Colorado Springs Wildfire Evacuation Clearance Times (1.5 ppv)

District One – One-Hour Response Time Results

Start Hour[1]		Contraflow On / Off	People per Vehicle[2]	Clearance Time (hours)
N2	N3			
0	0	Off	1.5	4:20
0	0	*Off: Rockrimmon Blvd Reduced	1.5	5:20
0	0	On	1.5	4:20
1	1	Off	1.5	5:10
1	1	On	1.5	4:30
0	1	Off	1.5	4:20
0	1	On	1.5	4:20

*For this run, traffic flow speed on Rockrimmon Blvd was reduced to 15 mph for all lanes.

District One – Two-Hour Response Time Results

Start Hour[1]		Contraflow On / Off	People per Vehicle[2]	Clearance Time (hours)
N2	N3			
0	0	Off	1.5	4:30
0	0	On	1.5	4:20
1	1	Off	1.5	5:20
1	1	On	1.5	5:20
0	1	Off	1.5	4:30
0	1	On	1.5	4:20

*The westernmost zone, N4, always begins evacuating at hour zero.
[2] 22,115 vehicles are simulated to evacuate with 1.5 ppv.

District One – Garden of the Gods Seasonal Traffic added (start time for all zones at hour zero, no contraflow)

Response Time (hours)	Garden of the Gods Vehicles	Total Vehicles	People per Vehicle	Clearance Time (hours)
1	3000	25,115	1.5	6:20
1	4000	26,115	1.5	7:20
2	3000	25,115	1.5	7:20
2	4000	26,115	1.5	8:10

Broadmoor Region

Response Time	People per Vehicle	Total Vehicles	Clearance Time (hours)
Residents only			
1	1.5	18,075	3:50
2	1.5	18,075	4:10
Residents + Resort[1] (14K)			
1	1.5	21,575	5:10
2	1.5	21,575	5:10
Residents + Resort + Zoo[2] (2K) + Seven Falls[3] (0.4k)			
1	1.5	22,275	5:20
2	1.5	22,275	5:10

[1]Evacuees from the resort are modeled using 4.0 ppv and begin at hour zero.
[2]Evacuees from Cheyenne Zoo are modeled using 4.0 ppv and begin at hour zero.
[3]Evacuees from Seven Falls satellite parking are modeled using 2.0 ppv and begin at hour one.

Broadmoor Region Tests with Traffic Flow Speed Reduced on Cheyenne and CO115 (all runs begin at hour zero with1-hour response time)

Road Reduced	Residents ppv	Total Vehicles	Clearance Time (hours)
Residents only			
West Cheyenne[2]	1.5	18,075	4:10
CO 115[3]	1.5	18,075	4:20
Residents + Resort[1] (14K)			
West Cheyenne[2]	1.5	14,345	5:20
CO 115[3]	1.5	14,345	5:10

[1]Evacuees from the resort are modeled using 4.0 ppv .
[2]Reduction of flow on West Cheyenne Rd was simulated by reducing traffic flow speed to 15 mph.
[3]Reduction of flow on CO 115 was simulated by reducing the roadway to a single lane in each direction.

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0	0	On	1.5	4:20
1	1	Off	1.5	5:10
1	1	On	1.5	4:30
0	1	Off	1.5	4:20
0	1	On	1.5	4:20

*For this run, traffic flow speed on Rockrimmon Blvd was reduced to 15 mph for all lanes.

District One – Two-Hour Response Time Results

Start Hour[1]	Contraflow		

N2	N3	On / Off	People per Vehicle[2]	Clearance Time (hours)
0	0	Off	1.5	4:30
0	0	On	1.5	4:20
1	1	Off	1.5	5:20
1	1	On	1.5	5:20
0	1	Off	1.5	4:30
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Broadmoor Region Tests with Traffic Flow Speed Reduced on Cheyenne and CO115 (all runs begin at hour zero with1-hour response time)

Road Reduced	Residents ppv	Total Vehicles	Clearance Time (hours)
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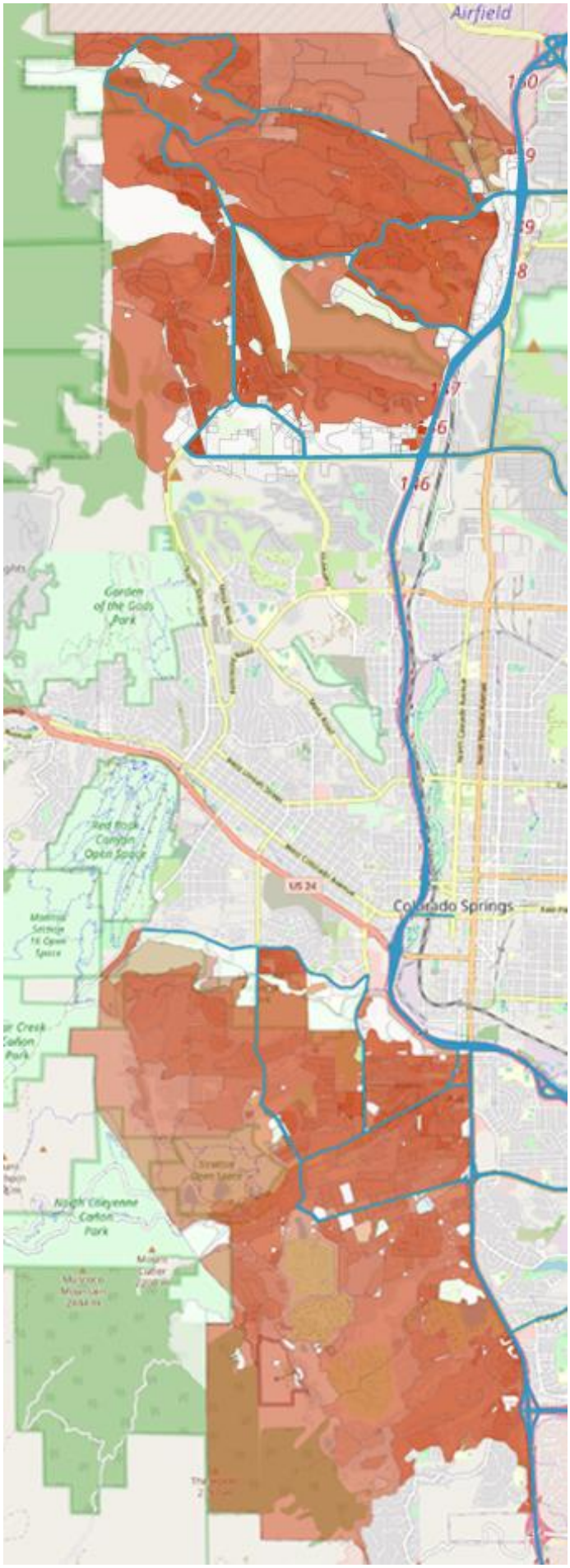
Airfield
Garden of the Gods Park
Red Rock Canyon Open Space
US 24
Colorado Springs
North Cheyenne Cañon Park

District One is approximately bounded by USAFA to the north, I-25 to the east, Garden of the Gods Road to the south, and foothills to the west.

The Broadmoor Region extends from Bear Creek Park to the north, CO115 to the east, Cheyenne Mountain Road to the south, and the foothills to the west.

Transportation M&S for Evacuation Planning and Analyses

Traffic modeling and simulation is a fundamental tool in the field of traffic engineering. It is particularly useful for “what-if scenario” analyses and comparison of alternatives and has been used throughout the world for decades to assess evacuations for: nuclear power plant emergencies (required for US NRC licenses), wildfires, hurricanes, terrorist threats, and many other natural and manmade hazards and threats.

Accurate evacuation modeling must include behavioral modeling and assessment, based on threat and response, to estimate who will leave, when they will leave, where they leave

from, vehicle utilization, vehicle occupancy, etc. There are also many indicators of system performance, including travel time, speed, delay, congestion, queue length. Perhaps the most important measure is evacuation clearance time – how long does it take to evacuate all who must leave. This key value is the focus of the FLEET model used in the evacuation scenarios completed Colorado Springs.

Although traffic modeling is an enormously power tool in the planning and analysis of evacuations, it – like all modeling and simulation – has limitations. Most notably, it is a computational process build upon decades of research and observation of traffic process and makes assumptions of human behavior. No model can capture and reflect every one of a wildfire evacuation's near infinite number of conditions, threat-response processes, and traffic situations. Evacuation models should be used as decision-support tools in which a range of scenarios are tested and evaluated and compared to past experiences and professional judgement. No outcome of a traffic simulation should be viewed as a forecast or prediction of what will happen in the next wildfire. Rather, a range of conditions need to be evaluate in which traffic, behavioral, and environmental factors are considered.

Wildfire Evacuation Planning Trends

Dire wildfire evacuation scenarios are increasing in frequency and severity. This is attributed to many factors but most notably extreme drought and wind events, fire suppression, and exurban development.

Dire scenarios usually begin with an extreme wildfire but other factors can exacerbate the direness of the scenario. Most notably, these include official decision making, warning systems, community development patterns, and transportation (egress) systems. While the public is acutely aware of the increase in the size and frequency of large wildfires, fewer people are aware of the increasing direness of many wildfire evacuation scenarios and associated causes.

In the simplest terms, **the direness of an evacuation scenario can be defined as the difference between the time available to evacuate an at-risk population and the time required to carry out the evacuation**. If there is ample time to evacuate a defined population relative to what's required, then the scenario would not be considered dire and the chances are good that it would go smoothly. If there is less time than required, then the scenario can be considered dire and these are the high-profile evacuation scenarios that tend to result in the greatest casualties.

There are a number of actions that can be taken to reduce the likelihood of dire wildfire evacuation scenarios in the future, and as wildfires grow larger and faster, these actions are expected to become increasingly critical in ensuring public safety in the wildland-urban interface.

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The FLEET Emergency Evacuation Simulation

Evacuation Clearance Times for Colorado Springs were estimated using the **Fast Local Emergency Evacuations Times (FLEET)** simulation.

FLEET is a revision of the widely used Real-time evacuation Planning Model (RtePM). RtePM was created with funding from the Department of Homeland Security. Development began at Johns Hopkins University Applied Physics Laboratory (JHU APL) to fill a gap in traffic and evacuation models. Most models required extensive setup of road networks, origin-destination matrices, and other inputs and required extensive expertise and effort. RtePM simplified the process such that emergency managers could draw an evacuation area on a map, and then calculate a resulting clearance time. RtePM development continued at Old Dominion University. The accuracy of RtePM was independently validated by a commercial contractor and by MIT Lincoln Laboratories.

FLEET provides **significantly improved precision** in identification of evacuation zones and considers smaller roadways than practical with RtePM while employing the same RtePM source code. Though only made available in August 2021, FLEET has been accessed by users in 20 states and the District of Columbia. **FLEET** is free and can be accessed at: https://fleet.vmasc.odu.edu/.

Colorado Springs Wildfire Evacuation Clearance Times

Colorado Springs suffered a major disaster in 2012 when on June 23 brush began burning west of Waldo Canyon. On June 26, the fire exploded in size, driven towards Colorado Springs by 65 mph winds. By June 27, over a 12-hour period, 2 people had died, 346 buildings burned to the ground, and 35,000 citizens evacuated. After Action Reports suggested evacuations prior to June 26 a recently completed evacuation plan and supporting modeling were key to saving lives.

No full evacuation plan has been completed since the Waldo Canyon fire. Many residents have expressed concern about their ability to safely flee a wildfire. At the request of Westside Watch: A Wildland Urban Interface Association and The Maverick Observer, the need for a regional wildfire evacuation study was assessed by estimating Evacuation Clearance Times for two areas in western Colorado Springs. The first area matched the City's **Fire District One**; the second (called the **Broadmoor Region**) included an area bordered by Bear Creek Park to the north, Cheyenne Mountain Zoo and Cheyenne Mountain Highway to the south, mountains to the west, and Nevada AVE (CO 115) to the east.

Establishing a reasonable number of evacuees in each vehicle (people per vehicle or ppv) is critical. FLEET models vehicles, not individuals. **Colorado Springs simulations assume 1.5 ppv**. In Colorado Springs, nearly 37% of households (HH) consist of a single adult and average 1.3 people per HH; other households average approximately 3.2 ppHH. Simulations assumed each smaller household evacuates with one vehicle (1.3 ppv) and larger households use 2 vehicles (1.6 ppv).

Each of the two areas was modeled using more than 80 scenario variations. District One scenarios included potential use of contraflow. Broadmoor Region models included additional evacuees at the Broadmoor Resort, Cheyenne Mountain Zoo, and Seven

Falls Park. Even with the extremely optimistic assumption that no incidents impact evacuation traffic, **the best realistic evacuation time for District One is over four hours -- even without tourists.** With 14,000 people at the Broadmoor Resort**, the best realistic evacuation time for the Broadmoor Region is over five hours**.

The population of Colorado Springs has increased approximately 15% since 2012. Based on these times and comparisons to the 2012 evacuation, **a full evacuation study is strongly recommended.**