COLORADO
Department of Transportation

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

4R Attributes

- Robustness: The strength of an asset or a system to withstand relevant threats
- Redundancy: The presence of a backup system or plan
- Resourcefulness: Ability to identify, diagnose, and treat problems with available resources
- Rapidity: Ability to restore functionality in a timely way

Organizational Examples

- CDOT partners with Colorado Division of Fire Prevention and Control (DFPC) to have equipment for wildfire suppression available.
- CDOT has pre-established emergency contracting and procurement protocols to expedite the purchase of materials. This allows the department to deploy repair teams and resources quickly, minimizing road closures and reopening vital routes swiftly. (Rapidity)
- CDOT utilizes GIS-based vegetation management to identify areas of heavy fuel load (e.g., trees, shrubs) near highways. This data can be used to inform targeted clearing and controlled burns to reduce fire risk and maintain firebreaks along critical transportation corridors in collaboration with the Colorado State Forest Service. (Robustness)
- CDOT equipment operators are trained in coordination with DFPC at the Colorado Wildfire and Incident Management Academy. These resources were utilized on several fires in 2018, including the Spring, Chateau, Lake Christine, and Weston Pass fires, and again in 2020 on the Pine Gulch and Grizzly Creek fires. (Resourcefulness)

A Resilient Transportation Organization

- Has an organizational mind-set of enthusiasm for challenges, problem solving, agility, flexibility, innovation, and taking opportunity.
- Understands interconnectedness and vulnerabilities across all aspects of agency function.
- Has established relationships, prearranged mutual aid arrangements, and regulatory partnerships.
- Has established response plans in place to mobilize when events occur

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. Environmental factors such as drought, rising temperatures, reduced snowpack, and earlier snowmelt increase the risk of large wildland fires.

A Resilient Transportation Asset

- Is designed to withstand and recover from unexpected events and challenges.
- Has parts, elements, systems, facilities, etc., that are substitutable, i.e., are capable of satisfying backup functional requirements in the event of disruption, degradation, or loss of functionality of the primary system. Redundancy may involve excess capacity.
- 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.
- Designed in such a way that it is quick to restore functionality, containing losses and avoiding disruptions.

Technical Examples

- CDOT considers the overall roadway footprint, including increases in pavement width, clear zones in ditches (e.g., remove beetle kill), and nonflammable pipes/culverts and materials in areas with existing fire risks. (Robustness)
- GIS-based vegetation data is used to identify areas of heavy fuel load (e.g., trees, shrubs) near highways. This data can be used to inform targeted clearing and controlled burns to reduce fire risk and maintain firebreaks along critical transportation corridors. (Robustness)
- In the wake of forest fires, CDOT uses LiDAR-equipped drones to assess damage to road surfaces, bridges, and tunnels, providing high-resolution 3D models of infrastructure to identify structural weaknesses and repair needs. This technology can identify heat signatures from residual fires that may not be visible on the ground, allowing for quicker assessments of hazard areas. (Rapidity)