Railroading Nevada

Transportation has turned out to be the Achilles' heel of the US nuclear waste programme on the national level. And the Achilles' heel in Nevada is the absence of a rail line to Yucca Mountain. ***By Fred Dilger and Robert Halstead***

The Nuclear Waste Policy Act (NWPA) of 1982 made the US Department of Energy (DoE) responsible for disposing of all high-level nuclear waste (HLW) from US civilian nuclear power plants and nuclear weapons facilities. The federal law directed the DoE to build two geologic repositories. The DoE evaluated five sites in western states for the first repository, and identified 20 sites in eastern states for a second repository. In 1987, Congress amended the law, deferring the second repository, and designated Yucca Mountain, Nevada as the sole candidate site for the first repository.

Most Nevadans viewed the 1987 legislation as the 'Screw Nevada' bill and Nevada political leaders vowed to stop the project. A bitter war of legislation, litigation, and public relations campaigns ensued. Meanwhile, the DoE struggled to develop a repository design and licence application for the volcanic tuff formation at Yucca Mountain, located 100 miles northwest of Las Vegas. Today, the proposed repository is more than 10 years behind schedule, tens of billions of dollars over budget, and more controversial than ever.

For most of the past two decades, the transportation impact debate focused on radiological hazards. Risk analyses were more generic than route specific, because no final routing decisions had been made. The Yucca Mountain transportation debate now enters a new phase. The previously identified radiological concerns are now linked to specific routes, and questions about the feasibility of the proposed Caliente rail project raise new challenges to the overall credibility of the DoE. It is no exaggeration to say that the success or failure of Yucca Mountain now hinges on the Caliente rail proposal.

TRANSPORT TO YUCCA

Back in 1986, in its Transportation Institutional Plan, the DoE recognised: "The success of its program to develop and implement a national system for nuclear waste management and disposal ... depends not only on safety, but on broad-based public understanding of and confidence in program activities and objectives. While each program element has its particular sensitivity, the transportation of the waste... may be the most visible element nationwide."

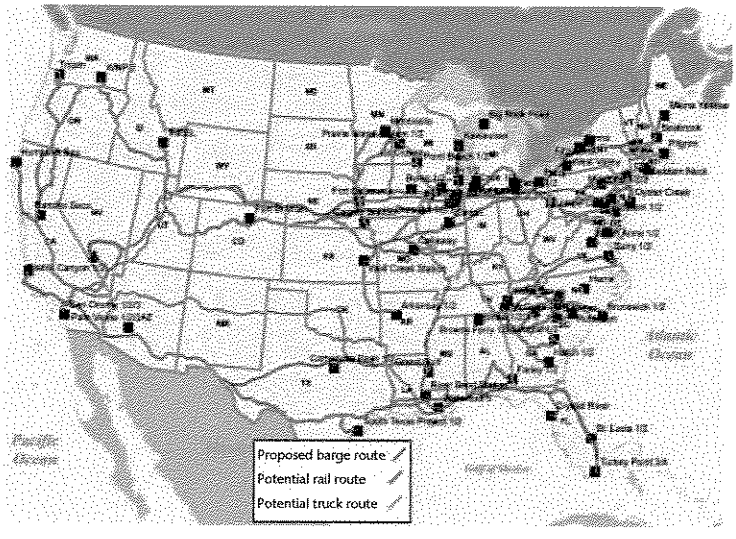
Also in 1986, DoE assessments of the first five repository sites ranked Yucca Mountain worst on feasibility of transportation access, and worst on transportation costs and impacts.

In 2002, the DoE identified 72 nuclear power reactor sites and five DoE nuclear facilities that would ship spent nuclear fuel (SNF) and HLW to Yucca Mountain. These facilities are located in 33 states, mostly east of the Mississippi river. The average shipping distance to Yucca Mountain would be more than 2000 miles. The representative routes identified by the DoE would traverse up to 45 states, 50 Indian nations, and 700 counties. Between 8 million and 11 million Americans reside within one-half mile of a potential shipment route. Between 100 million and 120 million Americans reside in the counties traversed by those routes.

Under the current federal law, the DoE would ship 70,000t uranium to Yucca Mountain. Over the first 24 years of operation, this would result in about 53,000 cask shipments by truck, or 10,700 cask shipments by rail and truck. If the DoE shipped all the projected US HLW (about 120,000tU) to Yucca Mountain, the result would be about 109,000 cask shipments by truck, or 22,100 cask shipments by rail and truck. Since Yucca Mountain lacks rail access, the only shipment mode currently feasible is truck, which would require six to eight cross country shipments per day, every day, for decades.

In 2002, the DoE identified five alternative rail corridors to Yucca Mountain. By 2004, rapid population growth in Las Vegas spilled over two potential rail corridors, making it too expensive to acquire right of way for the shortest routes. Opposition from the US Air Force eliminated a third corridor. The remaining two options considered by the DoE, Caliente and Carlin, were each more than 300 miles (480km) long. Selection of either would require construction of the longest new rail line in the USA in 80 years.

In April 2004, the DoE issued a



Potential rail, barge and truck routes to Yucca Mountain

record of decision and a notice of intent to construct a rail line along the Caliente corridor, connecting the Union Pacific mainline with Yucca Mountain. The proposed 319 mile-long rail line through rural Nevada traverses some of the most difficult terrain in the country and presents significant engineering challenges. Natural hazards (such as earthquakes, flash floods and wildfires) could occur along both the existing mainline to Caliente and the proposed new route to Yucca Mountain. The Caliente route would disturb less privately-owned land than the Carlin route, the deciding factor in the decision, according to the DoE. It did not hurt, that the repository project's only friends in Nevada are in the city of Caliente, Nevada where the rail spur would originate. The DoE is preparing a draft environmental impact statement, optimistically scheduled for publication by spring 2006.

Yet even if Caliente goes forward, the Yucca Mountain transportation campaign will be unlike anything attempted in the past. Between 1964 and 2001, there were about 2900 cask shipments of spent fuel in the USA. About 2500tU of SNF was shipped, and shipments traveled about 1.9 million shipment-miles.

By comparison, the Yucca Mountain shipping campaign will require:

- 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.
- Potential unprecedented reliance on barge shipments.

The DoE also plans to move waste year round. In past campaigns waste was moved in very tightly scripted spatially confined areas. This new campaign will span a continent and last for over a generation.

For most of the past two decades, the transportation impact debate in the USA has focused on radiological hazards. Risk analyses were more generic than route-specific, because no final routing decisions had been made. The state of Nevada has published extensive documentation regarding these radiological risks, which are summarised here.

MODE OF TRANSPORT

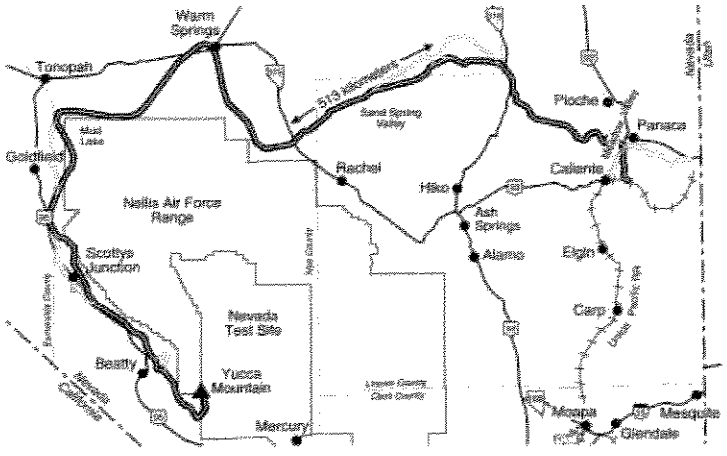
Modal choice is one key issue that deserves special mention. Shipping waste by truck or rail will have profound effects on the viability of the entire disposal programme. In April 2004, the DoE expressed a preference for the use of rail transportation. Primary reliance on rail reduces the numbers of cask shipments from 53,000 to 10,700. However, the DoE has also stated that an all-truck shipping programme may be necessary for the first six years of operation. The DoE's March 2004 supplement analysis evaluated the use of a container on flat car (COFC) approach. That is, a truck cask would be loaded onto a flat car and shipped by rail to an intermodal facility, and then picked up and transported by truck to the repository. The need to consider this mode is prompted by the uncertain availability of rail access to Yucca Mountain, and by the DoE's commitment to accept SNF under current contracts with nuclear utilities. In this event, the DoE might have to ask Congress for funds to build two shipping campaigns that would ultimately prove too expensive. The result could be an all-truck shipping programme.

On the other hand, while rail transport is preferable, it is not straightforward. The physical orientation of rail lines in the USA ensures that most of the waste shipped to Yucca Mountain will traverse dense urban areas. Additionally, rail routes will offer less flexibility than truck routes.

Rail access to Yucca Mountain

Although the Caliente route was the second longest (319 miles) and most expensive of the five rail access options identified by the DoE , it was chosen as the preferred route.

As an engineering endeavour, the railroad itself would be remarkable. Caliente would be considerably longer than the 113-mile (182km) Orin Line constructed by the Burlington Northern to access the Wyoming Powder River Basin coal fields in the 1970s. The Orin Line was the longest new track construction effort in the USA since the 1930s. By way of further comparison, the Caliente route would be longer than the distance from Washington to New York (204 miles, 328km); St Louis to Chicago (259 miles, 417km); or London to Paris (343 miles). The DoE estimates that it will take ten hours to for a train to travel one way to Yucca Mountain.

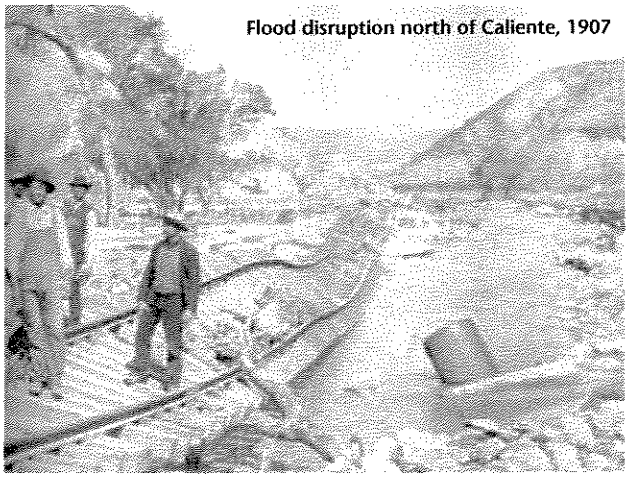


Proposed Caliente rail spur

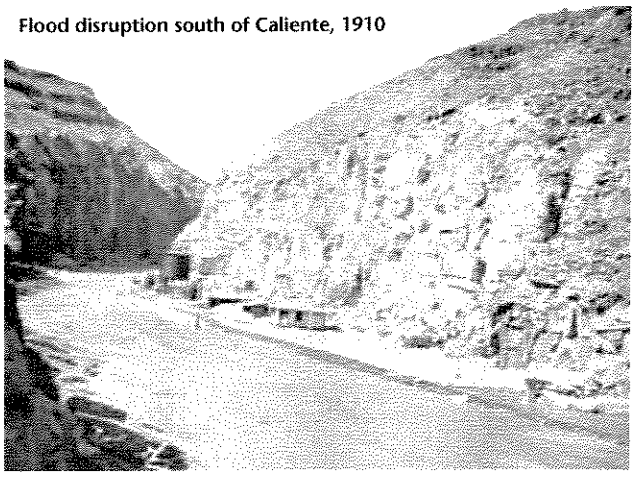
The Caliente spur will have to cross ten named mountain ranges. The rugged terrain along the route will require many long grades of 1.5-2.0%, numerous difficult curves, and more than a dozen major bridges, including some 600 feet (180m) or more in length. The current DoE estimate is that the rail line will cost $880 million dollars to construct and operate, and require 46 months to construct. The state of Nevada estimates that construction costs alone could range from $1.0 to 1.5 billion, and the project could require up to ten years for land acquisition, environmental approvals, and construction.

CONNECTING RAIL LINE

It would be hard to pick a more difficult connecting route to Yucca Mountain than the Union Pacific mainline through Caliente. A 1991 infrastructure assessment described the route: "The 118-mile (190km) study corridor traverses very rugged terrain. The route is confined within the canyon walls of Clover Creek and Meadow Valley Wash. The route exhibits a high degree of curvature as it descends 4300 ft (1310m) from the high plateau at the Utah border to the desert floor beyond the southern end of the study area." The steep grades and tight curves require speed restrictions for westbound trains on the downgrade from the Utah border to Caliente. The study identified 15 tunnels, 107 bridges,



Flood disruption north of Caliente, 1907



Flood disruption south of Caliente, 1910

66 culverts, and numerous falling rock and flood hazard areas, along the route.

Disruptions due to track and bridge washouts began soon after the route opened, and continue to the present time. The current Union Pacific mainline was among the last of the major pieces of the US transcontinental railway completed. It was not finished until 1905. Its construction came about largely as the result of a feud between rival New York and California rail barons. The rugged terrain also took its toll. After construction, nature weighed in, washing away the mainline three times in the next five years.

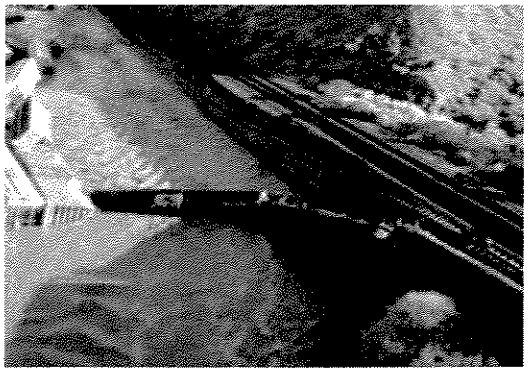
Despite repeated attempts to control the flooding nothing has succeeded. The Union Pacific mainline has been steadily upgraded, relocated and protected – largely to no avail. In January 2005, 100 years after its opening, the rail line was washed out again.

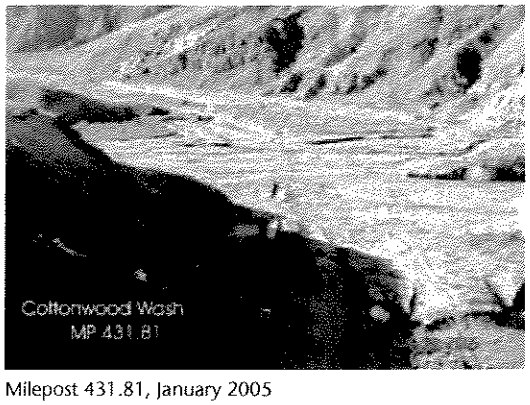
For over two months after the line was reopened, trains travelled with speed restrictions due to the poor track condition.

Some of the specific consequences of the 2005 flood were foretold in a 1991 report commissioned by the State of Nevada, which found:

- "At MP 431.82...The bridge appears to have been designed to allow passage of the 25-year storm. However there is a 30% chance that a 100-year storm (probability of 0.01) will occur in any 35 years, and a 51% chance that a 50-year storm will occur during the same period."
- "From the analysis of the 100-year flow through the wash between the bridge at MP 431.82 versus the capacity of the channel provided, it was found that there is a significant danger of track becoming flooded or possibly the bridge washing out."

Flood disruption on the Union Pacific mainline, January 2005





Milepost 431.81, January 2005

ASSESSING HAZARDS

So far, the DoE has failed to conduct an all-hazards assessment of the proposed Caliente rail line to Yucca Mountain. Such an assessment should have evaluated both the existing Union Pacific mainline to Caliente and the proposed new spur to Yucca Mountain. Had the DoE conducted such an assessment, it is difficult to conceive of the DoE selecting this route as its preferred route to Yucca Mountain.

Based on publicly available data, it is possible to gain a good understanding of where hazards occur that may disrupt the rail line. The best way to integrate the results of the analysis is in a geographic information system (GIS). This permits the type of analysis originally envisioned for GIS and was based on the work of Ian McHarg. The resulting information permits sophisticated visualisation and analysis.

For example, it is possible to determine where along the rail line there are areas with severe slopes. The locations where avalanche warning systems must be installed can be pinpointed fairly easily.

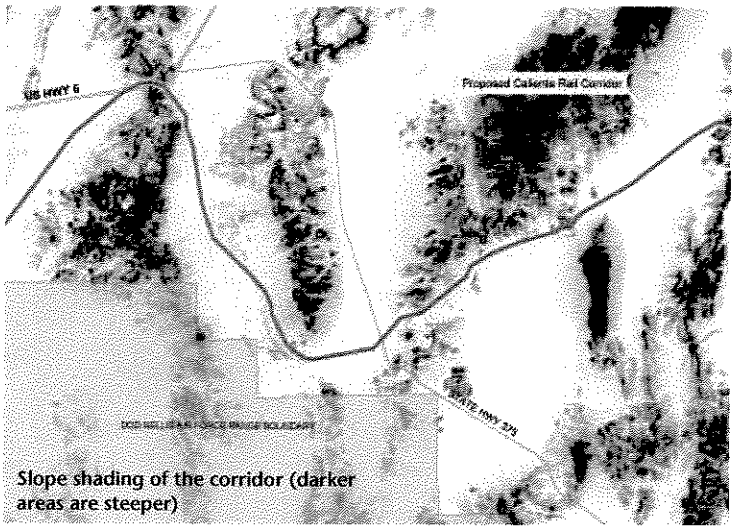
A grid overlay that shows the exact locations of these high slope areas reveals precisely where areas of greater slope occur. A different way to visualise the slope is to use 3D views. Using simple techniques, it is possible to immediately understand where problems are likely to occur.

A variety of other hazards can be examined in detail using sophisticated analytical tools, but the combination of the hazards data can yield new insights, sometimes with astonishing precision. In other cases, local knowledge of residents and field survey reveals the precise extent of the difficulty of constructing the rail line.

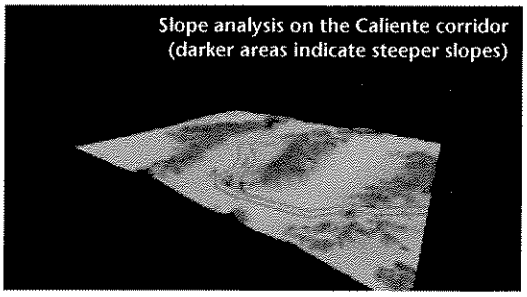
NEVADA'S RESPONSE

The state of Nevada has already filed a lawsuit to stop the DoE from designating the Caliente corridor as the preferred rail route to Yucca Mountain. If the DoE survives this challenge, additional lawsuits by the state and other stakeholders are likely at the next three stages: withdrawal of public lands, environmental approval of the proposed route, and acquisition of right-of-ways. Nevada is taking aim at each of those stages.

In September 2004, the Nevada Attorney General filed suit in the US



Slope shading of the corridor (darker areas are steeper)

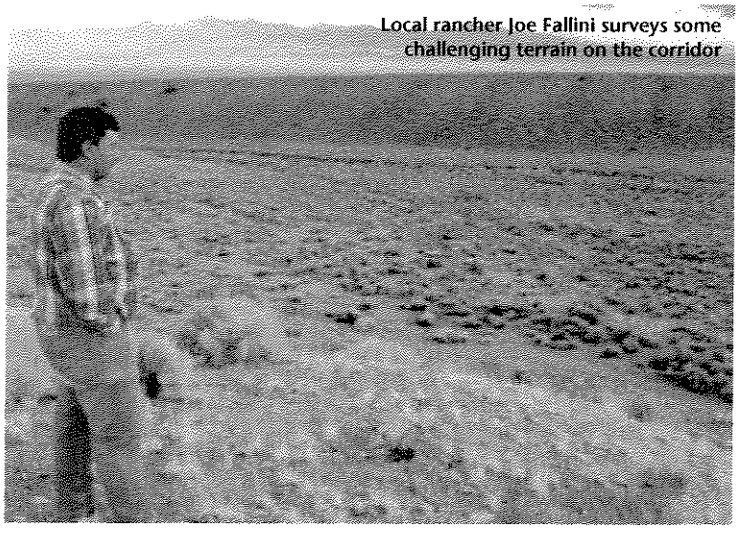

Slope analysis on the Caliente corridor (darker areas indicate steeper slopes)

Court of Appeals for the District of Columbia Circuit challenging DoE's selection of the Caliente route. Nevada charged that the DoE improperly assumed lead agency status for preparation of rail corridor environmental impact statement (EIS); failed to prepare a supplemental EIS on LWT (legal weight truck)/rail intermodal transportation; and failed to analyse expected impacts on specific parcels and current users of land, or specific land use conflicts or necessary land exchanges. According to Nevada, the DoE selected Caliente, without consulting residents and businesses along the corridor, based on the assumed absence of land use conflicts. Nevada noted in its lawsuit that the DoE admitted that Caliente was not "clearly environmentally preferable" and was the most costly alternative.

The state of Nevada filed its opening brief in March 2005 (*State of Nevada v Department of Energy and Samuel Bodman, Secretary, United States Department of Energy, On Petition for Review of a Decision of the United States Department of Energy, Case 04-1039*). The DoE filed its initial brief in May 2005, and Nevada filed its reply brief in June 2005. The US Court of Appeals for District of Columbia Circuit has scheduled oral argument for mid October 2005. A decision is not expected before early 2006.

In its current lawsuit, and in its preparations for the next round of environmental approvals and right-of-way actions, the state of Nevada has emphasised the physical impacts of the railroad, in addition to radiological risks. To the ranchers, miners, and other users of land along the Caliente corridor, the DoE is not simply proposing to build a railroad, but a 319 mile-long, crushed stone wall, with a railroad on top of it.

The wall would consist of the ballast and sub-ballast under the ties and rails, varying in height from 1-8 feet (0.3-2.4m), and 10-30 feet (3-9m) in thickness. Some portion of the railroad right-of-way may also be fenced. Despite construction of overpasses, underpasses, and at-grade crossings, the proposed wall/railroad would be a major barrier to the movement of humans, vehicles, livestock, wild animals, and water. The proposed wall/railroad would adversely impact residents, ranchers, miners, recreational users, and other users of public and private lands. The proposed wall/railroad could adversely impact land use and land users located many miles distant from the railroad right-of-way.


Local rancher Joe Fallini surveys some challenging terrain on the corridor

NOT EASILY MOVED

Meanwhile, local rancher Joe Fallini and his neighbours are preparing their own challenges to the DoE railroad project.

The Fallini's Twin Springs Ranch is one of the largest family-operated ranches in the USA. The Fallini grazing lands in Reveille Valley cover almost 1000 square miles (2600km^2), about the size of the state of Rhode Island. Cattle graze the entire valley. Joe Fallini and his daughter Anna sometimes herd them by airplane and helicopter. The terrain is rugged. At Cow Canyon, the DoE would need to build a bridge 700 feet (210m) long and 50 feet (15m) high. Fallini said the DoE railroad would divide this valley lengthwise for more than 30 miles (50km), separating the water resources on the west side from calving and grazing areas on the east side. The land use conflict would be irreconcilable.

The Fallini family have faced danger before. They are 'downwinders' – people immediately affected by the fallout from the above ground nuclear tests that took place nearby in the 1950s and 1960s. Joe Fallini took pictures himself of pink and green clouds carrying nuclear fallout across their ranch. These people will not be easily moved.

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