

Yucca Mountain Transportation Implications for California

Bob Halstead

Nevada Agency for Nuclear Projects

Fred Dilger, PhD

Black Mountain Research

Presentation to

California Energy Commission

IEPR Committee Workshop on

Nuclear Power Issues

Sacramento, California

June 25, 2007

Yucca Mountain Transportation Implications for California

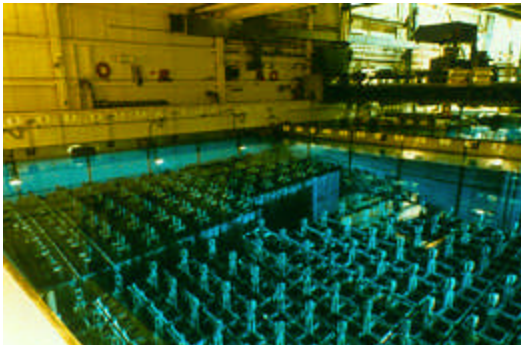
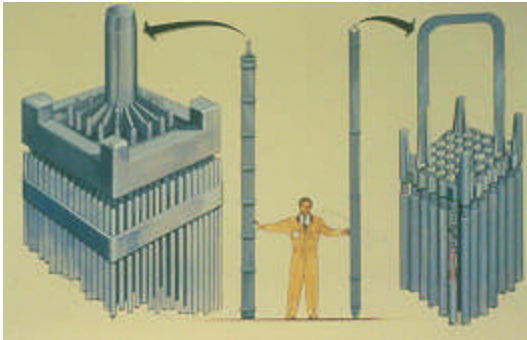
- California Cities Along Routes to Yucca Mountain
- SNF Transportation Safety and Security Issues
- NAS Report and Full-Scale Cask Testing
- Yucca Mountain Shipments Compared to Past Shipments
- Potential Shipments from California Reactors
- Potential Rail Shipments through California
- Potential Truck Shipments through California
- Heavily Impacted Areas Along California Routes
- Opportunities for Comment

Additional information: www.state.nv.us/nucwaste/trans.htm

California Cities along “Mostly Rail” Routes to Yucca Mountain



Spent Nuclear Fuel Remains Extremely Dangerous for Decades

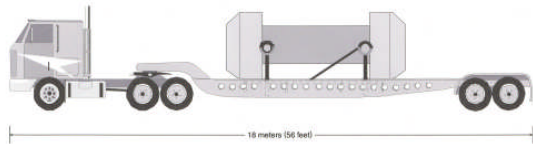


Cooling Time & Radiological Characteristics

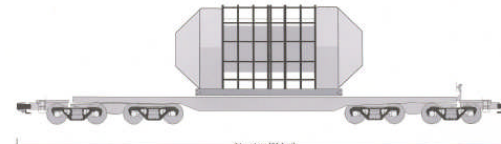
SNF Age (Years)	Activity (Curies)	Surface Dose Rate (Rem/Hr)	Lethal Exposure (Time)
1	2,500,000	234,000	10 sec.
5	600,000	46,800	1 min.
10	400,000	23,400	2 min.
50	100,000	8,640	4 min.

Source: DOE/NE-007, 1980

Casks Are Vulnerable to Sabotage, And May Be Vulnerable to Very Severe Fires



GA-4/9 Truck Cask Design



Generic Large Rail Cask Design



Tow Missile Warhead Test, 1998



Baltimore Rail Tunnel Fire, 2001

Spent Nuclear Fuel Transportation Safety & Security Issues

- Direct SNF exposure deadly for 50+ years
- Each cask contains enormous amount of dangerous fission products (especially Cesium-137, half-life 30 years, 136,00 to 810,000 curies per cask)
- Shipping casks not tested full-scale
- Cask breach in worst-case accident: 5-4,000+ latent cancer fatalities (LCFs) and \$300,000-\$10 billion+ cleanup costs
- Cask breach in successful terrorist attack: 4-1,800+ LCFs and \$10 billion+ cleanup costs
- Routine gamma radiation from casks hazardous to workers and to some members of public
- Lesson from Exxon Valdez accident – Disaster can occur after 8,000 safe shipments

Documentation available at www.state.nv.us/nucwaste/trans.htm

Nevada Agrees with Safety & Security Findings of NAS Transportation Study

- No fundamental barriers to safe transportation, but social and institutional challenges to repository transportation require expeditious resolution, and the challenges of sustained implementation should not be underestimated
- Malevolent acts (terrorism, sabotage, and theft) are a major technical and societal concern
 - Independent examination of security should be carried out before the commencement of repository shipments
 - Objective information about security risks and countermeasures should be shared with elected officials and the public to the fullest extent possible

NAS, Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States (2006)

Nevada Agrees with Risk & Impact Findings of NAS Transportation Study

- Risks can be reduced by shipping the oldest fuel first, maximizing use of rail transportation, using dedicated trains, and minimizing truck shipments
- DOE should identify and make public preferred highway and rail routes for repository shipments as soon as possible
- Most significant transportation accident risks would likely involve long-duration, fully-engulfing fires; additional steps must be taken to reduce the likelihood of such accidents.
- Full-scale testing should be used to determine how packages perform, but testing to destruction should not be required
- For many members of the public, social and economic impacts (often referred to as perceived risk impacts) are as important as health and safety impacts.

NRC Regulations Establish Cask Accident Performance Standards



30 foot drop **onto** essentially unyielding surface



40 inch drop onto 6 inch steel spike



30-minute fire @ 1475°F

8-hour submersion of undamaged cask under 50 feet of water

Source: Sandia National Laboratories

Nevada Cask Testing Recommendations

Revised in Response to NAS Study

- **Meaningful stakeholder role** in development of testing protocols & selection of test facilities and personnel
- **Full-scale regulatory testing** (sequential drop, puncture, fire, and immersion), of each cask design to be used for repository shipments, required either for NRC certification, or for DOE procurement (Est. cost \$50-70 million total for 5-7 casks)
- **Extra-regulatory fire test** of LWT or Rail cask - engulfing fire, 3 hours @ 1475°F-1800°F (800°C-1000°C), followed by cool-down (Est. cost \$4-7 million)
- Determine cask and fuel failure thresholds by computer simulations and component testing (not full-scale casks)
- No need at this time to evaluate costs and benefits of destructive testing of a randomly-selected production model cask (originally recommended by NV)

Estimated Shipments of SNF & HLW to Yucca Mountain

24 Years (70,000 MTU limitation retained)

Mostly Rail: 10,725 Cask-Shipments

- about 2 or 3 trains, per week, and 1 truck cask per week

Mostly Truck: 53,086 Cask-Shipments

- about 6 trucks per day

38 Years (70,000 MTU limitation lifted)

Mostly Rail: 22,057 Cask-Shipments

- about 3 trains per week, and 2 truck casks per week

Mostly Truck: 108,899 Cask-Shipments

- about 8 trucks per day

Source: DOE-EIS-0250, Appendix J

Yucca Mountain Shipments Compared to Past Shipments

- 43 Times More SNF Shipped Per Year
- 8 to 38 Times More Casks Shipped Per Year
- 5 to 40 Times More Shipments Per Year
- 443% Increase In Average Rail Shipment Distance
- 280% Increase In Average Truck Shipment Distance
- Western Route Characteristics and Operating Conditions
- Potential Unprecedented Reliance on Heavy Haul Truck and Barge Shipments

Source: Halstead & Dilger, "How Many Did You Say? Historical and Projected Spent Nuclear Fuel Shipments in the United States, 1964-2048," Waste Management'03 Conference, February 25, 2003, Tucson, AZ

California Nuclear Power Plants



Humboldt Bay



Diablo Canyon



Rancho Seco



San Onofre

Estimated California Rail Shipments to Yucca Mountain

	24 Years (Casks)	38 Years (Casks)
Diablo Canyon	121	308
Humboldt Bay	6	6
Rancho Seco	21	21
San Onofre	138	277
	286	612

Estimated California Truck Shipments to Yucca Mountain

	24 Years (Casks)	38 Years (Casks)
Diablo Canyon	729	2,101
Humboldt Bay	44	44
Rancho Seco	124	124
San Onofre	853	1,698
	1,750	3,967

Yucca Mountain Transportation System Issues

- **Yucca Mountain lacks rail access**
- **Proposed Caliente rail line would be longest (320 miles) new rail construction in US since 1930s, cost more than \$2 billion**
- **At least 24 of 72 shipping sites lack direct rail access**
- **No DOE comprehensive plan for national transportation to Yucca Mountain**
- **DOE has proposed “suite of routes” approach to route selection, which would utilize two or more rail and highway routes from each shipping site**
- **Proposed DOE TAD canister system would require rail access or barges and heavy haul trucks**
- **Legal-weight trucks used for at least 10% of SNF**

24 Reactor Sites Lack Rail Access

DOE Considering Barge Shipments at 17 Sites



California

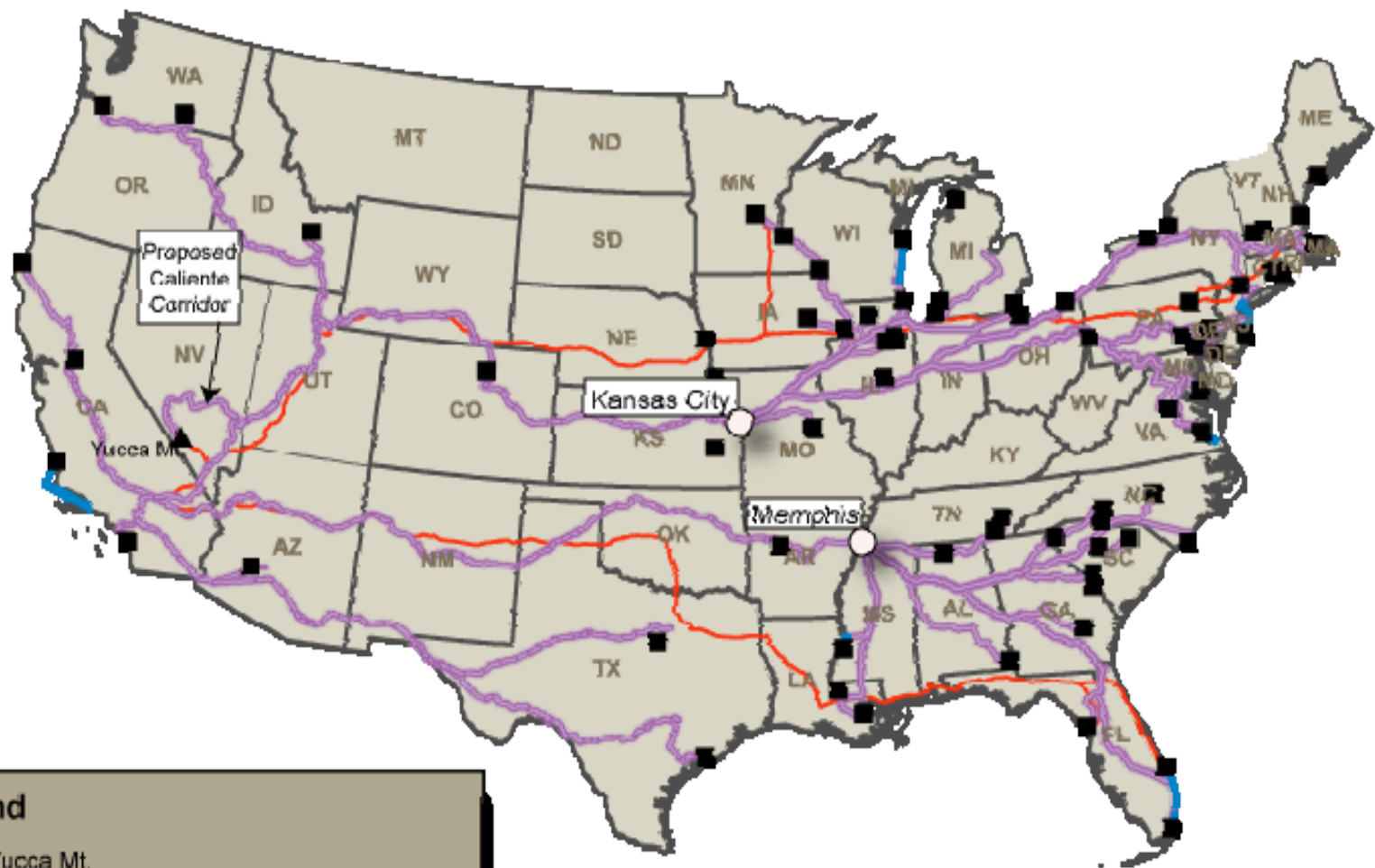
Pacific
Ocean

★
Diablo
Canyon

●
Oxnard,
Port of
Hueneme



Dedicated Rail Routes to Yucca Mt via Rail Gateways to the Proposed Caliente Spur



Legend

- ▲ Yucca Mt.
- Shipping Sites
- Dedicated Rail to Caliente (Gateways)
- FEIS barge routes
- Truck Routes from Sites without Rail Access

This map depicts routes from the nuclear waste shipping sites to the proposed Yucca Mt. repository via the proposed Caliente spur. It shows routes on Class I track from the shipping sites to the Union Pacific Gateways of Kansas City and Memphis. The map also depicts the truck routes from reactor sites that cannot handle rail shipments and the barge routes identified in the Final Env. Impact Statement.

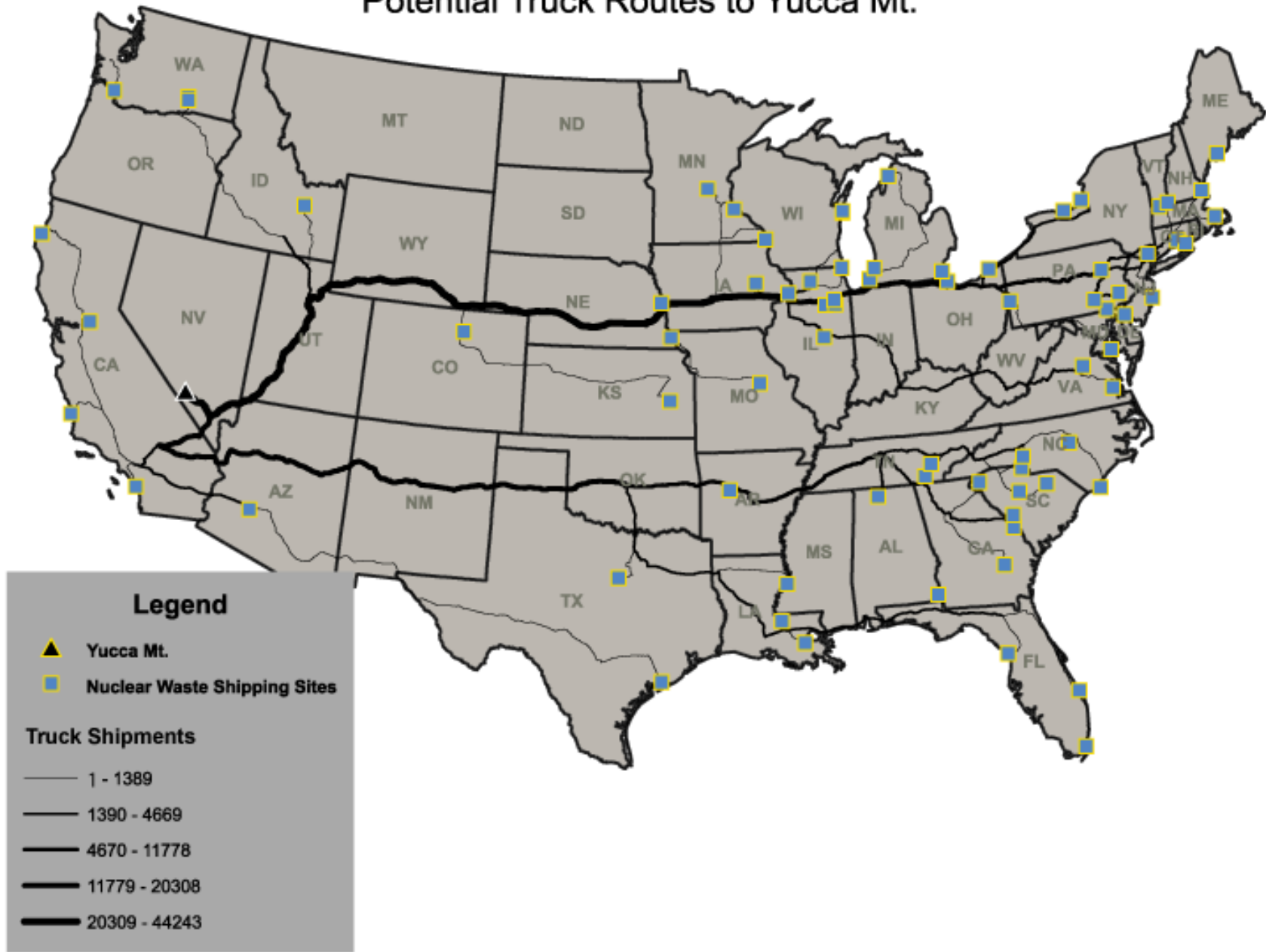
Mostly Rail, 24 Years Shipments Through California

- **Minimum: 660 rail casks (6%)**
About 28 Casks, in 7-10 Trains, plus 20 truck shipments, per Year (DOE, 2002)
- **Maximum: 8,528 rail casks (88%)**
About 355 Casks, in 110-120 Trains, plus 44 truck shipments, per Year (PIC, 1996)
- **Current Estimate: 4,384 rail casks (45%)**
About 182 Casks, in 60-70 Trains, plus 20 truck shipments, per Year (NANP Suite of Routes Analysis, 2007)

Mostly Rail, 38 Years Shipments Through California

- **Minimum: 1,207 rail casks (5%)**
About 32 Casks, in 10 Trains, plus 31 truck shipments, per Year (DOE, 2002)
- **Maximum: 14,924 rail casks (78%)**
About 392 Casks, in 130 Trains, plus 82 truck shipments, per Year (PIC, 1996)
- **Current Estimate: 7,450 rail casks (39%)**
About 196 Casks, in 65 Trains, plus 31 truck shipments, per Year (NANP Suite of Routes Analysis, 2007)

Potential Truck Routes to Yucca Mt.



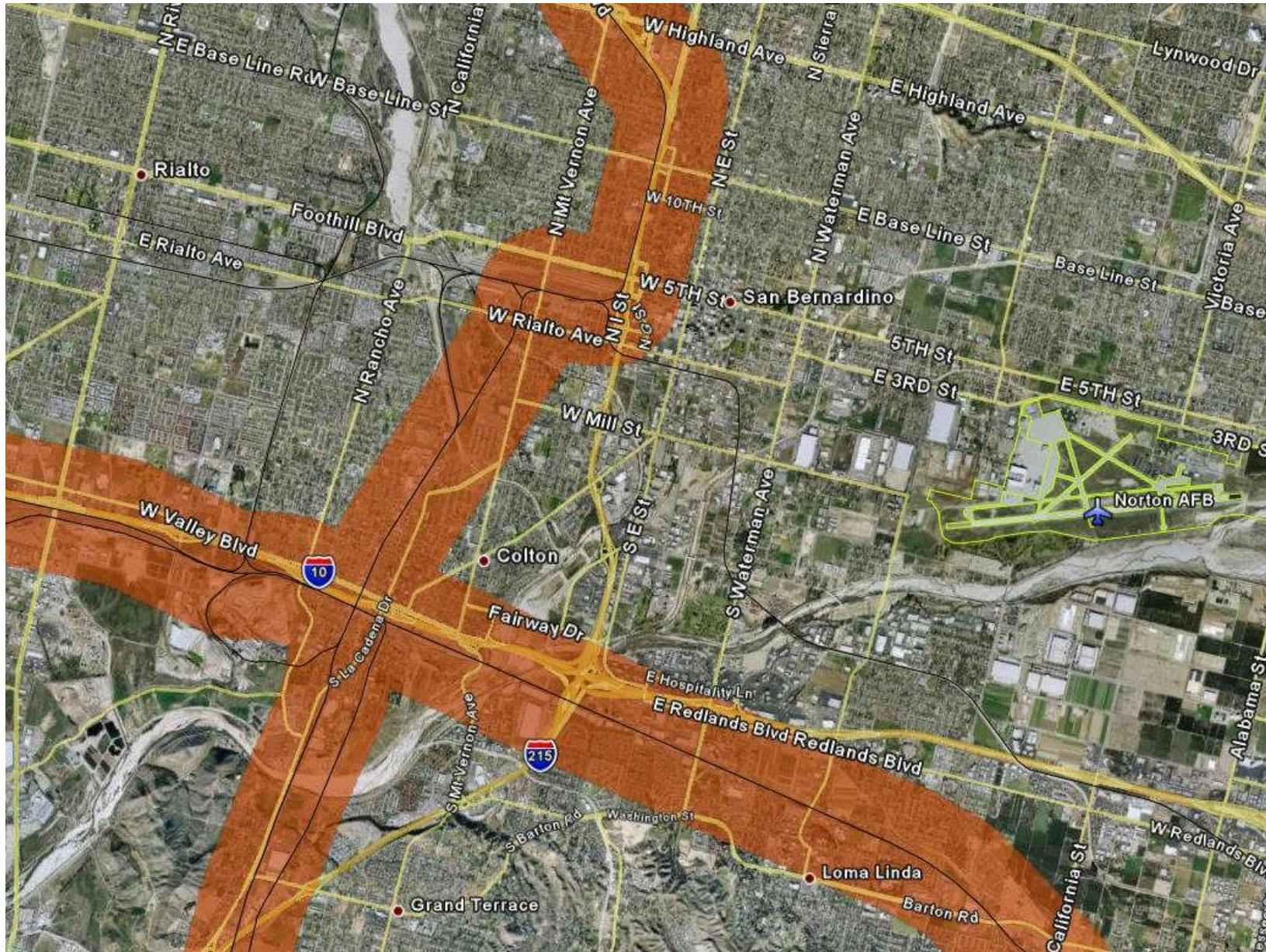
Mostly Truck, 24 Years Shipments Through California

- **Minimum: 6,867 trucks (13%)**
About 290 Casks per Year, 6 casks per week
(DOE, 2002)
- **Maximum: 48,062 trucks (90%)**
About 2,000 Casks per Year, 38 casks per week
(PIC, 1996)
- **Current Estimate: 23,764 trucks (45%)**
About 990 Casks per Year, 19 casks per week
(NANP Suite of Routes Analysis, 2007)

Mostly Truck, 38 Years Shipments Through California

- **Minimum: 14,179 trucks (13%)**
About 370 Casks per Year, 7 casks per week
(DOE, 2002)
- **Maximum: 89,554 trucks (82%)**
About 2,350 Casks per Year, 45 casks per week
(PIC, 1996)
- **Current Estimate: 44,158 casks (40%)**
About 1,160 Casks per Year, 22 casks per week
(NANP Suite of Routes Analysis, 2007)

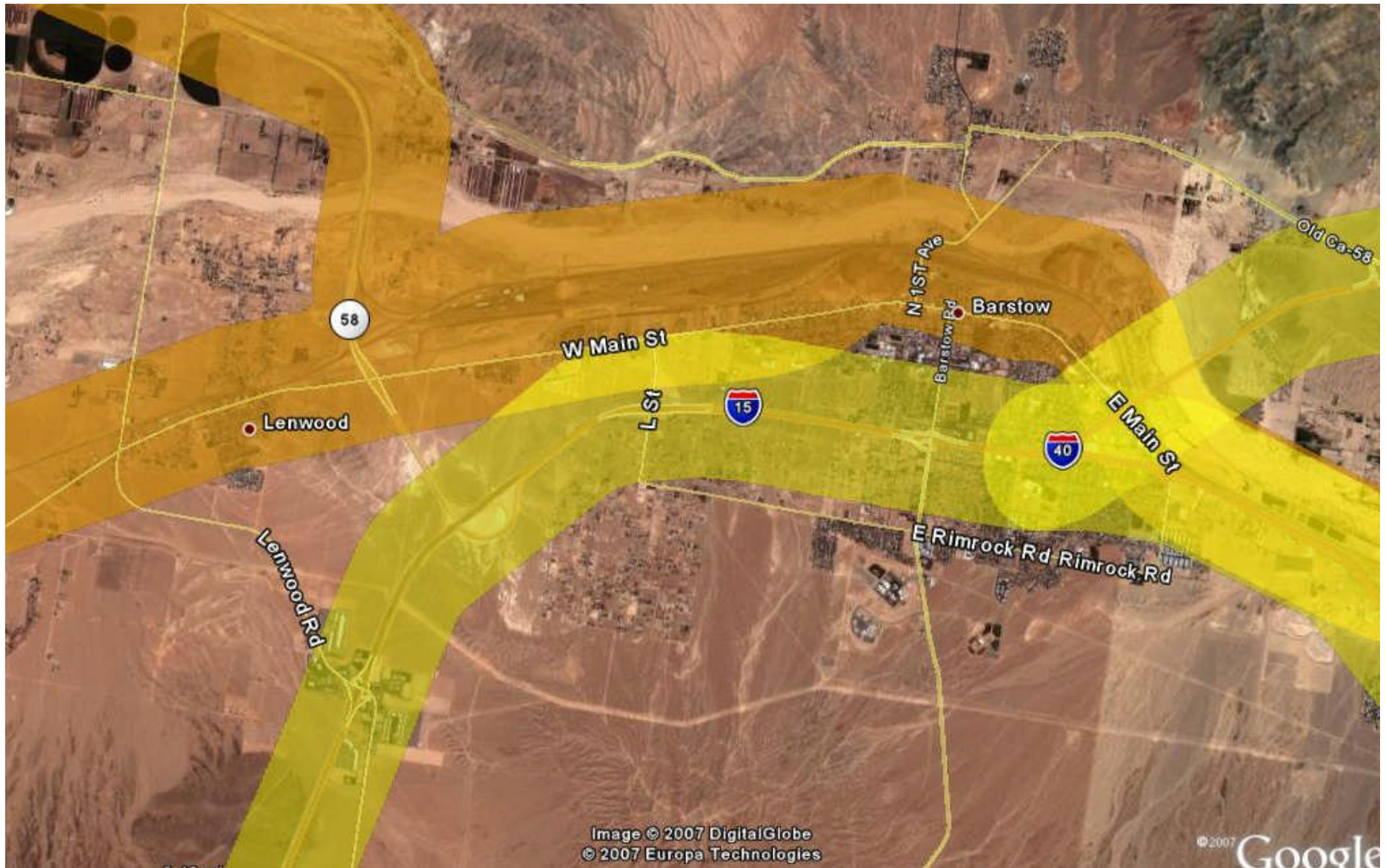
Heavily Impacted Area – San Bernardino



Heavily Impacted Area – El Cajon Pass



Heavily Impacted Area – Barstow



Opportunities to Comment Yucca Mountain Transportation

- **Summer, 2007 – DOE Draft National Transportation Plan**
- **October, 2007 – DOE Draft Supplement to YM EIS (TAD canister System)**
- **October, 2007 – DOE Draft Rail Alignment EIS**
- **June, 2008 – DOE Repository License Application to U.S. Nuclear Regulatory Commission**