment amount and number of years. If changes are required, they will notify the OAR PM and submit a problem statement if additional funds or years are requested.

• Appendix G – CDOT Office of Applied Research History

1962
U. S. Congress passed highway legislation which included a required 1.5% of the federal highway fund to be set aside for planning and research. The Colorado Department of Highways used these funds for various studies and planning activities, but it was not until a few years later that any actual research was funded.

1965
The Research and Special Studies Section was established within the Planning and Research Division of CDOT.

1966
The Section undertook its first major research project, working cooperatively with the Asphalt Institute to evaluate the Ordway, Colorado Experimental Base Project. Shortly thereafter, more roadway research projects were added with staff focusing on detailed evaluation of the roadway condition for the control and test sections.

1970
With the acquisition of a locked-wheel skid system, the Section started conducting an annual "Sufficiency Study" reporting the condition of the 9,000 miles of state highways. Data included skid resistance, roadway smoothness, and a windshield survey of cracking and rutting.

1972
To meet the requirement of the 1970 Clean Air Act, the section began a noise monitoring and modeling project and developed the program to implement it in the districts, with Richard Griffin leading the effort.

1973
The Section's first study that ventured beyond research evaluating roadway experimental features was on high-altitude vehicle emissions. It supported the design of the Eisenhower Tunnel which, at 11,000 feet, was to become the highest power-ventilated tunnel in the world.

1974
Mark Safford took over the section as BB Gerhardt retired.

1975
The Noise program developed by the section staff moved to the Regions.

The section began conducting air quality monitoring and modeling for construction projects to meet requirements of the 1970 Clean Air Act, with Robert LaForce leading the monitoring effort and Richard Griffin leading the modeling effort. Later Keith Burrows led the air quality program.

1977
Denis Donnelly took over the section as Mark Safford was moved to run the traffic monitoring and analysis program for the division.

1979
The Technology Transfer program was established in the section led by Lowell B. Steere, later by Rebecca Spain, and then by Beth Moore as the CDOT library was folded into it. The library has been in existence at CDOT since 1949, providing information and knowledge services for projects and research activities.

1980
The Air Quality program developed by section staff moved to the Environmental Branch.

1986
The section made Colorado the 39th state to establish a Local Technical Assistance Program (LTAP). The Transportation Information Center, as it was originally called, began serving local Colorado agencies in 1986 as a cooperative effort between the FHWA, CDOT, and Colorado State University. The program provides low-cost training and technical assistance to local road and bridge agencies.

1988
Congress established the Strategic Highway Research Program (SHRP). Colorado's involvement was coordinated by Denis Donnelly.

The section became the Research and Development Branch.

Steven Horton was hired to work in the branch to establish and develop CDOT's Pavement Management System (PMS).

1990
Denis Donnelly was placed on special assignment for one year to work directly for the SHRP program in Washington, D.C. and Richard Griffin became the Acting Research Coordination Engineer.

CDOT became the second state in the country to be approved by FHWA to operate under the Research Management Option where only very large projects required FHWA approval.

After its initial development in the Research Branch, the PMS program moved to the Materials Laboratory.

1991
Through Colorado legislation the Colorado Department of Highways became the Colorado Department of Transportation (CDOT).

Based on a federal initiative, the Intelligent Vehicle Highway System (IVHS) was established and developed within the Research Branch.

Denis Donnelly, shortly after returning from his special assignment in Washington, D.C., was promoted to Materials Engineer and left Richard Griffin again as the Acting Research Coordination Engineer.

1992
With Ralph Trapani (Manager of the Glenwood Canyon Project) as the Director, the Colorado Transportation Institute (CTI) was established with the Research Branch providing primary support.

1993
Congressional action required that 25% of the State Planning and Research funds be set aside for research.

Joan Pinamont became the CDOT librarian.

1994
The IVHS research staff and responsibilities were transferred to the new Intelligent Transportation System (ITS) Branch under the Chief Engineer.

1995
The research program was strengthened by expanding the use of technical expertise for identifying research needs, broadening the scope of the program, and raising the level of membership of the Research Council.

The Traffic Monitoring and Analysis Section was placed within the branch.

1996
Even with many accomplishments, including 2 patents, CDOT funding priorities changed, and CTI was dissolved.

1998
As part of a Division of Transportation Development reorganization, the Traffic Monitoring and Analysis Section moved out of the research program and the branch became dedicated solely to research.

The University of Colorado at Boulder replaced Colorado State University as the implementing contractor for the Colorado LTAP.

With research as its sole role, the branch continued expanding its focus from just pavement research in the earlier years to hydraulics, structures, traffic and safety, environmental, and alternative transportation modes.

2006
The Research Coordination Engineer, Richard Griffin, retired. Jake Kononov, Region 6 Traffic Engineer, became the Research Director and because of his background moved the branch toward more traffic and highway safety research and renamed the Research Branch to the Applied Research and Innovation Branch (ARIB).

2009
David Reeves joined the Research Branch.

2011
Bryan Roeder transferred from the Environmental Programs Branch to ARIB to manage the environmental research program.

2012
Jake Kononov retired, and Roberto DeDios (Pavement research program manager) became the Acting Director of ARIB.

2013
Roberto DeDios retired. Dr. Aziz Khan (Structure, Hydraulic, and Geotechnical research program manager) became the Acting Director of ARIB.

Amanullah Mommandi became the Director of ARIB after many years as CDOT hydraulic program research manager.

2014
Joan Pinamont retired as the CDOT librarian.

2018
Sarah Zepeda came to CDOT as the research librarian to serve ARIB and the CDOT community.

2019
Amanullah Mommandi and Dr. Aziz Khan retired. David Reeves (Safety, Operations, and Planning program research manager) became the Acting Director of ARIB.

2020
Dr. Stephen A. Cohn became the Director of ARIB.

Front Range Community College replaced the University of Colorado at Boulder as the implementing contractor for the Colorado LTAP.

Thien Tran joined ARIB to lead the Structure, Hydrology/Hydraulics, Geotechnical, Geohazards, and Pavement and Materials programs.

2024
The Applied Research and Innovation Branch (ARIB) was renamed the Office of Applied Research (OAR). The ARIB Manager position was renamed the DTD Assistant Director for Research.

Figure 9. CDOT has tested a variety of wildlife exclusion grates. Is there a pot of gold under this one?