COLORADO
Department of Transportation

Resilience Improvement Plan

October 2024

Table of Contents

Introduction

The Colorado Department of Transportation's (CDOT's) Resilience Improvement Plan (RIP) illustrates how resilience practices are being implemented into Colorado's transportation system processes. CDOT has been making progress towards proactively managing risks, minimizing disruptions, and adapting to changing conditions through the Risk and Resilience Program.

Colorado's transportation infrastructure directly affects the lives of all people living in the state and provides an essential service that underpins the state's economy and the movement of people, goods, and information. Maintaining secure, functioning, and resilient infrastructure is critical to the travelers' safety, prosperity, and well-being.

Resiliency became a priority for CDOT after a 2013 flood disaster along the Front Range resulted in nine deaths and caused over $4 billion in damage across the state. The event caused severe damage to roughly 500 miles of road and 50 bridges and required more than $750 million in emergency repairs to the state highway system alone. Every day the transportation system faces threats including floods, fires, avalanches, rockfall, and other unexpected events. Due to climate change, CDOT is preparing for increasing extreme weather events, as well as risks associated with human activities. In 2018, the Colorado Transportation Commission (TC) adopted Policy Directive (PD) 1905.0 Building Resilience into Transportation Infrastructure and Operations to enable CDOT to begin developing approaches to manage Colorado's risk of threats to ensure the system is better able to withstand the impact of events and recover more quickly. PD 1905 provides a common definition for resilience, directed the department to take proactive steps to manage risk and strengthen transportation system resilience, required considerations for operational resilience for mobility and operations, and outlined the responsibilities of CDOT's Risk and Resilience Program.

Planning for resiliency is gaining momentum nationwide as an essential consideration in infrastructure development and operations. The Infrastructure Investment and Jobs Act (IIJA, also known as the Bipartisan Infrastructure Law) established the Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) program. PROTECT has two funding programs designed to assist the resilience of transportation infrastructure; a formula program that is distributed to the state DOTs, and a competitive discretionary grant program that is eligible to multiple government agencies' special purpose districts and public authorities. PROTECT programs provide funding to ensure surface transportation resilience to natural hazards important to Colorado, including climate change, flooding, extreme weather events, and other natural disasters through support of planning activities, resilience improvements, and community resilience and evacuation routes.

In the 2045 Statewide Plan, CDOT included a Resilience Appendix to codify resilience as a priority in long-range plan considerations (see Figure 1). The RIP builds onto that appendix, and incorporates additional progress made by the Risk and Resilience Program. Additionally, the RIP addresses provisions and stipulations outlined by PROTECT to demonstrate how

resilience of the surface transportation system is assessed as part of CDOT's immediate and long-range planning activities and investments investment strategy. The Risk and Resilience Program is rooted in science- and data-oriented processes and tools that are being updated and refined continuously. As part of CDOT's adaptable approach to resilience improvement planning efforts, CDOT will continue updating this RIP to address changes in project prioritization, perform updates to tools/resources/methods, and incorporate lessons learned from varying experiences with threats.

Building resilience is like an insurance policy; by identifying a threat and implementing risk management strategies, we can reduce the risk to our system from future events. Proactive management of threats before they occur minimizes the resources needed to rebuild and restore service, minimizes the disruptions to people's lives and to business activity, and lowers the cost to CDOT and the traveling public in the long run.

Section 1: What Resilience Is and Why it Matters

1.1 What is Resilience? Developing CDOT's Risk and Resilience Program

The State of Colorado defines resilience as "the ability of communities to rebound, positively adapt to, or thrive amidst changing conditions or challenges—including human-caused and natural disasters—and to maintain quality of life, healthy growth, durable systems, economic vitality, and conservation of resources for present and future generations."

Resilience considerations are proactive (i.e., occurring before an event), compared with emergency response activities which are largely reactive. According to the Colorado Resiliency Office (CRO), resiliency planning involves links between the environment and social and economic sectors to improve communities holistically and to foster adaptability to changing conditions. Preparing the transportation network to cope with shocks and stressors is especially important as these routes provide access to homes, businesses, schools, and hospitals. During a disaster event, emergency personnel and communities rely on the transportation network for response and evacuations. CDOT defines resilience as the ability to keep our roads open and functional in the face of unexpected events and challenges.

CDOT developed and adopted a quantitative risk assessment method to "build back better" after the devastating 2013 flood disaster that caused over $750 million in damage to highway systems and the loss of nine lives. As CDOT's Flood Recovery Office (FRO) coordinated disaster recovery efforts from the 2013 flood, Federal Highway Administration's (FHWA) Emergency Relief (ER) Program had recently completed a new guide that highlighted the desire for agencies to address system resilience and reduce usage of the Federal Emergency Relief Program from similar events anticipated to damage transportation assets in the future. Working within the requirements of the ER Program, CDOT analyzed several damaged sites that staff anticipated could be at risk for future flood damage given historical records and observations. The method provided data-driven outcomes that informed the decision-making process for CDOT and FHWA investments in "reasonable resilient alternatives" and "replace to current standard" designs to reduce potential future losses from similar events and to maximize federal ER funds. The tools that were developed by the FRO for the 2013 flood recovery were operationalized and are currently used at CDOT to manage risks and build resilience into projects. The suite of tools is described in more detail in Section 4, including the *Risk and Resilience Analysis Procedure: A Manual for Calculating Risk to CDOT Assets from Flooding, Rockfall, and Fire Debris Flow* (R and R Manual) which describes in great detail how to use the tools.

Recognizing the importance of transportation resiliency, CDOT adopted PD 1905.0 in 2018, and subsequently, CDOT developed its Risk and Resilience Program within the Division of Transportation Development, integrating resiliency with performance management, and asset management, and planning functions (see Figure 1). The program is flexible and adaptable to

meet the changing circumstances of how we plan for extreme weather, natural disasters, and other unexpected events that could impact CDOT's system.

Figure 1 – Structure of the Performance and Asset Management Branch

The program is guided by the *4R Framework for Identifying and Evaluating Resiliency in Transportation System Assets and Organizations* described in detail in Section 4 (Table 4).

1.1.1 Resilience Planning for Stakeholders of Colorado's Transportation Network

Since 2015, CDOT has periodically convened the Colorado Resiliency Working Group (CWRG). The group includes subject-matter-experts (SMEs) from across many specialties/disciplines statewide. The Risk and Resilience Program also has an Executive Oversight Committee (EOC) that meets monthly as a strategic decision-making group to govern program initiatives. The CRWG was set up to help CDOT advance the Risk and Resilience Program into all aspects of CDOT's work and included staff from the following disciplines:

- Planners
- Engineers
- Asset managers
- Hydraulics
- Staff Bridge
- Staff Pavement
- FRO Director
- Maintenance and Operations
- Tunnels
- Geotechnical scientists
- Incident Management

- Office of Innovative Mobility
- Colorado Transportation Commission (TC)
- Federal Highway Administration (FHWA)
- Federal Emergency Management Agency (FEMA) and local offices of emergency management
- Statewide Transportation Advisory Committee (STAC)
- Transportation consultants/specialists
- Transportation Research Board (TRB)
- American Association of State Highway and Transportation Officials (AASHTO)

1.2 Benefits of Resilience Planning

The benefits of resilience are widespread, including safety benefits, fiscal benefits by saving the public funds, social and economic benefits, improving public health and response, and by saving the public time and ensuring timely access to markets for businesses and other everyday destinations.

Resilience improvements or countermeasures can minimize the loss of life and personal injuries from natural hazard events for the users of transportation infrastructure.

Managing risks saves money. A report from the United Nations indicated that every $1 invested in risk reduction and prevention can save up to $15 in post-disaster recovery. The National Institute of Building Sciences found that every $1 spent improving utilities, roads, highways, and railroads saves $4 in repairs. Nationally, the past 23 years of federally funded natural hazard mitigation ultimately will prevent 600 deaths, 1 million nonfatal injuries, and 4,000 incidents of post-traumatic stress disorder.

Managing risks reduces disruptions. CDOT is assessing risks from threats and has identified areas of the state system that are most at risk of losses from our priority events. Resilience improvements can align with proven safety countermeasures, or what could be put in place to reduce the vulnerability of an asset, and/or the probability that an event will succeed in

causing failure or significant damage. Ultimately, this helps ensure that the traveling public can get where they need to go.

Figure 2 – US 34 Big Thompson Canyon Rebuilt After 2013 Flood

US 34 Big Thompson Canyon was heavily damaged during the 2013 floods, after also suffering from flooding in 1976. CDOT and FHWA utilized a risk-based benefit/cost analysis to evaluate resiliency opportunities to "build back better" through permanent repair. The implementation of a practical design approach for permanent repairs that goes beyond the replace-in-kind (RIK) approach reduces the potential for future damage, minimizing disruption to the transportation system in future events. CDOT used 2D hydraulic analysis combined with 3D terrain models to analyze the hydraulic performance of infrastructure elements in relation to the flow of the river within the canyon. This analysis informed targeted improvements to mitigate severe flood damage, resulting in the development of several alternatives that enhance the Big Thompson channel's capacity (Figure 2) and provide the roadway with additional high-water relief to better handle large storm events.

Managing risks is important for climate adaptation. Transportation assets are impacted by changes in storm intensity and temperature over the long-term. A 2021 CDOT Climate

Resilience Study found that climate variable trends could affect geophysical processes, geohazard event frequency, and event magnitude, leading to increased rockfall, debris flow, and landslide under certain modeled scenarios. A 2024 study commissioned by FEMA and the Colorado Water Conservation Board (CWCB) developed a methodology to predict future precipitation and intensity duration frequency (IDF) curves out to calendar year 2100. The results and tools from that study are now being tested by CDOT Hydraulics to determine how design criteria must adapt to a changing climate and enhance benefit-cost analysis.

According to the US Environmental Protection Agency (EPA), four socially vulnerable populations—defined based on income, educational attainment, race and ethnicity, and age—may be more exposed to the highest impacts of climate change. Managing risks to vulnerable transportation infrastructure, evacuation planning, and disaster recovery strategies can reduce inequities. CDOT partnered in developing the Colorado's Enhanced State Hazard Mitigation Plan (E-SHMP), where it was noted that it is important to reduce risk to disproportionately impacted communities that face barriers in accessing essential functional needs during disasters.

Doing resilience planning through a RIP gives the department an opportunity to benefit from reduced project match requirements which maximizes funds that can be put toward other resilience needs. Using the suite of resilience tools detailed in Section 4, CDOT is targeting investments in resiliency when it makes sense from a benefit-cost perspective - where spending $1 now averts a much larger long-term damage cost in the future.

It is a good business practice to manage CDOT's transportation system in a way that reduces exposure to threats and to make investment decisions that improve system resiliency against predictable shocks and stressors. Proactively planning for and managing foreseeable threats before they occur reduces annualized risks and minimizes the resources needed to rebuild and restore service, lessens the disruptions to people's lives and to business activity, and lowers the cost to CDOT and the traveling public in the long run.

1.3 Interdisciplinary Resilience Considerations

1.3.1 Statewide Resilience Stakeholders

CDOT is involved in statewide, interagency planning efforts for resilience and emergency response, including a role in implementation of the following State of Colorado plans:

- 2020 Colorado Resiliency Framework, which lays out the State's resiliency vision and goals and explores risks and vulnerabilities across four themes. CDOT participates in several initiatives tracked in this framework related to the implementation of the Risk and Resilience Program.
- 2023-2028 Colorado Enhanced State Hazard Mitigation Plan (E-SHMP), a mitigation plan for all Colorado state agencies that documents sustained, proven commitment to hazard mitigation. CDOT's approach to risk and resilience is fully incorporated within the E-SHMP. Hazards profiled in the E-SHMP also identified in CDOT's enterprise-wide

risk register (Section 2.3.2) include: snow and avalanche events; geohazards, including landslide, debris flow, and rockfall; flooding; and wildfire.

- 2019 Colorado State Emergency Operations Plan (EOP) outlines general guidelines on how the state carries out its response and recovery responsibilities to address an emergency or disaster event. CDOT coordinated with the Division of Homeland Security and Emergency Management on Incident Debris Management, Recovery, and Emergency Support Function annexes.
- 2020 Resource Mobilization Plan is an all-hazards plan for the allocation, mobilization, and deployment of resources in the event of a disaster or local incident that requires more resources than those available under any existing jurisdictional or mutual aid agreement. The document contains a transportation section which describes how the State Emergency Operations Center coordinates with CDOT.

These plans address topics highlighted in the IIJA's RIP requirements, including resilience of other community assets (such as housing, health and social assets, infrastructure, and watersheds and natural resources); emergency response and mobilization of personnel and equipment; and access to emergency services by vulnerable or disadvantaged communities (which is considered as part of the "Whole Community" approach in the EOP). Furthermore, CDOT maintains a Continuity of Operations Plan that details how CDOT's staff will mobilize in the event of an emergency. CDOT also leads the Flood Technical Assistance Partnership in concert with 19 federal, state, local, and regional government agencies to advance the state of resiliency practice against natural hazards and to reduce duplication through interagency collaboration.

Key stakeholders for interdisciplinary resilience include:

- Colorado Resiliency Office (CRO), housed in the State's Department of Local Affairs
- Office of Climate Preparedness and Disaster Recovery
- Local Agency staff, administrators, and elected officials
- Stormwater management agencies
- Emergency responders
- Fire prevention districts
- State and university climatologists
- Colorado Water Conservation Board (CWCB)
- Department of Homeland Security and Emergency Management
- US Army Corps of Engineers Silver Jackets
- Community members, including business owners, health care facility managers, and school managers
- Federal land management agencies

1.3.2 The Colorado Resiliency Office

The Colorado Resiliency Office (CRO) used a holistic approach when building its Colorado Resiliency Framework by considering six sectors to identify challenges and opportunities that

are integral to Colorado adapting and thriving in adversity. The development and implementation of the framework is the charge of the CRWG, an interagency stewardship committee, of which CDOT is an active member, which works across agencies to leverage resources, build awareness, and integrate resiliency strategies across departments. The framework evaluates risks and vulnerabilities that focus on changing climate, understanding the risks and vulnerabilities from natural and other hazards, addressing the social inequities and unique community needs, and pursuing economic diversity and vibrancy.

The Colorado Resiliency Framework was the first of its kind in the nation, with the first framework released in 2015 and updated in 2020. CDOT is identified as a lead agency for many of the resiliency-strengthening strategies identified in the framework. The framework defines six resiliency priority areas that enhances resiliency and a vibrant future for Coloradans:

- Agriculture & Food Security
- Buildings & Infrastructure Sustainability
- Climate & Natural Hazard Resiliency
- Community Capacity
- Future-Ready Economy & Workforce
- Housing Attainability

Each of these priority areas has specific goals and strategies that will not only mitigate risk and vulnerability, but will help Colorado be even more adaptive to changing environmental, social, and economic considerations. To learn more about the Colorado Resiliency Framework, visit the CRO's website.

The CRO has several reference documents and tools related to advancing resiliency in all sectors of the State, emphasizing an interdisciplinary approach to resiliency. The Colorado Resiliency Framework Plan identifies core sectors critical to advancing resiliency in Colorado communities:

- Infrastructure
- Housing
- Economy
- Watersheds
- Community
- Natural Resources
- Health and Social

The CRO Resiliency Playbook is a guide for Colorado agencies interested in building multidisciplinary resiliency into their organizations, investments, and internal policies. The Playbook includes a "Resiliency Prioritization Assessment Tool," which provides a method for scoring a plan, project, or program on a wide variety of resilience indicators. CDOT could use this tool to assess resiliency planning associated with each iteration of the statewide

transportation plan to recognize advances in resiliency planning and to identify opportunities for further advancement.

Section 2: Risk Management Approach

2.1 Resilience vs. Risk Management

As described in Section 1, resiliency is the ability of a system to rebound, positively adapt to, or thrive amidst changing conditions or challenges, including human-caused and natural disasters, and to maintain quality of life, healthy growth, durable systems, economic vitality, and conservation of resources for present and future generations.

Risk is an uncertainty that can have either positive or negative impacts. For transportation planning purposes, risk can be understood as a factor of the consequences of an event, the vulnerability of an asset to those consequences, and threat likelihood. Risk can be calculated for both owners and users of the transportation system.

Risk Management is an inclusive management strategy that addresses risks, including mitigation strategies and preparedness approaches for emergencies. Risk management requires the identification and assessment of threats, evaluation of potential mitigation actions to reduce the impact of those threats, and processes to prioritize mitigation plans that align with overall agency strategic performance goals. Integrating risk into asset and performance management requires standard processes, methods, and tools.

CDOT has defined three cornerstones for considering risk and resilience in its asset management program. These include:

1. **Enterprise Risk Management:** An approach to managing risk across various levels—including agency, programmatic, and project/activity levels. See Section 2.2.
2. **Defined Risk Process:** The development of CDOT's risk register to establish risk-management priorities across the department. See Section 2.3.
3. **Risk and resilience as part of life-cycle planning and life-cycle cost analysis:** A comprehensive decision-making process that includes risk management and resilience as a part of budget setting and treatment selection. This also applies to the identification and treatment of twice-damaged assets (as required under 23 CFR 667). See Section 3.3.

2.2 Enterprise Risk Management

CDOT's risk management process (Figure 3) has been guided by documents, including the AASHTO Guide for Enterprise Risk Management and the International Organization for Standardization (ISO) 31000 Risk Management guidelines. Whenever possible, CDOT sought to incorporate AASHTO and ISO 31000 processes for risk management and associated

nomenclature. ISO guidance includes identifying sources of threats, causes, areas of impacts, and potential consequences.

CDOT uses a tiered approach to manage risks, from the CDOT-wide level down to the activity level. Specifically, CDOT incorporates four levels of risk management into its program:

- **Enterprise (Strategic, Corporate)** – Threats that affect mission, vision, and overall results of the asset-management program. Examples include politics, public perception, reputation, and levels of available revenue.
- **Program (Business Line)** - Threats that affect CDOT's ability to deliver projects and meet targets within a program. These may include organizational and systemic issues as well as revenue and economic uncertainties that cause delays. These causes are not related to any specific projects. Examples include project-delivery threats, revenue uncertainties, cost-estimating processes, revenue and inflation projection inaccuracies, construction cost variations, materials price volatility, data quality, and employee retirements.
- **Project** - Threats that affect the cost and schedule to deliver projects throughout the agency. Examples include shortages in material supplies that cause a delay in the project schedule and unexpected increases in materials costs that increase the overall project budget.
- **Activity-Level** - Threats that affect the ability of an asset to perform its function, assessed against the likelihood of the asset failing (asset condition) and the consequence to CDOT and/or users if the asset were to fail (asset criticality). For example, a bridge that is Structurally Deficient has a higher probability of failing than a bridge that is not, and the failure of a signal located at a major interchange could cause major delays to system users.

Figure 3 - CDOT's Risk Management Process

2.3 Defined Risk Process

CDOT's approach to evaluating and prioritizing risks includes assessing likelihood, consequence, vulnerability, and other considerations. The Executive Oversight Committee for Transportation Asset Management, and other CDOT SMEs participated in multiple workshops to identify enterprise-level threats, considerations, and various scoring rubrics to develop a prioritized lists of risks in a register. The threats and risk scores are updated every four years as aligned with the Transportation Asset Management Plan (TAMP) update cycle, or as needed by the Risk and Resilience Program as directed by the Executive Oversight Committee. CDOT's top 10 enterprise risks are in Section 2.3.2 below.

While CDOT's TAMP includes the initial documentation of the prioritized risk register, the threats identified extend beyond specific applications to transportation asset management. The TAMP prepares Colorado's transportation infrastructure for the future by analyzing risks, costs vs. needs, resources, and innovation opportunities across all twelve of its asset classes: pavement, bridges, buildings, culverts, fleet, geohazards, Intelligent Transportation Systems (ITS), Maintenance Levels of Service (MLOS), rest areas, signals, tunnels, and walls. In addition to raising awareness of the asset management process and objectives throughout CDT and its regions, the plan communicates CDOT's commitment to asset management to other transportation stakeholders and to the public and establishes the primary set of asset classes that the resilience assessment process can be applied to.

2.3.1 Quantifying Risk

CDOT incorporates three factors in scoring its risks: threat likelihood, consequence of impact, and vulnerability. Specifically, the risk formula is as follows:

Risk Score = T x C x V

T = Threat likelihood (probability) event will occur

C = Consequences and consideration of risk event

V = Vulnerability of CDOT to risk event or consequences. This can also be seen as the probability that estimated consequence will be realized.

Refer to Section 7.1 for each factor's scoring rubric.

Threat likelihood (T) is the probability that a threat event will occur, not its potential of impact to CDOT. This variable is based on expert opinion and historical and predictive analysis of the frequency of the event (i.e., annually, every 10-20 years, every 50 or more years, etc.) and assigned a numeric value from one to five based on a scaling rubric.

Consequences and considerations (C) are the worst reasonable impacts or results directly caused by a threat event. In the CDOT risk register, consequences are large-scale direct

impacts that can be qualified and quantified. Considerations are results that may have an impact, but the level of impact is unknown.

There are four consequence variables for which CDOT assigns a value of one to five, with one being low or no impact, and five being severe impact. The four variables are:

- Safety - event causes crashes, injuries, fatalities, or property damage (non-CDOT owned).
- Mobility - event affects access for the traveling public, commerce, etc.
- Asset Damage - event causes physical damage to CDOT-owned assets.
- Other Financial Impacts - event causes financial impacts to CDOT or financial impact on the community, overall economy, etc.

As mentioned, considerations within the register are impacts that are difficult to quantify. CDOT assigns a value of 0.05 to each consideration relevant to the risk in question. Under the risk calculation, consequences and considerations are calculated independently. They are then combined to give an overall (C) score. There are five consideration variables in the register:

- Funding - Does CDOT have adequate funds to deal with the risk event and potential impacts? Could the event affect future agency funding?
- Insurance - Do current levels of insurance cover potential impacts (e.g., personal injury, property damage, fines, or lawsuits)?
- Regulatory - Do federal, state, or local regulations inform CDOT planning and response to a risk event? What penalties exist for non-compliance?
- Political - Would the risk event spark political interest or response?
- Reputation - Would the event affect CDOT's reputation with relevant stakeholders (e.g., the media, traveling public, or taxpayers)?

The vulnerability (V) variable is a categorization of the potential impacts of a natural or human-made event to the robustness of the asset and system, or to CDOT response planning. This variable helps CDOT evaluate risk exposure to certain events, by considering previous resiliency efforts, asset engineering, and other risk management strategies. Asset managers assign a numeric value from one to five for vulnerability, with one representing low vulnerability to the event (i.e., strong preparedness or resiliency), and five representing severe vulnerability. While this section describes vulnerability as a categorization of an input used to calculate a risk score, Section 3.2 discusses vulnerability assessment factors comprehensively.

2.3.2 Risk Register

A Risk Register is a document detailing all identified risks, including description, cause, probability of occurring, impact(s) on objectives, proposed responses, owners, and status. A risk register is a tool that project teams should develop during the planning phase to address and document project risks and be able to determine the best overall planning level cost

estimate for the project. The risk register should then be maintained as part of the project file that also includes information related to the initial and future cost estimates. Proper application of cost estimating and risk management tools will result in the generation of credible ranges of costs of projects included in the long-range plan.

CDOT's risk register contains four primary elements: a threat/opportunity description, a risk statement (covered in Section 2.3.2), the risk score (covered in Section 2.3.1), and the preferred risk management strategies. The results of individual asset class risk assessments are described in the Transportation Asset Management Plan.

The risk statement is a brief description of the worst reasonable case (WRC) should an event occur. The WRC is a term that represents the maximum realistic losses of an asset from an applicable threat.

The risk management strategies provide preferred approaches to risk management by identifying combinations of five strategies to manage top-priority risks. These strategies are adapted from the risk response model developed by L.M. Smith and J.M. Violanti, and include:

- Treating the risk - taking action to reduce the chance of the risk occurring or lessening impacts.
- Tolerating the risk - accepting the current risk profile and planning for appropriate response if the risk event occurs.
- Transferring the risk - allowing another agency or third party to take on the risk exposure instead of CDOT (e.g., insurance).
- Taking advantage of the risk - seizing opportunities, such as by using unexpected revenue to improve the transportation network.
- Terminating the risk - taking action to eliminate a risk event or impacts.

CDOT maintains both an enterprise-level risk register and individual risk registers for each asset class. In 2022, enterprise-level risks identified in CDOT's 2022 TAMP identified natural, cyber, and individual concerns and in order include:

- Flood
- Post-Fire Debris Flow
- Funding Uncertainty (positive and negative)
- Geohazards
- Cost Uncertainty
- Fire
- Missing Infrastructure Targets for National Performance Measures
- Snow (Avalanche)
- Cybersecurity
- Staffing: Attrition

From these risks, the Risk and Resilience Program has focused efforts to managing the natural threats detailed in Table 1 below.

Table 1 - CDOT Enterprise-Level Risk Register

Threat/Opportunity	Risk Statement	Risk Score	Risk Management Strategy
Flood	There is a risk that flooding occurs leading to asset/route damage that causes mobility and safety impacts as well as increased asset management cost.	68 (T)5 * (C)4.5 * (V)3	Treat by implementing design standards; following agency continuity of operations plan; maintaining incident command center management structure; maintaining an Office of Emergency Management (OEM). Use tools and processes developed under the resilience program to identify high risk assets and corridors for focused analysis.
Post-Fire Debris Flow	There is a risk that post-fire debris flow occurs leading to asset/route damage that causes mobility and safety impacts as well as increased asset management cost.	48 (T)4 * (C)3 * (V)4	Treat by maintaining an OEM. Maintenance landscaping, erosion control, jersey barriers, and other practices.
Geohazards	There is a risk of geotechnical failure that causes mobility and safety impacts as well as increased asset management costs.	33 (T)5 * (C)3.3 * (V)2	Treat by implementing the geohazards management program and robust geohazards-management plan.
Fire	There is a risk that fire occurs, leading to asset/route damage that causes mobility and safety impacts as well as increased asset management cost.	14 (T)4 * (C)1.2 * (V)3	Tolerate in the case of wildfires. Treat by tunnel fire-suppression systems, bridge-design standards, etc. Use tools and processes developed under the resilience program to identify high risk assets and corridors for focused analysis.
Snow (Avalanche)	There is a risk of avalanche occurring that causes mobility and safety impacts as well as increased asset management cost.	11 (T)4 * (C)2.7 * (V)1	Treat by maintaining a Winter Operations Program. Use tools and processes developed under the resilience program to identify high risk assets and corridors for focused analysis.

In addition to these response approaches, CDOT has been integrating additional response approaches to its risks. For example, CDOT recently adopted a mitigation plan for Interstate 70 in Glenwood Canyon (see Section 7.2), looking at ways to reduce annualized risk and improve system resilience for specific assets at specific price points (e.g., replacing existing rockfall fences with more and higher capacity fences). CDOT also adopted benefit-cost calculations to assess alternative mitigation measures and reductions of annualized risks, expressed in dollars, to help justify mitigation plans for identified risks.

Section 3: Climate Change Considerations and Life-Cycle Planning

3.1 Climate Change

Projected future climate conditions should be considered as part of transportation system-level vulnerability analysis, as well as in project-level resilience assessment.

Environmental conditions in the future may be different from historic or current conditions and should be accounted for across the life cycle of a transportation asset. Climate change or changes in patterns of extreme weather may impact threat likelihood in the future.

A range of climate change scenarios may be used for the purpose of risk and resilience assessment. Higher, mid-high, and/or lower scenarios represented by Representative Concentration Pathways (RCPs) can be integrated into benefit-cost analysis. Over the next year, CDOT will consider how climate scenarios may be used and select one or more preferred RCPs for risk and resilience planning. Additionally, CDOT will test a future precipitation framework to develop future conditions IDF curves that modify the hydrologic and hydraulic design protocols for highway assets affected by flooding. The results will be used to update the calculations and data tools reflected in CDOT's current resilience manual, Drainage Design Manual, and potentially inform future design standards.

3.1.1 Climate Change Studies and Tools

Current climate change scenarios paint a picture that Colorado will face a hotter and drier future, while heavy and extreme rainfall events are expected to increase in frequency and intensity. To better understand climate change, CDOT uses two studies that seek to understand transportation-specific impacts of climate change:

- CDOT Climate Study: Changing Climate and Extreme Weather Impact on Geohazards in Colorado – The 2021 study provided a climate change assessment to identify expected weather patterns and extreme weather events that are a result of climate change. The information gathered from the study can be used to evaluate how geohazard frequency and magnitude could be affected.

- Colorado Climate Change Vulnerability Study – The Colorado Climate Change Vulnerability Study (2015) looked at the impacts of Colorado's climate past and future to the transportation sector. The report identifies key climate impacts, vulnerabilities, and recommendations towards preparedness.

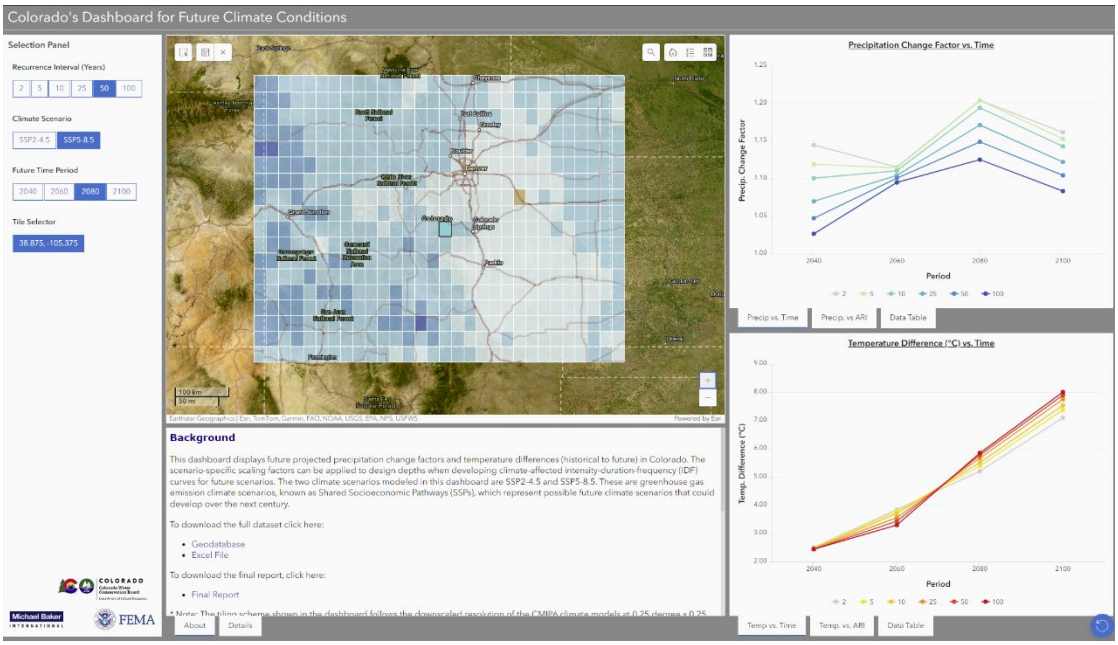
In addition to the above studies, CDOT also uses several tools to understand climate-related risks:

- Colorado EnviroScreen – EnviroScreen is an interactive environmental justice mapping tool and health screening tool for Colorado. The tool identifies areas with past and current environmental inequities, and pinpoints disproportionately impacted communities that CDOT has to understand potential GHG impacts of transportation investments.
- Fifth National Climate Assessment - The Fifth National Climate Assessment (2024) reports on climate change impacts, risks, and responses every four years, as mandated by the Global Change Research Act of 1990. Chapter 13: Transportation and Chapter 28: Southwest are of particular relevance to this RIP.
- Future Avoided Cost Explorer (FACE Hazards) – The FACE Hazards tool, provided by the Colorado Water Conservation Board, explores economic impacts of flood, drought, and wildfire in 2050. The impacts are reported in terms of expected annual damages and includes scenarios for bridges.
- Statewide Precipitation Scaling for Future Conditions – A study commissioned by FEMA and CWCB and prepared by Michael Baker International (2024) to predict future IDF curves to calendar year 2100. The report utilized the Coupled Model Intercomparison Project Phase 6 (CMIP-6) emissions scenarios developed worldwide and applied them to the entire landmass of Colorado.

3.2 Vulnerability of the Transportation System to Climate Change

Vulnerability is the measure of the transportation infrastructure systems susceptibility to damage from a natural hazard. It is quantified as the probability of the Worst Reasonable Case occurring if an event is realized. Vulnerability is the expected probability of loss and represents a number of factors that literature and empirical data imply may influence an asset's susceptibility to incur damage from threats. Factors can include mitigation measures, risk management strategies, and hazard management plans.

Figure 4 - Colorado's Dashboard for Future Climate Conditions



Colorado is susceptible to adverse effects of climate change and extreme weather events, including both exposure to threats—for example, how climate change will affect resources in the state—as well as to damage from natural hazards. Climate change impacts the state's resources in a variety of ways, including more rapid snowmelt, longer and more severe droughts, and longer growing seasons. Colorado's climate related disasters, such as floods, droughts, and wildfires, will continue to occur in the future and pose serious hazards to public safety and the economy.

Climate change and extreme weather events can negatively impact safety and asset management. Key vulnerabilities identified in the Climate Change Vulnerability Study for Colorado's transportation sector are detailed in Table 2 below.

*Table 2 – Colorado's Transportation Sector Vulnerabilities due to Climate Change**

Impacts of Current Climate Variability and Future Climate Change	Examples of Potential Vulnerabilities
Sustained extreme heat	
• Causes road and runway buckling. • Stresses bridge integrity. • Limits construction crew schedules. • Results in loss of lift for airplanes. • Causes rail deformation as well as derailments.	• The road system is vulnerable given the current adaptive capacity. Increased need for road maintenance closures for heat-related problems is possible in the future. • Airports may be vulnerable to reduced cargo capacity due to warmer air, particularly if unable to extend runways. • Rail lines are vulnerable to increased heat due to the very high cost of installing more heat-resistant tracks.
More frequent and intense drought which increases wildfire risk	
• Causes road closures, reduced visibility, and a greater risk of mudslides; decreases safety. • Wildfire creates cascading disasters that follow, especially flash floods and debris slides; decreases safety and damages highway assets.	• All elements of the transportation system are vulnerable to closures due to increased wildfires. Communities and users of the transportation system are vulnerable to safety hazards from wildfire.
Continued flooding events and increased intensity of winter storms	
• Can lead to submerged roads; flooded underpasses; roads and bridge scouring; increased landslides and mudslides, overloading of drainage systems, compromised structural integrity of roads, bridges, and tunnels; adverse impacts on road bases; the need for larger bridges and culverts; road closures; increased maintenance costs. • Can cause flooding of airports as well as damage to runways and drainage systems. • Can cause flooding of rail lines and damage to rail bed support structures; winter snows can damage rail track and cables and block tracks.	• The road network is vulnerable to closures and infrastructure damage due to intense precipitation, and traffic crashes are linked to extreme weather. • Communities with limited road access are highly vulnerable to being cut off by floods or winter storms. • Airports could be vulnerable to damage to runways and drainage systems from flooding events and winter storms that overwhelm their existing capacity to respond. • Railroads could be vulnerable to damage from flooding and winter storms that overwhelm their capacity to respond.

* Adapted from Colorado Climate Change Vulnerability Study (2015)

Climate hazards may result in transportation vulnerabilities with different affects for users across modes. The Fifth National Climate Assessment summarized available research* on climate hazards, transport mode, and associated impacts, adapted below:

*Table 3 - Climate and Transportation Vulnerabilities***

Transport Mode	Extreme Temperatures	Storms	Drought	Fire
Active transport (walking and biking)	• Shift from active transport to vehicle or public transport • Adverse health impacts for walkers and cyclists, including heat-related death and illness	• Shift from active transport to vehicle or public transport • Obstructions and infrastructure damage	• Adverse health impacts for walkers and cyclists due to degraded air quality and increased risk for respiratory illness	• Shift from active transport to vehicle or public transport • Reduced active transport due to short- and long-term health impairments
Roadways	• Cracking, buckling, and rutting from heat and permafrost thaw • Unsafe working conditions • Increased maintenance frequency	• Damage from flooding, erosion, saturated soil, and sea level rise • Increased risk of landslides • Reduced life-cycle from repeated runoff events • Travel lanes and bus routes blocked or rerouted due to flooding	• Reduced pavement integrity due to subsidence, collapsible soils, and increased groundwater pumping • Reduced slope stability due to decreased roadside seeding uptake • Emergency bridge maintenance • Reduced visibility and increased closures from dust storms	• Road closures and reduced visibility • Obstructions and debris flows • Increased chance of runoff and increased magnitude of flash flooding • Reduced slope stability due to burn scar • Direct damage or destruction of highway assets
Rail	• Buckling of rails • Reduced train speeds • Catenary line sag	• Flooding of bridges, tunnels, and low-lying rails • Damage from landslides	• Changes in soil stability affecting track geometry and integrity	• Damaged equipment • System disruption and rerouting

* The report contains a disclaimer that cells with few bullets represent the scarcity of research and not the lack of impact or vulnerability from climate hazards.
** Adapted from the Fifth National Climate Assessment (2024)

3.3 System Level Evaluation

FHWA suggests that transportation planning agencies conduct a system level vulnerability assessment of their transportation assets to identify which portions of their system are most at risk of damage from threats. At the systemwide planning scale, a vulnerability assessment may be more of a high level, broad brush look at where the system is at potential risk to various threats and where damage is likely to be greatest. The assessment may cover a variety of threats or could be limited to one or two threats most likely to occur within the study area. CDOT utilized a quantitative risk-based approach which identified that flooding, rockfall, and fire/debris flow tend to be the most impactful events in Colorado.

FHWA advises agencies to consider three factors when identifying asset vulnerability:

- Whether the assets are located within areas exposed to the selected threat(s).
- How likely the asset is to be damaged/compromised if the threat occurs.
- The adaptive capacity of the system to recover. In other words, how quickly or easily the system can recover from an event and how severely it compromises system operations.

For the first factor in identifying vulnerability, CDOT maintains the Asset Resiliency Interactive Mapping Application, which includes hazards or threats, route criticality, and pipeline projects from the Statewide Plan. More information is included in Section 4.3.1. Anecdotal or historical information about where flooding, rockfall, or other events have tended to occur may also be used.

For the second factor, information on the age or condition of the asset may be used and augmented by other indicators of how an asset will perform under stress (e.g., bridge scour rating).

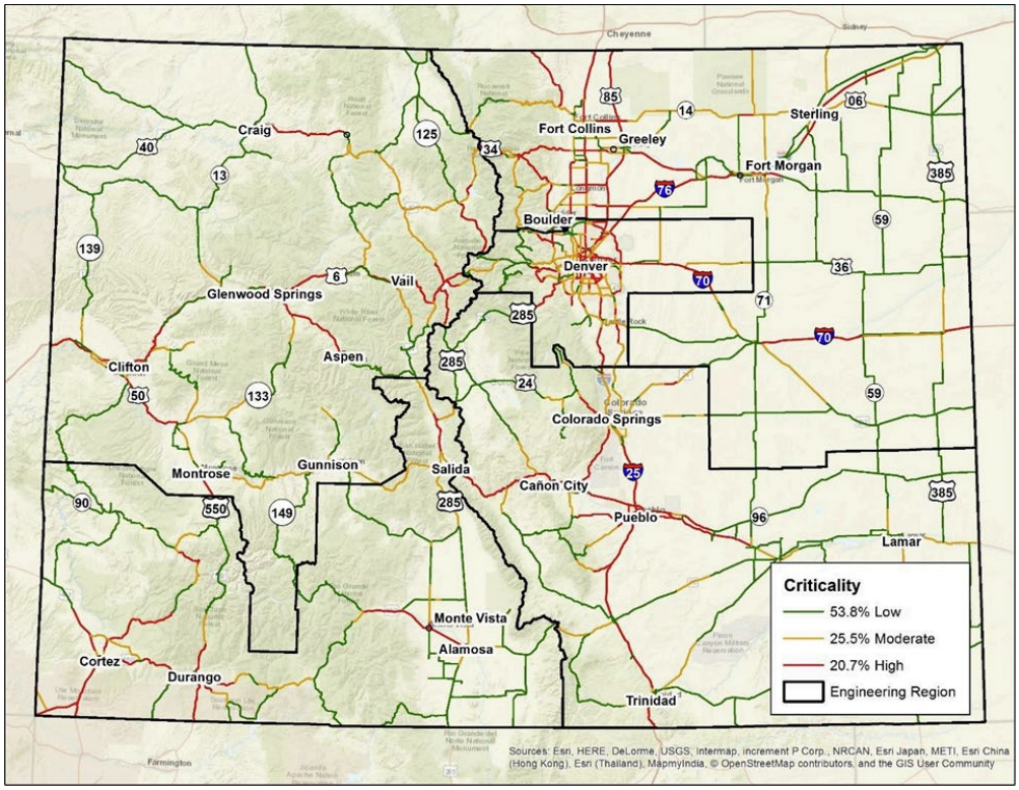
For the third factor, adaptive capacity, the agency can identify which portions of the transportation system are most critical to the continued operation of the system. This may be done via a rating system or model using various criteria (volume of traffic, availability of alternate routes, or social and economic characteristics of the areas being served by the identified portion of the transportation system).

CDOT has developed a criticality map (Figure 5) for all routes within the state highway system. The model used six criteria:

- Annual average daily traffic
- Redundancy (presence of alternate routes)
- Roadway classification
- Value of freight carried
- Social vulnerability index
- Value of tourism in the vicinity

Several reviews of the resulting criticality scores were conducted with members of the CRWG, the EOC, the CDOT TC, and CDOT regional staff. Many discussions ensued as to the potential use of the resulting criticality, and it should be noted that the purpose of the ranking is simply to reflect those assets of the CDOT system that are important to the capability of CDOT to provide system resilience and allow for movement of travelers across the state. Figure 5 is a map of CDOT asset criticality by CDOT Region. Red indicates assets rated high criticality; brown-orange indicates assets of moderate criticality; and low criticality assets are represented in green.

Figure 5 – CDOT's Criticality Map



The system level vulnerability evaluation, including criticality mapping, should be updated regularly, particularly in advance of the statewide transportation planning process. CDOT has a criticality model for System Resilience. Criticality reflects the importance of each transportation asset relative to overall operations in CDOT's transportation network. Criticality considers overall resilience of the system and success of CDOT to carry out its mission of delivering service to its travelers. It is not a measure of cost or a qualifier of how an asset would respond to a threat. CDOT has criticality data statewide that was modeled along development of the 2017 I-70 Risk and Resilience Pilot Study.

3.4 Use Identified Risks to Inform Transportation Decisions

The plan should articulate a process for how to use information on identified risks in transportation decision-making. Ideally risk and resiliency will be incorporated into all aspects

of the project lifecycle, including planning, asset management and project prioritization, project development and environmental review, project level design, system management and operations, and emergency management. The goal should be to build both technical resiliency by hardening or improving the physical system assets and organizational resiliency to improve CDOT's ability to make decisions and take actions to plan and respond to events.

The following sections define how resiliency could be integrated into various aspects of the project lifecycle:

1. **Project Prioritization:** Project screening and evaluation, which is the process used to prioritize projects and inform investment decisions, should consider resiliency as an evaluation criterion. For example, is the project located on a critical route? Would the project improve system resiliency?
2. **Project Development and Environmental Review:** Priority projects (e.g., those included in the 10-Year Plan) that are in hazard areas should be evaluated using the toolkit in Section 4.2 to identify design or operation strategies to reduce identified vulnerability.
3. **Project Design:** As a project advances into preliminary and final design, the design team should further consider the 4R Framework (Table 4), following evaluation using the toolkit. This framework encourages coordination and decision-making to inform project delivery in terms of enhancing project resiliency and reducing project vulnerability. More information is included in Section 4.2.
4. **Asset Management:** CDOT's Asset Management Program develops and implements risk-based strategies to ensure CDOT's limited funding is applied to the right project, for the right asset, at the right time. The 4R Framework also helps inform decisions for asset management. CDOT developed a process to ensure compliance with Part 667, Twice-Damaged Assets, that requires an analysis of Twice-Damaged sites prior to incorporating the project into the STIP (the requirements of Part 667 are integrated in this asset management fact sheet).

FHWA describes monitoring steps for keeping resiliency strategies current, which include:

- Updating the risk register
- Tracking changes in asset inventory
- Tracking vulnerability indicators
- Integrating strategies into other plans and programs

3.5 Assets repeatedly damaged by emergency events

Federal regulations require state DOTs to conduct periodic evaluations of facilities that have repeatedly required repair and reconstruction due to emergency events (23 CFR 667). To meet these requirements, CDOT maintains a database listing past damaged assets, and is developing processes to update the database as additional assets sustain damage in emergency events. CDOT has also asked Master Planning Organizations (MPOs) for data on locally owned damaged assets.

Transportation agencies are required to consider resilience during transportation planning processes (23 Code of Federal Regulations [CFR] 450.200 and 23 CFR 450.300). To implement the requirement, the final planning rule added "improving resiliency and reliability of the transportation system" as one of the 10 transportation planning factors that DOTs and MPOs must address. The final metropolitan and statewide planning rule also added a requirement for MPOs to coordinate with officials responsible for natural disaster risk reduction when developing a metropolitan transportation plan and Transportation Improvement Program (TIP). It also added a requirement to assess capital investment and other strategies that reduce vulnerability of existing transportation infrastructure to natural disasters (Section 450.324(f)(7)). The following section details CDOT's processes to advance resiliency integration in CDOT's statewide transportation planning.

Section 4: Risk and Resilience Within CDOT's Transportation Planning Process

CDOT and other transportation planning agencies are working to collect data about known threats to Colorado's transportation system. Since 2015, CDOT has been working to use this data to inform investment decisions and day-to-day business operations with the goal of hardening the system against threats. CDOT has also developed a resilience suite of tools, which includes tools to inform decisions that integrate resilience considerations.

The risk management process begins during the planning phase. Planning level cost estimates can have a significant effect on the overall transportation program and on the ability of CDOT to meet their transportation needs.

Resilience strategies can be physical or operational. To decide which strategies to implement, CDOT uses the tools detailed in the following section to:

1. Identify locations most at risk of hazards.
2. Determine the probability of this hazard/disaster occurring each year.
3. Considering the condition of the asset, determine the likelihood that the asset will fail if a hazard/disaster were to occur.
4. Calculate how much it would cost to repair and the cost to travelers of delay/detour.
5. Multiplying the cost of repairs by the probability of occurrence and the vulnerability of the asset, calculate the annual financial risk from hazards for CDOT and the traveling public.
6. Identify strategies and mitigation tools that can reduce the damage from the hazard or the chances it could occur.
7. Implement the most cost-effective strategies.

4.1 4R Framework for Identifying and Evaluating Resiliency in Transportation System Assets and Organizations

The 4R framework guides CDOT on decisions about assets, project planning, alternatives analysis, project design and delivery, mitigation development, construction, operations, and maintenance. The 4Rs provides a categorization of considerations and examples of resilience focused decisions CDOT could make on physical assets and potential actions to plan for and respond to events.

Table 4 - 4R Framework for Identifying and Evaluating Resiliency in Transportation System Assets and Organizations

Attribute	Description	A Resilient Transportation Asset	Technical Examples	A Resilient Transportation Organization	Organizational Examples
Robustness	The strength of an asset or a system to withstand relevant threats	Made of materials, structures, elements, systems, etc. Is maintained in proper condition, allowing it to withstand a given level of stress or demand without suffering degradation or loss of function. Is safe to fail -- designed, where relevant, to allow controlled, planned failure during unpredicted conditions, recognizing that the possibility of failure can never be eliminated.	Building to a higher design standard in an area prone to historic flooding (e.g., 50-year vs 20-year storm; upsizing culverts). Installing green infrastructure (e.g., vegetative swales) in areas prone to flooding. Installing nets on high-risk rock sheds.	Has an organizational mind-set of enthusiasm for challenges, problem solving, agility, flexibility, innovation and taking opportunity. Has identified vulnerabilities and has processes in place to use information on vulnerability to aid in decision-making. Has systems in place to recognize and reward high performance.	Systemwide vulnerability assessment and resiliency investment plan. Maintenance patrol plan in place to clean out at-risk culverts more frequently than normal. Feedback loop from emergency events with advice on how to improve asset strength
Redundancy	The presence of a backup system or plan	Has parts, elements, systems, facilities, etc., that are substitutable, (e.g., are capable of satisfying backup functional	Construction of an alternate detour route where none exists. Backup traffic operations center. Transit route/ express lanes on	Promotes open communication and mitigation of internal/external silos. Understands interconnectedn ess and vulnerabilities across all aspects	Backup computer servers. Development of a statewide detour map and evaluation of gaps in system redundancy. Cross-trained staff.

Attribute	Description	A Resilient Transportation Asset	Technical Examples	A Resilient Transportation Organization	Organizational Examples
		requirements in the event of disruption, degradation) or loss of functionality of the primary system. Redundancy may involve excess capacity (e.g., frontage lanes, breakdown lanes, managed capacity), or diverse means of capacity (e.g., detour routes, different modes).	a highly congested freeway. Bridge built with redundant methods of avoiding failure.	of agency function.	Supplemental snow patrol staff identified and on-call to assist in storm event.
Resourceful-ness	Ability to identify, diagnose, and treat problems with available resources	Includes equipment to monitor and alert to potential threats or failures before they occur. Sufficient materials are on hand to efficiently mobilize in case of emergency.	Stockpiling emergency repair/storm treatment materials to handle unplanned events. Optimizing positioning of snow plows and materials. Real-time stream gauges as a warning system in high-risk areas.	Has ability to efficiently mobilize a sufficient number of trained staff to monitor warning systems, with authorization to initiate action. Has established relationships, prearranged mutual aid arrangements and regulatory partnerships. Learns from the success or failure of previous efforts.	Intergovernmental Agreements (IGAs) with other agencies in place in advance to borrow needed materials in emergency situations. IT staff on-call with skills and abilities needed to respond to a cyber-attack. After-action reviews with feedback to change where needed.
Rapidity	Ability to restore functionality in a timely way	Designed in such a way that it is quick to restore functionality, containing losses and avoiding disruptions. Communications equipment and networks are in place and	Placing Variable Message Signs (VMS) in vulnerable areas to redirect users. Purchasing a temporary bridge for use as needed in	Has established response plans in place to mobilize when events occur. Has systems and manuals documented and in place for how to manage emergency	Documented structure and roles for emergency response – who is in charge, what skills each needs to have, etc. On-call contracts in place ahead of emergencies to

Attribute	Description	A Resilient Transportation Asset	Technical Examples	A Resilient Transportation Organization	Organizational Examples
		function at high performance.	emergency washouts.	events. Learns from the success or failure of previous efforts to improve response time.	mobilize needed contractor assistance. Establish and monitor performance measures for emergency response time. Traffic Incident Management Plan adopted. Conducting emergency response drills.

4.2 Project Development Resilience Toolkit

CDOT presents this step-wise toolkit for integrating resilience considerations into project development for the 10-Year Plan pipeline projects. Step 1 applies to all projects in the toolkit. Step 2 and Step 3 apply primarily to projects that are most vulnerable as described in Section 2 that would be eligible for PROTECT Formula Program Funds. This toolkit includes CDOT tools and resources referenced in Section 4.3. The workflow includes these steps:

1. **Document the project description, scope, and budget, including the highway and milepost to milepost location.** Describe the phase the project is currently in. Finally, list the major scope items. All this information will be used in step 2.
2. **Identify CDOT assets, threats, and criticality:** Use CDOT's Asset Resiliency Interactive Mapping Application to identify CDOT assets and threats and to identify criticality of the corridor. Criticality is described further in Section 3.3 and in CDOT's Risk and Resilience Analysis Procedure Criticality Model for System Resilience.
3. **Calculate risk to CDOT assets and evaluate benefits and costs:** Follow the process from CDOT's Risk and Resilience Analysis Procedure Manual (2020) to calculate risks to CDOT assets, evaluate mitigation, and consider benefits and costs to CDOT and the traveling public (owner and user risk). CDOT's Risk and Resilience Analysis Procedure Spreadsheet Tool facilitates this analysis. The analyst should run the risk model initially to determine the existing condition and establish baseline risk costs. Then, the analyst should run the risk model a second time to analyze risk reduction from the proposed mitigation. Next, the team should estimate costs of the proposed mitigation and determine the benefit to cost ratio.
4. **Create a more resilient system:** Use CDOT's 4R Framework to set the context of resiliency within transportation project delivery. This framework can guide project planning, alternatives analysis, project design and delivery, mitigation development,

construction, operations, and maintenance. CDOT's Risk and Resiliency Project Scoring Tool is available for aiding in project prioritization and documenting the 4R attributes. CDOT developed the Detour Identification Tool (2021) to inform evaluation and selection of detours. It was developed with the statewide travel demand management team to offer detour suggestions. At this time, the tool does not reroute real time based on congestion.

5. **Identify projects eligible for PROTECT Formula Program funds:** Document the findings in a memo to be used to determine PROTECT Formula Program eligibility. Integrate resilience considerations and solutions into stakeholder coordination (see Section 1.3), National Environmental Policy Act (NEPA) evaluations, securing funding, decision-making, design, and construction. Carrying forward decisions made during earlier phases and further analyzing the resilient options will assist the project team in delivering the most cost beneficial project that will withstand the threats identified.

4.3 Risk and Resilience Suite of Tools

The following tools aid CDOT staff in resilience planning.

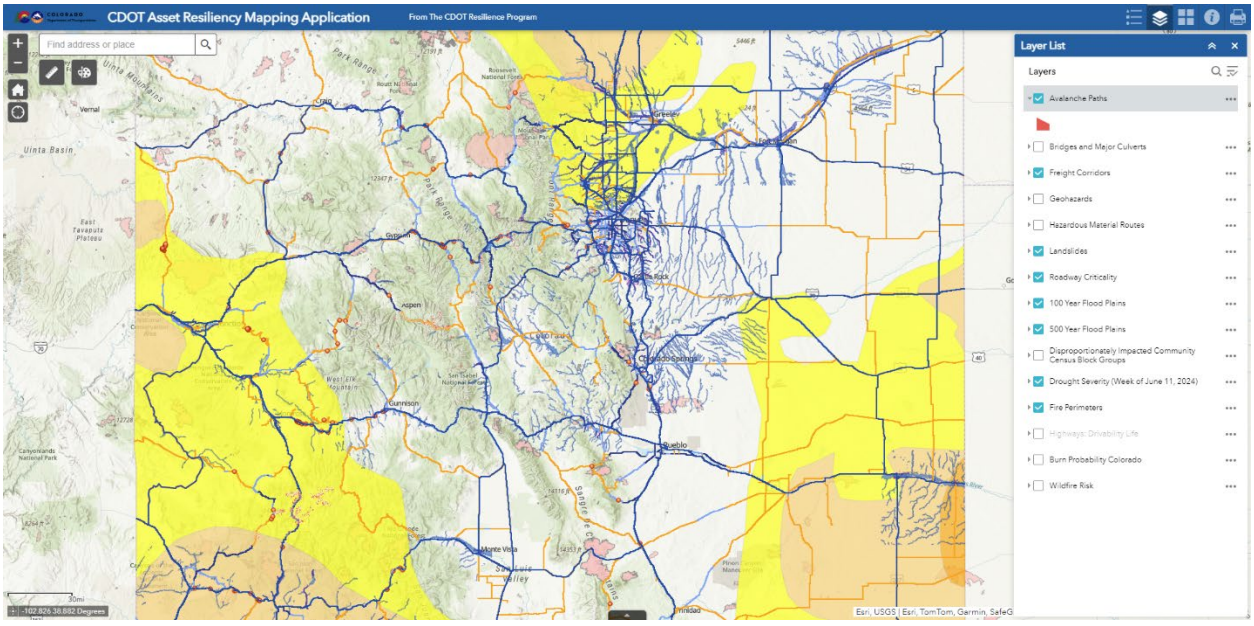
4.3.1 Asset Resiliency Mapping Application

CDOT has produced an Asset Resiliency Mapping Application (see Figure 6) that allows users to view and analyze various natural hazards and other threats as they relate to CDOT assets and assess risk as it relates to environmental risk factors. The mapping application overlays:

- 10-Year Plan projects for 1 to 4 years and 5 to 10 years
- Senate Bill 267 transit update CDOT criticality data
- CDOT's state highway network
- Social vulnerability, documented by Disproportionately Impacted Community Census Block Groups
- Hazardous materials routes
- Freight corridors
- CDOT existing assets, such as bridges, pavement types, guard rails, ditches, culverts, walls, traffic control and intelligent transportation system devices, trails
- Asset condition, such as highway drivability life data
- Wildlife impact incidents
- Natural hazard threats data, including geohazards, landslides, avalanche paths, fire perimeters, drought severity, wildfire risk

This map was produced to support a standardization for calculating risk and resiliency on the state's transportation system, CDOT has produced this interactive map for users to assess risk as it relates to numerous different geohazards. The tools allow users to explore criticality on different routes, find more information about individual events like landslides or fires, or search for a specific area of interest.

Figure 6 - CDOT Asset Resiliency Mapping Application



Using this data, CDOT conducted geospatial analysis on the 10-Year Plan projects to identify projects that are located within or near (within one-quarter mile of) a hazard zone for fire, flood, avalanche, or geohazard risks. CDOT also assessed the criticality of the highway corridor associated with each project. 10-Year Plan projects that are in or near risk areas and that are along corridors with moderate to high criticality may be most vulnerable to natural hazard threats. In addition, CDOT included a summary of whether each pipeline project is included in an area considered as a disproportionately impacted community. The analysis is based on data from the EPA's EJSCREEN tool.

For these most vulnerable projects, the Resilience Suite of Tools described in this section could be used to inform decision-making, with resilience in mind, during project scoping and project delivery.

4.3.2 Risk Assessment Manual (RAMCAP Process)

CDOT started an Interstate 70 Corridor Risk and Resilience (R and R) Pilot in 2015 to examine the Interstate 70 highway system's ability to serve traffic demand during times of natural disaster. Completed in 2018, one of the goals of this pilot was to investigate whether the findings could be useful to CDOT operations, planning, asset management, maintenance, and engineering design and how the data generated can be incorporated into these management programs to reduce system risk and improve resilience.

CDOT worked with FHWA to assess how the system might perform under a range of physical hazards affecting the interstate, from rock fall to flooding. CDOT examined each asset along Interstate 70 to determine asset vulnerability and risk to infrastructure in cases where

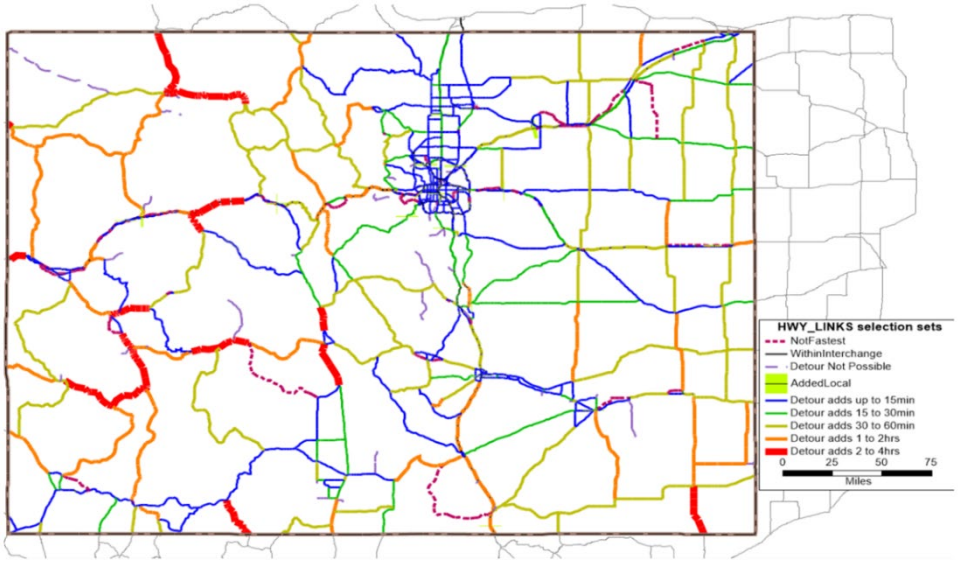
damage is incurred. This process involved conducting a benefit-cost analysis to determine the financial risk of potential damage to all assets along this corridor. The agency separated asset risks into two categories: the risk to the owner (the risk to CDOT to replace damaged assets) and the risk to the user (the delay in a user's trip caused by a road closure/route detour due to asset unavailability). CDOT incorporated the results of the asset vulnerability assessment from this R and R Pilot into its overall asset management program. CDOT used the Risk Analysis and Management for Critical Assets Protection (RAMCAP Plus) framework to identify Interstate 70's most critical assets based on threats and vulnerability and identify those where damage would most severely impact the operation of the highway system.

CDOT then developed and documented a standardized R and R analysis process which also uses RAMCAP. This process is documented in a manual, adopted in 2020, with instruction and assumptions on how to conduct R and R analyses on CDOT assets in the future, with a goal of improving consistency of analyses across different regions of the state. In developing the manual, CDOT conducted outreach with SMEs throughout the agency to fine tune the process and assumptions used in the R and R pilot.

4.3.3 Detour Detection

CDOT has developed an enhanced detour mapping tool to integrate travel time into the criticality models and resilience assessment. The detour tool uses the current Travel Demand Model (TDM) strategies to map out redundancy plus secondary and tertiary routes that are used to calculate user costs and ultimately generate the Benefit-Cost Analysis (BCA) to analyze resilient options.

Figure 7 - Detour Mapping Tool



4.3.4 Risk and Resilience Assessment Tool

The R and R tool is intended to support CDOT staff in their analysis of risk from physical threats to highway assets. It follows the common risk-management approach and a standard risk register format, tailored to CDOT. Given the relatively new field of quantitative risk assessment to highway assets from physical threats, the procedure is focused on threat-asset pairs. Each of the following threat-asset pairs was deemed reasonable to anticipate physical losses to CDOT assets or to impact travel:

- Rockfall-Roadway Prism
- Rockfall-Bridge
- Rockfall-Post Tension Concrete Slab (PTCS)
- Flood-Roadway Prism
- Flood-Bridge
- Flood-Bridge Approach
- Flood-Minor Culvert
- Flood-Major Culvert
- Scour-Bridge
- Fire-Debris Flow-Culvert
- Fire-Debris Flow-Roadway Prism

The R and R tool produces a benefit-cost ratio, which can be used to inform planning and investment decisions.

4.4 Operational Resilience

CDOT is engaged in numerous efforts to incorporate resiliency into operations. The following subsections detail processes related to event response and recovery, while Section 4.1-4.3 covers proactive planning measures to incorporate resilience.

4.4.1 Response (Continuity of Operations)

The Continuity of Operations Plan is an effort and response to assure the continuance of CDOT's ability to perform its mission essential functions (construction, maintenance and operations, multimodal services, and sub-allocated programs) when normal operations are disrupted during events. Such events may include avalanches, blizzards, climate change, cyber, earthquakes, floods, hazardous material spills, pandemic, vehicle crashes, and wildfires. These events can cause relocation of operations to locations like other CDOT facilities or telework.

There are four phases of continuity:

1. **Readiness and Preparedness:** This phase refers to the response to a continuity activation.

2. **Alert and Notification:** This phase refers to the communication and coordination of essential functions with personnel before, during, and after a continuity event.
3. **Continuity Operations:** This phase refers to the execution of mission essential functions and essential supporting activities at an alternative location.
4. **Reconstitution:** This phase refers to the conclusion of the continuity event and the resumption of normal operations.

To activate the continuity plan, the trigger points identified below may help identify an event and will be activated by the director or the assigned designee. When activated, employees will work at alternative locations listed in their division's continuity plan. Within twelve hours of the Continuity of Operations Plan activation, the Reconstitution Point-of-Contact (POC) will work with the Reconstitution Team to update office personnel on developments regarding reconstitution. The continuity event is concluded when normal operations are resumed, or the definition of new normal is outlined.

Table 5 - Decision Matrix for Continuity of Operations Plan Implementation

Event	Duty Hours	Non-Duty Hours
With Warning	• Is the threat aimed at the facility or surrounding area? • Is the threat aimed at organization personnel? • Are employees unsafe remaining in the facility and/or area?	• Is the threat aimed at the facility or surrounding area? • Is the threat aimed at organization personnel? • Who should be notified of the threat? • Is it safe for employees to return to work the next day?
Without Warning	• Is the facility affected? • Are personnel affected? Have personnel safely evacuated or are they sheltering-in-place? • What are the instructions from first responders? • How soon must the organization be operational?	• Is the facility affected? • What are the instructions from first responders? • How soon must the organization be operational?

The continuity event is concluded when normal operations are resumed, or the definition of new normal is outlined.

To properly prioritize and allocate resources in response to the event, damage assessment must be completed. There are four phases in the damage assessment described in the 2021 Emergency Operations Plan, including different components, time frames, and reporting forms that produce the damage assessment picture:

1. **Rapid Needs Assessment (RNA)** is a quick evaluation of critical infrastructure, major structural collapses, and areas that sustained the most damage to make the most

beneficial and effective decision regarding prioritization. It should be performed within the first few hours after the event, or as soon as first responder and field personnel can enter the area, to determine the nature and extent of life safety and damage to critical facilities.

2. **Initial Damage Assessment (IDA)** is an ongoing evaluation of buildings and infrastructure to determine the extent of the damage, cost, and impact. It is used to help determine the usability of critical facilities and is the first step in applying for federal assistance. This phase typically occurs 48 hours to two weeks following the event.
3. **Joint Preliminary Damage Assessment (PDA)** is a joint assessment to determine if the situation is beyond the combined capabilities of the state and local resources, and to verify the need for supplemental federal assistance. This phase typically occurs two to three weeks following the event, taking three to five days to complete.
4. **Recovery Assessment** is used to determine short- and long-term recovery needs within CDOT, outlining the priorities for restoration.

4.4.2 Snow Plow Routes

The effort and priority of maintaining the roads are based on condition, personnel, and available resources. Each road segment is categorized by the annual daily traffic (ADT*) and is assigned a level of service letter (see Table 6). The level of service definitions may be adjusted based upon the importance of the traveling purpose. Some may include commuting, medical and emergency transport, school bus routes, and mail routes. CDOT's winter operations require 24-hour snow removal** to be maintained throughout the storm on state highways that have ADT of 1,000 or greater until normal driving conditions have been restored; and 14 hours (5 am to 7 pm) of snow removal to be maintained if less than 1,000***.

Table 6 - Normal Levels of Service Road Conditions

Category 1	Category 2	Category 3	Category 4	Category 5
Interstate > 75,000 ADT A Bare Pavement B < 1 Hour C < 2 Hours D < 3 Hours F > 3 Hours	Interstate 15,000 – 75,000 ADT A Bare Pavement B < 2 Hour C < 4 Hours D < 6 Hours F > 6 Hours	Interstate < 15,000 ADT A < 2 Hours B < 4 Hour C < 6 Hours D < 8 Hours F > 8 Hours	NHS > 75,000 ADT A Bare Pavement B < 2 Hour C < 4 Hours D < 6 Hours F > 6 Hours	NHS 15,000 – 75,000 ADT A < 2 Hour B < 4 Hour C < 6 Hours D < 8 Hours F > 8 Hours
Category 6	**Category 7**	**Category 8**	**Category 9**	**Category 10**
NHS < 15,000 ADT A < 2 Hours B < 6 Hour C < 12 Hours D < 16 Hours F > 16 Hours	Other > 50,000 ADT A < 2 Hours B < 4 Hour C < 6 Hours D < 8 Hours F > 8 Hours	Other 5,000 – 50,000 ADT A < 4 Hours B < 6 Hour C < 12 Hours D < 16 Hours F > 16 Hours	Other < 5,000 ADT A < 6 Hours B < 8 Hour C < 16 Hours D < 24 Hours F > 24 Hours	MTN Passes (Non-Interstate) A < 8 Hours B < 24 Hour C < 48 Hours D < 72 Hours F > 72 Hours

*ADT: the average two-way daily traffic volume (total annual traffic for the year / 365)
**Subject to change based on condition, personnel, and available resources
*** From CDOT Procedural Directive 1055.2

4.4.3 Evacuation Plan Development

The Colorado Department of Public Health & Environment (CDPHE) provides an Evacuation Plan Development Tool Kit that is designed to guide facilities in developing and implementing effective evacuation plans in cases of emergencies. The Evacuation Plan Development Toolkit can be used alongside other emergency planning toolkits provided by CDPHE, although it can be used independently.

After forming a Comprehensive Planning Team (CPT), the CPT will follow the nine-section guide to develop an Evacuation Plan or Functional Annex that should be applicable to any disaster for any length of time:

- Section 1 defines the purpose and implementation of the annex, providing direction for the rest of the annex.
- Section 2 provides a general overview of the evacuation functions, followed by detailed explanations of specific response steps.
- Section 3 describes the evacuation responsibilities assigned to specific departments.
- Section 4 outlines essential information required to make the annex operational which may include situation briefs, weather reports, and status reports.

- Section 5 establishes the methodology of communicating during and after an evacuation, both internally and externally. This may include a call list, back up resources, and communication procedures.
- Section 6 consists of detailed requirements and availability of services for the facility during the evaluation scenario.
- Section 7 identifies who is responsible for coordinating revision of the evacuation annex. This may include keeping current attachments and ensuring necessary implementing documents are developed.
- Section 8 cites the authorities and references related to an evacuation.
- Section 9 uses tabs to gather important procedural information for the annex, such as maps, transportation plans, and shelter plans, which can be easily accessed and distributed during an emergency.

The Evacuation Functional Annex is a living document that should undergo revisions each time it is used to build the most optimal plan. Visit the Colorado Department of Public Health & Environment website for detailed steps in the process.

4.5 Recovery Toolkits

Resilience planning is essential to ensure the long-term viability, safety, and adaptability to communities in Colorado. As defined by CRO, it involves the development of tools, strategies, and actions that aim to mitigate long-term vulnerability and minimize the impact of present and future adversity. By improving the preparedness and response of communities to shocks and stressors, resilience planning contributes to their overall health, vibrancy, and strength.

CRO offers a Community Readiness and Resilience (Pre-Disaster) Toolkit and Post-Disaster Recovery Planning Toolkit that guides communities on how to develop a recovery plan that is tailored to their community that better prepares them for before and after a disaster. The toolkits are designed to be used at different stages of the planning journey and include resources such as templates, ordinances, and case studies to support planning efforts.

The Pre-Disaster toolkit is designed to guide Colorado's communities in developing resilience into planning efforts and operations. It involves a six-step process that forms a pre-disaster team, determining scope, inventorying existing plans, creating an ordinance, understanding the vulnerabilities and risks of a community, and developing pre-disaster recovery actions and identifying priorities for building recovery capacity. The toolkit outlines the six steps used to guide Colorado communities for the Pre-Disaster toolkit.

The Post-Disaster toolkit is designed to guide Colorado's communities in the process of recovery after a disaster. It involves a six-step process that identifies recovery needs, develops a recovery plan, plan implementation, and monitor progress. The toolkit outlines the six steps used to guide Colorado communities for the Post-Disaster toolkit. To learn more, visit CRO's website.

4.6 Available Resources Regarding Resilience Planning

CDOT has consolidated a summary of resilience planning resources and documentation from within CDOT and from other state, federal, and national entities, which are listed below. CDOT makes its resilience resources readily available for project teams and decision makers to identify threats relative to project locations and to consider mitigation solutions.

CDOT resources available on the Risk and Resilience Program Website:

- PD 1905.0 "Building Resilience into Transportation Infrastructure and Operations" (2018)
- Risk and Resilience Analysis Procedure: A Manual for Calculating Risk to CDOT Assets from Flooding, Rockfall, and Fire Debris Flow (2020)
- Risk and Resilience Excel Spreadsheet Tool (2022)
- Asset Criticality Model for System Resilience
- Risk and Resilience Project Scoring Tool
- 4R Framework for Identifying and Evaluating Resiliency in Transportation System Assets and Organizations (2021)
- CDOT Detour Identification Tool (2021)
- CDOT Asset Resiliency Mapping Application (2021)
- Resilience Case Studies:
    - Asset Management
    - Project Prioritization and Long-Range Planning
    - Maintenance and Operations
    - Project Scoping and Engineering
    - Environmental Planning
- I-70 Risk and Resilience Pilot Study
- Federal Lands Memorandum of Understanding (2016)

Additional State of Colorado resources:

- Colorado Hazard Mapping & Risk MAP Portal
- Colorado Resiliency Office
- State of Colorado Resiliency Framework
- Enhanced State Hazard Mitigation Plan (E-SHMP) (2023)
- State Emergency Operations Plan (2019)
- Resource Mobilization Plan (2020)
- CDOT's Statewide Plan
- CDOT's Sustainability in Roadway Design and Construction Guidance (2013)
- CDOT's Landscape Architecture Manual (2020)
- CDOT's Roadway Design Guide
- CDOT's National Environmental Policy Act (NEPA) NEPA manual
- CDOT's Planning and Environmental Linkages (PEL) Handbook

- Colorado Freight Plan
- Colorado Climate Preparedness Roadmap (2023)
- Colorado Department of Public Health and Environment (CDPHE) Office of Preparedness and Response
- CDPHE Heat and Health
- CDPHE Wildfire Preparedness, Response, and Recovery

Federal resources:

- 23 Code of Federal Regulations 667
- FHWA Resilience website
- Climate and Economic Justice Screening Tool
- Climate Mapping for Resilience and Adaptation (CMRA) website
- BLM Forest Resilience and Ecosystem Services website
- Federal Transit Administration Disaster Resilience & Transit Asset Management presentation (2017)
- Federal Emergency Management Agency (FEMA) website
- U.S. Forest Service (USFS) Transportation Resiliency Guidebook: Addressing Climate Change Impacts on USFS Transportation Assets
- EPA Climate Change and Social Vulnerability Report (2021)
- Environmental Protection Agency Adapting to Heat

National organization resources:

- AASHTO Resilience & Sustainability Management
- American Planning Association Planning for Infrastructure Resilience Report 596 (2019)
- National Institute of Building Sciences Natural Hazard Mitigation Saves Report (2019)
- AASHTO Resilience Improvement Plan (RIP) Resources
- University of Missouri Institute of Public Policy Equity and Resilience Policy Brief (2021)

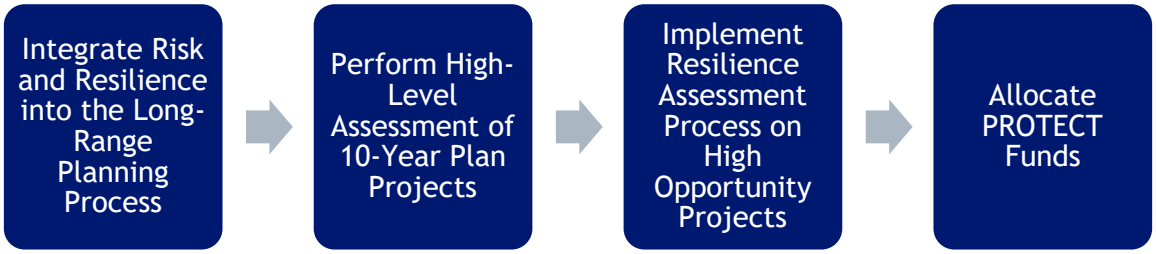
Section 5: Prioritization Process and Investment Plan

5.1 Overview

As noted in previous sections, CDOT has developed tools and resources to inform resilience planning and to integrate resilience in project delivery for projects in the 10-Year Plan projects. CDOT's goal is to integrate resilience considerations early when a project is less developed and may better accommodate resilience solutions. Knowing the projects and threats to consider may be subject to change over time, CDOT's tools and resources are adaptable. Section 5 discusses how Colorado used the long-range planning process to identify

potential resilient opportunities to invest in. The graphic below provides a quick visualization of the total process, and each step is described in more detail.

Figure 8 - Prioritization Process and Investment Plan



5.2 Integration of Risk and Resilience into the Long-Range Planning Process

As part of the long-range planning process, CDOT develops a 10-Year Plan. The 10-Year Plan is a statewide list of priority transportation projects developed alongside the long-range plan development. To develop the 10-Year Plan, CDOT implemented the following process:

1. Conduct stakeholder outreach to elicit transportation needs.
2. Aggregate needs to corridors, identify disproportionately impacted communities' considerations, and develop project lists.
3. Prioritization of projects by Transportation Planning Regions (TPRs) and MPOs based on Colorado TC criteria.
4. TPRs and CDOT engineers collaborate on project prioritization.
5. CDOT Regions identify projects lists for the 10-Year Plan.
6. 10-Year Plan is approved by the TC.

The 10-Year Plan reflects the highest priorities of the state, MPOs, and TPRs. The plan's purpose is to create an implementable strategy that best uses expected funding to meet the needs identified during the long-range planning process. To develop a method for integrating risk and resiliency into 10-Year Plan project selection, SMEs from CDOT, FHWA and Denver Regional Council of Governments (DRCOG) were assembled to determine how to integrate the 4Rs into local, regional, and federal planning activities and process. The SMEs recommended that planning partners tightly link a resiliency approach to existing project selection methods, and to adopt a resiliency mindset as a significant differentiator for projects that might otherwise not get prioritized.

To dial in on high-level resilience opportunities within the 10-Year Plan, CDOT performed a sketch analysis of project locations by using the criticality GIS tool to assess the criticality score and identify high, medium, and low criticality scores. CDOT then further assessed high

and medium criticality project locations using the CRO's Resiliency Prioritization Assessment Tool.

CDOT conducted two workshops with an interdisciplinary team of staff participated from the Division of Transportation Development (DTD), the Division of Transit & Rail (DTR), and CDOT Regions where the CRO Prioritization Assessment Tool was used to evaluate 10-Year Plan projects for resiliency potential using the following steps:

- **Criticality:** Use criticality layer on CDOT's Asset Resiliency Interactive Mapping Application to assign high, moderate, or low criticality.
- **Screening level risk assessment:** Identify potential risks from natural threats at the project location (or document logic for human-made risk) using the mapping application, and assign high, medium, or low risk.
- **Whether using current standards incorporates resiliency:** Document that assets at risk as identified in one of the map layers incorporates resiliency by using current standards or construction practices. Use the 4R Framework to identify and evaluate resiliency in transportation assets.
- **Projects with multiple assets/risks:** Select each risk that could affect the asset.
- **Asset vulnerability:** How vulnerable is the asset based on each risk identified? Assess whether the asset is very vulnerable, somewhat vulnerable, or not vulnerable.
- **Risk mitigation per threat:** To what degree have you mitigated the risk and made the asset more resilient? Select between mitigated or not mitigated.
- **Benefit-Cost Ratio:** Use the Risk and Resilience Assessment Tool.

Through the evaluation, the workshop participants focused on finding opportunities and advancing resiliency when practical on 10-Year Plan projects, guided by the following resilience considerations (which include nine criteria defined in the Colorado Resiliency Framework):

1. **Adaptive Capacity** - Include flexible and adaptable measures that consider future unknowns of changing climate, economic, and social conditions.
2. **Co-Benefits** - Provide solutions that address problems across multiple sectors creating maximum benefit.
3. **Economic Benefit-Cost** - Make good financial investments that have the potential for economic benefit to the investor and the broader community both through direct and indirect returns.
4. **Harmonize with Existing Activity** - Expand, enhance, or leverage work being done to build on existing efforts.
5. **High Risk and Vulnerability** - Ensure that strategies directly address the reduction of risk to human well-being, physical infrastructure, and natural systems.
6. **Innovation** - Advance new approaches and techniques that will encourage continual improvement and advancement of best practices serving as models for others in Colorado and beyond

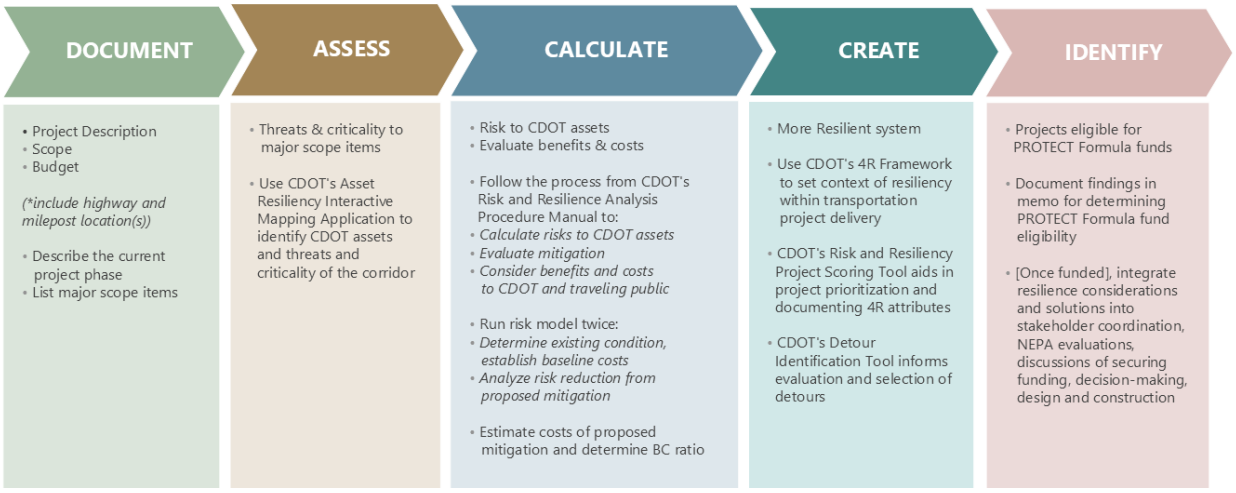
7. **Long-Term and Lasting Impact** - Create long-term gains for the community with solutions that are replicable and sustainable, creating benefits for present and future generations.
8. **Social Equity** - Provide solutions that are inclusive with consideration to populations that are often most fragile and vulnerable to sudden impacts due to their continual state of stress.
9. **Technical Soundness** - Identify solutions that reflect best practices that have been tested and proven to work in similar regional context.

The output of the evaluations is being used to identify 10-Year Plan projects that could be eligible to use PROTECT funds.

5.3 Implementing the Resilience Assessment Process

In CDOT's process, when a 10-Year Plan project is ready to go into the budgeting and design phase, those projects identified as high criticality are flagged and referred to CDOT's Risk and Resilience Program Manager to guide the project team on resilience considerations in scope development (see Figure 9). When a project has scope that could enhance resilience, they are instructed to complete the full risk and resilience assessment process described in Section 4: Risk and Resilience within CDOT's Transportation Planning Process. An end result of the risk and resilience assessment is to identify how much of the project scope can be funded using PROTECT funds.

Figure 9 - 10-Year Plan Analysis Process



The Risk and Resilience Program takes an enterprise-wide approach. In 2021, as part of CDOT's 2045 statewide transportation planning efforts, CDOT developed an initial draft of a resilience appendix to highlight the importance of resilience, connect resiliency to transportation planning, document CDOT's resilience evaluation of projects in the statewide

plan 10-year pipeline, and to provide a resilience toolkit for integrating resilience considerations into project development. The original appendix was built on the extensive work CDOT has done through its Risk and Resilience Program. In 2022, CDOT published the Transportation Asset Management Plan, which utilizes risk-based asset management strategies and applies resilience concepts.

In 2022, CDOT updated this resilience appendix to incorporate additional progress of its Risk and Resilience Program and to address requirements of a new federal initiative that promotes resilience planning in transportation.

Furthermore, CDOT is developing resilience performance measures, which will be available in 2022. These performance measures will provide insight into CDOT's investments in resilience and will inform decision-making, based on documented experiences. These performance measures may be evaluated and updated over time.

5.4 Forecasted PROTECT Funding

The PROTECT program was established by the Bipartisan Infrastructure Law (BIL). PROTECT allocated federal funding will be invested to safeguard critical transportation infrastructure for Colorado travelers against extreme weather events due to climate change. There are two funding mechanisms for PROTECT: a formula program that goes directly to CDOT, and a discretionary grant program for state and local governments, federally recognized tribes and affiliated groups, and planning and project organizations. CDOT expects to receive the following allocations:

FY 2022:
- Projects - $18,411,520
- Planning - $375,745

FY 2023:
- Projects - $18,779,750
- Planning - $38,3260

FY 2024:
- Projects - $19,155,345
- Planning - $390,925

FY 2025:
- Projects - $19,538,452
- Planning - $398,744

FY 2026:
- Projects - $19,929,221
- Planning - $406,719

5.5 PROTECT Allocations

As of April 2024, PROTECT Formula Program funds have been directed to three capital projects:

- I-25 CO 66 to CO 56, Segment 5 (24309.10.30): I-25 MP 243 to 250
- Vail Pass Aux Phase 1 CP 4 (24567.20.10): I-70 MP 179 to 192 in Eagle County
- Floyd Hill:
    - I-70 Floyd Hill Package 1 East Section (25174.20.10): I-70 Top of Floyd Hill to Johnson Gulch
    - I-70 Floyd Hill Package 2 West Section (25175.20.10): I-70 Top of Floyd Hill to Veterans Memorial Tunnels

CDOT has allocated planning funds to the following activities:

- Update of Risk and Resilience Suite of Tools
- Case study documentation
- Updating documents
- Ad hoc communication - presentations, web content, one-pager/fliers, etc.
- Development and implementation of resilience performance measures
- On-call support for resilience assessments
- On-call support for discretionary grant proposals
- Enhancements to threat analysis
- Development of climate change forecasting tools
- Development of an approach towards Representative Concentration Pathways (RCP) and Shared Socioeconomic Pathways (SSP)
- Development of strategies to manage wildland fire impacts to transportation

Financial Management Information System (FMIS) ultimately tracks all PROTECT funding decisions.

5.6 Project List for PROTECT Formula Program Funds

CDOT will direct PROTECT Formula Program funds to the Ten-Year Plan project list. As described in Section 5.2, staff have documented the results of evaluation of 10-Year Plan projects for resiliency potential in Appendix 7.4. For the purposes of the project list, post-fire debris flow is included within fire and geohazard threat types.

Section 6: Next Steps

CDOT strives to continuously improve processes and is reviewing available research for possible enhancements to the RIP and R and R program. Several emerging opportunities are described in this section.

6.1 Application of Climate Modeling

Since transportation assets can be affected by the intensity, duration, and frequency of precipitation—a contributing factor to top natural hazards including flooding and post-fire debris flow—future projected precipitation events may need to be addressed further in planning and design.

CDOT's 2021 climate study found that geohazards are influenced by extremes and rate changes, such as the projected shift towards more severe rainfall events. Storms with rainfall intensities and durations that are currently described as having a 100-year return period (understood as a 1 in 100 chance of occurrence) are anticipated to become more common in the future and shift to having a 50-year return period (or a 1 in 50 chance of occurrence). These climate shifts are anticipated to affect the occurrence and magnitude of geologic hazards, with corresponding economic impacts.

To develop an approach applying future precipitation modeling, CDOT will further review two pertinent studies from the CWCB:

- Climate Change in Colorado (2024)
- Statewide Precipitation Scaling for Future Conditions (2024)

These Colorado-specific studies provide enhanced data on future precipitation events in advance of the release of NOAA Atlas 15 in coming years.

6.2 Wildfire Threats and Transportation Consequences

Wildfire poses a threat to travel that can have severe consequences for the user. CDOT uses Procedural Directive 1507.1 to guide measures CDOT should take for highway operations on "Red Flag" or high fire risk days.

To develop ready-to-implement operational strategies and mitigation considerations, CDOT will engage SMEs and coordinate with relevant land managers, including FHWA's Central Federal Lands Highway Division.

Post-fire debris flows may be an increasing concern due to climate change, drought, and wildfire risks. In the summer of 2021, Interstate 70 in Glenwood Canyon was impacted by numerous mudslides that deposited tremendous amounts of debris onto I-70 and into the Colorado River. Flows were caused by significant rainfall intensity on and near the Grizzly Creek burn scar area. To reopen the interstate and complete emergency repairs, crews removed more than 3,300 loads of debris and tackled rockfall removal and mitigation above I-70, which required helicopter operations.

6.3 Evaluating Design Standards

To be prepared, CDOT will look at resilient design standards from a proactive approach. This includes evacuation routes, identifying high fire prone areas that threaten both availability for the users and damage to infrastructure, and finally training for planners and designers to incorporate these new standards into both the long-range planning process, and ultimately, incorporating resilience measures in project prioritization and design.

6.4 Natural Infrastructure

Much of the current knowledge on natural infrastructure focuses on coastal areas. The Risk and Resilience Program will continue to coordinate with the Environmental Programs Branch in the Division of Transportation Development to identify opportunities to leverage nature-based solutions to enhance infrastructure condition. This coordination will include assessing how permanent water quality structures and detention ponds could potentially be used to help manage floods and post-fire debris flow.

In addition, CDOT has a staff member on the panel for the National Cooperative Highway Research Project (NCHRP) 25-71, Prevention and Control of Wildfires Through Roadside Vegetation Management.

Section 7: Appendix

7.1 Risk Assessment Scoring

Table 7 - Threat Likelihood Scoring Rubric

Level	Descriptor	Description	Annual Probability Range	Probability
1	Low	50+ years between events	<2%	1.0%
2	Medium - Low	20 to 50 years between events	2% to 5%	3.5%
3	Medium	5 to 20 years between events	5% to 20%	12.5%
4	Medium - High	1 to 5 years between events	20% to 100%	40.0%
5	High	Once annual occurrence or greater	100%	99.0%

Table 8 - Consequence and Consideration Scoring Rubric

Level	Descriptor	Description	Cost Range for Event	Set Safety Cost for Event
Safety				
1	Negligible	Negligible safety hazard	<$100K	$50,000
2	Minor	Minimal safety hazard	$100K to $500K	$300,000
3	Major	Likely minor injuries	$500K to $2M	$1,250,000
4	Critical	Likely major injuries	$2M to $10M	$6,500,000
5	Catastrophic	Likely fatalities and major injuries	>$10M	$20,000,000
Mobility				
1	Negligible	Situation affects a small area (neighborhood or town) and/or small number of travelers for a short time (minutes).	<$100K	$50,000
2	Minor	Situation affects a small area (neighborhood or town) and/or small number of travelers for a moderate time (hours).	$100K to $500K	$300,000
3	Major	Situation affects a small area (neighborhood or town) and/or small number of travelers for a sustained period (days-weeks).	$500K to $2M	$1,250,000
4	Critical	Situation affects a large number of travelers for a short period (minutes-hours).	$2M to $10M	$6,500,000
5	Catastrophic	Situation affects a large number of travelers for a sustained period (days-weeks).	>$10M	$20,000,000
Asset Damage				
1	Negligible	Minimal or cosmetic damage	<$100K	$50,000
2	Minor	Minor damage requiring repair	$100K to $500K	$300,000
3	Major	Moderate damage requiring repair	$500K to $2M	$1,250,000
4	Critical	Extensive damage requiring significant repair or replacement	$2M to $10M	$6,500,000
5	Catastrophic	Destroyed or large-scale damage requiring replacement	>$10M	$20,000,000
Other Financial Impacts				
1	Negligible	Negligible financial impact	<$100K	$50,000
2	Minor	Minor financial impact	$100K to $500K	$300,000
3	Major	Major financial impact	$500K to $2M	$1,250,000
4	Critical	Critical financial impact	$2M to $10M	$6,500,000
5	Catastrophic	Catastrophic financial impact	>$10M	$20,000,000

Table 9 - Vulnerability Scoring Rubric

Score	Level	Description
1	Very Low	» Established risk management process(es) exist for event. » CDOT responses and contingency plans already in place and are fully tested. » Asset engineering design or asset condition ensures full functionality. » Previous resilience efforts provide a high degree of protection.
2	Low	» Established risk management process(es) mostly exist for event. » CDOT responses and contingency plans already in place, but with limited testing. » Asset engineering design or asset condition ensures mostly full functionality. » Previous resilience efforts provide a moderate degree of protection.
3	Medium	» Risk management process(es) for event being fully developed. » CDOT responses and contingency plans partially in place, with limited or no testing. » Asset engineering design and asset condition ensure only partial functionality. » Previous resilience efforts provide a low degree of protection.
4	High	» Established risk management process(es) for event in early development. » CDOT responses and contingency plans in early development, with no testing. » Asset engineering design and asset condition provide little assurance of functionality. » Previous resilience efforts provide a very low degree of protection.
5	Very High	» Established risk management process(es) do not exist for event. » No CDOT responses and contingency plans being developed. » Asset engineering design and asset condition will not assure functionality. » Previous resilience efforts provide no level of protection.

7.2 Twice-Damaged Assets Case Study: Interstate 70 in Glenwood Canyon

CDOT in 2020 and 2021 undertook a project to test and refine the process for assessing and mitigating twice-damaged assets. Interstate 70A in Colorado, near milepost 124, has been the site of damaging rockfall events in 2016, 2010, and 2004. The 2004 and 2010 events both occurred at mile post 124.9, and both damaged the same bridge and retaining wall. The rockfall hazard at the site is above the westbound lanes but affects both directions of the interstate, impacting geohazard, pavement, and bridge assets. CDOT performed an evaluation of the site, including the assets impacted. The evaluation included an assessment of the threat likelihoods and three mitigation options to counter future rockfall events. Following CDOT's Risk and Resilience Analysis Procedure, CDOT assessed each option, considering the likelihood of future threats, consequence of threats to both the owner (CDOT) and users, and vulnerability to future events. These options were then compared to a no-action scenario. Table 10 outlines the outcomes of analysis of each of the three mitigation efforts. Annual risk mitigation benefits were primarily (97%+) made up of benefits to the road user.

Table 10 - Analysis of Mitigation Options for I-70A Glenwood Canyon

Option		Annual Risk Mitigation Benefit	Annual Cost (Installation + maintenance + replacement)	Benefit/Cost Ratio (annual return on each $ spent)	Expected Life
A	Rockfall Barrier A 105-foot 3,000 kJ rockfall barrier	$2.3 million	$19,000	121	20 years
B	Concrete Barrier A 270-foot concrete barrier fence extension	$1.35 million	$15,000	86	10 years
C	Attenuator A 175-foot attenuator	$1.59 million	$29,000	54	20 years

7.3 Glossary

7.3.1 Key Definitions

Adaptation - Adjustment in natural or human systems in anticipation of or response to a changing environment that effectively uses beneficial opportunities or reduces negative effects.

Asset - An item, thing, or entity that is owned by and has potential or actual value to an organization.

Climate change - Refers to any significant change in the measures of climate lasting for an extended period. Climate change includes major variations in temperature, precipitation, or wind patterns, among other environmental conditions, which occur over several decades or longer. Changes in climate may manifest as a rise in sea level, as well as increase the frequency and magnitude of extreme weather events.

Consequence - The outcome of an event, including immediate, short- and long-term,

direct and indirect losses and effects.

Countermeasures - What is in place or could be put in place to reduce the vulnerability of an asset, and/or the probability that an attack will succeed in causing failure or significant damage.

Criticality - A measure of the importance of an asset to the resilience of an overall

system.

Extreme Weather Events - Weather events that can include significant anomalies in temperature, precipitation and winds and can manifest as heavy precipitation and flooding,

heatwaves, drought, wildfires, and windstorms (including tornadoes and tropical storms). Consequences of extreme weather events can include safety concerns, damage, destruction, and/or economic loss. Climate change can also cause or influence extreme weather events.

Mitigation – An action that reduces or eliminates negative impacts of a threat.

Performance Measure – A measurable result related to either quantitative or qualitative answers.

Preparedness – Actions taken to plan, organize, equip, train, and exercise to build, apply, and sustain the capabilities necessary to prevent, protect against, ameliorate the effects of, respond to, and recover from climate change related damages to life, health, property, livelihoods, ecosystems, and national security.

Redundancy - A measure of alternative routes available.

Resiliency – The ability of a system to rebound, positively adapt to, or thrive amidst changing conditions or challenges, including human-caused and natural disasters, and to maintain quality of life, healthy growth, durable systems, economic vitality, and conservation of resources for present and future generations.

Risk - An uncertainty that can have either positive or negative impacts.

Risk Management - Inclusive management strategies that address risks, including mitigation strategies and preparedness approaches for emergencies.

Risk Register – A document detailing all identified risks, including description, cause, probability of occurring, impact(s) on objectives, proposed responses, owners, and status. For CDOT, the risk register establishes risk-management priorities across the Department.

Threat - Any indication, circumstance, or event with the potential to cause the loss of, or damage to an asset, system, or network.

Threat Characterization - Process to identify possible scenarios and describe them in enough detail to estimate vulnerability and consequences.

Threat Likelihood - Probability that an event will occur.

Threat Assessment - A systematic process of estimating threat likelihood, determined based on historical frequencies or predictions from scientific tools and expert opinion.

Vulnerability - The probability of a successful event. The probability that the anticipated Worst Reasonable Consequence for a specific magnitude of an event occurs.

Vulnerability Assessment - A systematic process to estimate an asset or network vulnerability to a specific threat using scientific studies and/or expert opinion.

Worst Reasonable Consequence -The largest anticipated magnitude of an event.

7.3.2 Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
BIL	Bipartisan Infrastructure Law
BLM	Bureau of Land Management
CDOT	Colorado Department of Transportation
CRO	Colorado Resiliency Office
EPA	Unites States Environmental Protection Agency
ER	Federal-aid Highway Emergency Relief Program
IIJA	Infrastructure Investment and Jobs Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
PD	Policy Directive
PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation Program
R and R	Risk and Resilience
USDOT	United States Department of Transportation
USFS	United States Forest Service

7.4 Project List

Table 11 – Project Threat Area Classification and Criticality Rating

Project ID	Project Name	Eligible for PROTECT
0001	I-25 South Gap Package 3	Yes
0002	I-270: Widening from I-76 to I-70	Yes
0004	I-70 West: Floyd Hill	Yes
0005	I-70 Peak Period Shoulder Lanes (PPSL) - Year Two 267 Commitment	Yes
0006	Urban Arterial Safety Improvements (Urban Arterial Safety Improvements in Region 1)	Yes
0007	US 287 Bridge Preventative Maintenance Phases 1 & 2	
0008	US 285/CO 9 Intersection Improvement with Bridge Widening	
0009	US 50 and Purcell Drive Interchange	
0010	US 287 (A-Park Street South) - Lamar Downtown Concrete Paving	Yes
0011	CO 21 and Research Parkway Interchange	Yes
0012	M-22-AY Bridge Repair on CO 109 over US 50B in La Junta	
0013.1	I-25 Raton Pass Safety and Interchange Improvements - Exit 11 Improvements	
0013.2	I-25 Raton Pass Safety and Interchange Improvements	Yes
0014	I-25 through Pueblo New Freeway	
0015	I-25 and CO 94 Safety and Mobility Improvements	Yes
0016	I-25 Paving and Mobility– Fillmore to Garden of the Gods	
0017	I-25 Colorado Springs Ramp Metering Phase 2	Yes
0018	CO 115 – Safety and Paving improvements from MM 20-39	Yes
0019	Bridge Preventative Maintenance: CO 12, CO 194, and I-25 C	
0020	Bridge Preventative Maintenance on I-25, CO 16 & CO 24 in Colorado Springs (4 bridges)	Yes
0022	US 50 Texas Creek East	Yes
0023	US 287 to Kansas Border	
0024	CO 96 East of Ordway to Arlington	
0025	CO 96 - Near Eads to Sheridan Lake	
0026	CO 69 to Fremont County	Yes
0027	CO 67 - Between CO 96 and Florence	Yes
0028	CO 194 - Between US 50 and CO 109	
0029	CO 160 to south of County Rd E	
0030	US 160 and CO 100	

Project ID	Project Name	Eligible for PROTECT
0031	US 6 Fruita to Palisade Safety Improvements	Yes
0032	US 550 Montrose to Ouray County Line Safety Improvements	Yes
0033	US 50 Windy Point/Blue Creek Canyon	Yes
0034	US 50 Passing Lanes Blue Mesa	
0035	US 50 Grand Junction to Delta Repairs	Yes
0036	CO 9 Iron Springs to Main Street	Yes
0037	CO 13 Garfield County MP 11.3 to 16.2	Yes
0038	CO 13 Fortification Creek	
0039	CO 92 Rogers Mesa to Hotchkiss	Yes
0040	Intersection Improvements at CO 50/550	
0041	I-70B East of 1st to 15th Street	Yes
0042	I-70 West Vail Pass Safety Improvements - Phase 1	Yes
0043	I-70 Auxiliary Lane East Frisco to Silverthorne	Yes
0044	CO 92 Hotchkiss	Yes
0045	CO 92 Crawford East	Yes
0046	CO 64 Meeker West	Yes
0047	CO 34 Grand Lake	Yes
0048	CO 318 Browns Park East	
0049	CO 300 Leadville West	
0050	US 24 Leadville South	
0051	CO 149 Lake City North	Yes
0052	CO 14 Grizzly Ranch North	
0053	CO 139 Douglas Pass North	Yes
0056	CO 114 Parlin West	Yes
0057	CO 119: Safety / Mobility Improvements	Yes
0058	I-25 North: Segment 7 & 8 - Express Lanes on permanent EIS alignment (CO 402 to CO 14)	Yes
0059	I-25 North: Segment 5 & 6: BUILD Grant Funding Commitment Express Lanes on permanent EIS alignment (CO 56 to CO 402)	Yes
0060	HWY 59 South of Cope to I-70	
0061	CO 138: Sterling North Part 2	Yes
0062	CO 385: Near Smoky Hill River to Near County Road GG	
0063	CO 385: Phillips/Yuma CL South	

Project ID	Project Name	Eligible for PROTECT
0064	CO 6 Merino to Atwood	Yes
0067	CO 52 Resurfacing Prospect Valley	Yes
0069	I-76: Hwy 144 West Westbound Diamond Grind & Slabs	
0070	I-76: Hwy 34 East Both Directions Slabs and Diamond Grind Both Directions	Yes
0072	I-76: Sterling East	Yes
0073	US 50/285 Intersection Reconstruction (Round-a-bout)	
0074	US 550/160 Connection (Interchange Completion)	Yes
0075	US 160 McCabe Creek Major Structure Replacement	Yes
0077	US 50 N of 285 Resurfacing	Yes
0078	US 160 Aztec Creek MP 0-8	
0079	CO 370 Resurfacing	
0080	CO 17 MP 84.5 to 118.5	
0081	CO 149 Paving and Shoulders North of Creede	Yes
0082	CO 141&145 Slickrock & Redvale	Yes
0083	CO 141 N of Naturita	Yes
0084	CO 114 Paving and Shoulders	
0085	US 550 Pacochupuk South Broadway Mobility, Safety, and Billy Creek Wildlife Improvements	Yes
0086	I-70/Harlan Bridge Replacement	
0087	I-70 Corridor-West Metro Bridges	Yes
1004	Transfer Facilities for Regional Transit Services (Cripple Creek, Cañon City, Woodland Park)	Yes
1010	CO 67 Passing Lanes	Yes
1022	I-76 Corridor Improvements and Preservation	Yes
1023	CO 71 Corridor Improvements	Yes
1028	Regional Transit Service between Montrose and Telluride	Yes
1032	New Essential Bus Service between Craig and Frisco (Proposed Bustang Outrider Service)	Yes
1038	Expanded Regional Transit Service between Walsenburg-La Veta-Gardener- Cuchara	
1039	Southern Mountain Loop Trail	Yes
1044	Kim Transit Garage	
1045	Expanded Regional Transit Service for Branson, Kim, and Baca County	
1047	Expanded Regional Transit Service in Kiowa County	
1048	Baca County Bus Facility	

Project ID	Project Name	Eligible for PROTECT
1049	New Regional Transit Service between Campo and Lamar; Expanded Baca County Demand Response Services	
1051	US 285 Safety and Mobility Improvements between Center and Saguache	
1068	New Regional Fixed-Route Transit Service in Teller County	Yes
1070	Expanded Golden Shuttle Fixed-Route Service in Fremont County	Yes
1071	Expanded Local Fixed-Route Service between Florence- Penrose-Cañon City	Yes
1075	Cripple Creek Administration and Operations Facility	Yes
1079	Westcliffe Vehicle Housing	Yes
1080	CO 115 Shoulders and Safety Improvements	Yes
1081	New Interregional Transit Service between Cañon City- Florence-Colorado Springs	Yes
1084	Fairplay Mobility Hub	
1096	Montrose Multimodal Transit Center (All Points Transit)	
1102	Gunnison Transit Center	
1107	CO 92 Safety Improvements West of Hotchkiss	Yes
1133	US 550 Shoulder Improvements, Deer Fencing, and Animal Underpass	Yes
1151	I-70 Glenwood Canyon Critical Asset Repair	Yes
1157	I-70 and CO 9 (Exit 203) Interchange Improvements	Yes
1161	I-70 West Vail Pass Auxiliary Lanes	Yes
1165	Summit County Transit Operations Center	
1171	I-70 Interchange Improvements in Garfield County	Yes
1191	Frisco Transit Center	Yes
1203	US 24 Safety Improvements between Minturn and Leadville	Yes
1210	RFTA Glenwood Springs Maintenance Facility	
1217	RFTA Aspen Maintenance Facility Fuel Tanks	
1231	Snowmass Transit Center	Yes
1244	Winter Park Transit Maintenance Facility	Yes
1246	Redesign and Construct the Steamboat Springs Transportation Center (Phase 1)	Yes
1254	Steamboat Springs Bus Rapid Transit Planning Study	
1258	US 40 Shoulder Improvements West of Kremmling	
1259	US 40 Capacity Improvements	Yes
1267	Expanded Regional Transit Service between Trinidad and CO 12 Communities	Yes
1270	South Central Storage and Maintenance Facility	
1281	Kiowa County Bus Storage Facility	

Project ID	Project Name	Eligible for PROTECT
1285	La Junta Multimodal Transit Center	
1287	La Junta to Fowler Fixed-Route Service	
1288	City of La Junta Bus Barn Rehabilitation	
1289	Expand Deviated Fixed-Route Services in La Junta	
1297	Buena Vista Park-n-Ride and Intermodal Facility	Yes
1303	US 160 Intelligent Transportation Systems (ITS) Infrastructure	Yes
1309	Alamosa Transit Center	
1315	US 160 Trinchera Ranch Safety and Wildlife Mitigation	
1326	Pagosa Springs Transportation Center	Yes
1334	US 160 Elmore's Corner East	Yes
1339	Pagosa Springs' Main Street Reconstruction and Multimodal Improvements	Yes
1365	Durango Transit Capital Improvements	Yes
1426	New Local Fixed-Route Transit Service in Fort Morgan	Yes
1428 - 1430	I-76 Phase V Reconstruction from Fort Morgan to Brush	Yes
1428 - 1430	I-76 Phase IV Reconstruction from Fort Morgan to Brush: Multimodal Project Discretionary Grant (MPDG)	Yes
1443	US 85 Frontage Road Improvements	Yes
1456	US 287 Passing Lanes and Safety Improvements	Yes
1462	US 50 Asset Management North of Montrose	Yes
1469	US 50 Safety East of Gunnison	Yes
1482	Multimodal Improvements on CO 145	Yes
1484	Shoulder Improvements in the Gunnison Valley Transportation Planning Region	Yes
1493	CO 12 ADA Ramps and Sidewalk Improvements in La Veta and Trinidad	
1502	I-25C and US 160 Intersection Improvements	
1508	US 160 Freight and Safety Improvements	
1511	US 350 Shoulder Widening and Safety Improvements	
1572	I-70 Arriba Rest Area	
1614	US 50 Passing Lanes between Fowler and Kansas State Line	Yes
1617	Realign US 50 as a Part of US 287 Reliever Route Project	Yes
1625	CO 96 and CO 71 Intersection Improvements	
1626	CO 10 Shoulder Widening	
1628	US 160 Curve Alignment	
1631	Passing Lanes on US 385	Yes

Project ID	Project Name	Eligible for PROTECT
1633	CO 71 Passing Lanes	
1642	US 24 Shoulder Widening	Yes
1665	CO 96 Shoulder Widening	Yes
1697	US 34 and US 40	Yes
1710	US 40 Passing Lanes West of Kremmling	
1712	US 40 Passing Lanes between Craig and Steamboat Springs	Yes
1729	US 40 and Downhill Drive Intersection Improvements	Yes
1802	North I-25 Transit Service	Yes
1903	Vail Intermodal Site	Yes
1952	I-70 West: Dowd Canyon Safety and Capacity Improvements	Yes
2038	US 160 Multimodal Improvements in Alamosa	
2039	US 24 Intersection Improvements in Buena Vista	Yes
2061	Intersection Improvements at US 160 and Pike Avenue	
2069	US 285 Improvements in Saguache	
2070	Intersection and Pedestrian Improvements at CO 291 and US 50	Yes
2087	Intersection Improvements at US 160 and CR 30.1 (Phil's World)	Yes
2089	Wildlife Mitigation on US 160 between Cortez and Durango (near CR 30.1)	Yes
2125	New Essential Bus Service between Craig and Grand Junction (Proposed Outrider Service)	Yes
2340	Western Slope Storage and Maintenance Facility	Yes
2413	CO 86 Corridor Improvements	Yes
2416	US 385 Corridor Study Improvements	
2454	Outrider Improvements at Delta	
2454	Outrider Improvements at Gunnison	
2454	Outrider Improvements at Montrose	
2455	Outrider Improvements at Placerville	
2455	Outrider Improvements at Ridgway	
2455	Outrider Improvements at Telluride	
2456	US 50 Corridor Improvements in Poncha Springs	Yes
2485	Prowers Area Transit Bus Barn Expansion	
2485	Prowers County Bus Barn Office Extension	
2490	Outrider Improvements at Brush	Yes
2490	Outrider Improvements at Fort Morgan	

Project ID	Project Name	Eligible for PROTECT
2490	Outrider Improvements at Hudson	
2490	Outrider Improvements at Lochbuie	
2491	Outrider Improvements at Sterling	Yes
2492	Outrider Improvements at Moffat	
2492	Outrider Improvements at Alamosa	
2492	Outrider Improvements at Buena Vista	Yes
2493	Outrider Improvements at Cortez	Yes
2493	Outrider Improvements at Dolores	Yes
2493	Outrider Improvements at Durango	Yes
2493	Outrider Improvements at Mancos	Yes
2493	Outrider Improvements at Rico	Yes
2494	Outrider Improvements at Fraser	Yes
2494	Outrider Improvements at Granby	Yes
2494	Outrider Improvements at Hot Sulphur Springs	
2494	Outrider Improvements at Kremmling	
2495	Outrider Improvements at Fort Lyon	
2495	Outrider Improvements at Fowler	
2495	Outrider Improvements at La Junta	
2495	Outrider Improvements at Lamar	
2495	Outrider Improvements at Las Animas	
2495	Outrider Improvements at Manzanola	
2495	Outrider Improvements at Rocky Ford	
2495	Outrider Improvements at Swink	
2496	Outrider Improvements at Canon City	Yes
2496	Outrider Improvements at Cotopaxi	Yes
2497	Outrider Improvements at Aguilar	
2497	Outrider Improvements at Colorado City	
2497	Outrider Improvements at Walsenburg	
2498	CO 59 Safety Improvements	
2523	Bustang Outrider Service between Pagosa Springs and Durango	Yes
2525	Estes Park Transit Electric Trolley Bus Barn	Yes
2526	Estes Park Transit Electric Trolley Charging Station	Yes
2530	Estes Park Transit Improvements	Yes

Project ID	Project Name	Eligible for PROTECT
2530	Parking Lot Reconfiguration at the Visitor Center and Transit Transfer Center in Estes Park	Yes
2547	CO 21 and Airport Road DDI Interchange Construction	
2548	US 24 East Widening	Yes
2549	US 24 West over Ridge Road (Overpass)	Yes
2552	High-Capacity Corridor Improvements in El Paso County	Yes
2559	CO 96 West of Pueblo	Yes
2561	CO 47 Four-Lane Extension to US 50	
2562	I-25 Exit 108 (Purcell Boulevard) Replace Single Box Culvert Crossing Under I-25	
2563	Business US 50 Drainage Improvements at 36th Lane	
2565	I-25 at Exit 104 - Dillon Drive Improvements	
2567	CO 69 Shoulder and Safety Improvements	Yes
2568	I-70 Business (Pitkin Avenue) Corridor Improvements between First Street and 15th Street	Yes
2569	I-70 Business Corridor Improvements between 32 Road and I- 70 in Grand Junction	Yes
2570	I-70 Business Corridor Improvements between Main Street and 32 Road	Yes
2571	US 6 Corridor Improvements in Mesa County	Yes
2572	CO 340 Safety Improvements	Yes
2573	CO 141 (32 Road) Safety and Capacity Improvements	Yes
2574	Shoulder Improvements in Mesa County	Yes
2575	I-25 Interchange Reconstruction at Speer Boulevard and 23rd Avenue	Yes
2576	I-25 Valley Highway Phases 3 and 4 (Burnham Yard)	Yes
2578	US 6 and Wadsworth Boulevard Interchange	Yes
2579	C-470: US 285 to Morrison Road Interchange Reconstruction and Widening	Yes
2580	I-70 and Kipling Street Interchange Right-of-Way	
2581	US 285 Corridor Improvements near Pine Junction	Yes
2582	I-70 Climbing Lane from Bakerville to the Eisenhower Tunnel	Yes
2583	Eisenhower-Johnson Memorial Tunnels Maintenance	Yes
2584	I-25 North between 84th Avenue and 104th Avenue, Early Action Items	Yes
2585	Vasquez Boulevard Improvements	Yes
2586	CO 7 Priority Intersection Improvements	Yes
2587	US 85 Corridor Improvements between Sedalia and The Meadows in Castle Rock	Yes

Project ID	Project Name	Eligible for PROTECT
2588	I-25 at Belleview Avenue Interchange, Phase 1	
2589	CO 30 Improvements between Quincy Road and Airport Road	Yes
2590	Regionwide Bottleneck Reduction	
2592	Regionwide Signal and Ramp Meter Upgrades	
2595	Regionwide Trail Grade Separations and Crossings Improvements	
2596	CO 7 Corridor Improvements	Yes
2597	US 36/28th Street and CO 93/Broadway Intersection Improvements	Yes
2598	CO 42 Safety and Intersection Improvements	Yes
2599	CO 66 Corridor Improvements	Yes
2600	US 85 Corridor Improvements, Brighton to Fort Lupton	Yes
2601	CO 119 Bus Rapid Transit (BRT) and Managed Lanes	Yes
2602	US 287 Corridor Improvements: US 36 to CO 66	Yes
2603	North I-25 Express Lanes from CO 56 to CO 66	Yes
2604	I-25 and CO 14 Interchange Improvements	Yes
2605	Transit Service between Loveland and Greeley	Yes
2607	US 50 between Penrose and the Fremont/ Pueblo County Line	Yes
2608	CO 115 between Canon City and US 50	Yes
2609	US 285 South of Bailey to Park/Jefferson County Line	Yes
2610	US 24 between Trout Creek Pass and Hartsel	Yes
2611	US 24 Hartsel to east of Wilkerson Pass	Yes
2614	CO 67 between Florence and US 50	Yes
2615	CO 120 East of Florence to US 50	Yes
2616	I-25 Business Route through Walsenburg	
2617	US 160 Walsenburg West	
2618	US 160 Walsenburg East	
2619	CO 12 Junction US 160 South	
2620	CO 12 East of Valdez to Trinidad	Yes
2621	US 160 between North La Veta Pass and Junction CO 12	
2622	US 160 between I-25 Business Rout (Walsenburg) and I-25	
2623	CO 389 between CO/NM State Line and Junction US 160	
2624	CO 10 Otero/Pueblo County Line East	
2625	CO 101 between Las Animas and Toonerville	
2626	CO 160 between Pritchett and Kim	

Project ID	Project Name	Eligible for PROTECT
2627	US 350 between La Junta and Delhi	
2628	US 385 North of Sheridan Lake to Kiowa/ Cheyenne County Line	
2629	US 385 between Granada and Junction CO 96	Yes
2630	CO 136 east of La Jara	
2632	CO 172 between New Mexico to Ignacio	Yes
2634	CO 17 west of Antonito	Yes
2635	CO 151 between Ignacio and Arboles	Yes
2636	CO 15 west of La Jara	
2637	CO 371 between CO 15 and CO 368	
2643	US 40 east of Hayden (Phase 1)	Yes
2644	CO 9 south of Green Mountain Reservoir	Yes
2645	CO 65 Between CO 92 and Orchard City	Yes
2646	US 40 east of Hayden (Phase 2)	Yes
2647	CO 9 Green Mountain Reservoir – Phase 1	Yes
2648	CO 135 south of Crested Butte	Yes
2649	CO 318 between the Colorado/Utah State Line and Sunbeam	Yes
2650	CO 9 Green Mountain Reservoir (Phase 2)	Yes
2651	CO 65 Grand Mesa	Yes
2652	CO 139 between the Garfield/Rio Blanco County Line and Douglas Creek	Yes
2653	US 40 west of Tabernash	Yes
2654	US 50 south of Delta	Yes
2655	CO 139 between Douglas Creek and Rangely	Yes
2656	CO 125 Walden North	
2656	CO 125 north of Walden	
2657	US 50 south of Olathe	
2658	CO 92 between CO 65 and Austin	Yes
2659	CO 64 east of Rangely	Yes
2660	CO 125 south of Cowdrey to CO 127	
2661	CO 90 west of Montrose	Yes
2662	CO 90 west of Montrose	Yes
2663	US 50 Olathe Business Loop	
2664	CO 348 between Olathe and US 50	Yes
2665	CO 348 west of Olathe	Yes

Project ID	Project Name	Eligible for PROTECT
2670	I-70: Bridges near Limon	
2671	I-76: Atwood	Yes
2672	US 40: Wild Horse	
2673	287/40/94	
2674	CO 59: Sandy Creek Bridge	
2675	CO 59 Bridges	
2676	Six Mile Creek	
2677	CO 59: Siebert to Cope	
2678	US 385: Burlington	
2679	US 385: Idalia North	
2680	CO 71: Limon Structures	Yes
2681	CO 71: Big Beaver Creek	Yes
2682	CO 71: Stoneham	
2683	I-76 east of Sterling (Part 2 Slabs and Diamond Grind)	
2685	US 385 between Sand Creek and County Road 29	
2686	US 385 South of Cheyenne Wells	
2687	US 385 south of Julesburg	
2688	CO 71 south of CO 14	Yes
2689	CO 71 north of Brush	Yes
2691	Vision Zero Priority Improvements	
2694	I-25 and CO 7 Interchange Mobility Hub	Yes
2695	US 85 and US 34 Interchange	
2697	Regionwide Bridge Rehabilitation and Maintenance	Yes
2703	Bustang Fountain Mobility Hub	Yes
2714	Castle Rock Transit Station	
2715	Denver Heavy Maintenance Facility	
2716	Idaho Springs Park-n-Ride	Yes
2718	Bustang and Outrider Fleet Purchases	
2719	Colorado Springs Transit Center	
2720	Woodmen Rd Mobility Hub	Yes
2721	Monument Park-n-Ride	
2722	Bijou Street Storage and Maintenance Facility	Yes
2723	North Pueblo Mobility Hub	

Project ID	Project Name	Eligible for PROTECT
2725	Outrider Improvements at Tejon	Yes
2726	Outrider Improvements at Pueblo West	
2727	Arterial Transit and Bike/Pedestrian Improvements on I-70 Business/US 6 Corridor	
2729	Berthoud Mobility Hub	
2730	Longmont/Firestone/Weld County Mobility Hub	
2733	Harmony Rd Park-n-Ride Expansion	
2736	Bustang Fleet Purchases	
2739	Safer Main Streets	
2742	Centerra-Loveland Mobility Hub	
2744	Lone Tree Transit Station	
2747	Grand Junction Mobility Hub	
2753	I-70 Bustang Pegasus Park-n-Rides	
2757	I-25C North to I-25	Yes
2758	Implement Recommendations from Trinidad Traffic Study	
2759	Safety and Operational Improvements Exit 135 South Academy to Exit 138 Circle/Lake	Yes
2760	US 50 Safety Improvements west of Canon City	Yes
2761	CO 67 North of Woodland Park	Yes
2765	US 40 Red Dirt Hill Safety Improvements	Yes
2769	I-70 Corridor Improvements and Preservation (Bethune to Burlington Phase I)	
2771	CO 1 Safety Improvements	
2772	CO 52/CR 59 Roundabout and Safety Improvements	
2774	CO 61 Sterling East MP 32.3-41.0	
2775	CO 63 Akron North and South Resurfacing	
2777	US 24 North of Leadville	
2778	CO 145 Dolores East	Yes
2780	I-25 through Pueblo New Freeway; Advancing Transportation Safety	
2782	Advancing Transportation Safety / I-76 & CO 144 Interchange Safety Improvements	
2783	US 160 East of Fort Garland Safety and Wildlife Mitigation; Advancing Transportation Safety	
2784	Advancing Transportation Safety (Vasquez Boulevard Improvements: 60th Avenue to 62nd Avenue Project)	