

DATE: November 16, 2016

TO: Transportation Commission Resiliency Subcommittee

FROM: Lizzie Kemp and Heather Paddock, Co-Project Managers and Joshua Laipply, P.E. Chief Engineer

SUBJECT: I-70 Risk and Resiliency Assessment Pilot

Purpose

Briefing on status and next steps of the I-70 Risk and Resiliency Pilot project. The goal of the pilot is to quantify and improve system resilience in advance of future events to better prepare CDOT and reduce future system losses.

Moving Ahead for Progress in the 21st Century (MAP-21 §1106; 23 USC 119) legislation mandates transportation agencies develop and apply risk-based asset management processes to preserve or improve the performance of the road systems they own. This project will assist CDOT to advance how it complies with the directive and also help inform future maintenance, design and project selection processes.

Action

CDOT is requesting Subcommittee review, comment and approval on project progress to date, proposed decisions, and next steps.

Background

Recently, CDOT's system has suffered significant damage from floods, fire, rockfall and other physical events. Recovering from those events has been challenging, time-consuming, and expensive for the agency. In addition to reconstruction cost, these events have significant social, economic and environmental impact. The Pilot is a demonstration project to more fully understand and better manage the threats posed by physical events.

In September, CDOT briefed the Subcommittee on the pilot project to assess risk and resiliency of its transportation assets on Interstate 70 from the Kansas to Utah borders. The Subcommittee approved of the proposed scope, schedule and process for engaging the Commission. Since that time the Working Group and Data Advisory Team have met and completed the first two of seven steps in the project scope.

Details

- I-70 has been selected as the test corridor for this Pilot due to the diversity of terrain, environmental constraints, statewide significance and wide range of rural, recreational and urban character.
- The Pilot builds on CDOT's 2013 Transportation Asset Management Plan (TAMP), and methods utilized through the Flood Recovery Program. Specifically, the method builds upon a framework referred to as RAMCAP+ (*Risk Analysis and Management for Critical Asset Protection*).
- More specifically, using RAMCAP+ the project team will:
 - inventory and value system assets,
 - identify which assets are most critical to system operations,
 - identify which threats are appropriate to consider,

- calculate the probability of events occurring that could compromise those assets,
 - estimate the resulting damage, and
 - suggest alternative approaches for maintenance or improvement of those assets to increase resiliency and redundancy of our system in a way that is more cost-effective over the long term.
- The project team has completed the first two of seven steps in the RAMCAP+ process.
 - Determined which assets to address, how to value them and collected data.
 - Determined which threats to evaluate and collected data.
 - Determined criteria to identify which portions of our system are most critical from a usage, social, economic and environmental perspective. (detail on the criteria proposed by the Working Group and resulting map of critical assets statewide provided in the attached slides)
 - The number and types of assets and hazards to be evaluated in the Pilot is limited to ensure completion of the project within 12 months. (specifics provided in the attached slides)

Next Steps

The second of four all-day workshops with the Project Working Group is scheduled for December 6, 2016. At that workshop, the team will revisit/confirm the decisions made at its last workshop based on feedback received, and complete the next two steps in the process, defining the method to determine consequences and vulnerabilities of the selected threat types on our system.

The team proposes to return to the Resiliency Subcommittee three more times over the next nine months to report on progress and request guidance and feedback. A final report will provide CDOT the results of the full R&R analysis, and propose steps for implementing and institutionalizing the process across the State for consideration by the Commission.

Key Benefits

The results of this pilot will permit CDOT to evaluate the utility of such R&R analysis for internal use in pro-actively managing Colorado's road transportation network and its applicable physical threats in the future. The results will help to improve CDOT's current asset management, project prioritization, design and maintenance practices.

Attachments

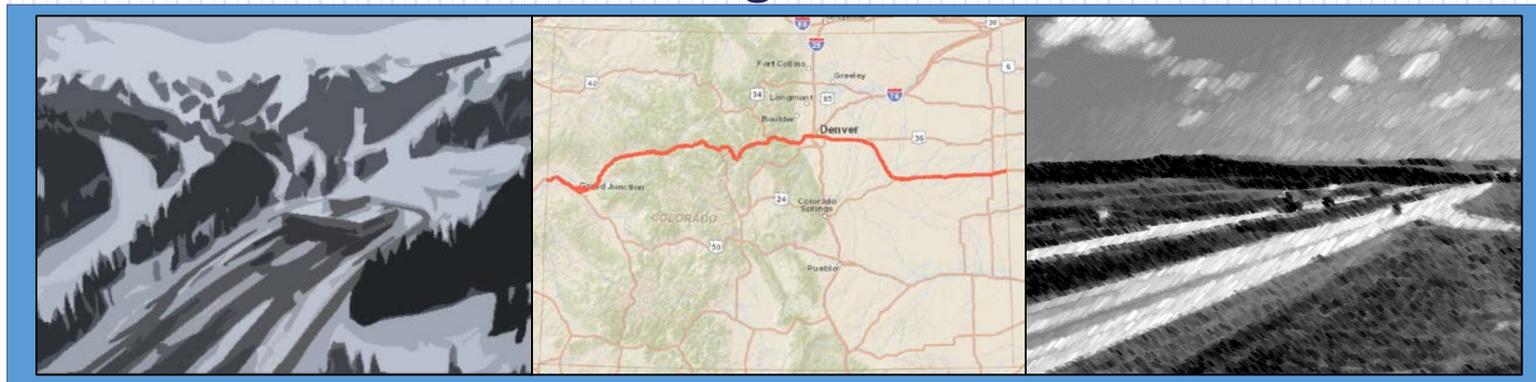
Powerpoint slide presentation



I-70 Corridor Risk & Resilience Pilot Study

November 16, 2016

Risk & Resilience Commission Sub-Committee &
Executive Oversight Committee



COLORADO
Department of Transportation



Presentation Outline

- I-70 Corridor R&R Pilot Study Motivation and Purpose
- RAMCAP Process
- Pilot Progress to Date

- Questions?

I-70 Corridor R&R Pilot Study Motivation

- Why now?

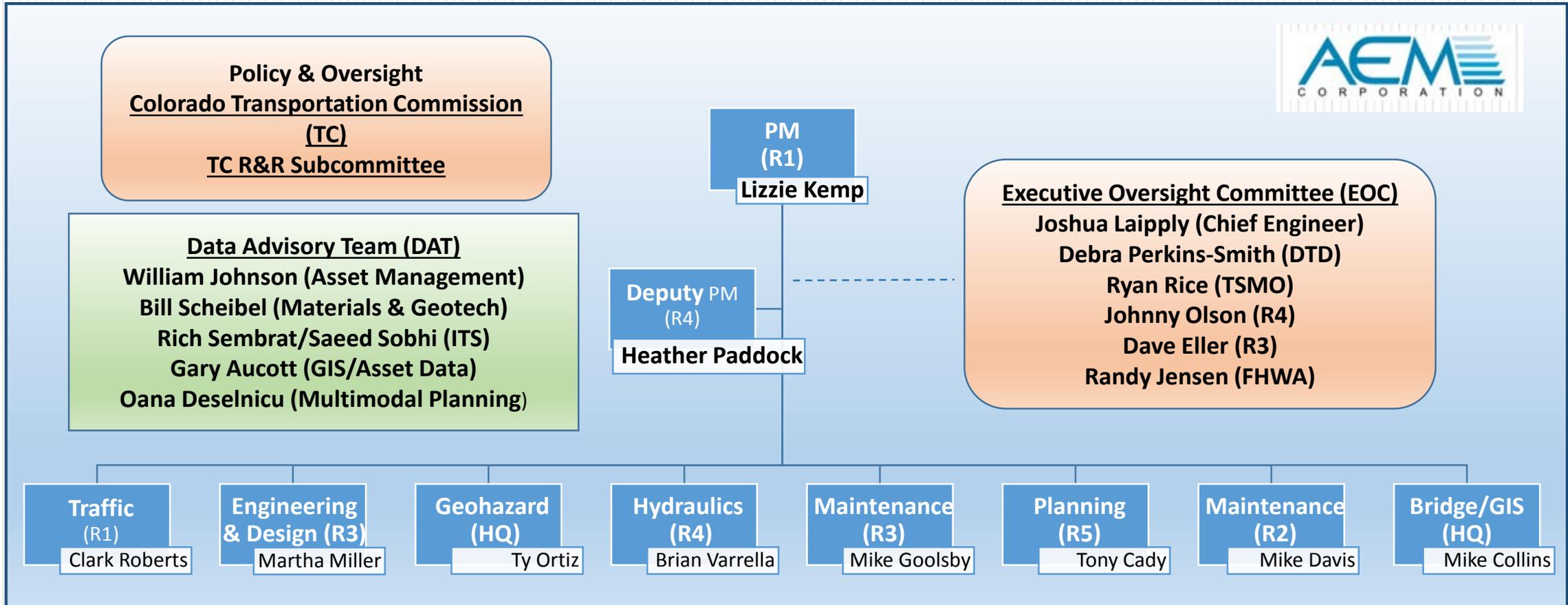
- Major impacts from events in the last five years
- Hazards will continue to occur and potentially increase due to changing climate patterns
- Opportunity to learn lessons from past disasters
- Federal legislation requires DOTs to assess risk in asset management
 - Final Rule for Risk Based Asset Management published in November 2016



CDOT Risk and Resiliency Experience

- Emergency Relief (ER) Process
 - CDOT Region 4 Flood Recovery Office worked with FHWA, using RAMCAP to analyze and justify betterments
- CDOT 2013 Risk Based Asset Management Plan
 - MAP 21 requires states to identify risks that can affect NHS condition and effectiveness
- Govr. Hickenlooper's Colorado Resiliency Project
 - CDOT staff led the Infrastructure Working Group

I-70 Corridor R&R Pilot Project Team



a/o 31 Aug 2016

I-70 Pilot Project Schedule

	2016					2017							
<i>Event</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>
NTP	11												
CTC													17
CTC R&R		14		16		18			19			19	
EOC	16			16		18			19			19	
DAT		29					15					18	
WG	16	27			6			23			6		

NTP: Notice to Proceed

CTC: Colorado Transportation Commission

CTC R&R: Colorado Transportation Commission Risk & Resilience subcommittee

EOC: Executive Oversight Committee

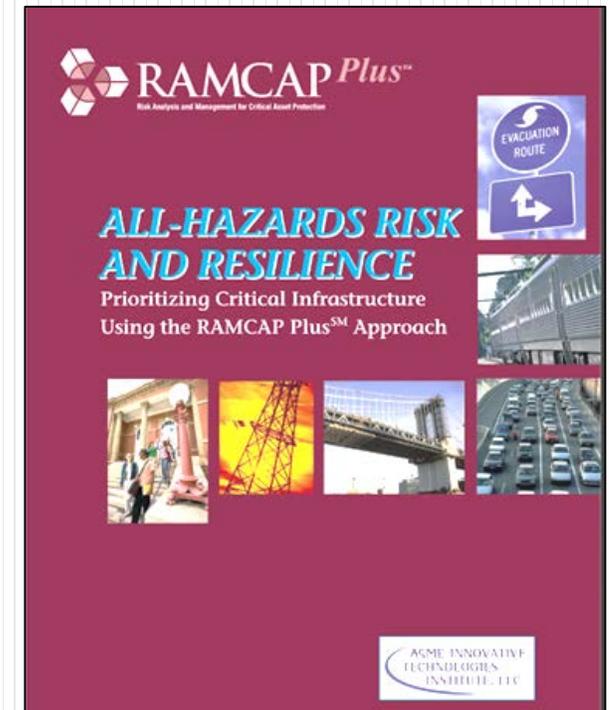
DAT: Data Advisory Team

WG: R&R workshop (working group)

I-70 Pilot Scope

I-70 Pilot Scope

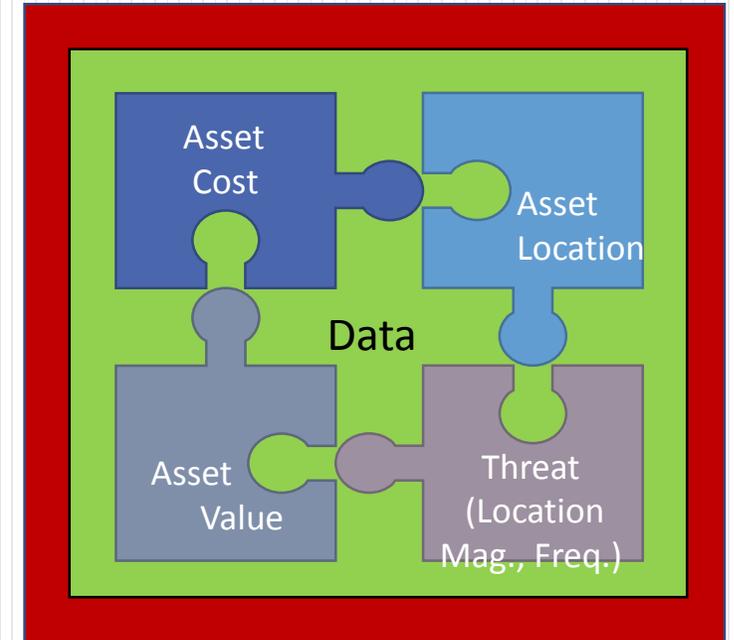
- Analysis of risk potential and resulting system resilience of I-70 corridor from Kansas to Utah
 - Risk – potential cost of losses to CDOT assets (direct and indirect)
 - Resilience – ability to remain functional even in presence of risks
- Building on RAMCAP Framework utilized in Flood Recovery Effort
 - “Risk Analysis and Management for Critical Asset Protection “
(American Society of Mechanical Engineers)



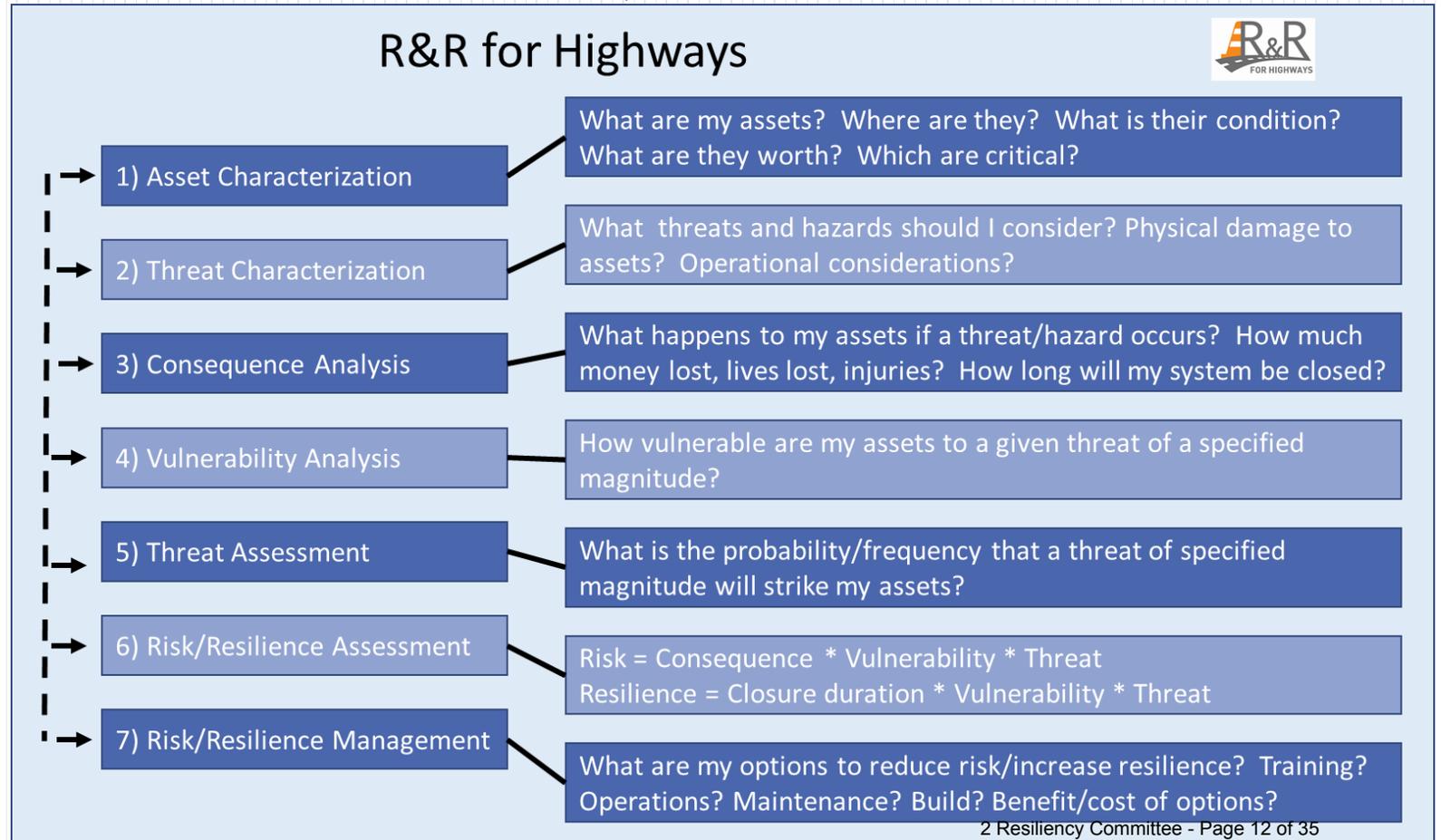
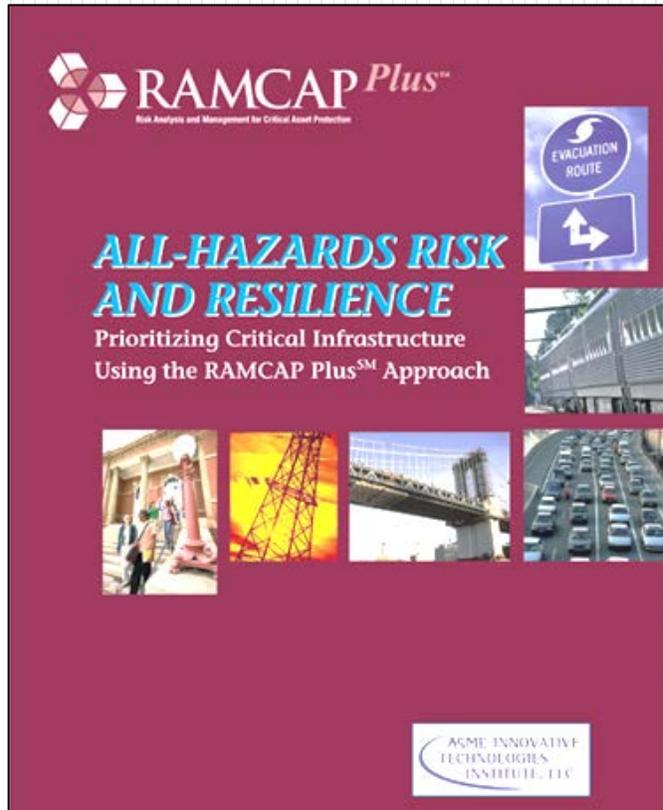
I-70 Corridor R&R Pilot

“Pilot” the data, assumptions, and methodology needed to quantify:

- What are CDOT’s **assets**?
 - Location, value, condition, criticality
- What are relevant **physical threats**?
 - Likelihood and location
- What **impact** would they have on our system?
- What are the **optimal investments** we can make now to improve resiliency in advance of future events?



RAMCAP Plus → R&R for Highways



I-70 Pilot Progress to Date

I-70 Pilot Progress

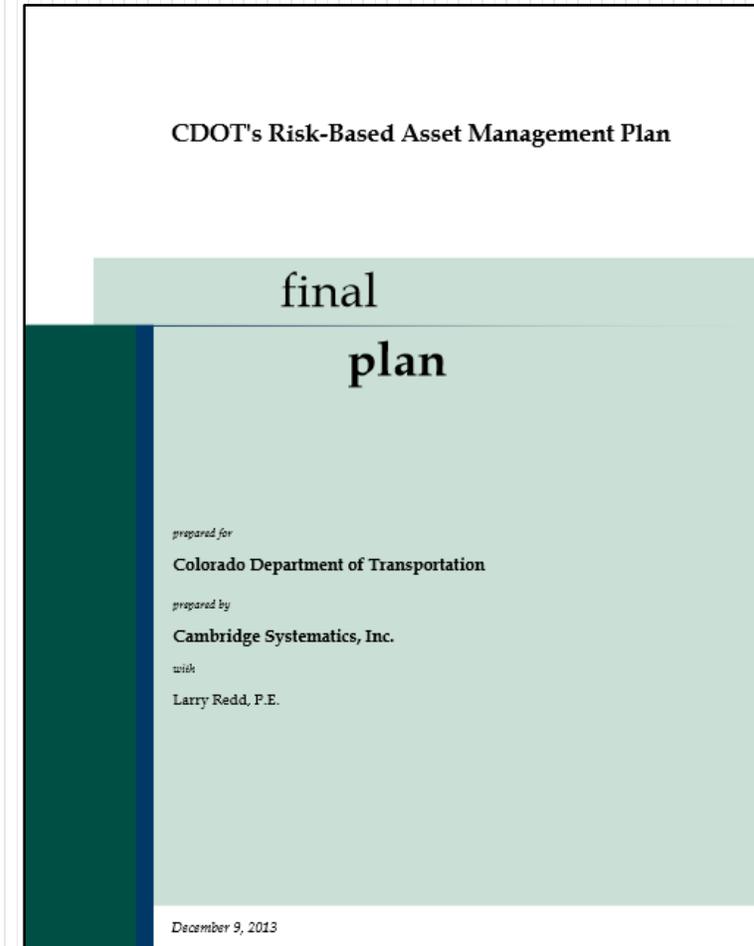
- September 14, 2016 – 1st TC Resiliency Subcommittee meeting, support for scope, schedule and process
- September 27 and 29, 2016 – 1st Working Group (WG) all-day workshop and Data Advisory Team (DAT) meetings
- November 4, 2016 – Webinar with WG to discuss Asset Criticality Screening Model
- November 16, 2016 – Executive Oversight Committee and Commission Resiliency Subcommittee -- status report, advise on assumptions and direction.

First 2 Steps of RAMCAP Process Complete

- Identified assets to be considered and appropriate data sources
- Agreed to assumptions for asset valuation
- Identified threats to be considered and appropriate data sources
- Determined measures to identify critical assets

Asset Classes to Be Considered

- ✓ Pavement
- ✓ Bridges
- ✓ Buildings (Tunnel Ops & CTMC)
- ✓ Walls
- ✓ ITS equipment
- ✓ Tunnels
- ✓ Culverts (sub-4' thru 20')
- ~~Rockfall mitigation sites~~
- ~~Fleet~~
- ~~Maintenance (signs, delineators, guardrail, lighting, signals, attenuators, pavement marking)~~



CDOT Risk-Based Asset Management Plan, 9 Dec 2013

Physical Threats to Consider

Natural Threats	Civil Threats	Dependency & Proximity Threats
Avalanche	HAZMAT	Utility failure
Earthquake	Cyber	<u>Dam Break</u>
Fire (wildland)	Bomb	
Flood (riverine/flash)	Bridge strikes	
Hail	<u>Chains, Mag-Chloride</u>	
Landslide/rockslide		
Tornado		
Wind storm		
Winter storm (freeze-thaw)		

Criteria for Determining Critical Assets

Three Pillars of Governor's Resilience Plan

- Social
- Economic
- Environmental

Select criteria for determining asset criticality reflecting these three pillars



Criteria for Asset Criticality

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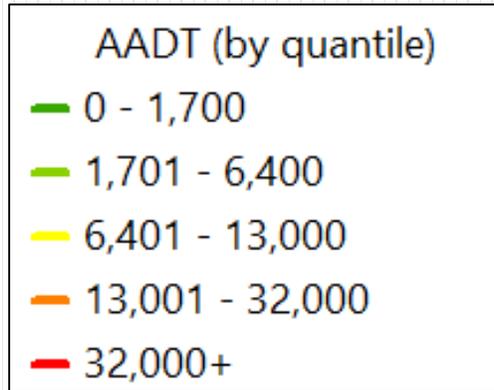
E
C
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- Usage: AADT + Roadway Classification ✓ ✓ ✓
- Economic Impact: Freight value (\$) + Tourism value (\$) ✓ ✓
- Social Impact: SoVI ✓
- System Impact: System Redundancy ✓ ✓ ✓

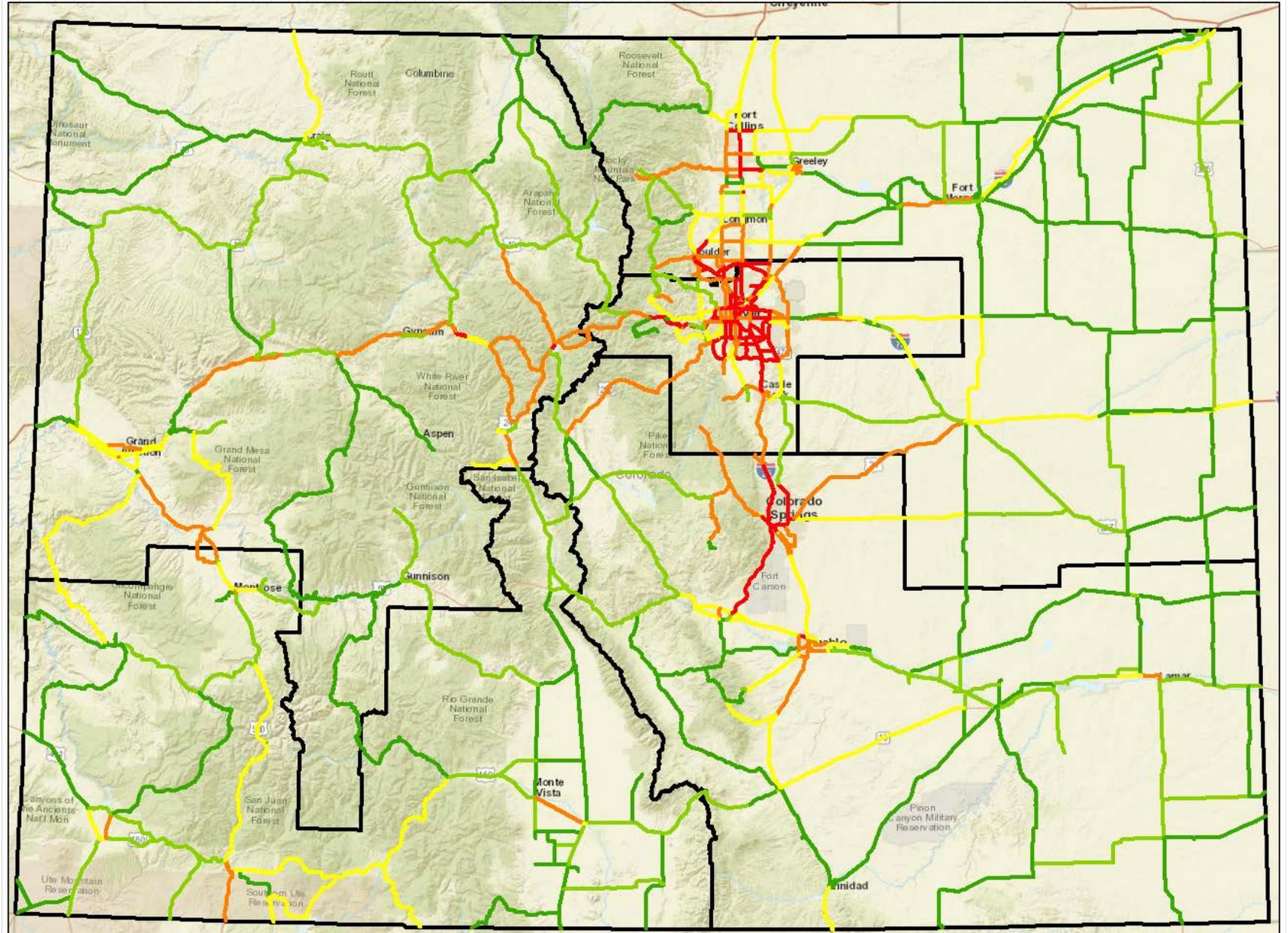
Source Data for Model – Usage

- AADT - CDOT
- Roadway Classification – National Transportation Atlas Database

AADT

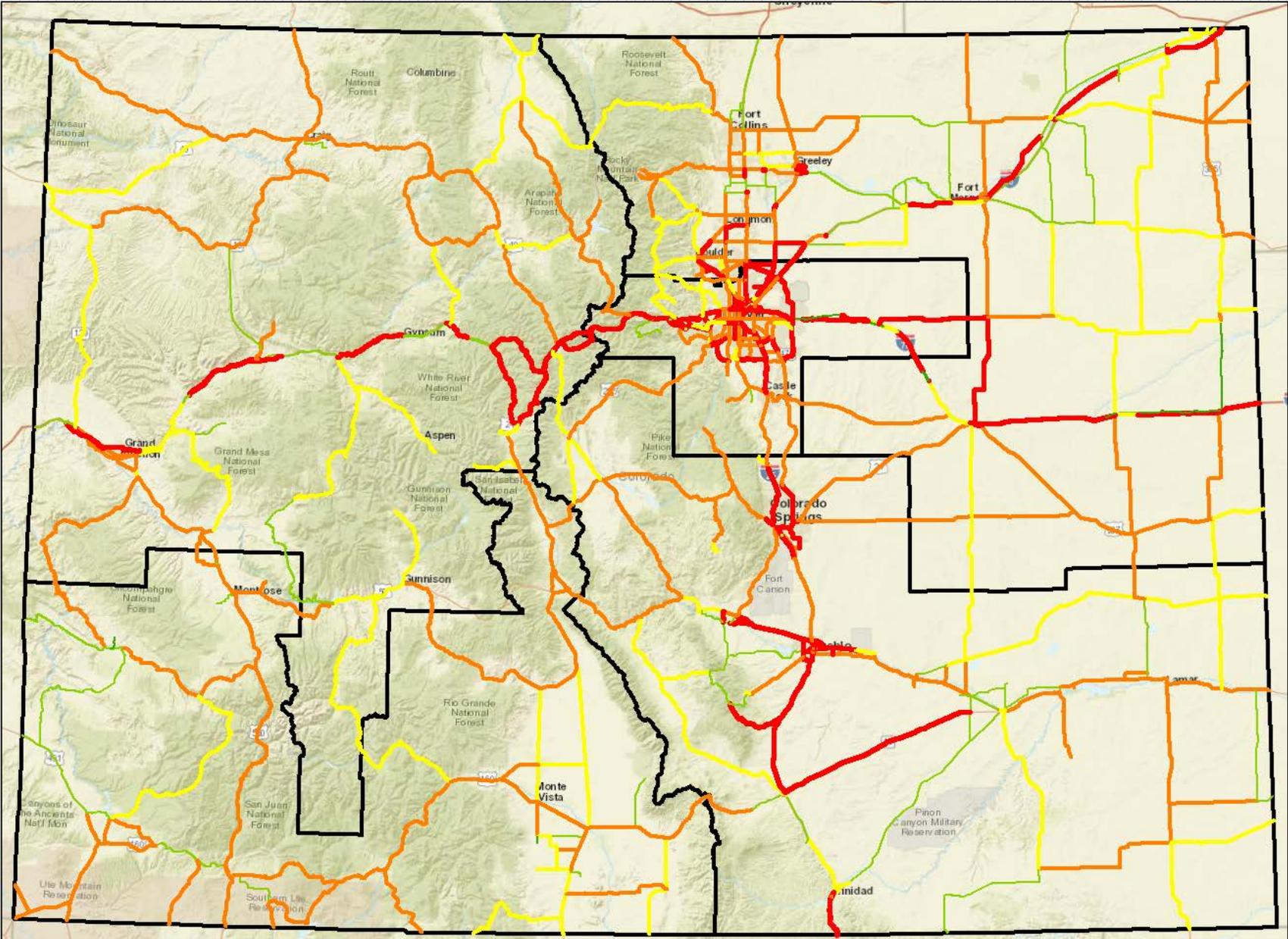


By quantiles



Roadway Classification

- Roadway Classification
- Minor Collectors
 - Major Collectors
 - Minor Arterial
 - Principal Arterial
 - Interstate, Fwy, Expressway



Source Data for Model – Freight and Tourism

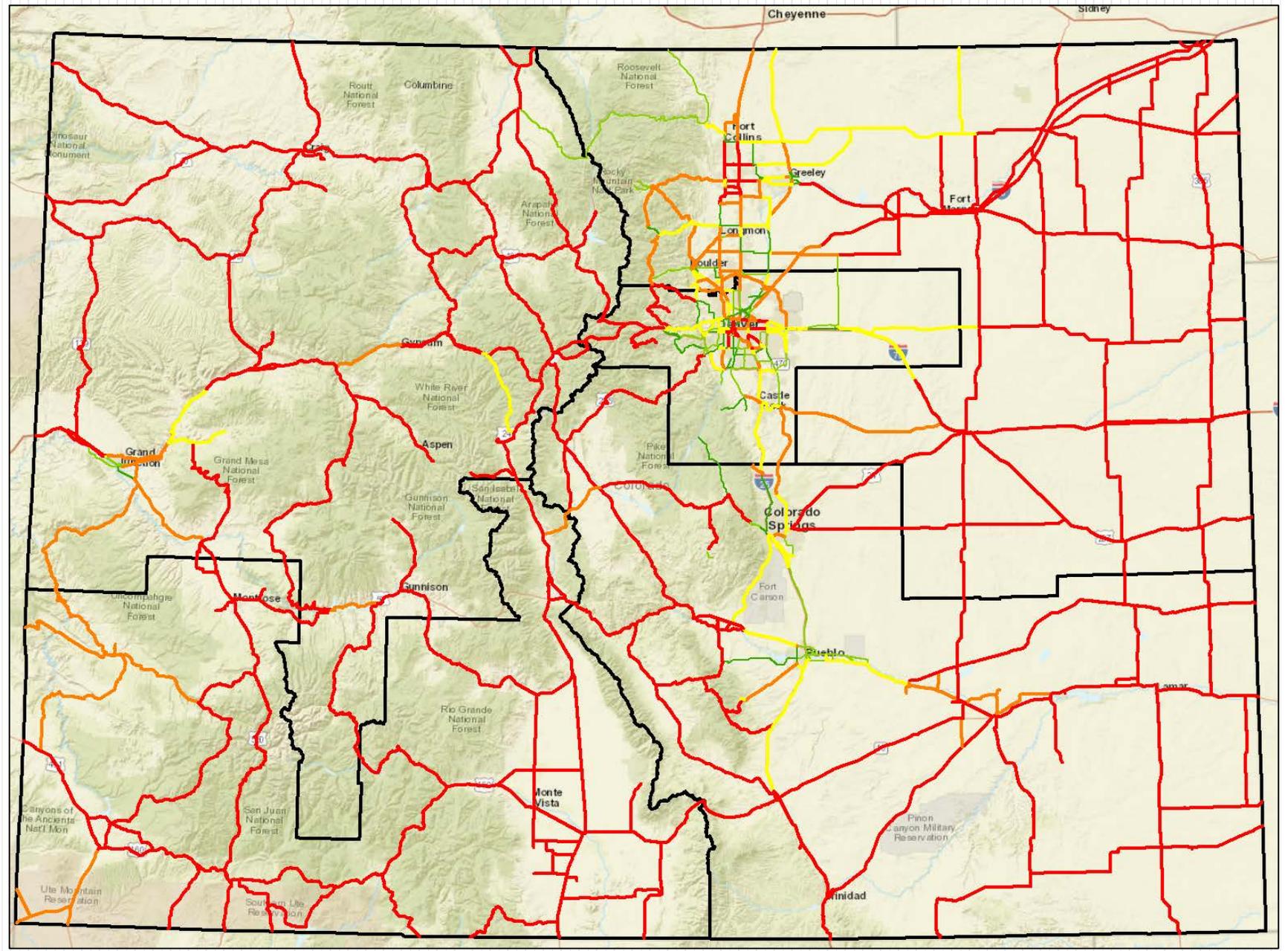
- Freight data is from the 2010 edition of Transearch database
 - Freight values are on a county by county basis. They include freight imports and exports for each county as well as the value of freight moved within each county.
- Tourism data is from the 2016 Colorado Travel Impacts study (Dean Runyon Associates), as prepared for the Colorado Tourism Office.
 - Travel values were derived from the 2007 NAICS (North America Industry Classification System (Office of Management and Budget—OMB)) industry values for Colorado on a per county basis

(Freight\$ + Tourism\$)/ Capita



By quantiles

*Reflects revised methodology
Allocating revenue from county to
Census tracts*

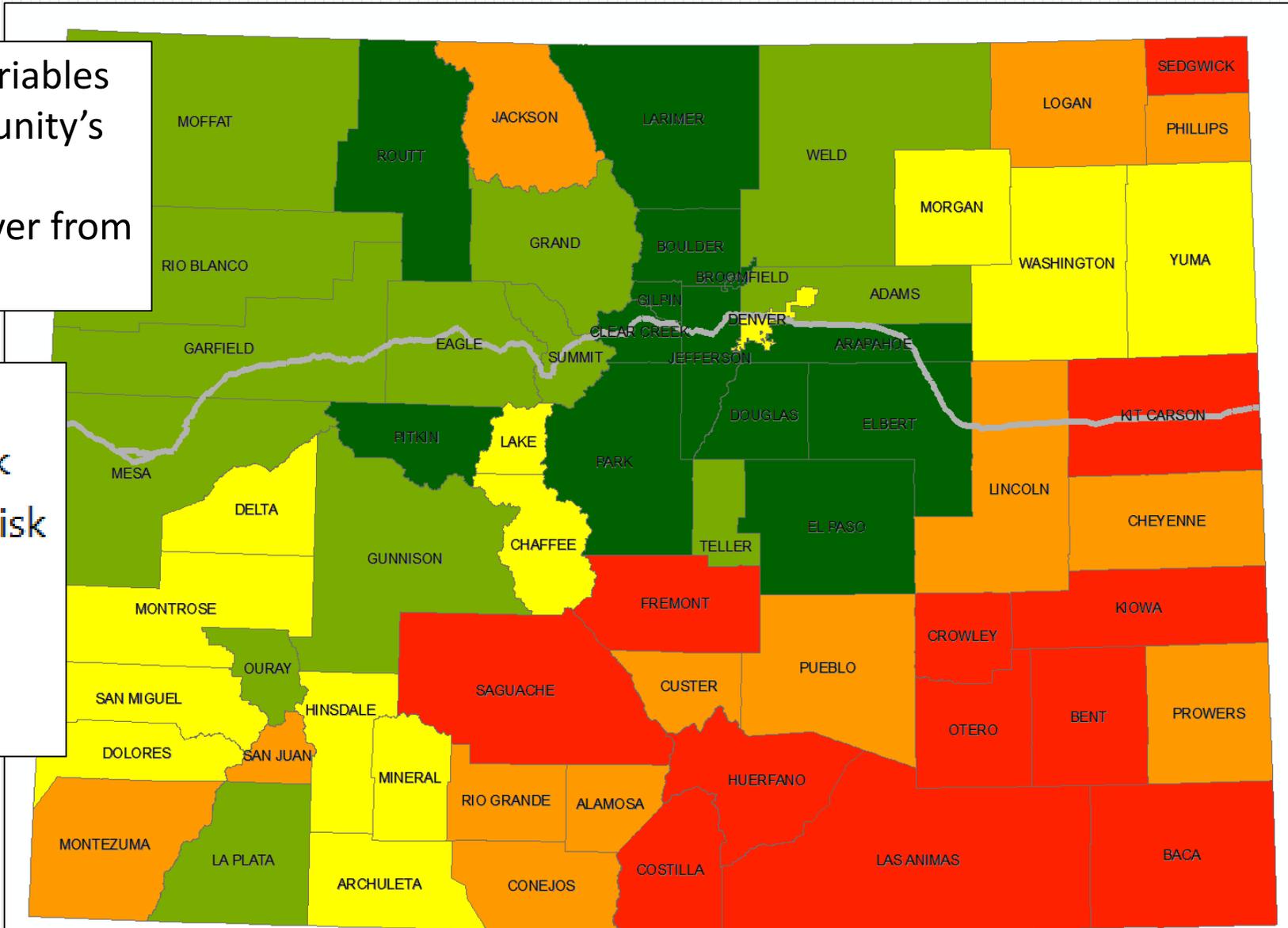
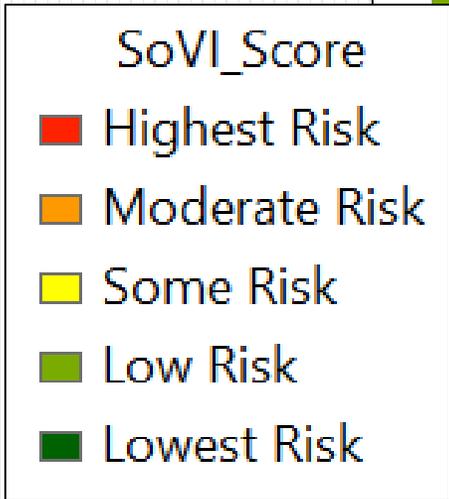


Source Data for Model - SoVI

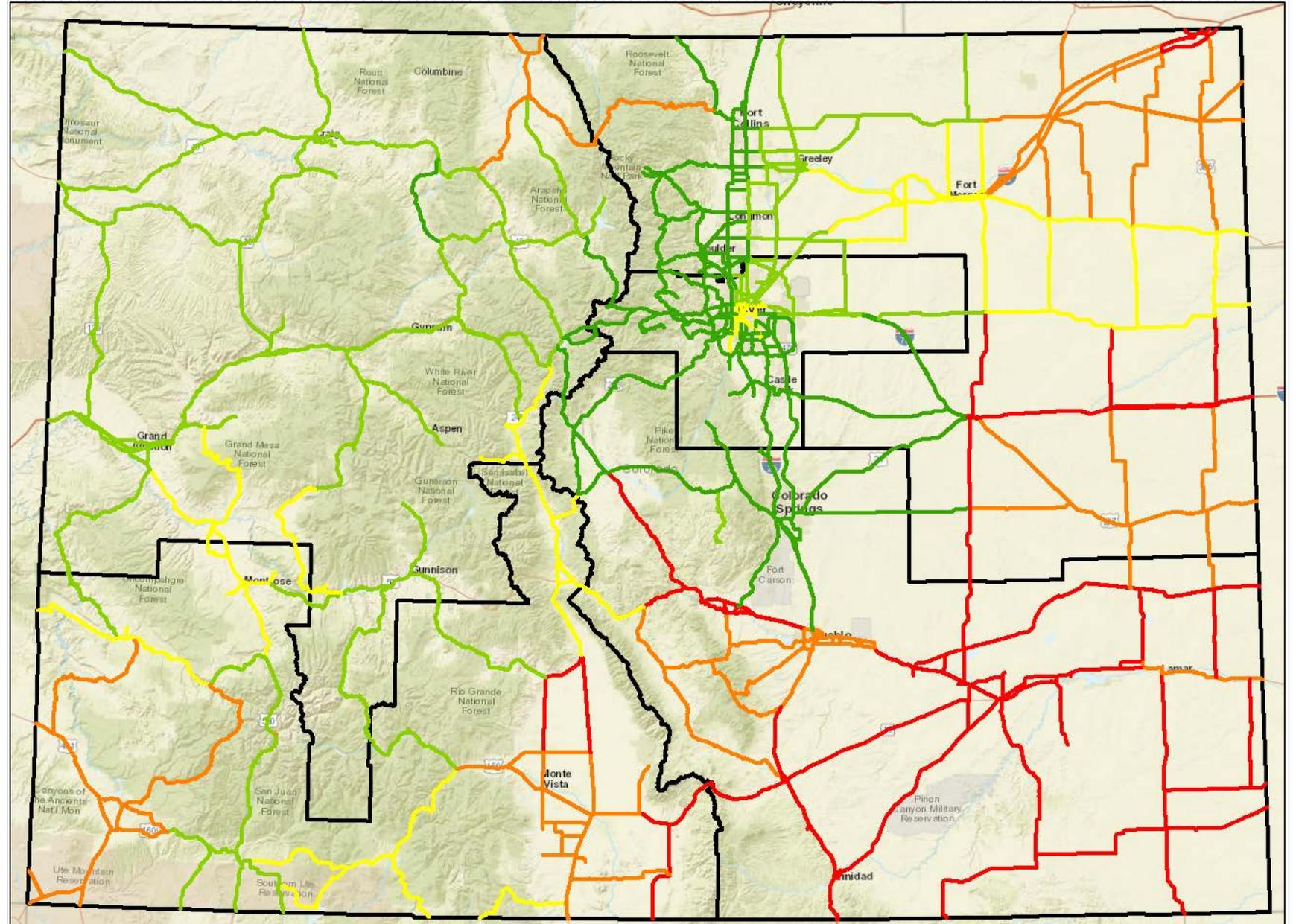
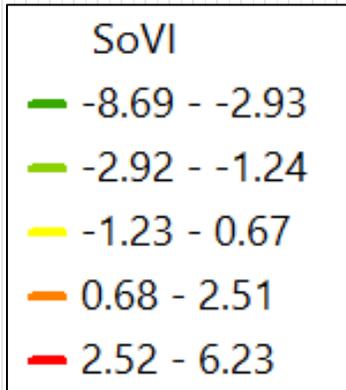
- Social Vulnerability to Environmental Hazards Index (SoVI®)
- A comparative metric that facilitates the examination of the differences in social vulnerability among counties
- Shows where there is uneven capacity for preparedness and response and where resources might be used most effectively to reduce the pre-existing vulnerability
- SoVI® also is useful as an indicator in determining the differential recovery from disasters
- Developed by University of South Carolina Hazards and Vulnerability Research Institute with underwriting by FEMA
- Adopted by the US Army Corps of Engineers (50 states + DC)

Community Resilience

Socio-economic variables indicating a community's ability to prepare, respond, and recover from natural threat



SoVI



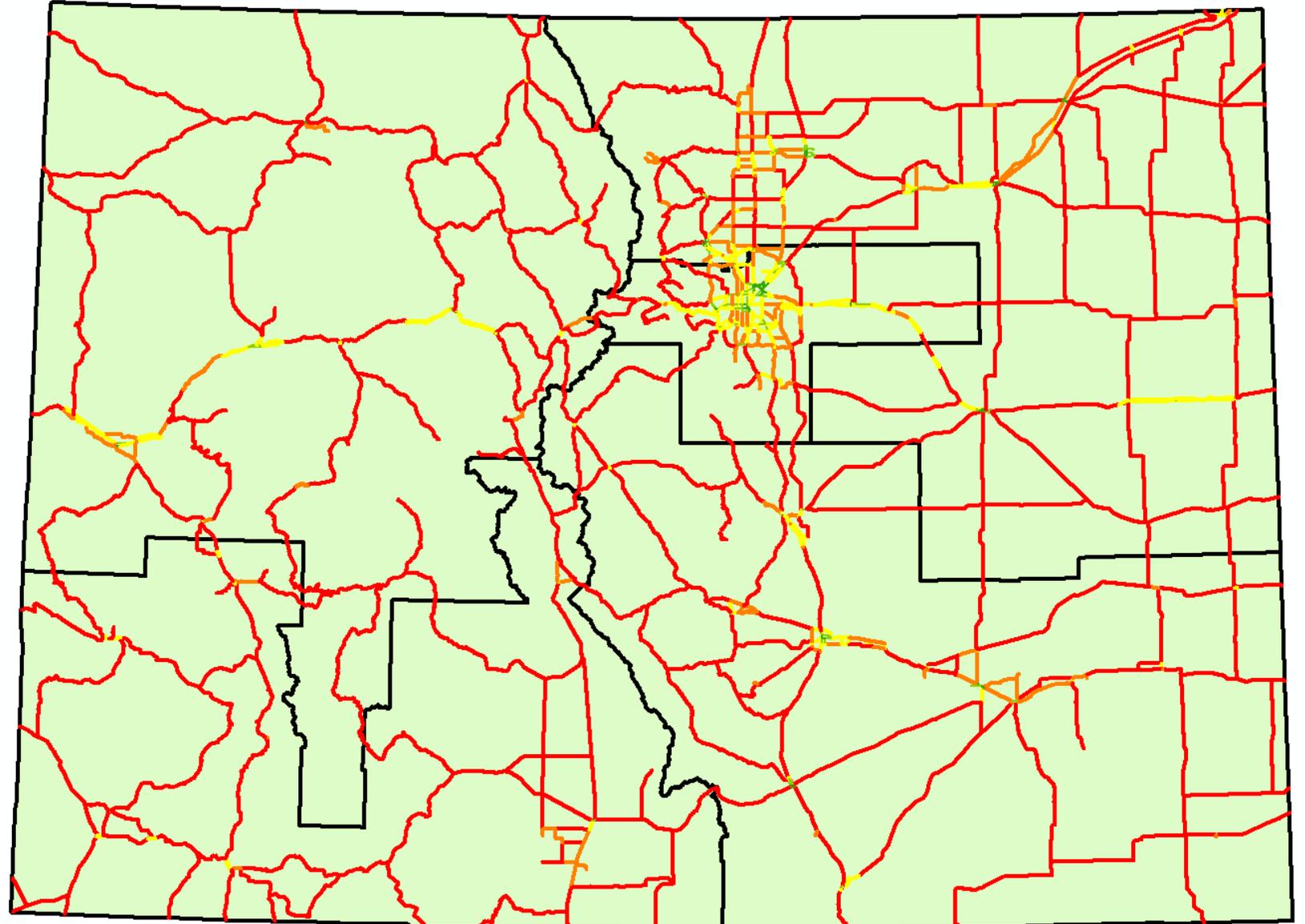
Source Data for Model – Redundancy (CDOT 2015)

- CDOT developed a map of major roads within the state, indexing each road for “redundancy”
- This is a “unit less” measure (count of number of roads)
- Redundancy is a measure of the number of alternative routes available
- Where redundancy is low, there are very few alternate routes for that section of roadway
- As might be expected, urban areas with their dense network of roads have high redundancy values. Rural areas with dispersed road networks have low redundancy values.
- The logic is that roads with low redundancy values are more critical, as there are few alternatives to these routes

2016 Redundancy

24 Oct. 2016 Revision:

- Removed off-system roads (non-CDOT facilities)
- Removed seasonal routes
- Removed roads w/weight-restricted bridges (“black,” no overweight permits)
- Removed approximately 2925 CL miles of road



Proposed Criticality Score

Criteria	Criticality Score					Weight
	1 Very Low Impact	2 Low Impact	3 Moderate Impact	4 High Impact	5 Very High Impact	
AADT	0 – 1,700	1,701 – 6,400	6,401 – 13,000	13,001 – 32,000	32,001+	25%
Roadway Classification	Minor Collectors	Major Collectors	Minor Arterial	Principal Arterial	Interstate Freeway Expressway	25%
(Freight \$ + Tourism \$)/Capita	< \$16,018	\$16,019– \$22,065	\$22,066 – \$31,558	\$31,559 - \$58,145	\$58,145 +	20%
SoVI	-8.69 - -2.93	-2.92 - -1.24	-1.23 – 0.67	0.68 – 2.51	2.52 – 6.23	20%
Redundancy Rating (CDOT)	4.51 – 50.5	3.01 – 4.5	2.01 – 3	1.51 – 2.0	1.0 – 1.5	10%

Criticality Level

Number of Criteria:	5
Minimum Score:	10
Maximum Score:	50

Criticality Score	Criticality Level
10 to 30	Low
31 to 40	Moderate
41 to 50	High

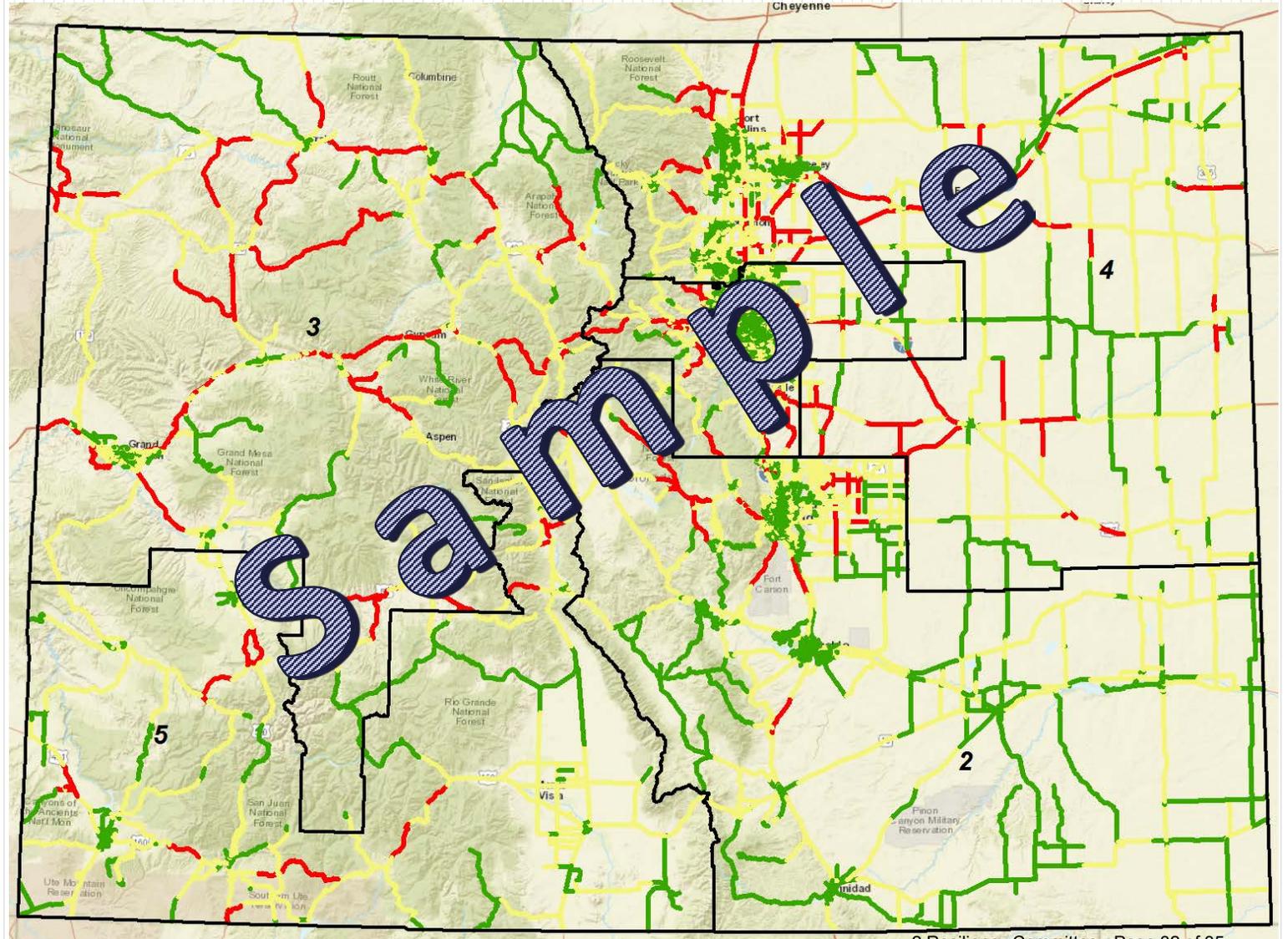
} Arbitrary Score

- Low, Moderate, or High Criticality Level value based on *percent of roads* in each class
 - Centerline miles (CL) from CDOT Redundancy data set

Criticality Level	Target (%CL)	Actual (%CL)	Actual Score
Low	50%	50%	14.5 – 31.5
Moderate	25%	26%	32 – 35
High	25%	24%	35.5 – 44

Sample Criticality Map

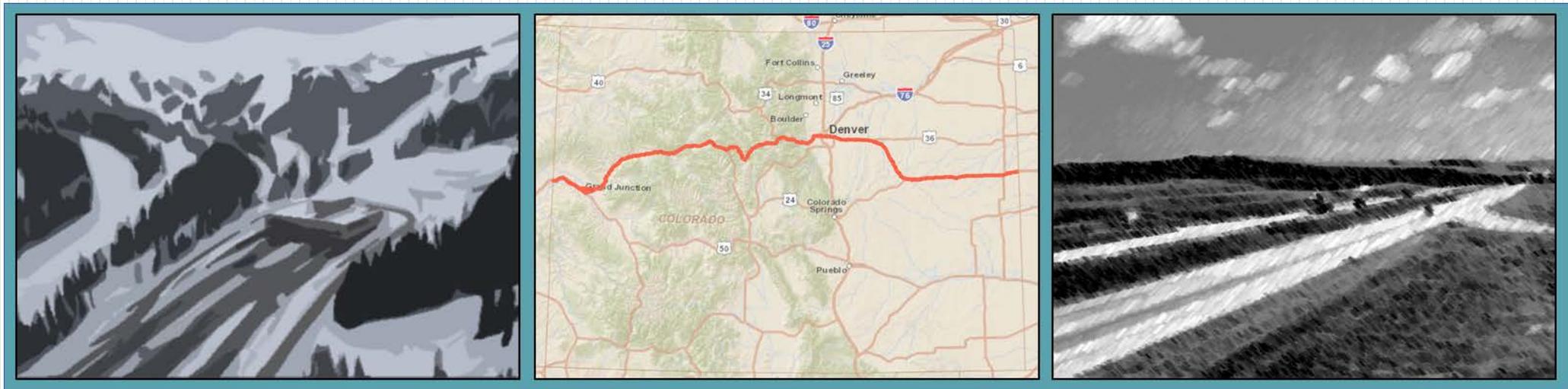
Criticality Score	Criticality Level
5 to 13	Low
14 to 19	Moderate
20 to 25	High



I 70 Pilot Next Steps

- November – December: Working Group to refine “critical roadways” model
- December 6: Next all-day Working Group workshop. Complete the next two steps in the process:
 - consequence analysis, and vulnerability assessment.
- January 18, 2017: Next EOC meeting and Resiliency Subcommittee briefing.

Questions?



Project Team Contact Information

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