



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 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).	Construction of an alternate detour route where none exists. Backup traffic operations center. Transit route/ Express lanes on a highly congested freeway. Bridge built with redundant methods of avoiding failure.	Promotes open communication and mitigation of internal/external silos. Understands interconnectedness and vulnerabilities across all aspects of agency function.	Backup computer servers. Development of a statewide detour map and evaluation of gaps in system redundancy. Cross-trained staff. Supplemental "snow patrol" staff identified and on-call to assist in storm event.



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Resourcefulness	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.	<p>Stockpiling emergency repair/storm treatment materials to handle unplanned events. Optimizing positioning of snowplows and materials.</p> <p>Real-time stream gauges as a warning system in high-risk areas.</p>	Has ability to efficiently mobilize 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.	<p>IGAs with other agencies in place in advance to borrow needed materials in emergency situations.</p> <p>IT staff on-call with skills and abilities needed to respond to a cyber-attack.</p> <p>After-action reviews with feedback to change where needed.</p>
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 function at high performance.	<p>Placing VMS signs in vulnerable areas to redirect users.</p> <p>Purchasing a temporary bridge for use as needed in emergency washouts.</p>	Has established response plans in place to mobilize when events occur. Has systems and manuals documented and in place for how to manage emergency events. Learns from the success or failure of previous efforts to improve response time.	<p>Documented structure and roles for emergency response - who's in charge, what skills does each need to have, etc.</p> <p>On- call contracts in place ahead of emergencies to mobilize needed contractor assistance.</p> <p>Establish and monitor performance measures for emergency response time.</p> <p>Traffic Incident Management Plan adopted.</p> <p>Conducting emergency response drills.</p>