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# Understanding Construction Change Orders

A U.S. DOT Project Delivery Center of Excellence Report

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January 2025

DOT-VNTSC-OST-25-02

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REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YYYY) 01-17-2024		2. REPORT TYPE Final Report		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE  Understanding Construction Change Orders				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)  Prepared by the U.S. DOT's Project Delivery Center of Excellence at the U.S. DOT Volpe National Transportation Systems Center. Report writing: Alaaddin Baskurt, Andrea Easton, Luisa Paiewonsky, Lorin Willett.				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. DOT Project Delivery Center of Excellence U.S. Department of Transportation John A. Volpe National Transportation Systems Center Kendall Square - 220 Binney Street Cambridge, MA 02142-1093				8. PERFORMING ORGANIZATION REPORT NUMBER  DOT-VNTSC-OST-25-02	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Office of the Under Secretary of Transportation for Policy 1200 New Jersey Avenue SE Washington, DC				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT This document is available to the public on the Volpe Center website: <a href="https://www.volpe.dot.gov">https://www.volpe.dot.gov</a> .					
13. SUPPLEMENTARY NOTES Final Report prepared under the direction of Cynthia Maloney, Director, U.S. DOT Project Delivery Center of Excellence.					
14. ABSTRACT This report identifies common issues that result in change orders and cause project delays and overruns, organized into three main categories relating to the quality of technical project development work, influences of organizational culture, and uncertainty introduced by financial forces. It also describes best practices to minimize and mitigate change orders and highlights noteworthy project delivery practices currently used by project sponsors of various transportation modes. Enhancing understanding of construction change orders can help practitioners with limited experience in federally funded transportation projects, along with their partners, achieve better project delivery outcomes.					
15. SUBJECT TERMS U.S DOT Project Delivery Center of Excellence; Bipartisan Infrastructure Law; U.S. DOT Volpe Center; reasons for change orders; minimizing change orders; best practices for change orders; technical; organizational; financial; processes; risk management; communication and partnering; alternative contracting methods; workforce capacity and experience; data and technology; organizational culture; project delivery; State, Tribal, local project sponsors; project agreement; on time, on task, on budget.					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES  58	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)

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# List of Abbreviations

Abbreviation	Term
AASHTO	American Association of State Highway and Transportation Officials
ACEC	American Council of Engineering Companies
ACM	Alternative Contracting Method
ADCMS	Advanced Digital Construction Management Software
AGC	Associated General Contractors
APTA	American Public Transportation Association
APWA	American Public Works Association
ARTBA	American Road and Transportation Builders Association
ASCE	American Society of Civil Engineers
BIL	Bipartisan Infrastructure Law
BIM	Building Information Modeling
CAGC	Carolinas Association of General Contractors
CDOT	Colorado Department of Transportation
CEVP	Cost Estimate Validation Process
CMAR	Construction Manager At-Risk
CM/GC	Construction Manager/General Contractor
CRA	Cost Risk Assessment
DBB	Design-Bid-Build
DB	Design-Build
DOT	Department of Transportation
E&O	Errors and Omissions
ERM	Enterprise Risk Management
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GMP	Guaranteed Maximum Price
MARAD	Maritime Administration
MDT	Montana Department of Transportation
NACTO	National Association of City Transportation Officials
NACE	National Association of County Engineers
NCDOT	North Carolina Department of Transportation
PCA	Post-Construction Assessment
PEPS	Professional Engineering Procurement Services
PRBE	Probabilistic Risk-Based Estimating
PS&E	Plans, Specifications, and Estimates
RFI	Request for Information
RFQ	Request for Qualifications
RFP	Request for Proposals
ROW	Right of Way
SANDAG	San Diego Association of Governments
SOP	Standard Operating Procedure

Abbreviation	Term
SUE	Subsurface Utility Engineering
TxDOT	Texas Department of Transportation
U.S. DOT	U.S. Department of Transportation
VMO	Value Management Office
WSDOT	Washington State Department of Transportation

# 1.0 Report Overview

Managing and controlling project scopes, costs, and schedule outcomes has been a primary challenge among transportation agencies for decades. In developing this report, the [Project Delivery Center of Excellence](#) consulted with national organizations representing transportation agencies, industry partners, and practitioners to identify some of the major causes of change orders and highlight methods that reduce their use. Enhancing understanding of construction change orders can help practitioners with limited experience in federally funded transportation projects, along with their partners, achieve better project delivery outcomes.

The \$1.3 trillion Bipartisan Infrastructure Law (BIL) presents a historic opportunity to make transformative investments in U.S. transportation infrastructure in all states and territories. The U.S. Department of Transportation (U.S. DOT) has prioritized the rapid delivery of thousands of projects to provide the benefits of BIL as soon as possible to the American people. In partnership with other federal, Tribal, state, and local agencies and the private sector, U.S. DOT has accepted the challenge to deliver infrastructure projects on time, on task, and on budget.

Project development and delivery are complex, interconnected processes that require careful coordination and multi-agency collaboration as projects progress through planning, permitting, design, contracting, and construction phases. Each activity affects its succeeding phase, and on-time, on-budget completion depends on coordinated execution of hundreds of tasks. Delays or disruptions at any point can have cascading impacts on a project's schedule, scope, and budget.

In October 2022, the White House released the [Action Plan for Accelerating Infrastructure](#) to fast-track and support more efficient delivery of infrastructure in America. One section in the Action Plan charged the U.S. DOT Project Delivery Center of Excellence with identifying the root causes of transportation construction change orders and reporting on best practices to improve project delivery.

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*The DOT Project Delivery Center of Excellence will convene a group of stakeholders (including the American Association of State Highway and Transportation Officials, the American Society of Civil Engineers, the American Road and Transportation Builders Association, and the American Public Transportation Association) to identify root causes of change orders and report to DOT on best practices to minimize their use. DOT will work with these organizations to disseminate best practices with project sponsors.*

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Project delivery rarely takes place on a linear path to completion, and managers require a variety of tools to keep projects moving forward. Construction change orders are a commonly used contractual tool that provides the means to legally modify a construction contract's scope, schedule, and budget without having to restart a new and time-consuming bidding process. They enable project sponsors to adjust to unexpected field conditions and circumstances through contract amendments. Most construction contracts anticipate the possibility of change orders and include language that specifies a process for identifying, processing, and approving change orders. However, overusing change orders, especially as a routine response to conditions foreseeable during project development, can lead to unnecessary delays and costs. This diverts resources from other projects and may indicate inefficiencies that erode public trust in the agency's effectiveness. Minimizing the use of change orders requires robust planning, design, permitting, and contracting procedures—resulting in comprehensive construction contracts that thoroughly address risks.

Chapter 2 identifies common issues that result in change orders and cause project delays and overruns, organized into three main categories relating to the quality of technical project development work, influences of organizational culture, and uncertainty introduced by financial forces. It is important to note that not all change orders are negative; change orders may provide a useful means to benefit projects during construction. For example, when faced with unanticipated conditions, design or constructability issues, opportunities for value engineering, or public concerns, agencies may use change orders to provide necessary flexibility to adapt and continue with the project while minimizing disruption. However, relying on change orders to compensate for incomplete designs, permitting, or public outreach can lead to detrimental cost increases, schedule delays, and a loss of the agency's credibility with the public.

Chapter 3 describes best practices to minimize and mitigate change orders based on successful efforts to ensure public confidence in project delivery. Best practices presented in this chapter provide practitioners with proven tools and considerations for implementing them across all phases of project delivery to influence the project's likelihood of on-time and on-budget execution.

Chapter 4 highlights noteworthy project delivery practices currently used by project sponsors of various transportation modes to manage change orders. State departments of transportation (DOTs), transit authorities, and metropolitan planning organizations have been leaders in innovating to improve project delivery practices to avoid and reduce the use of change orders. As practitioners, they have the incentives and real-world insights to test new approaches to more efficient project delivery. Around the nation, state and regional governments provide examples of identifying, preventing, and mitigating the causes of delays and cost increases.



Ultimately, understanding the underlying causes of change orders and deploying best practice strategies can help practitioners prevent or minimize the potential negative consequences of change orders. This will improve the likelihood of delivering the benefits of federal transportation funding to the public by ensuring projects are constructed on time and on budget.

## 2.0 Reasons for Change Orders

It is widely known among transportation agencies that successful project delivery begins long before the construction phase, and early and careful planning and project development is critical to ensuring project success. Rushed or suboptimal technical project development practices, an unhealthy organizational culture, and financial and funding stressors can lead to project development breakdowns that cause change orders that negatively impact project scopes, schedules, and budgets. This chapter describes some of the common causes of change orders identified through engagement with our partners in national associations, U.S. DOT modal administrations, and project sponsors.

### 2.1 Technical

The quality and consistency of work in key phases in project development—planning, design, estimating, scheduling, contracting, and construction—significantly impact the likelihood of change orders. Technical staff directly play a direct role in influencing or controlling these factors.

#### 2.1.1 Project Planning

Planning begins with a well-defined concept and subsequent work to include a comprehensive examination of current conditions, development of evaluation criteria, assessment of alternatives, public outreach and dialogue, identification of potential solutions for further analysis, environmental permitting, and design. Incomplete or rushed planning can result in inaccurate assumptions about the project's purpose and need, leading to incomplete scopes or insufficient consideration of funding and schedule requirements to advance the project toward completion. A comprehensive planning process is essential to avoid errors and omissions that can carry over through subsequent project phases, including design, permitting, and construction to requiring resolution through change orders.

#### 2.1.2 Project Design

Poor quality, incomplete, or rushed design processes can lead to incomplete, insufficient, or incorrect information in the plans, specifications, and estimates (PS&E) that provide the contractual basis for bidding and construction of projects. These deficiencies can disrupt project schedules and budgets by necessitating change orders to enact corrective actions during construction. Poor design quality often stems from inaccurate or missing information, rushed processes, or lack of internal and process standards and controls. Designs should be evaluated for constructability to confirm that sequencing, staging, and phasing of operations align with actual site and traffic conditions. Consider staging areas, equipment access, pedestrian pathways, and detours. Errors, omissions, and overly optimistic assumptions during

cost estimating and scheduling processes can result in budget overruns and schedule delays during construction.

### 2.1.3 Project Management

An agency's ability to make timely and well-informed decisions at the project, program, or enterprise level plays a major role in the frequency and extent of change orders. A lack of consistent, defined project management procedures can lead to inconsistencies and changes throughout project development and delivery. Successful project management involves careful coordination of activities, people, and resources, within established scope, time, cost, quality, and risk constraints. It requires skilled project staff with the authority and tools to make decisions, measure performance, and lead projects to completion. Change orders may become necessary to resolve project cost and schedule issues when proper attention and controls are not executed through project management.

### 2.1.4 Development of Project Agreements, Contracts, and Bidding Documents

The project agreement consists of construction and funding contracts and their supporting documents and is the most important tools in managing change orders. Project agreements are the principal documents that govern the contractual relationship among parties involved in the project, outlining their respective roles, responsibilities, and obligations. They provide the foundation for managing cost, schedule, and scopes during the construction phase. Following completion of planning, permitting, and design, the project agreement influences the bid environment during procurement and through management and administration of the project after contract award. Contracting practices that do not fully anticipate design challenges and limitations, risk identification and allocation, and unforeseen conditions are susceptible to change orders, cost overruns, and schedule delays. Well-designed contracts and agreements include a comprehensive design, assessment and allocation of risks, incentives and disincentives, and sufficient flexibility to account for unexpected conditions. Contracts must fully incorporate and address the project's complexity, constructability, design parameters, and risk, as defined by its extent and allocation of responsibilities.

**Contract Quality:** The quality of the construction contract itself can be a factor in the likelihood of change orders. Contract quality issues can include incomplete, insufficient, or inconsistent terms in the project legal documents; insufficient attention to the project's complexity and risks; and limited or non-existent project controls.

**Contracting Vehicles:** The type of contracting approach can affect the project's success in meeting budget and schedule requirements and depends on the project context, industry capacity and availability, risk assignment implications, and sufficient time for bidders to develop proposals. Contractors will consider factors such as pricing strategies, level of competition, constructability, and labor and material availability to bid accordingly. The agency's responsibility is to allocate risk, develop accurate cost estimates, clearly delineate

roles and responsibilities, gain public support, produce high-quality designs and necessary permits, and provide effective construction oversight in the public interest. In some cases, the agency may certify contractor capabilities prior to awarding contracts or include incentives and disincentives for on-time and on-budget project delivery.

### 2.1.5 Encountering Issues During Construction

Some issues encountered during construction can be traced to the design, planning, and contracting phases of project development. Conducting early and thorough design, permitting, and public engagement can prevent expensive changes once construction is underway. However, after construction has begun, other factors may come into play, including unexpected site conditions, the presence of natural or cultural resources that were not able to be identified in the early phases of project development, or construction quality and workmanship problems. Agencies are then responsible for deploying qualified personnel to determine the need for change orders to ensure compliance with contract specifications.

**Construction Site Conditions:** Unexpected site conditions are a common cause of change orders in the construction phase. These conditions can include unexpected or differing conditions from the design documents and project agreement in the field during construction. This could be related to location, asset condition, geotechnical issues, unidentified or improperly coordinated utility conflicts, extreme weather, the presence of endangered species, and/or historical artifacts. Traffic or road closures caused by major events, crashes, and the discovery of hazardous materials can also disrupt schedules and cause cost increases. These factors point to the need for comprehensive planning, careful design, thorough risk analysis, and, where applicable, the establishment of project controls before the construction phase begins.

**Construction Quality:** Project sponsors are responsible for ensuring that materials and workmanship incorporated into the project meet acceptable standards. Construction and product quality standards are governed by the specifications incorporated into the project agreement. The ability of the contractor to achieve the required quality may be affected by the availability of appropriate materials and labor to perform required work. Supply chain issues can cause delays in the arrival of critical equipment, supplies, and materials. Since these issues are not always predictable, especially considering pandemic-related supply chain issues, they can be mitigated through ongoing communication with the contractor industry and ongoing monitoring of suppliers' and manufacturers' capacity to produce needed project components. Properly managing operations, labor, equipment, supplies, and materials can minimize both the need for change orders and their impact on project outcomes when they are used.

## 2.2 Organizational

Organizational causes of change orders include issues in culture that can be traced to leadership, workforce capacity, communication, and accountability.

### 2.2.1 Leadership

The level and extent of leadership oversight, interventions, and enforcement of the technical factors described above can play a significant role in an agency's record of on-time and on-budget delivery. These actions can include regular communication about expectations for construction outcomes; active decision making in problem areas in the project development and delivery phases; imposition of accountability; incentives and disincentives among agency staff, designers, and contractors; and ensuring sufficient staffing, training, and resources are available for agency staff. The need for change orders becomes more likely when risks and problem areas are overlooked to avoid uncomfortable pressures or perceived threats from leaders in the organization's environment.

### 2.2.2 Workforce

Public agencies, design consultants, and contractors have all faced workforce shortages in recent years, due to a variety of reasons. Incomplete staff and oversight of all phases of project development and delivery can result in poor quality designs, hasty reviews, and insufficient oversight of construction contracts in the work zone. Change orders can result from issues throughout the project lifecycle without a robust and knowledgeable workforce that is empowered to identify and resolve problems. The U.S. DOT has a number of web-based and program resources to guide state and local agencies as they address critical hiring needs.

### 2.2.3 Internal and External Communication

Successful coordination and communication involve promoting mutual understanding of needs and responsibilities among internal and external partners to achieve project objectives. Effective coordination and communication ensure all relevant perspectives are captured in project development and delivery. This reduces late changes and helps ensure budgets and schedules remain on track.

**Internal Coordination:** This involves collaboration across functional project teams within the project sponsor organization during project development and delivery. A cohesive, multi-disciplinary approach to project delivery, buttressed by effective and regular communication among teams, increases the likelihood of a well-designed, constructible project that is completed without change orders. When internal communication breaks down, a project can become vulnerable to technical flaws and omissions, leading to change orders later in project delivery.

**External Coordination:** This involves ongoing collaboration between the agency and external project partners and stakeholders, including citizens, elected officials, advocacy groups, utilities, railroads, right-of-way owners, and others affected by project delivery.

Comprehensive external communication can help prevent late requests for scope changes, unexpected objections, and public controversy, all of which contribute to project delivery delays and budget overruns.

#### 2.2.4 Accountability

Organizations and their leaders have a strong influence on the willingness of staff to produce candid, realistic cost and schedule estimates. Producing overly optimistic estimates for presentations to leadership, elected officials, and the public often creates significant credibility problems for the agency when even minor delays appear as a broken promise.

Underestimating project budgets and schedules can also disrupt agency plans by causing the diversion of funds that could have been dedicated to other projects. Agency leaders who encourage honest assessments of project budgets, schedules, and risks, and who communicate those assessments transparently, are less likely to face the public fallout and distrust that result from project delays and overruns.

### 2.3 Financial and Funding

#### 2.3.1 Funding

The \$1.3 trillion BIL provided a major increase in federal transportation funding to state, regional, and local governments. Formula funding increased by as much as 25 percent, while billions of dollars have flowed into existing and new infrastructure grant programs. State DOTs and grant recipients have moved quickly to adjust to new funding levels by hiring staff, consultants, and contractors, while working to ensure that oversight and monitoring systems prevent waste and unnecessary overruns and delays. Projects can be funded by a variety of sources that come with their own eligibility requirements, which can introduce complexity in project delivery. Accurate budget forecasts are necessary to ensure that projects not only have sufficient funding and flexibility in place, but that specific funding requirements can also be satisfied without causing project delays.

#### 2.3.2 Price Volatility

Unpredictable price fluctuations in key materials used in construction, including asphalt, concrete, and steel, can undermine project cost estimates. While these are not directly within an agency's control, estimators should factor in recent trends and potential price increases in the early stages of design and provide regular updates as the project development phases progress. Change orders can be used by project sponsors to adapt project scope to respond to fluctuations in pricing or availability of labor, materials, budget, and equipment resources needed for project delivery.

## 2.4 Chapter Summary

There is no singular cause of construction change orders. The reasons for change orders span the quality of technical project development work; influences of organizational culture on project stakeholder behaviors; and uncertainty caused by unrealistic financial pictures and volatile external market pricing. Change orders can also be the result of a confluence of reasons across those categories. Understanding the variety of reasons that cause change orders to become necessary is the foundation to implementing the best practice strategies for avoiding, minimizing, and addressing change orders covered in Chapter 3.

## 3.0 Applying Best Practice Strategies

State, regional, and local agencies have developed innovative approaches and best practices to deliver projects on time and on budget by preventing and minimizing avoidable change orders or making the most effective use of unavoidable change orders. These can be generally bundled into the following categories:

- Ensuring consistency through documented **processes**
- Employing **risk management**
- Fostering **communication** and internal and external partnering
- Using **alternative contracting** methods
- Developing **workforce** capacity and experience
- Leveraging **data and technology**
- Considering **organizational culture** and barriers to decision-making.

Each of these strategies can be implemented independently or in conjunction with others to improve project delivery. While formalized processes, communication, and risk management can be standalone approaches to address change order concerns, they are often also foundational elements to implementing the other best practices.

For each best practice strategy, this section offers considerations for practitioners and leaders to better understand how they can address change orders within their team, department, or organization.



Figure 1: Best Practice Strategies to Prevent or Minimize Change Orders



### 3.1 Ensuring Consistency Through Documented Processes

Standardized workflows and procedures help practitioners understand roles, responsibilities, relationships, and expectations in project delivery. Having documented, repeatable processes in place can increase quality, consistency, and predictability as well as facilitate knowledge transfer and organizational continuity. As programs mature, periodic assessment of processes can ensure they serve their intended purpose and reflect lessons learned.



### 3.1.1 Process Considerations

#### Project Agreements and Planning

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Processes should be built to ensure that the project agreement is only executed once the project scope is fully defined and the design is verified. The plans and specifications contained in the project agreement are the project's "blueprint" that reduces the need for change orders. Standards should clearly delineate quality, systems, and responsibility requirements, but not be so prescriptive as to induce extraneous costs. Contract development processes should account for early legal counsel and sufficient time for quality reviews to identify and eliminate ambiguities, errors, and material omissions. Project agreements should provide mechanisms to navigate potential cost and schedule escalations and consider accountability measures that provide cost recovery for certain causes (e.g., design errors and omissions).

Processes that result in a strong project agreement minimize change orders by incorporating high-quality work products from project development and clearly outlining responsibilities, while also providing mechanisms to efficiently navigate change orders that are unavoidable.

*Explore construction contract products featured on the [U.S. DOT Project Delivery Center of Excellence website](#).*



#### Estimating and Scheduling

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Budget and schedule estimates should rely on realistic and risk-based contingency and adjustment factors to account for potential changes in designs, scopes or cost estimates. Realistic estimates and schedules that are vetted and developed through consistent processes can reduce the likelihood or adverse impacts of change orders.

*See [Data and Technology](#) and [Risk Management](#) best practice strategies for more information.*



#### Procurement

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Competitive, rigorous, and transparent procurement processes complement project agreements. These processes can incorporate industry engagement through events where project sponsors provide presentations, engage in questions and answer sessions, or participate in one-on-one discussions to give valuable feedback on how to structure contracts and procurements. Detailed Requests for Information (RFIs), Requests for Qualifications (RFQs), and Requests for Proposals (RFPs) identify material contractual terms and conditions; elicit thoughtful and complete proposals from qualified bidders; and discourage

underbidding that exploits change orders, renegotiations, or the filing of claims for later financial gain.

See [Communication](#) and [Alternative Contracting Methods](#) best practice strategies for more information.



## Subsurface Investigations and Utilities

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Comprehensive review of underground conditions and early coordination with relevant third parties (i.e., utility, railroad, ROW owners) reduces the need to reroute or redesign projects due to conflicts discovered late in the construction phase, saving time and costs. Establish checkpoints throughout project development to keep the project team informed of potential conflicts that could result in change orders.

See [Communication](#) best practice strategy for more information.



## Addressing and Negotiating Change Orders Efficiently in Construction

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The project agreement must clearly outline the change order process. Robust communication of this process is also critical to ensure project teams are prepared to efficiently manage and negotiate change orders when they do occur.

Process elements to consider include how to identify, document, and navigate:

- The need for a change order
- Which stakeholders must participate in the process
- Terms and price negotiation
- Approval authorities
- Deadlines for escalation
- Dispute resolution.

## Addressing Federal Requirements

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When projects use federal funding, even as a portion of the investment, U.S. DOT agencies—such as the Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), Federal Transit Administration (FTA), Maritime Administration (MARAD), and Pipeline and Hazardous Materials Administration (PHMSA)—perform oversight and develop guidance for compliance and efficient delivery of federal

funding. Ensure your organization has procedures in place that align with the funding provider's requirements to ensure a change order will not impact a project's funding eligibility.

Explore the [Project Delivery Toolbox's](#) federal oversight resources.



## Maintaining Standard Operating Procedures (SOPs)

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SOPs help to reduce reliance on tacit knowledge or ad-hoc, inconsistent processes and decision-making to improve continuity. They provide a formal reference of processes and roles, helping to enforce accountability, enhance oversight, and reduce mistakes and omissions. They also help to optimize effective use of contractors. SOPs that are thorough and well understood by the project team can help guide sound decision-making that prevents the need for change orders.

See [Communication](#), [Workforce](#), and [Organizational Culture](#) best practice strategies for more information.



## 3.2 Employing Risk Management

Deliberate risk management helps to improve decision-making across project activities and minimize or mitigate potential change orders. Risk management provides a structured way to navigate the array of uncertainties, variabilities, opportunities, and threats that may affect a project's ability to achieve its objectives<sup>1</sup>. Risk management helps agencies understand and plan for uncertainties or overall risk through systematic application of strategic tools.

A key step in risk management is documenting the responsibility for risks in project agreements. Developing a robust project agreement involves not only assessing risks but also assigning responsibility for them within the contract. The project agreement enables project sponsors to accept, mitigate, transfer, avoid, or enhance areas of uncertainty, effectively managing risks. Assigning risks creates a mutual understanding of liability for response and mitigation measures before problems arise, helping to reduce the adverse impacts of change orders. Liability for risks generally should be assumed by the party most able to manage them. Inappropriate risk shifting can lead to unnecessary change orders, disputes, or increased costs for contractors to cover them. Actively identifying and managing risk can reduce the uncertainty that causes change orders.

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<sup>1</sup> [https://www.planning.dot.gov/documents/FHWRiskMgmtRoadmap\\_July2018.pdf](https://www.planning.dot.gov/documents/FHWRiskMgmtRoadmap_July2018.pdf)

### 3.2.1 Risk Management Considerations

#### Risk Management Process

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Risk management provides a systematic approach to minimizing threats and maximizing opportunities to make decisions that will determine project success. It is essential to develop a comprehensive project agreement. While difficult to account for every possible risk a project may face, the risk management process provides a framework and can be a helpful tool to plan for instances when unknown risks occur later in the project. Generally, steps include identifying, assessing, planning, monitoring, and controlling risks. This process can be applied throughout each phase of the project lifecycle and at program and organizational levels. Early identification of risks allows project stakeholders time to resolve issues that could lead to change orders before projects get to construction.

See [Process](#) best practice strategy for more information.



#### Allocating Risk Based on the Project

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Properly allocating risk between the agency and the contractor is important to containing costs. Consider different pricing models and contracting methods to carefully balance the risks being assigned to each side. Not every project type is suited for one project delivery method. Evaluating the most appropriate project delivery method for individual projects or project types can reduce risk. Clearly defining which party owns project risks reduces misunderstandings and unpredictability that can lead to the need to amend construction contracts through change orders.

See [Alternative Contracting Methods](#) best practice strategy for more information.



#### Considering Risk in Budget and Schedule Estimates

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Probabilistic risk-based estimating (PRBE) methods provide decision makers with reliability-based information about uncertainty around project objectives. PRBE is a scalable technique that uses simulation to develop distributions of cost and schedule completion. Distributions provide the entire range of possible outcomes, exposing areas of uncertainty typically hidden in conventional, deterministic estimates.<sup>2</sup> Cost related change orders are less likely to be necessary when project sponsors have a high degree of understanding and confidence in project estimates.

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<sup>2</sup> [FHWA/NHI PRBE for Highway Project Cost and Schedule \(FHWA-NHI-134205\)](#)

## Enterprise Risk Management (ERM)

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ERM assesses risk to enhance the overall success of an agency rather than focusing solely on individual business units, programs, or projects. It strategically addresses risk by aligning goals across organizational levels. Executives play a key role in championing this process and fostering a culture of risk management. Organizational uncertainties could include reputation, data integrity, funding, safety, and policy. An organizationally directed culture of risk management is integral to deploying project teams prepared to mitigate the risks in project delivery that can result in change orders.

See [Organizational Culture](#) best practice strategy for more information.



### 3.3 Communication and Partnering

Change orders may originate from poor communication throughout a project's lifecycle. Early and frequent communication, partnering, and relationship building strengthen teams and produce information and solutions that can prevent project changes. Incorporating communication checkpoints into project delivery processes can help bridge information gaps to solve problems before they become challenges that require change orders to resolve. Early involvement of project stakeholders, understanding of the project agreement by all parties to it, and mutual efforts to foster collaborative relationships all result in benefits to successful project delivery.

Open and honest communication, whether integrated into formal processes or outlined in the project agreement, is helpful to both internal and external partners like project stakeholders, consultants, and the contracting community. Strong communication is embodied by teams that question preconceptions and consider project circumstances from different viewpoints. Partnering can manifest through informal or formal communication processes to create strong working relationships that reduced the number and impact of change orders by allowing space to the needs of all project stakeholders.

#### 3.3.1 Communication Considerations

##### Internal and External Communication

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Frequent communication across functional units and external partners and at key milestones can help to address some of the causes of construction change orders early in the planning, design, and procurement phases. Effective internal communication can promote alignment on the resolution of critical issues that may otherwise result in change orders or escalate to claims.

See [Process](#) best practice strategy for more information.



## Early Contractor Involvement

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Early contractor involvement can benefit the project by improving transparency, leveraging contractor experience, while identifying and addressing risks collaboratively to avoid issues later in the project lifecycle. Solicit industry feedback through RFIs, pre-solicitation conferences, or alternative contracting methods to increase understanding of project context, needs, and requirements. Soliciting industry expertise and treating well-informed contractors as partners early in the project development process can contribute to more thorough plans and designs that are less vulnerable to change orders.

See [Alternative Contracting Methods](#) best practice strategy for more information.



## Right of Way and Permitting

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Early coordination with entities that own assets on or near your project site or that issue permits can avoid delays during construction. Formalize solutions through pre-award railroad, utility, or permitting agreements. Frequent and good-faith communication with these entities may promote programmatic solutions that prevent conflicts that cause change orders on future projects.

See [Process](#) best practice strategy for more information.



## Culture of Communication

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Clear and open communication between agency leadership and technical staff is critical to support effective decision-making that precludes the need for avoidable change orders during construction. An organizational culture that establishes safety for practitioners to critically examine issues through open communication can improve project delivery practices at all levels. Importantly, it empowers project staff to speak up about issues before they can manifest as change orders.

See [Organizational Culture](#) best practice strategy for more information.



## Stakeholder and Public Outreach

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Early engagement and collaboration with stakeholders and the public to identify mutual, complementary goals and potential issues helps to identify solutions and avoid change orders late in project delivery.

## Involving Industry

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Actively engaging in collaborative problem-solving with industry partners can foster stronger relationships and avoid adversarial situations that might result in unproductive use of change orders that increase costs and cause delays. Understanding the constraints of the contracting community and staying abreast of evolving industry trends helps to develop stronger project agreements, inform process improvements, and better prepare for potential change orders.

Formal partnering efforts with industry can include documented agreements, roles, and procedures. Informal partnering and relationship-building opportunities happen at project meetings and industry summits and during post-construction reviews. Incorporating industry perspective into project development can help agencies address issues that might otherwise result in change orders before they can impact a project.



### 3.4 Alternative Contracting Methods

Employing alternative contracting methods balances agency and contractor perspectives and risks to minimize project vulnerabilities that can lead to change orders. Transportation infrastructure construction contracts have historically been governed by low-bid, design-bid-build (DBB) contracting methods where the project sponsor is responsible for designing the project and awarding the contract to the lowest responsible bidder, while the contractor is responsible for constructing the project according to the terms established in the project agreement.

While alternative contracting is not appropriate for all project contexts, project sponsors may consider, as appropriate and permitted by state and local law, methods like best value selection, design-build, progressive design-build, construction manager/general contractor, public-private partnerships, and alliance contracting to create opportunities for early contractor involvement and collaboration. Under such project agreements, project sponsors and contractors are also able to collaboratively determine the most efficient and fair allocation of risk, which can minimize change orders which result in unexpected cost and schedule growth during project construction.

Other mechanisms such as incentives and disincentives or value engineering processes provide sponsors with options for flexibility, innovation, and accountability within conventional contracting frameworks.

### 3.4.1 Alternative Contracting Considerations

#### Selecting a Project Delivery Method

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The use of alternative delivery methods requires enabling authority in federal, state, or local legislation. A decision-making process should be in place to determine the appropriate approach for a given project based on goals, risks, pricing model, assets, capacity, stakeholder needs, and experience. Decision matrices are a useful tool to objectively weigh factors to select a legally authorized contracting method. Project sponsors may consider different methods based on:

1. Cost impacts
2. Schedule impacts
3. Opportunity to manage risk
4. Complexity of design and construction phasing
5. Stakeholder engagement
6. Opportunity for innovation.

FHWA's Every Day Counts Initiatives and Special Experimental Project No. 14 - Alternative Contracting provide examples of how some agencies have investigated the use of alternative contracting methods and the reasoning behind selecting a particular method, which can include reducing change orders.

See [Process](#) and [Risk Management](#) best practice strategies for more information.



#### Encouraging Contract Compliance

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Incentive and disincentive structures, pricing models, and bid options may encourage successful cost and schedule performance as well as compliance with contractual obligations by making the initiation of change orders or claims disadvantageous to all parties of the project. Alternative contracting methods introduce new ways to involve the contracting community in project development and negotiating the terms of project agreements. Adherence to a project agreement's terms and conditions minimizes the number of disputes that may necessitate change orders.

#### Organizational Capacity to Administer Alternative Delivery Methods

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Ensuring the organization has the necessary resources and expertise to administer a project using the proposed delivery method helps to minimize or mitigate risks that may result in change orders during construction. Alternative delivery methods often require project sponsors to relinquish some control over risk tolerance, costs, and decision-making. Internal staff should be well-versed and encouraged to lead a project through a more flexible



environment and still achieve the desired results. This may require new procedures, standards, and specifications to advance projects with less robust designs and accommodate contractor-driven innovation and methods.

See [Workforce](#) and [Process](#) best practice strategies for more information.



## 3.5 Workforce Capacity and Experience

Access to a robust and skilled workforce is essential to manage projects and produce complete, consistent, and quality work that minimizes the need for change orders. An insufficient or inexperienced workforce may lead to change orders. Agencies need sufficient and competent staff with the requisite legal, operational, and technical expertise to manage the development and execution of the project agreement.

### 3.5.1 Workforce Considerations

#### Technical Training and Development

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Training opportunities are available to support agency workers, including Local Technical Assistance Programs, Tribal Technical Assistance Programs, Rural Transit Assistance Programs, and University Transportation Centers. Engaging with industry associations and their regional counterparts and institutes such as the American Association of State Highway and Transportation Officials (AASHTO), American Council of Engineering Companies (ACEC), Associated General Contractors of America (AGC), American Public Transportation Association (APTA), American Public Works Association (APWA), American Road and Transportation Builders Association (ARTBA), American Society of Civil Engineers (ASCE), National Association of County Engineers (NACE), and National Association of City Transportation Officials (NACTO), among others, can provide learning opportunities and access to training products. Federal training resources include the National Highway Institute, National Transit Institute, and Federal Aid Essentials. Utilizing these training resources can help agencies achieve a workforce that is knowledgeable about the risks and challenges that contribute to change orders on transportation construction projects.

#### Documenting Lessons Learned

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Conducting post-construction reviews and documenting lessons learned are valuable processes to build and maintain institutional knowledge of project development and delivery. Technical staff can organize knowledge capture programs within and across teams for an organic approach to training to prevent knowledge gaps that later cause change orders, even as staff turnover occurs.

## Project Management Training

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Though not all project staff need to be as well-versed as the project managers, some amount of training in project management can improve performance in management of individual work streams, contractor progress, and project controls. Transparency and attention to the progression of project activities by all contributors can help to avoid oversights and pitfalls that can later require change orders to resolve.

## Developing Organizational Capacity

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Cross-training agency staff across roles and subject matter expertise can improve an agency's capacity to administer projects of varying scopes and complexities. If consultants are expected to be members of project delivery teams, procurement through qualifications-based selection and inclusion of the consultant community through partnering and training alongside internal staff can contribute to developing a culture of quality and consistency. The occurrence of change orders can be reduced as an agency's workforce knowledge and capacity increases to lower the incidence of incomplete or incorrect work products.

See [Process](#) best practice strategy for more information.



## 3.6 Data and Technology

Data and technology support more efficient decision-making and problem solving that reduces negative change order outcomes by facilitating communication, combating bias, and identifying risk areas. Data collection and evaluation help to identify recurring or emerging risk areas, enabling allocation of resources to the most impactful cost and schedule solutions. They also provide an opportunity to institutionalize project lessons learned to improve future delivery. Data can also mitigate internal and external biases and misrepresentations by supporting decision-making with objective facts.

Technology tools such as Building Information Modeling (BIM), Advanced Digital Construction Management Software (ADCMS), Digital As-Builts, E-ticketing, Performance Dashboards, and risk simulators enable project sponsors to leverage data more easily and develop solutions earlier.

### 3.6.1 Data and Technology Considerations

#### Collect and Manage Change Order Data

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Documenting the specific causes of change orders helps to identify patterns and develop metrics to assess the frequency and impact of change orders, enhancing determination of whether actions or corrections are necessary. Using data to evaluate past occurrences and

trends is a useful first step in identifying and evaluating change order risks that could jeopardize the efficiency of projects and programs. This data can be used to develop better informed estimates and risk assessments for different project types based on the type of asset or construction method (also referred to as “reference class forecasting”). ADCMS solutions can provide further streamlining of such analyses by enabling staff to assign codes to change order causes that can be used to aggregate reports that demonstrate trends. Tracking performance outcomes helps to improve the decision-making process by identifying where to allocate organizational resources to reduce the likelihood and impact of change orders that pose the most risk to a project’s cost and schedule.

See [Risk Management](#) best practice strategy for more information.



## Utilizing Data and Technology in Design, Construction, and Reporting

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Technology solutions can improve the consistency and communication of project and asset information, allowing project team members to identify and address issues that may lead to change orders before construction begins. When using data management processes and technology, regular reviews are important to determine whether existing tools are meeting organizational needs or if capacity needs to be expanded.

**BIM and 3D modeling** can promote design quality by facilitating early identification of conflicts. Information tools can support communication with project sponsors through easily digestible visual models, helping to avoid changes from misunderstandings.

**Digital as-builts** identify and monitor conflicts with existing conditions and facilitate partnering with utility and other asset owners to ensure conflicts are identified and addressed timely.

**ADCMS** streamlines interoperability, project management, submittal processes, communication, contraction administration, and approval processes to facilitate the execution of necessary change orders and accelerate communication that highlights potential issues that can become change orders.

**E-ticketing** monitors real-time use of project quantities to anticipate the potential need for adjustments or changes.

**Dashboards** facilitate performance monitoring, evaluation, transparency, and accountability to more quickly identify project issues that can result in change orders and encourage project sponsors to deliver projects that maintain the integrity of promised schedules and costs.



## 3.7 Organizational Culture

Organizational culture sets the tone for project delivery by aligning goals, defining responsibilities, and empowering the workforce to create a healthy project ecosystem that is prepared to address change orders and their causes. It permeates all aspects of project delivery, and as such has the potential to contribute to change orders downstream.

Leadership is responsible for establishing organizational values around quality and successful project delivery, advocating for change, and ensuring accountability to meeting goals. Creating a culture of alignment allows for candid communication and dissenting views without the threat of retaliation or adversarial pressures. Therefore, leaders should be chosen based on experience and demonstrated success in exercising those actions.

Project sponsors have distinct functions, divisions, and teams, and projects change hands multiple times throughout development. These hand-offs can result in changes<sup>3</sup> or delays when teams work in isolation and are not informed of priorities or involved in each other's efforts. An organizational culture that centers collaboration amongst teams and the safety of participants to raise issues is essential to identifying and addressing project risks and weaknesses before they become major issues requiring change orders.

Creating a "project first" culture aligns project goals and priorities across leadership, technical teams, and stakeholders to ensure execution of the vision without unnecessary cost overruns, duplication, and delays.

### 3.7.1 Organizational Culture Considerations

#### Multidisciplinary Project Teams

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Cross-functional teams can help projects advance more efficiently and ensure goals and priorities remain consistent, and decisions are made holistically to avoid project gaps that can later result in detrimental change orders. Creating opportunities for interdisciplinary collaboration can also result in value engineering proposals or innovations.

See [Communication](#) strategy for more information.



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<sup>3</sup> [NACTO Structured for Success](#)

## Organizational Structure

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Aligning funding and staff with clearly defined roles and responsibilities makes it easier to agree on priorities and implement projects. Mapping and documenting processes can help establish more transparent norms and practices, reducing redundancies and improving communication and handoffs between teams to prevent project development oversights that can later require change orders to rectify.

See [Process](#) best practice strategy for more information.



## Putting the Project First

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Clear priorities and shared goals between project parties are essential for successful projects. A project-first culture that prioritizes project quality empowers project staff to dedicate sufficient time to develop realistic project deliverables and incorporate stakeholder feedback. Similarly, projects benefit when each involved party understands and appreciates the others' goals early in project development. This helps to prevent rushing projects to move through programmed funds, which can lead to downstream cost and schedule consequences.

## 3.8 Chapter Summary

There are many approaches to preventing and minimizing the likelihood and impact of construction change orders. The best practice strategies presented in this chapter can be used independently or in combination with each other to address technical, organizational, financial and funding causes of change orders depending on the pervasiveness of change orders in a program. Practitioners can consider how to:

- Implement formal processes that ensure quality, consistency, and completeness of technical work products
- Use risk management to improve decision-making that targets project elements that can potentially cause change orders
- Promote early and frequent communication with internal and external stakeholders to fortify project teams and facilitate information exchange as well as the understanding of stakeholder roles and responsibilities in the project delivery lifecycle to ensure project designs and agreements are completed with input from all perspectives
- Employ alternative contracting methods where appropriate to balance project sponsor and contractor risks and minimize project vulnerabilities that can lead to change orders
- Access a robust and skilled workforce that has the capacity to manage projects and produce work free from errors, omissions, and oversights that require change orders to correct

- Leverage data and technology to support more efficient communication, decision-making, and problem solving that precludes the need for construction change orders
- Nurture an organizational culture that establishes a project-first environment where stakeholder goals are aligned and respected and practitioners are empowered to think critically.

These strategies help practitioners strengthen project agreements to ensure the reasons for change orders are considered and addressed to make projects resilient to the impacts.

## 4.0 Noteworthy Practices

Noteworthy practices demonstrate how sponsors of federally funded projects have successfully implemented variations of the best practice strategies to address the impacts of change orders. These stories illustrate that change orders can arise from various issues and be addressed through a variety of best practice strategy solutions. When organizations earnestly assess opportunities to improve their practices and prioritize communication in their processes, many benefits, including reducing or better managing change orders, can be realized. The following examples are multidimensional, applicable across modes, and scalable to fit practitioner needs.

- Washington State DOT (WSDOT) deploys a probabilistic risk-based estimating (PRBE) approach to cost and schedule estimating that helps to ensure sufficient accounting of project risks to reflect the most realistic range of costs and schedule implications. WSDOT also developed the Cost Estimate Validation Process for high-cost projects. Together, these position WSDOT to avoid or reduce change orders impacts due to inaccurate estimates on their projects.
- Colorado DOT uses a Subsurface Utility Engineering (SUE) program to communicate with utility owners to manage subsurface utility information throughout the project lifecycle. This contributes to fewer change orders, delays, and safety hazards resulting from utility conflicts by providing the project team with more complete and accurate information to develop design and project agreement documents.
- Texas DOT's Design and Professional Engineering Procurement Services divisions developed new procedures that partner with the consultant community to improve design quality, consistency, and accountability. These processes increase workforce capacity and help prevent costly and time-consuming change orders required to address design errors and omissions discovered during the construction phase.
- The San Diego Association of Governments and Valley Metro of Phoenix, AZ use alternative contracting methods to appropriately distribute project risks between parties. By proactively addressing risk collaboratively with the contracting community, project sponsors are able to resolve design and constructability concerns early in project development and formalize responsibilities through a comprehensive project agreement, to prevent challenges that can later become change orders without adversely impacting agencies or contractors.
- North Carolina DOT uses constructability reviews and post-construction assessments to improve communication between design and construction teams before and after projects are constructed. This contributes to a better working relationship between the DOT and contractors, while building the capacity of the workforce to better identify and prevent change orders on future projects.

- Montana DOT employs its Partnering Program to ensure early and continuing coordination among project partners throughout the project development and delivery phases. The program produces better working relationships between the DOT and contracting community to collaboratively address risk areas that can necessitate change orders. It also implements a structured approach to problem resolution, reducing change orders and preventing issues from escalating into a claim or litigation.



## Noteworthy Practice: Washington Department of Transportation (WSDOT) Cost Estimate Validation Process

One of the most difficult aspects of project delivery is sufficiently accounting for risk when developing cost and schedule estimates. Unaccounted risk frequently leads to change orders and other cost and schedule overruns. Probabilistic risk-based estimating (PRBE) is a scalable approach to cost and schedule estimating that helps to ensure sufficient accounting of project risks. PRBE uses data and statistical simulation to identify potential risks before significant design decisions are made or construction begins. Good processes and organizational culture are foundational to PRBE. The goal of PRBE is to identify the risks to a project, quantify their potential cost and schedule impacts, and determine the best methods for managing and communicating them.

*WSDOT has used PRBE methods for over two decades to successfully deliver hundreds of transportation infrastructure projects.*

### Change Order Issue

Traditional cost estimating may insufficiently account for project-specific risks, obscure flaws in the estimate or design, or underestimate the degree of uncertainty within the estimate.<sup>4</sup> WSDOT historically used this method of estimating, which relied on a project estimator's experience and judgement without explicitly identifying a project's individual uncertainties and risks.<sup>5</sup>

During the 1990s, WSDOT faced public mistrust of their ability to manage projects and communicate estimates. In particular, WSDOT's State Route 167 expansion project saw compounding cost and schedule growth that far exceeded the original estimate.<sup>6</sup> WSDOT needed a PRBE process to help them better identify and account for the "unknown-knowns" and "unknown-unknowns" that make it difficult to estimate project costs and schedules.

#### PRBE Risk Assessments

**Qualitative risk assessment** addresses subjective risk elements and may be sufficient for small projects.

**Quantitative risk assessment** numerically evaluates risk elements and may be necessary on more complex projects. It involves techniques such as **Monte Carlo** simulation (WSDOT Project Risk Management Guide).

**Monte Carlo** simulation computes probability to determine a distribution of cost or schedule outcomes (NHI, PRBE for Highway Project Cost and Schedule).

<sup>4</sup> Gabel, M., Sujka, M., Davis, Z. W., & Keizur, A. E. (2023). Performance of Risk-Based Estimating for Capital Projects. Transportation Research Record, 2677(1), 1059-1070. <https://doi.org/10.1177/03611981221103238>

<sup>5</sup> [WSDOT Project Risk Management Guide, P.1-7](#)

<sup>6</sup> [Building Public Trust | FHWA \(dot.gov\)](#)

**Best Practice Solution** In 2002, WSDOT developed the Cost Estimate Validation Process (CEVP®) for high-cost projects. This PRBE process assesses risk using historic qualitative and quantitative data to produce estimates expressed as a range of values, rather than an individual number. This value range aims to convey the degree of uncertainty in the estimate, which can assist the agency in project-specific risk management. WSDOT creates two components for estimates—the base cost (or likely cost) component and the risk component.<sup>7</sup> The risk component includes defined events, with each having a corresponding likelihood and consequence to produce a risk register. The estimate is then subject to a robust review by independent subject matter experts for validation of the assessment.

**What is a risk register?** A risk register is a control document for risk identification, risk updates, and risk treatment actions. It records all identified risks and includes details and characteristics for those risks (NHI, PRBE for Highway Project Cost and Schedule).

WSDOT has continually refined the process for use on projects of varying sizes and risk profiles. After initial success with the CEVP for large projects, WSDOT began using a scaled-down version, referred to as Cost Risk Assessment (CRA) workshops, for smaller and less complex projects.

In addition to improving decision-making and project outcomes, WSDOT uses the results of CEVP/CRA workshops to communicate project risks to the public and project partners through simple and concise one-page summaries. These not only help to improve accountability, but also appropriately establish expectations and perceptions of cost growth.

State and agency leadership gave early support to the development and implementation of PRBE. Adopting the practice was an organizational effort made easier by early successes, as well as active and continuous improvement efforts.<sup>8</sup> WSDOT has documented lessons learned and provides targeted training to continue to build an organizational culture of risk management.<sup>9</sup>

Involvement in PRBE is organization wide, including executives, senior leaders, and project staff from across departmental units. External consultants and subject matter experts may also participate in the workshops to stymie bias and assist with validating estimates.<sup>10</sup>

## Major Considerations

WSDOT embedded risk-management into their organizational culture and existing processes, which can be a challenging but important undertaking for any agency. Agencies looking to

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<sup>7</sup> [WSDOT Project Risk Management Guide, P.1-7](#)

<sup>8</sup> Gabel, M., Sujka, M., Davis, Z. W., & Keizur, A. E. (2023). Performance of Risk-Based Estimating for Capital Projects. Transportation Research Record, 2677(1), 1059-1070. <https://doi.org/10.1177/03611981221103238>

<sup>9</sup> [WSDOT Project Management training webpage](#)

<sup>10</sup> [WSDOT Project Risk Management Guide, P.A-1](#)

implement or strengthen their risk-based estimating processes should develop strategies to engage with leadership and cultivate their support. Once implemented, maintaining and improving the risk-based estimating process is critical to its success.

Resources can be a constraint for many agencies looking to implement more robust risk-based processes. To address resource constraints, such as internal staffing availability, available technology, and budgets, WSDOT scales their PRBE process based on project size or complexity. Agencies may need to evaluate their staffing levels, budgets, and project profiles to implement appropriately scaled processes.

## Results

WSDOT's implementation of PRBE has been a success in achieving better project outcomes and organizational change.<sup>11</sup> WSDOT projects that used a CRA process have shown a reduction in cost and schedule growth related to change orders, compared to projects that did not use a CRA process. On average, this reduction is 4.8 percent for cost and 6.7 percent for schedule.<sup>12</sup> Consistently delivering projects on time and on budget to build public trust was one of the main goals of WSDOT's CEVP. It has also resulted in building an organizational culture of risk management supported by [dozens of resources](#) and a robust [Project Risk Management Guide](#) to consistently implement their processes.

### *Takeaways*

Agencies of any size can use PRBE to mitigate cost and schedule growth, communicate valid and realistic expectations to stakeholders, and more efficiently allocate resources. Potential strategies include:

- Implement a standard project risk assessment process:
  - Collect data to document historical risk likelihood and impacts
  - Conduct risk assessment workshops
  - Use data to inform and validate reference class forecasting
  - Escalate levels of analysis based on project profiles (size, complexity, etc.).
- Develop materials to communicate risk with project teams and external stakeholders.
- Record best practices and lessons learned to build organizational culture.

**For more information, contact WSDOT's CRA and CEVP program manager at:**  
[Mark.Gabel@wsdot.wa.gov](mailto:Mark.Gabel@wsdot.wa.gov).

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<sup>11</sup> Davis, Z., Gabel, M., Sujka M., & Keizur, A. E. (2022). [Implementing and Sustaining a Cost Risk Estimating and Management Program](#). International Conference on Transportation and Development.

<sup>12</sup> Gabel, M., Sujka, M., Davis, Z. W., & Keizur, A. E. (2023). Performance of Risk-Based Estimating for Capital Projects. Transportation Research Record, 2677(1), 1059-1070. <https://doi.org/10.1177/03611981221103238>

## Noteworthy Practice: Colorado Department of Transportation (CDOT) Subsurface Utility Engineering

Utility conflicts are a common cause of change orders on transportation construction projects. Subsurface utility engineering (SUE) is the process of obtaining, identifying the quality of, and managing subsurface utility information throughout the project lifecycle.<sup>13</sup> Establishing a SUE process can involve overcoming organizational barriers to avoid conflicts that can lead to change orders, delays, disruption to the public, and hazards by improving communication and coordination between project partners. Effective SUE relies on good processes to govern its use, which can help agencies manage risk with appropriate data management and technologies.

*CDOT has been a leader in developing practices that improve project delivery across the transportation systems they manage, including highway, bridge, transit, rail, and aviation. CDOT's SUE program<sup>14</sup> is one such notable initiative that has seen rapid and significant improvement in recent years.*

### Change Order Issue

Dated, inconsistent, or unavailable utility information was adding risk to CDOT projects, often resulting in higher upfront project costs as well as change orders.

CDOT also recognized the need for improved SUE processes following a deadly gas explosion in the state, which the National Transportation Safety Review Board attributed in part to a lack of utility documentation.<sup>15</sup>

### Best Practice Solution

CDOT, the contracting community, state legislature, utility owners, and other stakeholders worked together to develop a bill to address utility risks on infrastructure projects. CDOT's SUE process follows the requirements set forth by Colorado Senate Bill 18-167 and Revised Statute 9-1.5. The revised statute establishes a process for coordination throughout the project lifecycle to assess data and avoid conflicts before they result in change orders or hazards including:

- Notification of CO 811, the communication link between the utility/facility owners and excavators and homeowners, on SUE projects to receive relevant records and data
- Requirement for new utilities to be electronically locatable

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<sup>13</sup> <https://www.fhwa.dot.gov/programadmin/sueindex.cfm>

<sup>14</sup> <https://ops.colorado.gov/sites/ops/files/documents/BestPracticeSubsurfaceUtilityEngineering.pdf>

<sup>15</sup> [NTSB Pipeline Accident Brief, April 17, 2017](#)

- Creation of the Underground Damage Prevention Safety Commission for enforcement and the development of best practices.

American Society of Civil Engineers (ASCE) 38, *Standard Guideline for Investigating and Documenting Existing Utilities* was legally adopted as the means to implement the revised statute's requirements. ASCE 38 provides guidance for performing utility investigations and documenting the results to understand potential utility conflicts and minimize risk by using four levels of SUE data quality—increasing in data precision from Quality Level D (most basic) to Quality Level A (most precise).<sup>16</sup>

CDOT bolstered their implementation of ASCE 38 with other measures, including the use of ASCE 75-22, *Standard Guideline for Recording and Exchanging Utility Infrastructure Data*; documented best practices; standardized internal processes; and technology to assist with data management and sharing. ASCE 75-22 complements ASCE 38 by standardizing the collection and exchange of utility data for reliability in digital or non-digital platforms to improve design processes and communications.<sup>17</sup>

CDOT leverages a suite of technologies for their improved 3D accuracy, data collection, classification, and management processes. This includes a centralized database that can be used with Geographic Information Services (GIS) and Computer Aided-Design and Drafting (CADD) software. Hardware that collects geospatial data integrates with software compatible with smart phones, tablets, and office computers to allow real-time access, editing, and visualization of the database for project staff.<sup>18</sup> This can help to improve communication and decision-making among project staff wherever they are located.

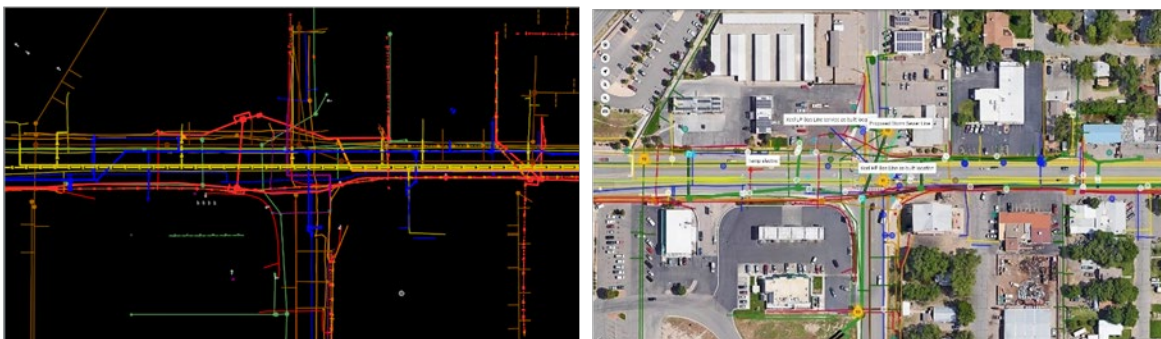


Figure 2: Examples of Utility Data Layers in CADD and GIS.

<sup>16</sup> [Standard Guideline for Investigating and Documenting Existing Utilities \(38-22\) \(asce.org\)](https://www.asce.org/standards-and-guidelines/38-22)

<sup>17</sup> [Standard Guideline for Recording and Exchanging Utility Infrastructure Data \(75-22\) \(asce.org\)](https://www.asce.org/standards-and-guidelines/75-22)

<sup>18</sup> [CDOT-Whitepaper-REV02062023-WEB.pdf \(pointman.com\)](https://www.pointman.com/CDOT-Whitepaper-REV02062023-WEB.pdf)

## Major Considerations

Agencies should consider their program's risk profile, industry relationships, and legal environment before revising their SUE program. Legal solutions can yield benefits, but all stakeholders should be engaged in determining which standards and processes will be most balanced, beneficial, and enforceable. Implementing standards and processes through legislation may not be necessary, but it can help strengthen adherence and consistency, as it did in Colorado.

Technological solutions can improve the effectiveness and efficiency of a program or project, but they also can be cost prohibitive for agencies, with or without existing data management systems. Before making investments, agencies should evaluate their needs to determine the type and scale of technologies that may be feasible for adoption.

While particularly helpful for agencies trying to reduce change orders related to utility conflicts, CDOT's SUE program presents a noteworthy example of how creating new processes or retooling existing processes with a risk-based perspective can improve a program. Establishing robust processes and standards to address risks is essential for adopting advanced technologies that enhance direct communication of data and decision-making among project stakeholders throughout the project lifecycle. Improved processes for documentation and data management standards, independent of investments in technology, may also yield benefits in better risk management and communications.

## Results

Although use of SUE has been linked to cost savings and fewer change orders for decades,<sup>19</sup> CDOT is still determining the extent to which their SUE program has mitigated potential change orders and excess costs across their program.<sup>20</sup> The Central 70 Project was recently completed with zero change orders related to utility conditions. This 10-mile reconstruction of Interstate 70 in an urban context involved removing a 54-year-old viaduct, lowering the interstate, and constructing a 4-acre park above.<sup>21</sup>

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<sup>19</sup> Lew, J.J. (2000). [Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering](#)

<sup>20</sup> National Academies of Sciences, Engineering, and Medicine. 2022. Implementation of Subsurface Utility Engineering for Highway Design and Construction. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26588>.

<sup>21</sup> [Central 70 Project Snapshot \(2019\) \(codot.gov\)](#)

### ***Takeaways***

SUE encompasses several principles that are fundamentally tied to reducing or mitigating change orders. Agencies should consider:

- Implementation of consistent processes with organizational support
- Standards for collecting and maintaining data, including utilities
- Project screening for specific risks, such as utilities
- Internal and external collaboration to identify solutions
- Formalized communication channels and requirements
- Use of appropriate technological solutions such as software platforms or hardware.

For more information, contact CDOT's SUE program manager at: [Rob.Martindale@state.co.us](mailto:Rob.Martindale@state.co.us).

## Noteworthy Practice: Texas Department of Transportation (TxDOT) Errors and Omissions Process

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Change orders and delays are often due to unnoticed or unaddressed errors and omissions (E&O) in contract documents and design plans, specifications, and estimates (PS&E). E&O can result from miscommunication and human error during the stages of project development. Agencies can minimize E&O by implementing processes that encourage quality control of design and contract documents and preparing for mitigation during construction. Assigning responsibility for the E&O and determining the most efficient solution require an organizational culture of coordination and accountability, achievable with open communication and a well-trained workforce able to exercise independent judgement that aligns with established processes. Data can be used to track and identify E&O causes and trends to improve project and programmatic performance.

***TxDOT successfully manages thousands of active consultant contracts valued over \$1 billion each year to deliver transportation construction projects across a sweeping multimodal system.***

### Change Order Issue

From 2001 to 2015, TxDOT determined that approximately one-fourth of all change orders and approximately one-third of all change order value were related to E&O. Following the Federal Highway Administration (FHWA) and internal audits, TxDOT set a goal to reduce the amount and cost of E&O, establish consistency across the organization, and maintain positive relationships with industry.

### Best Practice Solution

TxDOT's Design and Professional Engineering Procurement Services (PEPS) divisions published procedures and guidance for TxDOT staff in 2008. This guidance outlines a process to fulfill state law and minimize negative impacts of E&O on projects.<sup>22</sup> The process includes several important considerations for preventing and addressing E&O, such as:

- Utilize quality control reviews prior to interim and final submissions of designs and PS&E.
- Implement a communications plan between TxDOT, consultants, and contractors throughout the project life cycle.
- Keep the consultant contract active through construction and pre-construction meetings.
- Develop corrective action and recovery mechanisms to resolve E&O issues.

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<sup>22</sup> [TxDOT, Consultant Errors & Omissions Correction and Collection – Policy and Procedures \(2014\)](#)



- Establish consistency among organizational units while retaining independent decision-making.
- Utilize specific change order codes to track the source of E&O-related change orders.
- Develop training on how to address change orders associated with consultant E&O. TxDOT routinely invites members of the consultant community to participate in the class to provide a consultant perspective.
- Engage with the consultant community through workshops to discuss the process and answer questions.
- Create an internal working group between the department's PEPS, Construction, and Finance Divisions to support the districts in evaluating change orders, identifying the responsible party for resolving the E&O, and recovering additional costs caused by the E&O when appropriate.

TxDOT partnered with the Texas A&M Transportation Institute to create dedicated training that brings agency staff and the consultant community together to better understand the practice of managing E&O by working through real-world examples.

## Major Considerations

The policy guiding TxDOT's E&O process was implemented as a result of a Texas government code passed to track and reduce costs related to E&O in engineering contracts.<sup>23</sup> While not a requirement to implementing processes, legal authority can be leveraged to gain support. Agencies similarly looking to establish processes to address E&O should consider existing legal authorities in their state or municipality. However, these may not always be necessary or may not be the more efficient option to reduce negative outcomes related to E&O.

Organizational structure, program size, typical project types, and local or regional industry are other important elements to consider when establishing processes intended to address E&O in project documents. Industry and consultant communities are important partners on transportation projects, and TxDOT's policy contains necessary provisions that provide for timely notification and coordination with the project consultants and contractors to create a culture of accountability. Strong relationships and industry feedback are essential to successfully developing and implementing policy and processes.

## Results

TxDOT is tracking the outcomes of its E&O process to determine the extent of its impacts and realizing benefits from its collaborative resolution process and cooperative training efforts. By

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<sup>23</sup> Texas Government Code Section 2252.905

focusing on quick resolution of issues when they arise, the department has made progress in meeting goals for on-time and on-budget delivery. Through a publicly available dashboard<sup>24</sup>, TxDOT reports increasing success in on-time project completion between 2017 and 2022, while consistently surpassing targets set for the percentage of projects completed on budget. The dashboard allows the agency to use the data it collects to inform decision making and improve accountability.

### ***Takeaways***

Having a process in place that anticipates E&O and mitigates their cost and schedule impacts is achievable by organizations of any size. Potential strategies include:

- Use data to track causes of change orders and responsible parties.
- Implement processes that encourage quality control reviews and open communication when E&O are identified.
  - Use communication channels and problem solving to build a culture that prioritizes project outcomes.
- Develop and manage a well-prepared and managed workforce.
  - Train and develop staff to identify content that is prone to E&O and exercise independent decision-making.
  - Screen projects to efficiently use resources based on historic project outcomes.

**For more information, contact TxDOT's Director of Professional Engineering Procurement Services at: [Dan.Neal@TxDOT.gov](mailto:Dan.Neal@TxDOT.gov).**

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<sup>24</sup> [TxDOT's project performance dashboard](#)

## Noteworthy Practice: San Diego Association of Governments (SANDAG) Alternative Contracting

In appropriate contexts, delivering projects with alternative contracting methods (ACMs) can help to manage change orders by mitigating risk compared to traditional low-bid design-bid-build contracts. For example, with the Construction Manager/General Contractor (CM/GC) contracting method<sup>25</sup>, the contractor is involved during the design phase to offer feedback on constructability and pricing of design options. Early contractor involvement helps develop a project culture and processes focused on outcomes, while meeting the goals of all partners. CM/GC fosters coordination that optimizes risk identification and allocation before construction begins to avoid conflicts or conditions that lead to change orders in traditional project delivery environments. As in traditional project delivery, tracking change order data can be useful for documenting outcomes and lessons learned.

***SANDAG is both a metropolitan planning organization and council of governments that plans and delivers transportation infrastructure projects across modes in a region with diverse and wide-ranging transportation needs.***

### Change Order Issue

The Mid-Coast Extension of the UC San Diego Blue Line Trolley was a complex, high-value project that required a proactive approach to minimizing risks and managing change orders. SANDAG determined that a traditional design-bid-build contract would not be sufficient to identify and manage the project's risks. Because of the project's complexity and concurrent, multiple work packages in the project corridor, SANDAG needed a delivery method that would allow effective risk assignment and coordination and provide flexibility to build the project with minimum disruption to rail, traffic, commercial and educational stakeholders.

### Best Practice Solution

SANDAG prepared an Alternative Project Delivery Report for the Mid-Coast Project in 2012 that evaluated construction delivery methods focusing on the timeframe for environmental clearance, full funding grant agreement approval, design development, right of way, permitting,

#### **SANDAG's Key Benefits of CM/GC:**

- Involves a thorough pre-construction phase
- Equitably assigns and manages risks in partnership with the contractor
- Improves relationships between sponsor, designer, stakeholders, and contractor
- Develops a "project first" approach where everyone focuses on collaboratively resolving issues and creating solutions to achieve project objectives.

<sup>25</sup> [CM/GC may also be referred to as Construction Manager at Risk \(CMAR or CMR\).](#)

construction staging, and duration. The report analyzed 15 factors from the Transportation Research Board's *Transit Cooperative Highway Research Program (TCRP) Report 131*.<sup>26</sup>

Because of the project's size and complexity, it was important for SANDAG to select a delivery method that facilitated early contractor involvement. CM/GC allows the contractor to be engaged during the pre-construction phase to optimize design for cost-efficiency, schedule certainty, and constructability, which can reduce unanticipated change orders during construction. Early collaboration with the contractor also contributes to a positive project culture where parties focus on finding solutions and achieving project objectives while fairly managing shared risk.

At a sufficient level of design for pricing, SANDAG and the CM/GC negotiated a guaranteed maximum price (GMP). The GMP established a baseline scope and cost for construction and assigned risks with allocated responsibilities for project cost changes. The CM/GC contract provided SANDAG with a mechanism to incorporate other pre-planned work packages for parallel projects in the same rail corridor. The CM/GC contracting method reduced SANDAG's risk for potential additional cost and schedule delays due to interface conflicts from work on adjacent projects in the same rail corridor.

## Major Considerations

Before considering the use of an alternative delivery method, it is important for agencies to understand which methods are authorized under applicable local, state, and federal regulations. For the Mid-Coast Project, the CM/GC procurement followed Federal Transit Administration (FTA) Circular C 4220.1F, *Third Party Contracting Guidance*<sup>27</sup>. Additionally, the CM/GC procurement method was authorized under California Senate Bill 1549, which provided SANDAG with authority to use alternative contracting methods for project delivery.

Agencies should develop processes to determine when alternate *delivery* methods, such as CM/GC, are the best fit to deliver projects. SANDAG determined that CM/GC was well suited for the Mid-Coast Extension project based on the project's complexity and need for a flexible project agreement.

Using alternative delivery methods may also introduce additional risk due to unfamiliarity with procedures and contractual structure of the method. Agencies should consider preparing their staff and consulting with the contractor community to improve project outcomes when using new delivery methods. With preparation and research, SANDAG was successful in delivering the Mid-Coast Extension project despite it being their first CM/GC project.

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<sup>26</sup> [TCRP Report 131: A Guidebook for the Evaluation of Project Delivery Methods](#)

<sup>27</sup> [Federal Transit Administration \(FTA\) Circular C 4220.1F, Third Party Contracting Guidance](#)

The FTA's *Project and Construction Management Guidelines*<sup>28</sup> provide summaries of common ACMs, including CM/GC.

## Results

By leveraging the flexibility and early contractor involvement afforded by the CM/GC delivery method, SANDAG was able to begin construction ahead of schedule. This ultimately resulted in the \$2.1 billion, 11-mile Mid-Coast Extension project being completed a year early with no claims. SANDAG was also able to track and control change orders, limiting most changes to anticipated additions to the scope (see Figure 3) that were within the contemplated project cost and schedule contingencies.

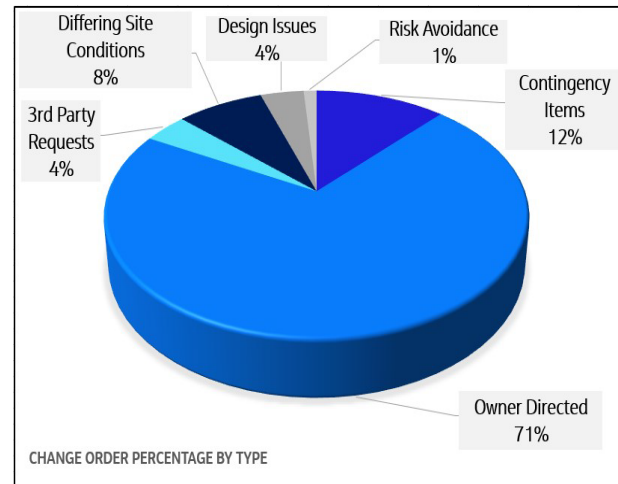


Figure 3: Change Order Percentage by Type for Mid-Coast Extension Blue Line Project. Source: SANDAG

### Takeaways

CM/GC encourages open participation by the contractor in design, pricing, and problem resolution tied to reducing or mitigating change orders. Agencies should consider:

- Developing processes to determine which projects are most suited to an alternative delivery method.
- Using data to track project outcomes, including change order causes to measure ACM impact.
- Coordinating with contractors early to address risk, build a collaborative project culture, and optimize pre-construction activities.
- Coordinating with contractors early to address risk, build a collaborative project culture, and optimize pre-construction activities.

For more information, contact SANDAG's Mid-Coast Extension Corridor Director at: [Venky.Ganesan@sandag.org](mailto:Venky.Ganesan@sandag.org).

<sup>28</sup> [Project and Construction Management Guidelines \(dot.gov\)](https://www.fdot.gov/resources/projects/Project-and-Construction-Management-Guidelines.pdf)

## Noteworthy Practice: Valley Metro Alternative Contracting to Navigate Risk

In appropriate contexts, delivering projects with alternative contracting methods (ACMs) can help to mitigate or avoid change orders compared to traditional low-bid design-bid-build contracts. For example, with the Construction Manager at Risk (CMAR)<sup>29</sup> contracting method, the contractor is involved during the design phase to offer feedback on constructability and pricing of design options. Early contractor involvement helps develop a project culture and processes focused on outcomes, while meeting the goals of all project partners. CMAR fosters communication that can help optimize identification and allocation of risks before construction begins to avoid conflicts or conditions that contribute to change orders in traditional project delivery environments.

*Valley Metro is the regional public transportation authority in the Phoenix, AZ metropolitan area that plans, builds, operates, and maintains multimodal transportation programs for commuters, seniors, and people with disabilities.*

### Change Order Issue

The Northwest Extension Phase II (NWE II) project featured a complex scope in an urban setting with many potential conflicts. Valley Metro needed a project delivery method that would provide flexibility in the project agreement to manage work packages as the project progressed, efficiently distribute risk between project partners, and minimize the number and impact of unplanned change orders.

The **Guaranteed Maximum Price** is collaboratively developed to inform the distribution of risks and the consideration of contract options. Options are desired, pre-planned work items that are not necessary for the project's completion or operation but can be added to the project agreement if schedule and contingencies allow.

### Best Practice Solution

Valley Metro used the CMAR method to deliver the NWE II project. This included a structured, escalating approach from Transportation Cooperative Research Program (TCRP) Report 131, involving an analytical assessment, a weighted scoring system, and, if necessary, a cost and schedule risk analysis. Under CMAR, a guaranteed maximum price (GMP) is developed in coordination with the contractor as a part of the project agreement. To inform

The **NWE II risk matrix** categorizes risks based on common sources, such as utilities, permitting, environment, and right-of-way. Risks are further categorized based on their potential impacts, such as cost or schedule.

<sup>29</sup> [CMAR may also be referred to as Construction Manager/General Contractor \(CM/GC\).](#)

the GMP, the project team creates a risk matrix, which categorizes, describes, and identifies whether a risk is owned by the contractor or Valley Metro. The risk matrix allows the cost of contractor-owned risks to be considered in the GMP, while flagging other risks as potential change orders.

CMAR also provided flexibility to add options, or pre-planned work packages, to the project agreement as the project progressed. These packages may not be necessary for the project's completion, but their cost is considered in the GMP, keeping the project team aware of the necessary contingent funds and final dates for options to be constructed.

Valley Metro was able to open the NWE II project for revenue service early and under budget despite a complex scope that included:

- 3 stations (1 above grade)
- A 4-story parking structure
- 3 bridge crossings
- Embedded and direct fixation tracks
- 2 traction power substations and signal interlocking with signal building
- Communications systems and fare vending machines
- Roadway improvements, drainage, and utility relocation

## Major Considerations

Before considering the use of an alternative delivery method, it is important for agencies to understand which methods are allowable under applicable local, state, or federal regulations. Decision-making processes such as the example in TCRP Report 131<sup>30</sup> should be used to determine when alternate delivery methods like CMAR best fit project needs. Carefully consider delivery methods as part of risk assessment because while ACMs may provide benefits that solve problems common to traditional project delivery methods, they may also introduce complications when a method is not well-suited to a particular project context. All project partners should understand the selected delivery method's contractual terms and procedures. Valley Metro maintained a log of lessons learned to document successful CMAR practices, which can be beneficial to improving workforce capacity and knowledge.

The Federal Transit Administration's *Project and Construction Management Guidelines*<sup>31</sup> provides summaries of common ACMs, and *FTA Circular 4220.1F*<sup>32</sup> provides specific guidance on third-party procurement requirements.

## Results

While work continues, the NWE II has opened for revenue service 13 months ahead of schedule and is on track to be completed \$30 million under budget. While the project still

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<sup>30</sup> National Academies of Sciences. "[A Guidebook for the Evaluation of Project Delivery Methods](#)." The National Academies Press, 12 May 2009.

<sup>31</sup> [Project and Construction Management Guidelines \(dot.gov\)](#)

<sup>32</sup> [FTA Circular 4220.1F](#)

experienced change orders, they were nearly all sponsor-requested or related to additional work packages as planned in the preconstruction phase. This success can be attributed to Valley Metro and the CMAR negotiating the GMP to collaboratively solve issues anticipated during construction, which helped avoid change orders and keep the project on schedule and on budget.

### ***Takeaways***

CMAR is an alternative contracting method that encourages many principles fundamentally tied to reducing or mitigating change orders. Agencies should consider:

- Developing processes to:
  - Determine when an ACM is appropriate for a project, and which method is best suited to the project
  - Manage risk and contingency throughout the project's lifecycle
  - Formally track lessons learned and project outcomes to build workforce knowledge.
- Using data to track project outcomes, including change orders and lessons learned.
- Communicating with contractors early to address risk, build a collaborative project culture, and optimize preconstruction activities.

For more information, please contact Tony Santana, P.E., or Kyle Strickland at the Valley Metro Capital Development Department: [tsantana@valleymetro.org](mailto:tsantana@valleymetro.org), [kstrickland@valleymetro.org](mailto:kstrickland@valleymetro.org).



## Noteworthy Practice: North Carolina DOT (NCDOT) Design and Construction Knowledge Management

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The design stage of a project can significantly influence its final cost and schedule outcomes. Incomplete designs or designs that do not consider constructability, contractor experience, or real-world conditions can often leave a project vulnerable to cost growth and schedule delay change orders. Constructability reviews and post-construction assessments (PCAs) are two processes that facilitate communication and create feedback loops between design and construction teams before and after projects are constructed. These processes incorporate data and lessons learned to strengthen workforce experience and build an organizational culture of continual improvement in avoiding and mitigating risk when developing projects.

***NCDOT has conducted constructability reviews for over three decades, leading to the PCA initiative in 2021.***

### Change Order Issue

Institutional knowledge and lessons learned from completed projects can be lost if not formalized or due to staff turnover. Losing track of these valuable lessons can contribute to avoidable change orders on future projects. Over the past several decades, NCDOT has worked to improve its organizational knowledge management of design and construction practices to prevent, minimize, and mitigate potential change orders. Constructability reviews and PCAs are key processes in their formal knowledge management program.

### Best Practice Solution

Constructability reviews bring together engineers, contractors, and other partners to uncover potential flaws or vulnerabilities in a project's design before construction begins. NCDOT uses these reviews to address design challenges before they manifest during construction as delays, change orders, or other cost and schedule escalations.<sup>33</sup>

NCDOT's Value Management Office (VMO) has led their Constructability Review program for over 10 years and acts as a third party in coordinating between the Project Management teams and the Carolinas Association of General Contractors (CAGC). Contractor participation is voluntary; participating contractors can bid on the project under review once it is advertised for letting. By coordinating with the contracting industry, NCDOT has been able to foster active participation in the program so contractors can better understand the project, identify risks, share their input, and offer more efficient solutions for construction.<sup>34</sup>

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<sup>33</sup> [CRP Fact Sheet.pdf \(ncdot.gov\)](#)

<sup>34</sup> [Ibid](#)

To enhance the program, the VMO tracks data on each constructability review, including project type, current estimate, location, participating contractors, lessons learned, and more. Although not required, constructability reviews are encouraged for projects based on their risk profile, such as those that involve new designs, construction methods, or materials. NCDOT incorporates formal risk management processes to use resources more efficiently by identifying which projects are most appropriate for constructability reviews and at what design phases they are most effective.<sup>35</sup> Designers can build on the outcomes of the reviews and risk management principles to address design and contracting requirements on future projects.

NCDOT supplements their constructability review process with PCAs, which provide a forum for construction and maintenance teams to communicate their experience and lessons learned back to the design team after projects are completed. This feedback loop is critical in ensuring lessons learned during construction and maintenance are incorporated into early project phases including prioritization, estimates, and designs. The PCA process occurs through meetings involving the DOT, contractors, and consultant partners facilitated by the VMO. Other personnel may also participate to share knowledge or learn how they might overcome obstacles on other ongoing projects. Photos, videos, and project documents from construction and

#### **NCDOT's Suggested Practices for Constructability Reviews**

- Establish a well-rounded attendees list to include multi-disciplinary subject matter experts.
- Include department representatives from construction and maintenance, and members of the contracting community.
- A third-party facilitator can drive the conversation, ensure the critical items are discussed, and provide support to capture the conversation and recommendations.
- Capturing the conversation and outcomes is critical to implement the recommendations.
- Holding the meetings in the earlier design stages allows for changes and flexibility to be incorporated into the process.
- Distribute design documents to attendees one week in advance to allow for review and development of questions.

#### **NCDOT's Suggested Practices for Post Construction Assessments**

- Engage a third-party facilitator to manage the prep, run the meeting, capture the minutes, and submit the outcomes into a database.
- Obtain buy in from all participants to have open conversations.
- Invite designers to hear from the contractor and maintenance community and DOT construction personnel to hear feedback.
- A visual format facilitates cross-disciplinary knowledge sharing.
- Prepare early with the Construction Resident Engineer and Area Construction Engineer to establish the agenda of best practices and lessons learned to be discussed.

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<sup>35</sup> [Risk Management Program \(ncdot.gov\)](https://www.ncdot.gov/riskmanagement/)

maintenance are shared during the meeting to help participants understand the project's real-world context and outcomes.

## Major Considerations

In 2019, NCDOT conducted an evaluation of their constructability review process to identify potential improvements, leading to new guidelines and formalized measures for conducting reviews and implementing results.<sup>36</sup> Agencies adopting constructability reviews, PCAs, or other practices should continually implement new processes and improve existing processes based on changing circumstances, evolving project complexity, and organizational needs.

Constructability reviews and PCAs can improve project cost and schedule outcomes but may involve additional resources at the beginning or end of a project. Agencies planning to adopt these processes should consider their capacity and budgets to administer these practices and develop risk-based screening methods to efficiently allocate resources.

Measuring project outcomes is important to ensure effective implementation of processes. NCDOT uses a performance dashboard and annual performance reports that track project delivery data to communicate results and provide accountability. A platform to monitor project outcomes before and after initiating processes can be a useful tool for agencies to track the impacts of their efforts.



Figure 4: Incorporate constructability reviews and PCAs into the project delivery lifecycle.

## Results

The combination of constructability reviews and PCAs has allowed NCDOT to improve its construction program with each successive project. These formal processes provide a means to incorporate lessons learned from previous projects to better manage risk, develop workforce experience, and facilitate communication between project teams, which contributes to an organizational culture built upon continuous improvement and knowledge sharing. Through its coordination with the contracting community, NCDOT averages 10 constructability reviews a year with 60 actively participating firms. The Department has completed nearly 30 PCAs and documented over 200 lessons learned since beginning the practice in 2021.

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<sup>36</sup> [RP 2020-41 - Final Report.pdf \(ncdot.gov\)](#)

### *Takeaways*

More thorough design phases can be an effective way for agencies of any size to prevent and mitigate avoidable change orders during construction. Agencies interested in implementing constructability reviews and PCAs should consider:

- Coordinating with industry groups to develop collaborative, mutually beneficial processes
- Using risk management principles to identify when to use constructability reviews or PCAs
- Implementing formal communication channels between internal teams
- Collecting and formally documenting lessons learned and other project data to develop an experienced workforce
- Exploring ways to capture more data trends that inform the organizational culture of strategic planning.

For more information, contact NCDOT's Value Management Engineer at: [Awtamer@ncdot.gov](mailto:Awtamer@ncdot.gov).

## Noteworthy Practice: Montana Department of Transportation (MDT) Partnering Program

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Positive relationships between project partners can help to avoid change orders or mitigate their cost and schedule impacts. A culture of open communication and collaboration fosters these relationships, which encourages resolution of issues before unnecessary escalations lead to costly delays and legal claims. Using formal partnering to complement the execution of processes or programs can help overcome organizational barriers that may have previously contributed to adversarial postures. Partnering is the practice of developing collaborative relationships between project stakeholders to better manage risk, strengthen the workforce, and facilitate better outcomes for everyone involved in the project.

*MDT has been a leader in partnering since 2020. Their Partnering program<sup>37</sup> is one component of an organizational approach to project delivery that prioritizes positive relationships between all project partners.*

### Change Order Issue

Without formalized channels, such as partnering, to communicate with contractors, projects can be more vulnerable to change orders and claims. In 2019, MDT began emphasizing collaboration and communication with contractors when processing change orders in a major revision to their process. They established a formal Partnering program in 2020, which has inspired informal communication improvement efforts between departments within the agency.

### Best Practice Solution

MDT adopted a wide-ranging approach to efficiently and collaboratively address change orders, including a review of internal processes and implementation of a formal Partnering program. MDT first reviewed their change order processes with the goals of:

- Remove administrative bottlenecks and improve accountability by delegating authority to process change orders
- Gather sufficient documentation and data to standardize change order monitoring
- Use risk assessment to efficiently allocate resources.

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<sup>37</sup> [Partnering Program | Montana Department of Transportation \(MDT\) \(mt.gov\)](https://www.mt.gov/Portals/0/MDT/Programs/Partnering/Partnering%20Program.pdf)

MDT utilizes a formal Partnering program to improve relationships with industry and achieve better project outcomes, including avoiding the escalation of change orders to claims and litigation.<sup>38</sup> The Partnering program creates formal opportunities for MDT staff and contractors to develop better personal and professional relationships. This promotes creative thinking and shared knowledge and experience to address challenges such as risk mitigation, issue resolution, and adversarial tension that might otherwise result in change orders or claims.<sup>39</sup>

Partnering is formally conducted through training and project meetings. A project's complexity determines the approach taken—Level 1 Partnering or Level 2 Partnering. Level 1 is used for more complex projects that face higher risk and are led by a neutral facilitator selected by the contractor. Level 2 is used for less complex projects and is led by either a Partnering program manager or jointly by MDT and the contractor.

In Level 1 Partnering, MDT and the contractor attend the kickoff workshop to achieve consensus on the following:

1. **Project Overview:** Ensure all parties understand the project's scope, schedule, and objectives.
2. **Partnering Objectives, Values, and Risk:** Each party establishes their objectives, values, and how Partnering will be implemented. Allow parties to establish communication and develop solutions to mitigate risk.
3. **Communication and Issue Resolution:** Establish communication channels and proactive identification and resolution of issues. Designate personnel along the issue resolution ladder to streamline issue resolution.

Project progress meetings are held at agreed-upon intervals throughout the project life cycle. These may include daily meetings, meetings to discuss personnel changes, meetings to discuss new project phases, or team-building activities. Close out meetings are held when projects are complete and provide a space for the project team to reflect on successes, challenges, and lessons learned.

MDT supplements their change order process with multiple forums for discussion and collaboration, including:

- Informal discussions between internal teams to identify issues and solutions that avoid or mitigate change orders.
- Constructability and post construction reviews to better administer projects and document lessons learned.

Kickoff workshops for **Level 2** Partnering cover the same topics as **Level 1** kickoff workshops. However, the Level 2 workshops might not be as extensive because projects assigned to this level have already been screened as lower risk.

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<sup>38</sup> [Partnering Program - Level 1 | Montana Department of Transportation \(MDT\) \(mt.gov\)](#)

<sup>39</sup> [Montana Partnering Field Guide \(mt.gov\)](#)

**Issue resolution ladders** are an agreed-upon structure for project parties to resolve problems at the lowest level possible. Thresholds are established to determine when to escalate issues, without resulting in a claim.

MDT has informally internalized some partnering principles through improved communication between the Preconstruction and Construction programs. This includes quarterly meetings where each program alternates responsibility for organizing a meeting to discuss processes, details, specifications, and concerns to collaboratively develop solutions that could prevent change orders on future projects. Another internal partnering effort between Preconstruction and Construction divisions is the constructability and post construction review processes that allow each program to identify lessons learned that can be used to improve future project performance.

## Major Considerations

Agencies should engage with their contracting community to determine what solutions and Partnering practices would best support the interests of all project delivery partners. In Montana, this entailed the creation of a new Partnering office in the organizational structure with staff dedicated to administering the program.

Partnering is not intended to be a cure-all for change orders, delays, or other project delivery problems, but is meant to improve working relationships and project outcomes. Agencies and contractors should consider what problems are prevalent across their projects and identify mutually beneficial goals and opportunities for partnering. Screening projects for their level of risk can be a useful strategy for smaller agencies to develop scaled approaches to partnering, similar to MDT's two-tiered Partnering facilitation. Partnering principles can be used to improve internal efforts as well.

## Results

MDT has seen less contention with contractors and increased efficiency in processing change orders since implementing their Partnering program. While the program isn't intended to eliminate the need for change orders, MDT has been able to avoid claims and litigations and improve project delivery outcomes due to the improved relationships and communication practices.

### ***Takeaways***

Partnering promotes practices that are fundamentally tied to reducing or mitigating change orders. Agencies can benefit from the example of MDT's Partnering program by considering:

- Project-specific communication and issue resolution processes
- Screening projects for risk to efficiently use resources
- Internal and external collaboration to identify solutions to project or organizational culture issues.

Contact MDT's Partnering Program Manager at [clmartin@mt.gov](mailto:clmartin@mt.gov) for more information on Partnering, or MDT's Construction Engineering Services Bureau Chief at [spegram@mt.gov](mailto:spegram@mt.gov) for information on change order processes.

## **4.1 Chapter Summary**

Nationally, project sponsors have made significant progress in improving project delivery by implementing targeted efforts to prevent and minimize the negative impacts of change orders stemming from reasons discussed in Chapter 2, using variations of the best practice strategies from Chapter 3. Each of the seven noteworthy practice stories presented in this chapter relies on bolstering internal and external communication as a foundational best practice strategy to create a project-first culture that prioritizes project outcomes in concert with other strategies. Practitioners have successfully implemented best practice solutions to address inaccurate estimates; utility conflicts; design quality and accountability; constructability; industry and contractor involvement; strained relationships; and workforce knowledge gaps to reduce the likelihood and impact of change orders in their programs.

By continuing to focus on understanding the causes of change orders as well as the best practice strategy solutions available to address them, practitioners will improve the likelihood of completing projects on time, on task, and on budget.



## 5.0 Conclusion

Recipients of BIL funds can improve on-time, on-task, and on-budget project delivery by understanding the causes of change orders and applying best practice strategies to prevent, minimize, and mitigate their negative impacts.

Change orders can be attributed to technical, organizational, and financial and funding causes, and can result from a confluence of multiple causes ranging across categories. For example, technical causes may be driven by upstream organizational or financial forces. Strong organizational support is necessary to spend time and resources creating high-quality work products early in project development

Addressing change order causes before a project goes to construction requires solutions that consider the entire project ecosystem through the lens of the project agreement and may leverage a combination of best practice strategies. Establishing standardized processes, communicating frequently, and supporting a culture of quality, knowledge, and accountability are fundamental aspects of addressing change orders. Data, technology, alternative contracting methods, and risk management are additional tools that can be employed to achieve better project delivery outcomes.

Practitioners should reflect on their roles as technical staff or organizational leaders to determine how to best influence project delivery and change order outcomes. They can connect with peer and partner organizations to learn from noteworthy change order challenges and successes from across the country.

Thank you to our partners at federal operating administrations, national associations, and project sponsors for sharing resources, experiences, and lessons learned to inform this product.

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DOT-VNTSC-OST-25-02