CHAPTER THREE
IMPACTS TO THE STATE OF NEVADA

Impacts of the proposed Yucca Mountain project and related high-level nuclear waste transportation from around the country to a repository would be ubiquitous, major in scale, and long lasting. This is the conclusion reached as a result of the extensive research program undertaken by the State of Nevada since 1986 and, more recently, by affected units of local government within the State. This chapter summarizes the key findings of that socioeconomic research. More in-depth analyses are to be found in the appendices to this report. In addition, detailed descriptions of the State's impact studies and their findings can be found in the three major summary reports on the Nevada socioeconomic studies published in 1989, 1993, and 1995, respectively.[1] The NANP's study team has also published two major books dealing with the policy implications of the findings of Nevada's socioeconomic research.[2] The NANP Technical Review Committee issued two reports of its findings with respect to the studies, and a summary of the Nevada research was published in the ***Proceedings*** of the National Academy of Sciences.[3] A complete list of references is attached as Appendix I of this report.

3.1 Impacts to Nevada's Major Economic Sectors

The most serious and potentially catastrophic economic risk for Nevada stemming directly from the Yucca Mountain project involves the likelihood of damage to the southern Nevada visitor economy. Studies carried out since 1986 show that the groups and individuals essential to Nevada's economic health are highly sensitive to the radioactive risks associated with a high-level nuclear waste (HLW) repository and with transport of spent nuclear fuel (SNF) and other highly radioactive wastes. The most serious form of such risk is the potential for stigma impacts on the tourist and visitor industry.

State of Nevada research indicates that each one-percent annual decline in visitor spending due to the HLW program would cost the local economy $315 million in lost revenues. Total losses, including a multiplier of 2.5 as a conservative indirect effect on businesses providing services to residents and employees, makes each percentage point drop worth $787.5 million. Estimates of visitor loss range from 7% to 75%, depending

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[1] Ref. (1) "An Interim Report on the State of Nevada Socioeconomic Studies," (June, 1989); (2)"State of Nevada Socioeconomic Studies of Yucca Mountain 1986 - 1992: An Annotated Guide and Research Summary," (June 1993); and (3) "State of Nevada Socioeconomic Studies Biannual Report: 1993 - 1995," (June 1995).

[2] Ref. One Hundred Centuries of Solitude, by James Flynn, et al., Westview Press, Boulder, Colorado (1995); and The Dilemma of Siting a High-Level Nuclear Waste Repository, by D. Easterling and H. Kunreuther, Kluwer Academic Publishers (1995).

[3] Ref. "Interim Statement of the Technical Review Committee on the Yucca Mountain Socioeconomic Project," by G. F. White, et al. (January, 1990); "Nuclear Waste's Human Dimension," by K. Erikson, et al., in Forum for Applied Research and Public Policy, Fall, 1994; and "Socioeconomic Studies of High-Level Nuclear Waste Disposal," in Proceedings of the National Academy of Sciences, Vol. 91, pp. 10786 - 10789, November, 1994.

upon the conditions, according to DOE plans and various accident and incident scenarios (Easterling, Appendix II). Even with a perfectly operated repository system and minimal negative impacts, the annual loss to the Las Vegas and Nevada economy could exceed $5.5 billion. With adverse events or accidents, the single case cost could be $39 billion or more.

The Yucca Mountain site is approximately 90 miles northwest of Las Vegas, which serves as the media dateline for reports on repository news stories. This is close enough to tarnish the image of the city. Moreover, the current design of the repository calls for shipments of spent nuclear fuel to pass within view of the huge casino-hotel complexes along the Las Vegas Strip. Despite assurances to the contrary, it is entirely possible that these shipments could lead to a transportation accident or other "risk event" that attracts widespread media attention.

The most serious and potentially catastrophic economic risk for Nevada stemming directly from the Yucca Mountain project involves the likelihood of damage to the southern Nevada visitor economy. Even with a routinely operating repository, annual stigma-related losses to the Las Vegas and Nevada economy could exceed $5.5 billion. In the event of a nuclear waste accident, losses could exceed $39 billion.

An extensive body of empirical research indicates that if such a scenario were to occur, southern Nevada would almost inevitably suffer significant visitor losses. This research, conducted in large part by a team of nationally recognized social scientists under contract to the Nevada Agency for Nuclear Projects (NANP), demonstrated that a nuclear waste repository has a tremendous potential to trigger avoidance behavior on the part of the general public (Chalmers et al., 1993; Flynn et al., 1995; Nevada Commission on Nuclear Projects, 2000). On a general level, this research has supported the notion that nuclear risks are "socially amplified," such that even seemingly minor events have major economic, political, and social repercussions because they send signals of serious underlying risks (Kasperson et al., 1988; 1992; 1996; Pigeon, Kasperson, and Slovic, forthcoming 2002). On a more specific level, the research has shown that a repository at Yucca Mountain could cause visitors to avoid southern Nevada by either: (a) increasing the perceived risk associated with visiting the area (Easterling, 1997); (b) giving rise to noxious imagery that becomes associated with Nevada in the public's mind (Slovic et al., 1991); or (c) conferring a stigma on the area, which would lead to widespread avoidance (Edelstein, 1988; Slovic et al., 1991; Gregory, Slovic & Flynn, 1996; Easterling, 2001a).

Because the southern Nevada economy is based so heavily on tourism and conventions, stigma-induced avoidance would have major repercussions on revenues and employment. Additional economic losses would occur as a result of avoidance on the part of investors and in-migrants. Public services would be adversely impacted across the State due to the decline in tax revenues, which in Nevada are geared to the health of the visitor economy.

The Stakes -- What is at Risk?

Visitor and Tourist Spending

Nevada is unique among all the states in terms of its vulnerability to adverse visitor impacts. According to a 1994 study, almost 40 percent of the state's labor force was employed in tourism-related jobs (e.g., hotels, casinos), more than double the rate of any other state and almost 10 times the national average (Edmonston, 1994). During the year 2000, the Las Vegas metropolitan area attracted 35.8 million visitors who contributed $31.5 billion to the local economy — through gaming, hotel stays, meals, transportation, etc. (Las Vegas Convention and Visitor Authority, 2001).

The number of individuals visiting Clark County in 2000 is five times what is was in 1970, which equates to an average annual growth rate of 5.5 percent. As visitor volume has expanded, the nature of those visitors has changed markedly. No longer simply a gambling destination, southern Nevada now attracts families with children who are drawn to the "theme-park" environment of the new mega-hotels. With the construction of huge new exhibit halls, Las Vegas became the number-one convention destination during the 1990s. In 1999, the city hosted 3,847 conventions, which attracted 3.8 million delegates (Las Vegas Convention and Visitor Authority, 2001). More than anyplace else in the country, Clark County's economy depends on the willingness of out-of-state residents to visit.

State and Local Revenues

Visitor spending in Nevada generated about $3.3 billion in state government revenues in 2000, about 34% of the state total. This revenue source provided 19% ($1.3 billion) of revenues for Nevada local governments. The costs to state and local governments for services to visitors and tourists are about 10-20% of these revenues. Losses in visitor spending would create major negative impacts on funding for essential state and local government services.

Property Values

A repository at Yucca Mountain would require tens of thousands of waste shipments on Nevada highways and rail routes. These shipments would adversely impact the values of adjacent properties. The Komis case in New Mexico that was upheld by the New Mexico Supreme Court fixed the lost value of adjacent property along the Santa Fe bypass built to transport transuranic wastes to the Waste Isolation Pilot Plant (WIPP) at 4.75% of the fair market value. Expert opinion studies show that impacts in Nevada, even in the case of no accident, could be several billion dollars. Privately held property along the transportation routes in Nevada has market values in the tens of billions of dollars, and potential losses would be massive. This problem is most acute for Nevada since all the shipments would eventually go through the state to reach Yucca Mountain. It is also a

serious problem for routes across the country, especially those that would be the major collector highway and rail corridors.

New Business Investments, Retirement, and Job In-migration

Southern Nevada is one of the nation's leading destinations for new investment, retirement location, and job seekers. Nevada growth has increased during the past two decades from less than a million to more than two million, with Las Vegas repeatedly noted as the fastest growing metropolitan area in the country. The attraction of the area is essential to supporting the existing economy and diversifying for greater economic stability in the future. The attractiveness of the state and its communities would be seriously diminished by the location of a repository at Yucca Mountain and the transport of tens of thousands of HLW shipments on the state's highways and/or rail routes.

Concern over the Economic Impacts of a Repository

Business executives in Nevada have become quite vocal in arguing that a Yucca Mountain repository would cause potential visitors to avoid the state. In particular, a study that interviewed executives of the Clark County gaming industry concluded that:

> It is clear that the gaming industry believes that the transportation of high-level waste (HLW) through Clark County would bring increased risk to the primary economic base for the entire state of Nevada. ... According to virtually every gaming industry representative interviewed, the most serious risk is from the stigma that would result if there is any accident of any kind involving the shipment of HLW. . ... Gaming executives described the potential impact of a serious accident on their industry as crippling, devastating and "Chernobyl" like (UER, 2001b, p. 15).

This concern over visitor impacts led a number of industry associations to take official stands in opposition to building a repository at Yucca Mountain. In 1991, the Nevada Resort Association (NRA) passed an anti-repository resolution stating, in part:

> The establishment of a high-level nuclear waste repository is inconsistent with the positive image the state seeks to present to the world. ... [A]ny news stories about the repository and associated transportation of radioactive materials to it could cause special damage to the reputation enjoyed by Las Vegas and the success of its tourism promotion efforts (NRA, 1991).

The Las Vegas Chamber of Commerce voted January 31, 2001 to oppose the repository. According to the Chamber's resolution, "One accident involving the transportation of nuclear waste, no matter how minor, could create fears and hysteria among the general public and cause fewer tourists to travel to Southern Nevada, even if scientists determine these fears are unfounded" (Strow, 2001). The Las Vegas Convention and Visitor Authority followed suit by unanimously approving its own anti-repository resolution.

Similar concerns have been raised within almost every other state that has been named as a candidate to host a nuclear-waste facility. Beginning with the initial attempts to find HLW repository sites in eastern and western states, citizens and public officials have presented stigma-related concerns to DOE in thousands of public comments (Kraft 1992; Brody and Fleishman 1993; Desvousges, Kunreuther et al. 1993; Dunlap, Kraft et al. 1993; Dunlap, Rosa et al. 1993; Kraft and Clary 1993; Rosa and Freudenburg 1993).

Attempts to find a site for a monitored retrievable storage facility during the late 1980s and early 1990s also prompted public and official opposition based upon stigma effects. For example, when DOE proposed to build an MRS facility for nuclear waste in Oak Ridge, Tennessee, Governor Lamar Alexander cited the possibility that an MRS "would impose a negative and economically harmful image on the area" (Sigmon, 1987). In almost precisely the same vein, Utah's Governor Michael Leavitt prevented San Juan County from pursuing the opportunity to volunteer to host an MRS. "I do not believe it is in the best interests of San Juan County or Southeastern Utah to accept an MRS facility. ... The tourism and recreation industries, which are highly important to San Juan County, would suffer significantly from the stigma of being what would be characterized nationally as a 'nuclear dumping ground'" (Leavitt, 1993, p. 1). New Mexico opposed the interest of the Mescalaro Apaches in negotiating with the federal Nuclear Waste Negotiator on the basis that a MRS facility on tribal lands would harm the tourist and visitor industry in the state (Wald, 1993). Governor Mike Sullivan of Wyoming cited risks to tourism while vetoing Fremont County's interest in a MRS facility (Sullivan, 1992).

Concern over stigma has also arisen with regard to repositories for low-level radioactive wastes (LLW) as states have searched for sites to fulfill their obligations under the Low-Level Nuclear Waste Policy Act of 1980. Over 200 proposed communities have opposed the siting of LLW repositories, at least in part on economic grounds (U.S. General Accounting Office, 1999; Weingart, 2001). After more than two decades, not one LLW facility has been built under the federal program due to public opposition. This is both a demonstration of the stigma attached to radioactive wastes and the widespread belief that host communities would suffer economically and socially.

Social Science Methods And Data: Approaches To Measuring And Assessing Socioeconomic Impacts

The possibility of the risk of negative economic impacts has been consistently raised whenever a site has been named as a possible location for a radioactive waste storage or disposal facility. This risk is even more serious in the case of the Yucca Mountain site because of the size of the southern Nevada visitor economy. Still, the mere fact that local officials and business leaders are concerned over a repository does not, in and of itself, mean that such effects are inevitable. In order to substantiate the credibility of the economic risk, the Nevada Agency for Nuclear Projects has sponsored a wide-ranging research program to provide empirical answers to some of the major questions surrounding repository-induced avoidance behavior.

There are a number of valid and reliable ways to assess the socioeconomic impacts from high-level radioactive waste activities (see Nevada Comments on the Yucca Mountain DEIS, 2000, Appendix I). These impact methods employ established scientific approaches, similar in basic ways to research in the physical sciences but with specific application to human individuals, groups, communities, and organizations. These approaches incorporate studies of three overarching types:

1. Basic and Applied Research. Social science research parallels that of other sciences by including observation, experimentation, replication, and development of conceptual models and frameworks. A primary focus for understanding socioeconomic impacts is to conduct experiments in decision-making and judgment about risks. Another approach collects data from relevant populations using interviews, as with survey research. Case studies using existing records, direct observation behaviors in social interactions, and elicitation of social values, motives, and intentions also produce important, independent data and the means for interpreting the results of other studies (e.g., survey results). The development of conceptual and methodological models or frameworks increases the validity and reliability of impact assessments.

2. Examination of past and ongoing analogous cases. This involves a study of the historical record for cases that are the same, similar, or informative about the substance and/or processes that illuminate the evaluation or estimation of impacts from high-level radioactive waste activities. Examples are the case-based data that were used to analyze the Social Amplification of Risk framework (Kasperson, et al., 1988; 1992; 1996; Burns, et al., 1990; 1993; Renn, et al., 1992) and the historical cases of managing nuclear technologies and public responses (Flynn, 2002; Carter, 1987; Welsome, 1999; Kraft, et al., 1993). These studies lead to development of concepts, frameworks, and models that organize data, provide parameters for analysis, and guide forecasts, projections, and the range of potential future impacts.

3. Expert opinions. Experts are individuals who, because of their occupations, education, experience, study, and interests, have developed insights into social processes and the behavior of specific groups under a variety of conditions. Real estate professionals, for example, can offer expert opinions about what conditions are important to the value of properties, how buyers, sellers, and other professionals view risk and real estate values, and the probable effects of various scenarios. Convention planners can consider and provide an informed opinion about risk conditions and their relationship to convention attendance. Certainly, social scientists who have studied the historical data and conducted basic and applied research on questions of human behaviors in response to high-level nuclear waste risks and the resulting socioeconomic impacts are primary sources of expert opinion on effects of a repository program.

Research Demonstrating Why People Would Avoid Areas Near a Repository

In order to determine whether or not there is actually any possibility of visitors avoiding areas near a nuclear-waste repository, NANP commissioned a team of renowned social scientists to study the decision process underlying these behaviors. The results of these studies have been published in a plethora of reports, books, and journal articles (See the attached Bibliography). These studies document that people regard HLW storage, transportation, and management programs as high-risk ventures. They look upon HLW with dread and uncertainty. As a result, they carry extremely negative images of the proposed Yucca Mountain repository program. Following the direct implications of these evaluations and images, the public prefers to avoid places and conditions that might expose them to radiation from HLW.

Slovic and his colleagues (Slovic, et al., 1991) provided a research design and outlined a set of related propositions to examine the connections between images, Yucca Mountain, radioactive waste stigma, and the potential visitor behaviors. The research tested the following three propositions:

1. Images associated with environments have diverse positive and negative affective meanings that influence preferences (e.g., in this case, preferences for sites in which to vacation, retire, find a job, or start a new business).

2. A nuclear waste repository evokes a wide variety of strongly negative images, consistent with extreme perceptions of risk and stigmatization.

3. The repository at Yucca Mountain and the negative images it evokes would, over time, become increasingly salient in the images of Nevada and of Las Vegas (Slovic, et al., 1991, pp. 686-687).

Support for these propositions demonstrates a mechanism whereby the HLW repository would adversely impact tourism, migration, and business development in Nevada. This demonstration is based on established patterns people use to evaluate and characterize information about places as a prelude to making behavioral decisions. As such, these studies do not rely merely upon introspective statements about future behaviors but reveal the underlying rationale for choices about places. The basis for evaluating places as revealed by images applies equally to places with or without radioactive waste facilities and includes the full range of amenities and disamenities as perceived by respondents. This was clearly demonstrated in a test-retest study of Phoenix, Arizona survey respondents. In the retest interviews conducted 16-18 months after the first image elicitation, respondents were asked in which cities or states they had vacationed since the original interviews were conducted. The data showed that the affective quality of the respondent's original image ratings were clearly related to the probability that person subsequently vacationed at places with the highest positive image ratings and avoided places with negative, notably nuclear, images, with the relationship being stronger for states than for cities. Simply, images predicted behaviors.

The relationship between imagery and visitation behavior was replicated in a study of convention attendees (Easterling & Kunreuther, 1993). Namely, members of a professional organization were more likely to attend the organization's annual meeting if the meeting was held in a city that had a more positive image for the individual. This result was also confirmed in a series of studies conducted by Jenkins-Smith (1994) under contract to DOE.

The survey of convention attendees also found that individuals are less likely to visit a city if they believe it involves a high level of risk, either from crime, natural hazards, or pollution (Easterling & Kunreuther, 1993). Likewise, convention planners are less likely to schedule meetings in cities they regard as imposing a heightened sense of risk (Kunreuther, Easterling & Kleindorfer, 1988). These results are consistent with a much larger body of literature in health psychology demonstrating that people take deliberate actions to reduce their vulnerability to harm (Becker, 1974; Weinstein, 1988).

Together, these studies demonstrate that Nevada would experience visitor losses if the repository leads to the public attachment of more risky or negative imagery to Las Vegas and/or Nevada. The degree to which this would occur depends on: a) the specific imagery that is associated with a HLW repository; and b) the degree to which repository-related imagery becomes associated with visitor destinations in Nevada. Thousands of survey respondents have been queried about their images of a HLW repository. These data provide a baseline for answering the first part of the question about the nature of repository images. At present, we know with a high degree of certainty that repository images are overwhelmingly negative. Perhaps this helps explain the unseemly haste by the owners of and communities with nuclear power plants to remove their wastes from current safe storage and advocate transporting it across the country to Nevada, even though they have reached an economic and social accommodation at the current localities.

Slovic and his colleagues conducted four surveys that interviewed 3,334 respondents and produced a total of 10,000 images in response to a question about an "underground nuclear waste repository." The respondents also rated the effect associated with these images. The most arresting and important finding was the extreme negative quality of the images. More than 56 percent of the total images could be classified as negative consequences and negative concepts. These images included danger, toxic, death, sickness, environmental damage, bad, scary, decay, slime, darkness. There were 232 images pertaining to war, annihilation, weapons, and things military. Positive imagery was less than a quarter of the total. The response "safe" was given only 37 times out of the 10,000 images (0.37 percent). Other concepts generally considered positive – "necessary," "employment," and "money/income" combined to total only 2.5 percent of the images.

Prior Instances Where Radiation Events Led to Visitor Losses

It is clear from the research that the more risky or negative the images associated with a place, the less likely that people would visit there. The critical question is whether locating a HLW repository at Yucca Mountain and/or transporting waste through Clark County or other areas of Nevada would lead the public to associate negative imagery with the state and its communities. A review of prior incidents involving nuclear technologies suggests that such an effect is indeed possible.

The March 1979 accident at the Three Mile Island (TMI) nuclear plant near Harrisburg, Pennsylvania provides one of the first documented cases where people have avoided areas affected by radiation events. The near-meltdown of the reactor core transfixed the public, although only a small amount of radiation actually entered the environment. In the first few weeks following the accident, both the Harrisburg area (immediately adjacent to TMI) and the Lancaster area (approximately 50 miles away from TMI) experienced declines in tourism in excess of 50 percent. The National Hardware Dealers' spring convention, scheduled for Harrisburg, was canceled. Within a few months (as it became clear that little if any radiation had been released into the environment), these losses appeared to abate (Pennsylvania Governor's Office on Policy and Planning, 1980; Himmelberger, Ogneva-Himmelberger & Baughman, 1993).

More extreme visitor impacts occurred with the accidental release of radiation into the environment that occurred in Goiânia, Brazil during the fall of 1987 (Petterson, 1988; Brooke, 1995). This happened when two men cut into a discarded radiotherapy machine and released 100 grams of cesium-137. Children playing in the junkyard were attracted to the glowing material and passed it among themselves and their families. Through ingestion and physical contact, 129 individuals were contaminated, of whom 50 were hospitalized and 7 died. This event sparked fears throughout Brazil, with severe economic consequences. Hotel occupancy in the city dropped by about 40 percent for six weeks following the accident. A number of scheduled conventions were canceled. In addition, residents of Goiânia were denied access to planes, buses, and hotels throughout the rest of Brazil; cars with Goiânia license plates were stoned; and local agricultural products would not sell. The impacts from this event persisted in an extreme form for about a year, dissipating as it became clear that the threat of contamination had abated (Brooke, 1995).

Tourism losses were also reported on the Normandy Coast of France following of a highly publicized report in the British Medical Journal (January 1997) that identified the Hague nuclear-fuel processing plant as a suspected cause in 27 leukemia cases found among young persons living near the facility. According to the mayor of Beaumont, the incident was "a catastrophe" for the area's reputation. Correspondingly, "when summer arrived, campers and hikers stayed away" (Whitney, 1997; Balter, 1997).

Urban Environmental Research (2001c) reports two additional case studies in which incidents at nuclear power plants have led to losses in tourists and visitors. An accident at the Tokaimura nuclear fuel facility power plant in Ibarka Prefecture, Japan produced immediate and dramatic impacts to the local tourism sector. Local hotels, inns, and restaurants suffered a loss of 1.47 billion yen within the first month and one hotel filed for bankruptcy. In the second case, the Dounreay nuclear power plant in Scotland released radioactive contaminants that appeared in the sand on local beaches. A local resort owner has filed suit against the United Kingdom's Atomic Energy Authority to gain compensation for the resulting lost business.

There is also some evidence that the Nevada Test Site (NTS), located just adjacent to Yucca Mountain, had a negative impact on visitor behavior for those communities that were downwind from the aboveground nuclear tests. Specifically, St. George, Utah, which received major doses of radioactive fallout during the 1950s, suffered a drop in its tourism and convention trade when the increased incidence of leukemia in the area was publicized (Fradkin, 1989).

Taken as a whole, the historical record suggests that overt, publicized releases of radiation, particularly those with identifiable health effects, would trigger drops in visitation. If the repository leads to events that are comparable to the examples described here, there is every reason to believe that southern Nevada would experience losses just as large.

Self-Reports Among Potential Visitors to Las Vegas

The plausibility of repository-induced avoidance behavior is corroborated even more by studies that ask economic agents to predict their response to scenarios involving the transport and storage of high-level nuclear waste. In study after study, potential visitors report that they would avoid locations "near" a repository, as well as locations that are "near" routes along which nuclear waste is transported. For example, in a 1987 survey of 1200 individuals from across the country, 57 percent of the sample reported that a HLW repository would make it "less desirable" to vacation in a place located 100 miles away (about the distance between Yucca Mountain and Las Vegas) (Kunreuther, Desvouges & Slovic, 1988).

Following this 1987 survey of the general public, Easterling and Kunreuther (1993) undertook two studies to investigate the potential impacts of a repository on the Las Vegas convention industry. They considered two possible ways that a repository at Yucca Mountain might cause a loss in convention business: a transfer of conventions from Las Vegas to other cities, and a decrease in the number of people who would attend meetings still held in Las Vegas. These possibilities were examined by looking at the convention location process and the role of convention planners and by interviewing convention attendees. In this way, the two important decision levels (planners and attendees) that determine attendance at conventions were addressed.

The convention attendees study, conducted in the fall of 1989, was a telephone survey of 600 individuals who belonged to professional organizations and regularly attended conventions. In one series of questions, respondents were told to assume that they had made a tentative decision to attend a convention, and then found out that the host city was located 100 miles away from a particular facility (either a prison, a nuclear reactor, a hazardous waste incinerator, a low-level radioactive waste repository, or a high-level nuclear waste repository). When the HLW repository was raised as a possibility, 23 percent of the sample reported that they would not attend the meeting. In contrast, only 1 percent of the sample indicated they would not attend the meeting if a *prison* were within 100 miles of the host city, and only 3 percent reported they would not attend if a *nuclear power reactor* were within 100 miles. This study indicates that the HLW repository elicits much stronger aversion than occurs for existing facilities.

Approximately the same level of avoidance was found in a 1988 survey of convention planners (Kunreuther, Easterling & Kleindorfer, 1988). Each of the 153 planners in this study had selected Las Vegas for a meeting in the past. As part of a longer interview, the planners were provided a description of the proposed repository and asked to reconsider their selection of Las Vegas under the assumption that the repository had recently opened at Yucca Mountain. When confronted with this scenario, 32 percent indicated that they would lower their ranking of Las Vegas and 8 percent reported that they "would no longer consider Las Vegas as an option." Under a more serious scenario (where the repository was plagued by recurrent accidents and safety lapses), 75 percent of the sample lowered their ranking of Las Vegas and 43 percent indicated that they "would no longer consider Las Vegas" for the meeting.

Similar results have been found in studies conducted by researchers working outside the auspices of NANP. For example, Fox et al. (1985) conducted a study for the State of Tennessee to see if vacation behavior might be influenced by the presence of a MRS facility at Oak Ridge. Among a sample of 306 persons living outside the state, 47 percent indicated they would change their vacation plans if they learned that their destination was located "near" an MRS facility.

Even researchers working for DOE have found evidence visitors would change their vacation plans in response to repository scenarios. Among a sample of 2400 individuals from around the country, Jenkins-Smith and Silva (1996) found that 7.7 percent were "very likely" to vacation in Nevada within the next five years. However, when this question was prefaced with information indicating that spent nuclear fuel would be transported through Nevada, only 6.0 percent of the sample indicated that they were "very likely" to vacation in Nevada (a 22% drop in the number of "very likely" visitors).

Across the board, studies that have asked people to project their vacationing and convention-going behavior have found that people want to avoid areas near a HLW repository. The level of avoidance is from 7 to 75 percent, depending on the

methodology, the scenario, and the threshold for defining "avoidance behavior" (e.g., "probably would not attend" versus "definitely would not attend").

Scenarios that Produce Visitor Impacts

Taken together, the social science research and analogous cases reviewed here (and described in more detail in the appendices) provide a great deal of evidence that a repository at Yucca Mountain would produce visitor losses because of the nature of public evaluations of radiation hazards and the likelihood of events and/or accidents that increase the perceived risk or negative imagery. This body of research also indicates what types of repository-related events would increase perceived risk or produce negative imagery, and thus lead to visitor impacts (Easterling, 2001b).

On the high end of the economic impacts are repository scenarios that are almost certain to cause losses to the visitor economy. Events such as transportation accidents involving the release of radiation in or near Las Vegas fall within this category. More specifically, the analogous cases indicate that visitor impacts would be greatest if there is radiation release with death or illness. In this class of conditions causing severe impacts are media stories of radioactive contamination in the area.

Even for less extreme repository scenarios, negative visitor impacts are predictable. Again, based on analogous cases, it is likely that southern Nevada would experience visitor losses with a report of increased incidence of cancer among residents that could be plausibly connected to the HLW program activities. A comparable condition would result with media reports of transportation accidents anywhere in the country because this would suggest a special danger for Nevada, which would be the final destination of all HLW shipments to Yucca Mountain. Media stories about terrorism risks with regard to the transport of nuclear waste would have adverse effects, as would accounts of mismanagement in the transportation, handling, or storage of HLW.

Only if all these scenarios can be *ruled out,* is it legitimate to conclude that a repository at Yucca Mountain would not lead to visitor impacts for Nevada.

Levels of Impact

The large body of research leaves little doubt that a repository at Yucca Mountain would produce visitor losses under a range of different scenarios. However, the number of visitors who avoid Nevada would be greater or lesser depending on the severity and duration of the risk events that define the scenario. Thus, any assessment of how the repository would impact Nevada's visitor economy must rely on scenario-specific forecasts.

The most reliable forecasts would be those using scenarios that are comparable to events that have occurred in the past. For example, consider the cases of Goiânia, Brazil and Three Mile Island described above. In Goiânia, 50 people were hospitalized and 7

died from exposure to cesium from a salvaged radiotherapy machine, while the accident at the Three Mile Island reactor resulted in only a "minor" release of radiation into the atmosphere. Despite the difference in the severity of radiation contamination, the two incidents produced very similar levels of visitor impact. Namely, in the months immediately following the two events, hotel occupancy rates dropped by 40-50 percent in nearby areas.

Interestingly, the September 11th attacks produced a very similar level of visitor loss in New York City. A month following the attack, hotel occupancy was off by 45 percent (the initial impact during the first week was even higher).

Extending these experiences to the case of a HLW repository, it would appear that Nevada could expect to suffer at least 40-50% declines in the case of a transportation accident that releases radioactive material in or near Las Vegas. This conclusion is reinforced by the convention planners survey, which found that a "moderate" transportation accident would cause 64 percent of planners to lower their ranking of Las Vegas and 31 percent to avoid Las Vegas altogether (Easterling, 2001b). The duration of these losses would depend on whether or not there were any lasting effects of the accident – persistent radioactive contamination, a lingering sense that more accidents could occur in the future, or even an undefined stigmatization of Nevada as an undesirable place to visit.

In considering the impact of a repository on the Las Vegas visitor economy, it is important to recognize how many visitors correspond to each percentage-point drop in visitor volume. Compared to Goiânia and central Pennsylvania, Las Vegas would lose a much higher **number** of visitors in response to a radiation event. For example, the cities of Harrisburg and Lancaster in Pennsylvania experienced a 50% decline in visitors following the accident at Three Mile Island, which translated into a $5 million impact. If Las Vegas experienced a month-long 50% drop in tourists, this would amount to losing 1.5 million visitors and $1.2 **billion** dollars in revenue (using the Las Vegas Convention and Visitor Authority's figures for 2000 as the base).

Moreover, if repository-related accidents lead to longer-lasting public concern, those losses would quickly mount. For example, consider the case where a transportation accident produces a 50% decline the first month and then visitation gradually rebounds over the next 11 months -- so that one year after the event, visitor volume is back to its pre-event level. Under this pattern of visitor impact, the cumulative loss for the year would be 9 million visitors and $8 billion in revenue.

With an even more extreme repository scenario, Nevada could experience even longer-lasting visitor losses. For example, a serious transportation accident within the city of Las Vegas could lead to a situation where nuclear waste imagery and a sense of danger become more permanent features of the "image set" that people associate with the city. If public perceptions change in this manner, visitor losses would likely persist well into the future. Visitor volume would probably begin to climb again at some point in

time, but it may take years to reach levels that Clark County has enjoyed in the absence of a repository. Certainly, the rate of increase in visitor volume would fall short of the 5.5% figure that Las Vegas has experienced over the past 30 years.

An innovative University of Nevada Las Vegas study by Riddel and Shaw (2001) was designed to determine the economic value of tolerating exposure to transportation of high-level nuclear wastes through Southern Nevada communities. The study used a modified contingent valuation method design with an individual auction procedure to arrive at a dollar amount for willingness to accept the HLW shipment-exposed property.

A three-step survey process was employed. Residents of Southern Nevada were contacted by telephone and, when they agreed to participate, they were sent a printed booklet with a description of potential risks, including transportation of HLW, presented on a "risk ladder." These respondents were then interviewed by telephone. The scenario presented to them offered the choice of moving away from the transportation route, with moving costs paid by a special public program, or staying at their residence with compensation for the risk. The interview was interactive and offered lower or upper bounds depending upon the initial consideration of compensation. This was accomplished through a bid-and-response module in the survey. Compensation was described as an annual federal income tax rebate for the term of the HLW transportation program.

The average price per household for the annual compensation option was $10,050. Riddel and Shaw conclude: "Our results indicate that the costs of the risks borne by households near the transportation route exceeds $10,000 annually." These costs are free choice estimates (i.e., not constrained by the expenses of relocation) of the individually calculated risk versus no-risk from the proposed DOE transportation program. These results apply to several hundred thousand households in Southern Nevada, but they could also apply to households in 43 states nationwide along the transportation corridors.

Conclusion

Since 1986, the Nevada Agency for Nuclear Projects has supported a comprehensive research program to understand the potential for a repository at Yucca Mountain to cause visitors to avoid coming to Nevada (Chalmers et al., 1993; Flynn et al., 1995; Nevada Agency for Nuclear Projects, 2000). This research program (which has resulted in over 200 technical reports and 100 publications in professional journals) has demonstrated that a large fraction of people predict that a repository would have a negative influence on their willingness to visit a nearby area, particularly if the repository is accompanied by accidents that release radiation into the environment. These studies have also established the credibility of perceived risk and negative imagery as pathways through which visitor impacts could occur.

On the basis of this body of research, the independent Technical Review Committee concluded that:

> The greatest potential socioeconomic difficulty of the proposed repository stems from the intense negative imagery associated by the public with a high-level radioactive waste repository, combined with the vulnerability of the Nevada economy to changes in its public image. Because of the high profile nature of the whole nuclear waste disposal program, the potential exists for Nevada to become associated with this negative imagery to the detriment of its attempts to attract tourists, conventions, migrants and new industry to the state (White et al., 1990, p. 4).

This conclusion is even more prescient in the aftermath of the September 11th attacks. Economies that rely heavily on visitors to generate revenues can be quickly upended when an "unforeseen" incident raises the specter of danger.

Las Vegas attracts most of its visitors by offering entertainment, gaming, and a carefree, carnival-like atmosphere. Most of the casinos, particularly the larger ones, are designed so visitors can leave their daily existence and experience a world of opulence or excitement. The imagery associated with a HLW repository (e.g., danger, poison, contamination, wrong) is antithetical to the view the city seeks to project. If repository-laden images displace the city's current imagery, there is every reason to expect that many potential visitors would find other destinations.

Based on analogous cases where visitors have avoided areas following radiation releases, environmental contamination, violence, or earthquakes, it is reasonable to conclude that southern Nevada could suffer a 30% drop in visitation following "moderate" repository-related accidents. More extreme incidents could easily lead to a 50% drop, possibly lingering well into the future.

Table 3.1.1 Summary of Las Vegas Visitor Economy and Potential Impacts of a HLW Repository at Yucca Mountain

Visitors to Las Vegas Metropolitan Area (2000)*	35.8 million
Total Visitor Annual Spending (2000)*	$31.5 billion
Regional economic effect (indirect) @ 2.5 multiplier	$78.75 billion
Value of each percent of annual visitor spending (Direct + Indirect)	$787.5 million
Benign Scenario Impact @ 7% visitor decline	$5.5 billion
Moderate Scenario Impact @ 15% visitor decline	$23.8 billion
Accident Scenario Impact @ 30% visitor decline	$39.4 billion

*Las Vegas Convention and Visitor Authority, 2001 (data for 2000)

With a visitor economy as substantial as Nevada's, these declines represent devastating losses to income, property value, and tax revenues. The cumulative impact following a serious transportation accident near the Strip could easily reach almost $40 billion, which is substantially more than the $7 billion that the United States has invested in the entire repository program over the past 20 years. This possibility imposes a huge

risk on the one state that has been unlucky enough to draw the short straw in shouldering the country's nuclear waste burden.

Table 3.1.2 "Analogous Events" That Have Produced Visitor Impacts: Radiation-Related Incidents

1. Accident At Three Mile Island (Pennsylvania Governor's Office On Policy And Planning, 1980; Himmelberger, Ogneva-Himmelberger & Baughman, 1993)
   Incident: In March 1979, a loss-of-coolant event occurred at the TMI nuclear power plant near Harrisburg, Pennsylvania, leading to partial meltdown of reactor core and "slight" release of radiation into the atmosphere.
   Visitor Impact: Tourism declined by approximately 50% in the Lancaster and Harrisburg areas during the month following the incident. One convention was cancelled. Visitor volume returned to prior levels within a few months.

2. Contamination from Nuclear Testing into Utah (Fradkin, 1989)
   Incident: A series of aboveground nuclear explosions at the Nevada Test Site during the 1950s (e.g., "Shot Harry" in 1953) spread plumes of radioactive fall-out that contaminated areas of southern Utah.
   Visitor Impact: Tourism and convention business declined in St. George, Utah following the release of data indicating an increased rate of leukemia in the area.

3. Contamination in Goiania, Brazil (Petterson, 1988; Brooke, 1995)
   Incident: In September 1987, radioactive cesium-137 was released from a discarded radiotherapy machine, contaminating 129 individuals and killing 7.
   Visitor Impact: Hotel occupancy in Goiania dropped by about 40% during the six weeks following the incident. Numerous conventions cancelled. Visitor volume approached prior levels within a year.

4. Leukemia Cluster on the Normandy Coast in France (Whitney, 1997)
   Incident: In January 1997, a scientific report was published in the *British Medical Journal* implicating the Hague nuclear-fuel processing plant as a suspect in 27 cases of leukemia among young persons living nearby.
   Visitor Impact: Local officials reported that tourists avoided the Normandy Coast area the following summer.

5. Tokaimura Nuclear Plant, Japan (UER, 2001c)
   Incident: In September, 1999 an accident occurred at the Tokaimura nuclear power plant in Ibarki, Japan
   Visitor Impact: Local hotels, inns and restaurants lost 1.47 billion yen. One hotel filed for bankruptcy. Tourism had not fully recovered 10 months later.

6. Dounreay Nuclear Plant, Scotland (UER, 2001c)
   Incident: In 2000, spent nuclear fuel stored at the Dounreay nuclear power plant released radioactive contaminants that appeared in the sand on local beaches.
   Visitor Impact: Owner of a resort in Caithness considering legal action to gain compensation for lost business.

Table 3.1.3 "Analogous Events" That Have Produced Visitor Impacts: Other Incidents that Suggest Visitors Would be at Risk

1. September 11th Terrorist Attacks (Bagli, 2001; Sharkey, 2001; Burghart, 2001)
   Incident: On September 11, 2001, terrorists crashed two jetliners into the World Trade Centers in New York City, another crashed into the Pentagon in Washington, and a fourth went down in Pennsylvania. These attacks were followed by the appearance of anthrax-contaminated letters in New York, Washington and other East Coast cities.
   Visitor Impact: Hotel rates fell from 84% to 20% during the first week. A month after the attack, occupancy was down by 45%. Two months later, visitor volume was beginning to rebound, but only because of deep discounts.

2. Violence Against Tourists in Miami (Navarro, 1995)
   Incident: In 1993, nine tourists (four of them Germans) were murdered, many when they became lost coming out of the airport.
   Visitor Impact: Between 1993 and 1994, Miami suffered a 57% drop in German visitors and a 7% decline among all international tourists.

3. Violence Against Tourists in New York City (Hays, 1990)
   Incident: In 1990, a Utah tourist was shot on the subway when trying to protect his parents from robbers.
   Visitor Impact: Unspecified decline in tourists.

4. Rodney King Riots (*Rochester Times-Union, 1992)*
   Incident: In 1992, riots broke out throughout Los Angeles when the police accused of beating Rodney King were found innocent by a jury.
   Visitor Impact: The Los Angeles Convention and Visitors Bureau predicted that the city would lose $1.1 billion in revenue the following summer.

5. Hoof and Mouth Disease in Britain (UER, 2001c)
   Incident: Beginning in 2000, livestock throughout rural Britain were infected with hoof-and-mouth disease.
   Visitor Impact: During the first year of the outbreak, tourism revenues declined by 80% in the most impacted areas of Devon and Cumbria, and 10% for the country as a whole

6. Medical Waste Along the New Jersey Shore (Lyall, 1991)
   Incident: During the summer of 1988, medical waste washed ashore on beaches in New Jersey and New York.
   Visitor Impact: Visitor losses in the amount of $1.5 billion.

7. Legionnaires Disease (Morgan-Witts, 1982)
   Incident: Outbreak of a fatal respiratory disease during a convention of the American Legion at the Bellevue-Stratford Hotel in Philadelphia in 1976.
   Visitor Impact: The hotel in which the convention was held lost so much business that the new owners decided to change its name.

8. Mount St. Helens (Kreck, 1981)
   Incident: In March 1980, Mt. St. Helens in southern Washington State erupted, decimating the nearby forest, sending a plume of ash across the Pacific Northwest and killing a number of individuals in the immediate vicinity.
   Visitor Impact: Short-term 30% decline in tourism in the region.

Table 3.1.4 Studies Where Individuals Report That A Repository Would Impact Their Own Visitor Behavior

Stimulus = Nuclear Waste Repository near the Vacation Destination

1. 1987 NWPO Surveys (Kunreuther, Desvousges & Slovic, 1988)
Sample: 1201 US residents and 804 Nevada residents
Questions: "Think about a community that would be located about 100 miles from a high-level nuclear waste repository. Would this make the community a less desirable place for you to visit on vacation? Would it be a less desirable place to attend a convention?"
Results: 57% of National sample and 51% of Nevada sample reported that a repository 100 miles away would make the community less desirable to visit on vacation. 43% of each sample reported that the community would be less desirable for attending a convention.

2. Convention Attendees Survey (Easterling & Kunreuther, 1993)
Sample: 600 members of professional organizations that regularly attend annual conventions.
Questions: "How would your decision to attend a convention be influenced by the following factors, if at all? If you learned that a [prison, hazardous waste incinerator, nuclear power plant, low-level radioactive waste repository, high-level nuclear waste repository] was located within 100 miles of the convention city, would you definitely attend, probably attend, probably not attend, or definitely not attend the convention?"
Results: If a high-level nuclear waste repository were within 100 miles, 7% would *definitely* not attend their convention and another 16% *probably* would not attend (i.e., 23% unlikely to attend).

3. Tennessee MRS Study (Fox et al., 1985)
Sample: 306 persons living outside Tennessee
Question: "Would you change your vacation plans if you learned that a monitored retrievable storage facility for nuclear waste was located near your destination?"
Results: 47% indicated they would change their plans.

Stimulus = Nuclear Waste Transported Through Vacation Destination

DOE Survey of HLW Transport Impacts (Jenkins-Smith & Silva, 1996)
Sample: 2,400 U.S. residents
Questions: "How likely are you to take a vacation in Nevada in the next five years? If you knew that the government was going to transport spent fuel from nuclear power plants through Nevada, how likely would you be to take a vacation in Nevada in the next five years?"
Results: Whereas 7.7% of sample were "very likely" to take a vacation in Nevada in the next five years, this figure dropped to 6.0% when the repository was added to the scenario (a 22% reduction in the number of "very likely" visitors).

Stimulus = Accident Involving Nuclear Waste Occurring Near Vacation Destination

Convention Planner Survey (Kunreuther, Easterling & Kleindorfer, 1988)
Sample: 157 meeting planners who had scheduled a convention for Las Vegas within the past year.
Questions: "For the next set of questions, we would like you to tell us which city you would prefer for *this meeting* [the meeting for which the planner had selected Las Vegas] under the following set of conditions... We would present you with a scenario describing a hypothetical situation relating to the high level nuclear waste repository that might be located in southern Nevada... After reading each scenario, we want you to indicate how you would rank Las Vegas relative to the other possible locations."
Results: For a "moderate-severity" transportation accident involving a small release of radiation 40 miles from Las Vegas, 64% of the planners lowered their ranking of Las Vegas relative to other cities, with 31% reporting they would "no longer consider" Las Vegas for the meeting. For a "minor-severity" transportation accident (i.e., no release of radiation) accompanied by significant media attention, 49% would lower their ranking and 21% would no longer consider Las Vegas for the meeting.

3.2 Impacts to Property Values

Studies undertaken by State of Nevada and Clark County researchers have found that the value of property, especially along potential nuclear waste shipping routes in Clark, Washoe, and Elko counties, stands to be dramatically affected should the Yucca Mountain project go forward.[4] Even under the most benign conditions (i.e., where there are no projected radioactive waste accidents), property value losses are likely along shipping corridors, as well as at distances up to three miles from the actual highway or rail route.

Property values along nuclear waste shipping routes in Clark County alone could decline an average of 3.5%, even without a major accident or incident. In the event of an accident, losses in real market value could be between $5.6 billion and $8.8 billion. In Washoe and Elko counties, property value losses between $1.9 billion and $2.2 billion and between $110 million and $129 million, respectively, are possible.

The findings indicate that an accident, even without a release of radioactive waste, would significantly increase the rate of property value diminution. If a major accident involving radiological contamination were to occur, property value losses would be devastating. Research shows that residential property values along nuclear waste shipping routes in Clark County alone could decline an average of 3.5%, even without a major accident or incident, due to the irreducible risks from a designated HLW shipping route. In the event of an accident, losses in real market value could be between $5.6 billion and $8.8 billion. In Washoe and Elko Counties, the estimated residential property value losses are between $1.9 billion and $2.2 billion and between $110 million and $129 million, respectively. Percentage declines of comparable magnitudes can be expected in counties and communities all along Yucca Mountain transportation routes.[5]

Stigma that is related to risk has been associated with all aspects of nuclear energy including property value diminution. If DOE goes ahead with its program, it is likely that over the next 30 years, 77,000 metric tons of spent nuclear fuel and high-level nuclear waste may be shipped to a repository at Yucca Mountain. It is also likely that proposed routes for transporting nuclear waste would go through Clark County, Washoe County, and Elko County, Nevada. Given the high level of public concerns over the risks of

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[4] "Final Report: Results From Key Informant Interviews About Potential Property Value Impacts From the Shipment of High-Level Nuclear Waste and Spent Fuel Through Clark County, Nevada," by Urban Environmental Research, LLC (August, 2000) and "Clark County Residents and Key Informant Surveys: Beliefs, Opinions, and Perceptions about Property Value Impacts From the Shipment of High-Level Nuclear Waste and Spent Fuel Through Clark County, Nevada," by Urban Environmental Research, LLC (December, 2000).

[5] As discussed in succeeding sections of this report, specific research initiatives clearly demonstrate the likelihood and magnitude of property value impacts in Clark, Washoe, and Elko counties. Due to funding and time limitations, it was not possible to apply the research findings to property values in all communities along potential shipping routes. However, the work done in the three major Nevada counties is applicable to other jurisdictions. Potential property value impacts to Nevada as a whole stand to be considerably larger than the figures reported for the studied counties.

shipping nuclear waste, the mere possibility of an incident (even with no release of radioactive material) could result in significant property value diminution over an extended period of time.

Findings in this section of the report are derived from the results of two surveys, one of the public and the other of property value experts, and the application of the findings from the experts survey to actual property value data in the three counties.

Approaches To Evaluating Property Value Impacts

To assure confidence in the findings of the property value studies, the research involved the convergence of three methods: (1) Analysis of literature on property value impacts from nuclear and other hazardous facilities and activities; (2) A survey of Clark County residents; and (3) A survey of property value experts - Clark County lenders and appraisers - that was subsequently applied to appraisal data for three land use classifications (residential, commercial, and industrial) within the three counties to determine the range of potential losses.

The work undertaken by State and Clark County researchers is the first time an estimation of property value diminution resulting from DOE's proposal to construct the Yucca Mountain repository has been undertaken. The study did not address the full range of land uses in the targeted counties and did not attempt to extrapolate findings to other locales along shipping routes.

While all residential properties in the studied counties were included in the research, only a limited number of commercial and industrial land uses were considered. Of particular note, this study did not address the many land uses associated with Nevada's dominant economic sector, casinos and hotel-casino related properties. As a result, the substantial property losses that are likely to occur because of nuclear waste shipments and are reported here underestimate the actual potential magnitude of losses and the real vulnerabilities to future property values.

The studies also did not examine the large number of land parcels that are yet undeveloped. Land uses associated with tourism and undeveloped parcels represent an important component of the study area's current economic base and its future. The impacts of Yucca Mountain nuclear waste transportation on these land uses must be considered to obtain a more complete understanding of the full extent of property value diminution that could - and likely would - occur.

When these limitations on the scope of the property studies are taken into account, the conclusions about negative property value impacts must be viewed as extremely conservative and, as such, they likely understate the full costs for each scenario evaluated.

The Clark County Public Survey

The Clark County public survey involved a randomly selected sample of 512 county residents. It was conducted by telephone in August 2000 by the Cannon Center for Survey Research at the University of Nevada, Las Vegas. Assuming a 95% confidence interval, the sampling error for the survey was approximately +/- 4.5%.

In the telephone survey of Clark County residents, respondents were first asked whether various "environmental conditions" or facilities would increase, decrease, or have no effect on nearby residential property values. The responses were similar to the Santa Fe, New Mexico survey described below. Residents stated that a polluting manufacturing plant, a landfill, and a freeway used to ship nuclear waste would have the most negative effects on property values of the twelve facilities that were provided in the survey.

Almost 82% of the respondents stated that a nearby shipping route would either 'decrease a lot' or 'decrease' the likelihood of their purchasing residential property. Almost 41% indicated that commercial property values would decrease.

The survey found that almost three-fourths of the respondents would not purchase properties near nuclear waste shipping routes ***under any conditions***. In addition, the mean expected drop in selling prices for homes near a transport route compared to a similar home at a considerable distance from such a route was approximately 25%.[6]

The Komis Case in New Mexico

The Clark County survey questionnaire was closely adapted from a seminal New Mexico study (Zia Research Associates, 1990). This survey is important in three ways. First, it demonstrated that residents believe the transportation of radioactive waste would adversely impact property values, and that they are unwilling to purchase properties near these routes. Second, the survey results were central to a New Mexico legal case demonstrating that damages for property value losses can be compensated because of stigma associated with the shipment of nuclear waste (City of Santa Fe versus John and Lemonia Komis, 1992). Third, the survey design was readily adaptable to the Clark County survey, thereby allowing comparison of findings between the two surveys and supporting the conclusion that both populations consider property values to be diminished because of radioactive waste transport.

In estimating the impact of stigma effects on property that is located near a transportation route, it is informative to examine the data from the New Mexico case and calculate the jury award of damages, which were upheld by the New Mexico Supreme

[6] For illustration purposes, the application of this perceived diminution rate for residential properties to the current assessed valuations of residential properties within one mile of the I-15 transportation corridor results in an estimated loss of $604.6 million in residential assessed valuation.

Court. Table 3.2.1 below gives the basic facts about the property and the jury award. Notice the remaining Komis property is close to one square mile (630.339 of 640 acres).

Table 3.2.1 Descriptive Facts Of Komis Property And Jury Award

Total Komis property in acres	673.77
Property taken by Santa Fe	43.431
Value of taken property	$489,582.50
Value of taken property per acre	$11,272.65
Property remaining with Komis, in acres	630.339
Stigma award for value loss of remaining property	$337,815
Stigma award per acre of remaining property**	$535.93
Stigma value as a percent of market value of $11,272.65 per acre***	4.75%

*Stigma Value from the Jury Findings in the Santa Fe v. Komis, upheld by New Mexico State Supreme Court (26 August 1992, Case #20,325). Descriptive facts are from the opinion written by Justice Gene E. Franchini.

**$337,815 ÷ 630.339 = $535.9259;

***$535.93 ÷ $11,272.65 = 4.75425

It should be noted that the findings from the Komis case demonstrated the existence of significant property value impacts just from the designation of a highway as a nuclear waste shipping route, without any actual shipments occurring and in the absence of any nuclear waste accidents or incidents. As such, these findings lend strong support to the empirical findings of the Clark County lenders-appraisers study.

The Lenders and Appraisers Study

In face-to-face interviews, Clark County lenders and appraisers were asked to estimate potential property value changes for three different transportation scenarios. The three scenarios involved (1) a benign, no-incident scenario, (2) a transportation accident involving a Yucca Mountain shipment that results in no release of radiation, and (3) a significant but plausible accident event resulting in the release of radiation along the shipping route. The transportation routes were defined as Interstate 15 in Clark County and the proposed northern Beltway, identified in DOE Yucca Mountain DEIS as a preferred shipping route.

Based on the three scenarios, the two professional groups were asked to evaluate property value changes to an average residential single-family home, a 250,000 square-foot office building, and a 100,000 square-foot industrial warehouse at two distances from a proposed shipment route. The resulting diminution factors (see Table 3.2.2) were then used as assumptions in estimating real dollar losses in assessed valuation for three property value types along shipment corridors in Clark County, Washoe County, and Elko County, Nevada.

Application of Diminution Factors to Property Values

In Clark County, the assessors' valuation data by parcels were integrated by property type and placed on a Geographic Information System (GIS) framework. One mile and one to three mile distances were applied to the GIS base. Two proposed routes, I-15 through Las Vegas and the Beltway route, were evaluated for real dollar impacts to assessed value by applying the different diminution rates to three property types at two distances. The diminution in property values was then expressed as losses in fair market value.

The diminution factors derived from the survey of two professional groups were also utilized to estimate property value changes in Washoe and Elko Counties. Assessor's data from Washoe and Elko Counties were used as a basis to calculate the diminution in property values from the proposed shipment of high-level nuclear waste. Washoe County includes the Reno-Sparks metropolitan area, while Elko county includes the smaller urban area of the City of Elko.

Different methods were used to estimate the loss in property values in both counties. Washoe County, like Clark County, possesses a high-resolution GIS, enabling a very precise estimate of diminution based on proximity to the transportation route. While tabulations for Elko did not include the use of a GIS, the data available were sufficient to devise an acceptable database for the calculations.

Clark County Property Value Impacts

Clark County lenders and appraisers provided data on diminution factors that would result from the transportation of nuclear waste through Clark County. The diminution factors affecting property values vary by distance from routes (one mile and one to three miles), the three scenarios, and land use type-light industrial, commercial-office, and residential. Although small differences appear between lenders and appraisers in the diminution factors for Scenario 1 (no accident) and Scenario 2 (minor accident), there is a strong consistency in their evaluation of property value impacts under Scenario 3 (major accident). Table 3.2.2 shows the diminution factors by distance, scenario, and property type in mean percentages.

Under Scenario 1, appraisers and lenders both indicated that residential properties would lose the most value in percentage terms. Appraisers indicated that, within one mile of a shipment route, residential properties would decline on the average of 3.5%, while lenders indicated the decline would be approximately 2.0%.

Table 3.2.2. Property Value Diminution Factors (in Percent) by Distance, Scenario, and Land

Use	Scenario 1		Scenario 2		Scenario 3	
	Lender	Appraiser	Lender	Appraiser	Lender	Appraiser
One-mile Distance						
Residential	2.00	3.50	6.18	7.96	29.00	33.79
Commercial	0.56	3.21	4.00	7.39	22.00	31.88
Industrial	0.56	1.25	4.00	5.29	21.25	25.54
One-three miles						
Residential	0.50	1.46	1.64	4.00	20.00	23.65
Commercial	0.56	1.25	1.00	3.04	16.67	20.50
Industrial	0.56	0.83	1.00	2.08	10.00	16.73

As the table shows, commercial property values could be expected to decline by 3.2 % and industrial property values by 1.25% within one mile of a shipment route under Scenario 1.

Under Scenario 3, substantial property value declines should be anticipated. Residential property values could drop approximately 30% at one mile and over 20% at one to three miles from a route. Appraisers indicated that the potential property value loss for commercial property could be 32% at one mile and 20.5% at one to three miles. Industrial property value losses could range from 21.3% to 25.5% within one mile of the transportation routes for nuclear waste, and from 10% to 16.7% at one to three miles.

Table 3.2.3 shows the actual dollar declines when these diminution factors are applied to fair market values for the three property types along two potential routes, I-15 and the Beltway route within Clark County. Even under Scenario 1, a no-event characterization, property value losses would occur in all three market segments - residential, commercial, and industrial.

The largest declines in present market values ($6.2 - $7.3 billion) would be experienced in the residential sector within three miles of the I-15 route in the event a serious accident occurs along the shipping route. The rate of decline under this scenario is less for commercial and industrial properties, with losses of up to $927 million estimated for commercial properties within three miles of I-15.[7]

The results demonstrate the potential that significant adverse impacts can be anticipated along either of the Clark County routes proposed and for all property types, even under the most benign transportation scenario.

[7] It should be noted that the I-15 corridor is more fully built than the Beltway. This study did not examine the property value impacts on undeveloped land or land uses other than the three that were addressed. Thus, a direct comparison between the routes in terms of route selection should not be made based on these data. However, the results should be seen as significantly understating the magnitude of potential impacts along either shipping route.

Table 3.2.3 Cark County Transportation Impacts on Adjacent Property Values (in millions $)*

Transportation Route	I-15	Beltway
Residential Market Value	$27,983	$23,817
Scenario One Decline**	$243/$550	$204/$463
Scenario Two Decline	$773/$1,393	$646/$1,176
Scenario Three Decline	$6,219/$7,319	$5,270/$6,203
Commercial Market Value	$3,820	$1,003
Scenario One Decline	$21/$73	$5/$15
Scenario Two Decline	$77/$171	$12/$34
Scenario Three Decline	$704/$927	$172/$214
Industrial Market Value	$2,518	$1,057
Scenario One Decline	$14/$23	$6/$9
Scenario Two Decline	$54/$84	$16/$27
Scenario Three Decline	$362/$508	$126/$192
Total Decline Scenario 1 Scenario 2 Scenario 3	 **1) $279 to $646** **2) $904 to $1,648** **3) $7,285 to $8,754**	 **1)$215 to $487** **2)$674 to $1,237** **3)$5,568 to $6,609**

* See Appendix III. Distances of 1-mile and 1-to-3-mile properties are combined.
**Dollar amounts show expert opinion of lenders/appraisers, in that order, applied to current market value of adjacent properties.

The findings of this research indicate that increasing the severity of potential nuclear waste transportation events results in significantly larger impacts on property values. There is compelling evidence that property value impacts in Clark County could be substantial and that, in the event of a serious nuclear waste accident, estimated losses for the three property types could exceed $6.6 billion along the Beltway route and $8.7 billion along the I-15 corridor.

Washoe County Property Value Impacts

The Washoe County Assessor's data included 132,778 land parcels with a total assessed value of over $9.4 billion. Of these parcels, $8.1 billion falls within the 3-mile Interstate 80 corridor, which is a potential shipment route for SNF and HLW. The impacts on property values addressed three land use types in Washoe County - residential properties, commercial-office, and light industry.[8]

[8] As with Clark County, other property types were not included in the study. Therefore, the findings can be expected to underestimate potential impacts.

Table 3.2.4 Washoe County Transportation Impacts on Adjacent Property Values (in millions $)*

Transportation Route	Highway
Residential Market Value	$6,672
Scenario One Decline**	$71.5/$149.20
Scenario Two Decline	$224.8/$367.5
Scenario Three Decline	$1,563/$1,835.5
Commercial Market Value	$459
Scenario One Decline	$2.5$11.5
Scenario Two Decline	$13.5/$26.7
Scenario Three Decline	$92.2/$127.5
Industrial Market Value	$864
Scenario One Decline	$6.3/$13
Scenario Two Decline	$37.2/$51.1
Scenario Three Decline	$209.7/$264.4
Total Decline Scenario 1 Scenario 2 Scenario 3	 **1) $80.3 to $173.74** **2) $275.5 to $445.3** **3) $1,864.9 to $2,227.4**

* Appendix IV. Distances of 1-mile and 1-to-3-mile properties are combined.

**Dollar amounts show expert opinion of Lenders/Appraisers, in that order, applied to current market value of adjacent properties.

As in the Clark County evaluation, to calculate diminution estimations for Washoe County, property loss factors for each of the three scenarios were applied to parcels within the one-mile corridor and multiplied by the total assessed value for each of the land uses addressed. Similar calculations for the corridor of one to three miles from the route were undertaken. The sum of these calculations is the estimate of property value diminution for the three miles from the route that can be anticipated if nuclear waste shipments occur through Washoe County. Table 3.2.4 shows the potential property value losses in market value by property type and scenario within a 3-mile distance from the shipment route.

Under a Scenario 3 event, it is possible that property losses in market value could exceed $2.2 billion.

Elko County Property Value Impacts

The property value impact study for Elko County examined property parcels within the Elko municipal area. All parcels are within three miles of the interstate highway that would be used to transport high-level nuclear waste. To be consistent with the methodologies used in Clark and Washoe Counties, the evaluation considered three land use types (residential, commercial-office, and light industrial), two distance factors (one mile and one to three mile distances from the route), and the three transportation scenarios.

Table 3.2.5. Elko Highway Transportation Impacts on Adjacent Property Values (in thousands $)*

Transportation Route	Highway
Residential Market Value	$308,050
Scenario One Decline**	$6,402/$11,490
Scenario Two Decline	$19,827/$24,715
Scenario Three Decline	$98,965/$115,478
Commercial Market Value	$13,354
Scenario One Decline	$55/$303
Scenario Two Decline	$374/$698
Scenario Three Decline	$2,120/$3,052
Industrial Market Value	$35,028
Scenario One Decline	$252/$521
Scenario Two Decline	$1,501/$2,062
Scenario Three Decline	$8,446/$10,624
Total Decline Scenario 1 Scenario 2 Scenario 3	 **1) $6,709 to $12,314** **2) $21,702 to $27,475** **3) $109,531 to $129,154**

* See Appendix IV. Distances of 1-mile and 1-to-3-mile properties are combined.

**Dollar amounts show expert opinion of Lenders/Appraisers, in that order, applied to current market value of adjacent properties.

Table 3.2.5 shows the results of the property value diminution in market value that are likely to result from transporting nuclear waste through Elko County. Property value impacts for the entire 3-mile corridor would result in estimated losses of over $115 million in fair market value for residential property, $3 million for commercial property and $10.6 million for industrial property. In all, Elko County property values losses along the I-80 corridor could total more than $129 million.

3.3 Other Economic Impacts

In addition to negatively impacting Nevada's visitor economy and property values along transportation routes, the federal high-level nuclear waste program would also affect the State's economy in a number of other ways. Even the so-called beneficial effects of a program of this size (i.e., jobs, program spending, etc.) would have negative overall impacts on Nevada's economy. This is because, under the State's tax structure, repository-related increases in population would cost the State and local governments more for providing public services than they provide in revenues, a difference of between $670 and $1,000 per person, per year (as estimated in 1990).[9] If these very conservative figures are applied to the estimated Yucca Mountain-related peak population increase of 3,716 (per DOE's Draft Yucca Mountain Environmental Impact Statement), the project, absent any other impacts, would cost the State and local jurisdictions between $2.5 million and $3.7 million annually. This is a consequence of the "standard effects" of the project and is separate from and in addition to any stigma-induced economic effects that may occur during the life of the program.

Not only would the Yucca Mountain program act as a net drain on State and local revenues, but the overall negative impact to Nevada's economy would not be mitigated by future increases in Yucca Mountain-related economic activity. Even the "positive" aspects of this program would result in negative overall impacts to the State.

Further, studies show that Yucca Mountain site characterization has been a very minor contributor to the state's economy, and that the construction and operations phases of the project would be minor contributors as well. The program's contribution to statewide gross regional product (GRP) is only 0.2%, as compared to 35% for visitor spending. The per dollar contributions are also small compared to visitor spending:

- At $1.33, statewide GRP per dollar of YMP appropriation is 48% below GRP per dollar of visitor spending.
- At 5.5 cents, net state government revenue per dollar of YMP appropriation is 48% below that of visitor spending.
- At 0.9 cents, net local government revenues are about 41% below that of visitor spending.

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[9] The dependence of Nevada state and local jurisdictions on revenue contributions of visitors is unique and results from the fiscal structure of the state. Other economic developments, private or public, that do not expand the contributions of visitor spending also would have negative fiscal impacts. Public expenditures per person would have to be provided for repository-related population in excess of the revenues that these people would contribute through taxes, fees, etc. This means that, in the absence of payments made by DOE for mitigation or compensation or changes in the Nevada tax/revenue structure, the repository program would consistently produce significant negative fiscal impacts even without negative stigma-related effects.

These comparisons reflect the historical fact that Nevada's economic and revenue bases are built around the visitor-gaming economy. While the Yucca Mountain project provides a certain amount of employment and procurement, the structure of Nevada's economic and revenue base limits its contribution to the GRP or to state/local revenues.

This finding has important implications with regard to the program's potential to result in severe economic consequences to Nevada. If, as State research has shown likely, the Yucca Mountain program is responsible for the loss of economic activities linked to the visitor sector (i.e., conventions, visitors and tourists, new visitor-related projects such as hotels and casinos), not only would the federal program act as a net drain on State and local revenues, but the overall impact to Nevada's economy would not be mitigated by future increases in Yucca Mountain-related economic activity. In this regard, even the "positive" aspects of this large, multi-year federal program would result in negative overall impacts to the State.

3.4 Impacts to State of Nevada Agencies

The Yucca Mountain repository project, even if it were not accompanied by risk/stigma effects, would act as a net drain on the State of Nevada's General Fund. The direct costs of preparing for and dealing with the project and the massive nuclear waste shipping campaign that would accompany it would be staggering for State agencies. Estimates for start-up costs plus the costs associated with the first year of operations exceed $657 million. The total costs to agencies over the forty-year life of the Yucca Mountain shipping campaign would likely be in the range of several billion dollars.

Beginning in 1987, the State of Nevada, through the Agency for Nuclear Projects, funded a series of studies designed to project the fiscal impacts on Nevada State agencies from the siting of the high-level nuclear waste repository at Yucca Mountain. While the studies employed a combination of methods, the basic methodology for these studies included a mandate driven approach that utilized scenarios in order to project impacts and their fiscal costs to state agencies (Mushkatel and Pijawka, 1995) combined with the more traditional fiscal impact analysis used by municipalities in forecasting public costs resulting from increased demands caused by growth. (Advisory Commission on Intergovernmental Relations, 1992; Ross and Thorpe, 2000; Urban Environmental Research, 2001a).

The costs of preparing for and dealing with the project and the related massive nuclear waste shipping campaign would be staggering for State agencies. Estimates for start-up costs plus costs associated with just the first year of operations exceed $657 million. The total costs to agencies over the forty-year life of the Yucca Mountain shipping campaign would be in the range of several billion

Three separate series of studies were undertaken to assess potential fiscal impacts of the Yucca Mountain project on State of Nevada agencies. While these studies were done at different times and utilized slightly different assumptions regarding the nature and timing of repository events, the fundamental elements of the research are consistent enough to permit findings to be discussed in an integrated fashion.

1998 and 2001 Cost Studies

In 1998, research on potential cost impacts of the Yucca Mountain program was conducted for four other State agencies: the Nevada Department of Transportation (NDOT), the Nevada Highway Patrol (NHP), the Division of Emergency Management (DEM), and the Nevada Public Service Commission (PSC) (since renamed the Nevada Public Utilities Commission). [See Appendix V] During 2001, fiscal impacts to the Bureau of Federal Facilities (BFF) located in the Division of Environmental Protection (DEP) and the Radiological Health Section (RH) within the Bureau of Health Protection Services within the Nevada State Health Division (NHD) were assessed. [See Appendix VI]

In addition to these studies, additional fiscal impacts were assessed for other State level activities. These included costs to the State of Nevada for ongoing monitoring and technical oversight of the Yucca Mountain project by the Governor's Office through the Agency for Nuclear Projects and two critical health effects monitoring efforts that would be need to be implemented to assure adequate monitoring of the health impacts on Nevada citizens. Fiscal cost projections from the 1998 and 2001 research are provided in Table 3.4.1. The projections are for start up costs and costs of year one operations. The total costs associated with 30 or more years of repository operations would be much greater – several times the amounts shown in Table 3.4.1.

The studies that were done to generate this estimate assumed that the agencies would need to be fully prepared to deal with Yucca Mountain nuclear waste shipments beginning in 2007. The date was selected because legislation was pending in Congress at the time that would have accelerated waste shipments to Nevada and allowed HLW shipments to begin in 2007. The estimates include the costs of gearing up for the shipping campaign plus the operational costs associated with the first year of shipments. The estimates include only the incremental or additional costs State agencies would incur as a result of the Yucca Mountain program. Actual total costs, especially with respect to operational expenses, would be significantly greater.

Table 3.4.1 The 2001 and 1998 State Fiscal Cost Projections

Agency	Personnel	Training	Contractual/ Equip./Other	Purpose/Impact
DEP (Bureau Fed. Facilities) (2001 study)	$1,677,643		$505,566	Annual cost beginning 2007-monitoring site-AIP is Model $103 million over 30 years
NHD (Radiological Health Section) (2001)	1,051,439		71,829	Annual Cost beginning 2007-Monitor POE-total has $15,545 of miscellaneous-$53 million over 30 years
Agency for Nuclear Projects (2001)	1,375,000		11,770,700	Continuing technical and regulatory oversight-per annum cost computed at 3% increases from 2001
			2,957,782	Urban Health Effects Monitoring-Clark County-start-up and development costs
	591,556		134,009	Annual costs of the Clark County health effects Monitoring beginning 2006
			1,971,855	Rural Health Effects monitoring for 15 counties @100,000 per community start-up
			938,978	Annual cost of rural health effects monitoring studies beginning 2006
	125,197		250,394	State-wide integration & administration for rural monitoring programs-startup and annual cost of $250,394 beginning 2006
NDOT (1998)	156,273		500,302,372	Highway infrastructure upgrades
			35,225,371	Construction of 2 Ports of Entry
			5,743	Equipment for additional personnel
NHP (1998)	3,166,389	2,164,473	2,053,095	Escorts for shipments and POS personnel
			1,818,538	Annual operating expenses-reoccurring
NHP and/or NDOT	152,118		30,224,698	Emergency Communications System including annual operations costs
DEM (1998)	501,821	1,619,984	36,298,679	Radiological detection equipment
			522,730	HAZ/MAT vans &equipment
			247,550	Space and operations
PSC (1998)	72,248			One additional rail inspector
Education (1988)			1,727,675	Not all equipment-some ED driven costs
Human Resrcs (1988)			11,920,958	Not all equipment-some ED driven costs
Emplymt Secur. (1988)			1,727,675	Not all equipment-some ED driven costs
Taxation (1988)			3,714,501	Additional programs and personnel
Totals	**$ 8,869,684**	**$3,784,457**	**$ 644,390,698**	**Overall Total: $ 657,044,839 (Start-up + year 1)**

1987 Through 1994 Fiscal Studies

The mandate driven fiscal impact studies from 1987 through 1994 were carried out in three distinct investigations that culminated in a 1995 report that simply identified State agencies that already had or would likely be impacted by a repository siting (Mushkatel and Pijawka, 1995). This 1995 summary deviated substantially from previous

and future efforts in that it attempted to project likely types of mandate impacts that would affect State agencies, rather than actually projecting dollar impacts.

The 1995 summary report is helpful in that it affords insight into the actual number of State agencies that are likely to be affected by the Yucca Mountain project and in what manner. The three distinct investigations during this period were organized as follows:

1. A 1987 study designed to identify those agencies that were already impacted, had undertaken some planning, or had responded to DOE plans. This study used intensive face-to-face interviewing and did make dollar estimates for impacts already sustained. It also provided estimates of costs to the agency if the siting of Yucca Mountain as a repository were to be completed. Finally, State agency impacts were tracked as they migrated down to local governments.

2. A 1988-1989 study extended the earlier 1987 effort by including a number of additional agencies in the investigation as well as updating information for the agencies studied in 1987. The same methodology consisting of case studies and marginal cost analysis using intensive interviews was employed.

3. A 1994 series of individual agency studies that once again updated the cost projections for selected agencies thought to be critical to any State efforts at preparedness. For this study, actual dollar projections were not obtained for the impacts to State agencies. Instead, the likely impacts to State agencies were categorized.

These series of studies identified over thirty State agencies where impacts were likely to occur as a result of the repository program. A summary of agencies identified as impacted through the 1987 – 1994 studies is contained in Table 3.4.2, together with the categories of likely impacts.

Table 3.4.2 The Affected State Agencies by Type of Impact

Agency	Programmatic	Fiscal	Personnel	Planning/Eval.
I. Department of Transportation	I	I	I	I
II. Conservation & Natural Resources				
Division of Environmental Protection	I	I	I	I
Division of Forestry		I	I	I
Agency for Nuclear Projects (reorganized into Governor's Office)	I	I	I	I
Division of Water Resources etc.		I	I	I
Bureau Federal Facilities				I
Bureau Waste Management				
Bureau of Air Quality		I	I	I
III. Department of Library Museum etc.				I
IV. Department of Motor Vehicles and Public Safety				
Division of Emergency Management	I		I	I
Highway Patrol Division	I	I	I	I
Data Processing	?	I	I	I
Registration Division/Motor Carrier	I	I	I	I
State Emergency Response Commission		I	I	I
State Fire Marshal		I	I	I
V. Department of Human Resources				
Radiological Health Section	I	I	I	I
Division Mental Hygiene and Mental Retardation			I	I
VI. Department of Business and Industry—Division of Minerals				P
VII. Nevada Energy Office				?
VIII. Division of Industrial Relations: Occupational Health & Safety Section			?	I
IX. Mine Safety & Training Section				I
X. Division of Agriculture				I
XI. Department of Taxation		I	I	I
XII. Public Service Commission	?	I	I	I
XIII. Attorney General's Office		I	?	I
XIV. Department of Administration		?	I	I
XV. Nevada University System	G			
XVI. State Legislature Budget Office And Various Committees				I
XVII. Indian Commission			?	I
XVIII. Department of Education			I	I

I= Already incurred projected impact; P = possible projected impact; ? = unclear at this time; G = currently receiving direct grants from DOE for research and other activities

While planning and evaluation impacts are most often projected, personnel and fiscal impacts are also quite prevalent. The nature and scope of these impacts are consistent through all of the studies. What is clear from the table is that the number of agencies projected to be impacted by the Yucca Mountain program is very large indeed.

Table 3.4.3 below presents an integrated summary of the various studies and findings with respect to impacts that are likely to occur to State of Nevada agencies as a result of the Yucca Mountain project. Taken together, the research indicates that these impacts would be pervasive and extremely costly to affected agencies.

TABLE 3.4.3 THE INTEGRATED NEVADA PROJECTED GOVERNMENTAL FISCAL IMPACTS

1. Agency	2. Source	3. Data Base	4. Information	5. Major Results	6.Type & Range of Impacts	7. Degree of Potential Impacts
Bureau Federal Facilities	Urban Environmental Research (UER, 2001a)	Mandate Fiscal Impact Projection-Agency Interviews	Benign Scenario to determine impacts on agency	$2,183,209 in personnel & equipment costs starting in 2007	Annual Major impacts to Bureau	Personnel, monitoring and permitting
Radiological Health Section	UER, 2001a	Same	Same	$1,123,268 beginning 2007, $53 million over 30 years	Annual Major impacts-Monitoring Ports of Entry	Personnel, monitoring
Agency for Nuclear Projects	UER, 2001a	Mandate Fiscal Impact Projection-Agency Interviews	Same Benign Scenario	$19,176,493 in Monitoring, Health Effects in Clark Co. and Rural Counties, personnel, equipment and start-up costs, annual costs high	Severe Impacts-Health effects Monitoring studies are annual costs-see Table - Regulatory Oversight	Oversight mandate involves agency in a wide variety of activities
Nevada Department of Transportation	PIC & Mushkatel, 1998	Mandate Fiscal Impact Projection Agency interviews	Interim Storage Scenario—no Accidents	$535,689,759 projected fiscal impacts in infrastructure	Severe Impacts equipment, Engineering costs-personnel	
Nevada Highway Patrol	PIC & Mushkatel, 1998	Same	Interim Storage Scenario-no accidents	$39,579,311 projected fiscal impacts	Severe Impacts-included State Emergency Communication System	Escort Vehicles and personnel, training, annual operating expenses occurring
Nevada Division Emergency Management	PIC & Mushkatel, 1998	Same	Interim Storage Scenario-no accidents	$39,190,764 Projected fiscal impacts	Severe Impacts-Rad Detection Equipment Training, Haz/Mat Van	See Table
Public Service Commission	PIC & Mushkatel	Same	Interim Scenario No accident	$72,248 fiscal impacts	Minor	Mission changing

3.5 Impacts to the Public Safety Sector

The Fiscal Impacts to Clark County Public Safety Agencies

Local government public safety agencies would bear the brunt of fiscal impacts associated with preparing for and dealing with the massive SNF and HLW shipping campaign that would accompany a Yucca Mountain repository. In Clark County alone, the incremental costs of preparing for shipments, excluding operational expenses associated with responding to the actual shipments themselves, are estimated at approximately $360 million. Statewide, public safety agencies' costs associated with the federal program would likely total several billion dollars over the life of the shipping campaign.

In Clark County alone, the incremental costs of preparing for shipments, excluding operational expenses associated with responding to the actual shipments themselves, are estimated to be at least $360 million. Statewide, public safety agencies' costs associated with the federal program would likely total several billion

The same technique used for estimating the State agency fiscal impacts (referred to as the mandate approach at the State level) that utilizes marginal cost analysis through a case study technique was applied to the public safety agencies in Clark County.[10] The study focused on assessing only the incremental or additional costs to public safety entities within Clark County that would be directly attributable to the siting of the repository at Yucca Mountain and the subsequent shipping campaign. Impacts to public safety agencies in other counties are summarized in Chapter 4 and addressed in more detail in the individual county reports included in Appendix VII.

Three scenarios were presented to public safety personnel in the County that described the "future" shipping campaign. They were then asked to describe how the events in each scenario would affect their respective agencies. The major characteristics of each scenario can be found in Table 3.5.1.

[10] As the largest metropolitan area to be impacted by Yucca Mountain-related waste transportation, and as the most densely populated region in Nevada, Clark County public safety agencies are expected to be the most heavily impacted in the State. In addition, Clark County agencies have mutual aide and other agreements with various other jurisdictions that will be heavily affected by SNF and HLW shipments, including Nye County (the situs jurisdiction) and Lincoln County (the location of a potential intermodal facility).

Table 3.5.1 The Scenarios Major Characteristics

Scenarios	Description
1	No accident of any kind has occurred. However, anti-nuclear environmental groups and property owners along the route (who claim that their property values would decrease) have generated considerable publicity.
2	Shipments of nuclear waste to the Yucca Mountain repository site have progressed for several years without incident. Three days after New Year's Day 2010, the driver of a truck transporting nuclear waste loses control of the vehicle and runs into the median of Interstate 15. The cask containing the nuclear waste breaks away from the trailer and skids 50 yards along the median of I-15 in North Las Vegas. The cask remains intact and no radiation is released, but the national media covers the event heavily.
3*	An accident involving a truck carrying spent nuclear fuel and a gasoline tanker on I-15 near the Las Vegas Strip. The accident triggers a chain reaction collision. Twenty-seven civilians, four sheriff's deputies, and seven firefighters are hospitalized after exposure to radiation at the site of accident. Another 1,000 or more persons are exposed to radiation from the fire's radioactive plume. Experts indicate that 5 to 200 latent cancer fatalities may result from the accident. The affected highway and several access ramps are closed for four days. The two drivers of the spent fuel hauler and the gasoline tanker, and one driver-escort, died from head injuries and burns. Six months later, the cleanup effort is still under way, and thousands of lawsuits have been filed. Preliminary reports estimate cleanup costs and economic losses in excess of $1 billion.

*Source: State of Nevada, Agency for Nuclear Projects

The major characteristics of each scenario are based on the DOE Draft Environmental Impact Statement for the Yucca Mountain project. The location of the accident (in Scenarios 2 and 3) varied, depending on which community was being studied. Public safety officials consisting of firefighters, police officers, and emergency management personnel from Clark County, the City of Las Vegas, Henderson, North Las Vegas, Boulder City, Mesquite, and the Moapa Band of Paiutes participated in the study (Urban Environmental Research, 2001a, b, c, d, e, f, g). Additional data on the vulnerability and capacity of hospitals in southern Nevada were also collected, but no fiscal cost estimate was projected for them.

The results of the series of studies reveal major negative impacts on the public safety agencies within Clark County and its local jurisdictions. One important finding is that none of the public safety agencies studied is currently adequately prepared or equipped to respond to any of the three HLW shipping scenarios used in the study. This lack of adequate preparation is consistent with the 1995 Public Safety Advisory Committee's report examining public safety needs in the county. Table 3.5.2 provides a summary of the projected fiscal impacts from the maximum reasonably foreseeable

accident (MRFA) under Scenario 3 on the police departments in the entities being examined.[11]

Table 3.5.2 Projected Fiscal Impacts Costs on Police Departments in Clark County

	Personnel	Training	Equipment	Cost
Clark County	$17,582,464	$8,080,604	$42,023,301**	$67,686,369
Las Vegas	*	*	*	*
North Las Vegas	0	711,021	0	711,021
Henderson	510,195	0	442,232	952,427
Mesquite	1,876,446	34,754	917,760	2,828,960
Boulder City	186,000	18,880	200,000	404,880
Moapa	0	0	0	0
Totals	**$20,155,105**	**$8,845,259**	**$43,583,293**	**$72,583,657**

* Las Vegas Metro provides services to both Clark County and the City of Las Vegas

** Equipment includes capital costs

Source: *Impacts to Clark County and Local Governmental Safety Agencies Resulting from the Yucca Mountain Project.* A Clark County Nuclear Waste Division, Comprehensive Planning Department Report, prepared by Urban Environmental Research LLC: 2001.

As can be seen from Table 3.5.2, the major impact on police departments is on the Las Vegas Metro Department, the largest force in the State. The projected impacts for this department are over $67 million. The total for all of the police forces examined is more than $72.5 million (for details see Urban Environmental Research, 2001a, and the series of reports issued by Clark County on each of these projected fiscal impacts).

Table 3.5.3 presents the projected fiscal impacts on fire departments in Clark County to prepare for a Scenario 3 event. As can be seen from the table, Clark County's Fire Department estimates fiscal impacts of over $195.8 million dollars. These costs are, in part, driven by the large geographic area encompassed by the county, much of it in remote areas that the Fire Department must be prepared to serve. The total projected cost to fire departments is over $275 million.

Table 3.5.3 Projected Fiscal Impact Costs on Fire Departments in Clark County

	Personnel	Training	Equipment	Cost
Clark County	$25,991,241	$13,615,031	$156,289,783**	$195,896,055
Las Vegas	5,711,370	4,044,588	34,840,835	44,596,793
North Las Vegas	3,851,129	5,121,073	13,449,200	22,421,402
Henderson	140,592	70,296	75,045	285,933
Mesquite	1,874,429	333,133	1,943,889	4,151,451
Boulder City	0	0	0	0
Moapa	1,791,292	94,584	6,152,768	8,038,644
Totals	**$39,360,053**	**$23,278,705**	**$212,751,520**	**$275,390,278**

[11] It should be noted that the State level cost projections discussed above were done assuming the benign scenario would be applicable. The cost projections in Table 2-9 are based on what is believed necessary to be prepared for a Scenario 3 event. Hence, the fiscal cost projections for the State agencies are much lower than would be the case if the MRFA had been used in those studies.

** Equipment includes capital costs
Source: *Impacts to Clark County and Local Governmental Safety Agencies Resulting from the Yucca Mountain Project.* A Clark County Nuclear Waste Division, Comprehensive Planning Department Report, prepared by Urban Environmental Research LLC: 2001.

The projected fiscal costs to Offices of Emergency Management in Clark County can be found in Table 3.5.4. While emergency management functions are housed within fire departments, these offices maintain identifiable staff and functions separate from the larger fire department. As can be seen from the table, the estimated projected fiscal impacts on emergency management offices to be prepared for a MRFA event by the year 2007 is just over $12 million.

Table 3.5.4 Projected Fiscal Impact Costs on Offices of Emergency Management

	Personnel	Training	Equipment	Cost
Clark County	$340,340	$9,552	$10,264,493**	$10,614,385
Las Vegas	561,265	0	0	561,265
North Las Vegas	0	207,623	0	207,623
Henderson	61,463	13,401	73,705	148,569
Mesquite	0	0	0	0
Boulder City	0	0	0	0
Moapa	203,353	0	277,500	480,853
Totals	**$1,166,421**	**$230,576**	**$10,615,698**	**$12,012,695**

** Equipment includes capital costs
Source: *Impacts to Clark County and Local Governmental Safety Agencies Resulting from the Yucca Mountain Project.* A Clark County Nuclear Waste Division, Comprehensive Planning Department Report, prepared by Urban Environmental Research LLC: 2001.

Table 3.5.6 presents a summary of projected costs to these Clark County public safety entities, along with the Moapa Band of Paiutes.[12]

Table 3.5.6 Total Projected Costs by Community/County

	Police	Fire	Emergency Management	Cost
Clark County	$67,686,369	$195,896,055	$10,614,385	$274,196,809
Las Vegas	*	44,596,793	561,265	$45,158,058
North Las Vegas	711,021	22,421,402	207,623	$23,340,046
Henderson	952,427	285,933	148,569	$1,386,929
Mesquite	2,828,960	4,151,451	***	$6,980,411
Boulder City	404,880	**	**	$404,880
Moapa	N/A	8,038,644	480,853	$8,519,497
Totals	**$72,583,657**	**$275,390,278**	**$12,012,695**	**$359,986,630**

* Las Vegas Metro provides services to both Clark County and the City of Las Vegas
** Because of the projected distance to the HLW shipment corridor, Boulder City estimated impacts only for the Police Department.

[12] The Moapa Bad of Paiutes occupy reservation land that encompasses stretches of both I-15 and the Union Pacific main railroad in Clark County. The Band maintains a separate fire and emergency response capability and must be prepared to deal effectively with a nuclear waste accident on reservation lands.

*** In Mesquite, Emergency Management is a function of the Fire Department and thus costs are combined under Fire.
Source: UER

As can be seen from the tables, the fiscal impacts from siting the repository at Yucca Mountain on the public safety agencies are extraordinary. The total cost to community/county public safety agencies is projected to be almost $360 million. This includes just the start up costs for responding to a Scenario 3 event. The projection does not include costs that would be incurred annually in response to the continued operation of a repository and the transportation of HLW. These estimates do not include the fiscal impacts to the southern Nevada hospitals that are not adequately prepared in terms of training, decontamination facilities, and other necessary personnel and equipment.

3.6 Impacts to Native American Communities

Native American tribes in the immediate vicinity of the Yucca Mountain project area and along potential transportation routes are, for the most part, economically disadvantaged. Reservations and communities in Nye, Clark, Lincoln, and Inyo counties are rural and isolated, and either lack a land base or have land bases too small to support their populations by ranching or other locally common means. A large number of people are unemployed, underemployed, and/or living below the poverty level. Educational levels have improved in recent years, but without job opportunities in local communities, people must leave to take advantage of their training. Any negative statewide economic impacts associated with or caused by the repository or repository-related nuclear waste transportation would have a disproportionate impact on such communities because of these depressed baseline conditions.

Native American communities are extraordinarily vulnerable to negative impacts associated with the Yucca Mountain project and nuclear waste transportation. Any negative statewide economic impacts associated with or caused by the project would have a disproportionate impact on such communities because of their depressed baseline conditions.

Major Native American concerns and issues include the following: (1) lack of any type of voice other than the most minimal in the siting of this repository; (2) lack of any designation and funding by DOE as "affected tribes" to conduct their own studies; (3) vulnerabilities of rural reservation tribes and persons to specific economic and health effects based on their cultural subsistence patterns (cattle, local plants, animals); (4) vulnerabilities of rural and urban populations and lands to contamination of reservation and aboriginal lands and water from repository and transportation-related accidents and incidents; (5) fiscal impacts to tribal governments to provide emergency preparedness equipment and services as well as social services to members for stress and loss of quality of life; (6) fiscal impacts to tribes for loss of present as well as potential economic revenue; (7) fiscal impacts to tribes to develop technological infrastructure to deal with the requests for monitoring; (8) vulnerabilities to further cultural loss, based on fear of engaging with their lands as previously; (9) violation of treaty rights and individual rights and international law in the repository construction and operation; and (10) further erosion of trust in government to respect tribal sovereignty and land and resource dignity. Impacts to Native American communities are addressed in more detail in Chapter Three.

3.7 Environmental Impacts

Environmental impacts of the federal high-level nuclear waste program in Nevada are driven largely by the construction and operation of facilities for transporting spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain repository site. As such, this section of the State Impact Report should be interpreted in conjunction with the discussion of transportation impacts contained in section 3.8, below.

The lack of definition with respect to the transportation system DOE proposes to use to ship waste to Yucca Mountain makes the assessment of environmental impacts extraordinarily difficult. The "system" described in the draft Yucca Mountain EIS is in reality a series of alternatives involving various highway and rail routes, differing modes of transport, alternative rail spur corridors, and alternative intermodal/heavy-haul transport (HHT) facilities and routing options. Even the number and types of shipments are left undefined and uncertain, with ranges that make planning and impact assessment extremely problematic.

The Yucca Mountain program, especially the transportation elements of that program, is a potential major source of environmental impacts that would affect wide areas of the State, both rural and urban. Absent a complete and adequate evaluation of the environmental impacts associated with the Yucca Mountain program, any recommendation to move ahead with the repository project in Nevada is not only premature, but also legally deficient.

The discussion of environmental impacts contained in this report is to be governed by the following caveat: The assessment of environmental impacts is necessarily done at a very general level of analysis. It is by no means complete, comprehensive, or definitive. The discussion is included to demonstrate that the Yucca Mountain program, especially the transportation elements of that program, is potentially a major source of environmental impacts that would affect wide areas of the State, both rural and urban, if this project is permitted to go forward. It is Nevada's contention that, absent a complete and adequate evaluation of the environmental impacts associated with the Yucca Mountain program, any recommendation to move ahead with the repository program in Nevada is not only premature, but also legally deficient.

DOE's HLW Transportation System

The U.S. Department of Energy's Draft Environmental Impact Statement for Yucca Mountain (DEIS) identified fourteen "implementing alternatives" for possible use in transporting HLW and spent nuclear fuel to the Yucca Mountain site. These implementing alternatives were defined as potential rail, heavy-haul, or legal-weight truck. While the transportation corridors are identified in the referenced DEIS, DOE has yet to disclose HLW shipment numbers, modal mix, and the specific resources that would be impacted along routes in Nevada or the national as a whole. In effect, DOE has not

demonstrated the technical, economic, or environmentally acceptable feasibility of transporting spent nuclear fuel and HLW waste to the proposed repository in Nevada. Absent this information, communities throughout Nevada and the nation, which could experience HLW transportation related impacts, have no way of determining the level and type of impacts that might occur. Example of such impacts might include:

- Release of radiation due to a transportation accident or terrorist attack and the resulting costs for assessing radiation doses to humans and/or contamination of the natural environment;

- Fiscal impacts to State and local agencies responsible for addressing HLW transportation accidents caused by human error and/or natural disasters for both highways and railroad accidents; and,

- Impacts to the environment and subsequent loss of productive resources caused by hundreds of miles of rail line construction. Examples include effects on endangered species, contamination of surface and groundwater resources, degradation of soils and vegetation, impacts to archaeological resources, despoiled wildlife habitats, declines in usable grazing allotments, and restrictions on mining exploration and development.

Since risk assessments and environmental impact analyses have not been performed for each potential rail corridor or highway route in Nevada, or the nation as a whole, DOE has deferred the legally required analysis for selecting a preferred HLW transportation route(s). This means the Department has sidestepped the legally required process for disclosure of environmental impacts for shipping HLW to Nevada (see 10 CFR 1021).

State officials contend that such information and analysis is needed to define the minimum and maximum environmental risks associated with moving spent nuclear fuel and HLW to a repository at Yucca Mountain. Defining such impacts is an essential component in determining HLW modal-mix and routing decisions. To date, however, this decision making process has been ignored by DOE. Moreover, State officials contend that construction in Nevada of a rail line, intermodal waste transfer facility, and/or road reconstruction to support heavy haul trucks cannot be completed without environmental impacts that may or may not be amenable to mitigation. Yet without a detailed description of those construction activities, it is impossible to assess impacts and evaluate how or whether they can be safely and legally managed.

Areas of Environmental Impact

Air Quality: In terms of air quality impacts, the Las Vegas Valley has been classified by the U.S. Environmental Protection Agency as a serious non-attainment area for carbon monoxide (CO) and particulate matter (PM10). Because Clark County is in non-attainment for air quality emissions, the pollutants generated by the Yucca Mountain

project are of concern. While the referenced DEIS did translated some of the air quality impacts into fatalities estimates, air quality impacts important to Clark County for regulatory purposes (i.e., community growth) were not considered in the DEIS.

The construction and operation of transportation facilities to support the Yucca Mountain project would greatly affect the ability of Clark County to meet national air quality standards. Failure to meet these standards would harm the community's ability to obtain federal funding for transportation facilities and would generally harm the quality of life in Clark County.

Vehicular emissions are the primary source of CO pollutants in the Las Vegas Valley. In addition to vehicle miles of travel, traffic congestion is also a significant contributor to increased CO emissions. Over 35 million tourists visit Las Vegas each year, which translates to an at-capacity traffic situation throughout most of the major interstate road systems in Las Vegas Valley -- including all systems that would be used to move spent fuel and HLW to Yucca Mountain.

As noted in the repository DEIS, the Department is considering using heavy-haul trucks on existing highways as one option for delivering spent fuel and high-level nuclear waste to Yucca Mountain. Under this scenario, nuclear waste would be delivered by rail and then transferred to heavy-haul tractor-trailers at an intermodal transfer station. DOE has proposed three possible locations for intermodal transfer stations: Caliente, located in Lincoln County; Apex/Dry Lake, located north of Las Vegas; and Sloan/Jean, located south of Las Vegas. Five possible routes along existing highways would be used to move the waste from an intermodal station to Yucca Mountain. One-way travel distances for these routes range from a low of 114 miles (Apex/Dry Lake) to 330 miles (Caliente). The heavy-haul tractor-trailer would be 220 feet in length, with an unloaded weight of 200,000 pounds. (For comparison, a commercial semi-truck hauling triple trailers is only 115 feet in length and grosses 80,000 pounds.) In terms of potential threats to increasing air pollution in the Las Vegas Valley, the operation of DOE's "heavy-haul truck" alternative would cause enormous traffic delays that would greatly impact air quality in the local air basin. Because heavy-haul trucks travel at 20 to 30 mph, they would cause significant delays and slow traffic substantially. These delays would multiply by causing additional delays for the vehicles following the heavy-haul trucks. Cars would be unable to pass the heavy-haul trucks, and the congestion caused by those trucks would dissipate slowly.

The impacts on air quality due to heavy-haul and legal-weight truck shipments would be very substantial in Las Vegas -- given the State's intent to have all HLW waste shipments escorted by the Nevada Highway Patrol. Needless to say, DOE has yet to fully assess the air quality impacts in the Las Vegas Valley from the various transportation alternatives defined for moving HLW and spent nuclear fuel to Yucca Mountain.

Wildlife Habitat: DOE has yet to clearly define specific effects to biological resources, which would result from construction and operation of new rail lines, intermodal transfer

stations, and/or road reconstruction activities needed to support heavy-haul trucks. State officials note that several transportation corridors cross or pass near crucial habitats for sensitive species including big game and wild horses. Examples of critical habitats include bighorn sheep crucial winter range, mule deer crucial winter range, pronghorn winter range, sage grouse strutting areas, sage grouse nesting areas, and chucker and quail crucial habitat. Frequent trains passing through or near to crucial habitat areas could significantly reduce the value of that habitat even though the habitat was not physically disturbed by construction or operation. The region of influence for biological resources must include all habitats potentially affected, not just disturbed by construction and operation of a rail line, intermodal waste transfer facility, or areas affected by road reconstruction to support use of heavy-haul trucks.

Range Resources: Most ranching operations in Nevada are based on a combination of privately owned lands and grazing leases on publicly owned lands (i.e., grazing allotments). In many, if not all cases, these ranching units depend on grazing allotments to be economically viable. Splitting an existing operation with a rail line that would limit access to the leased land can have significant adverse effects on the operation of the ranch. The degree of impact from splitting a ranching operation would be much greater if the railroad right-of-way is fenced. The DEIS and supporting DOE documents contain conflicting information regarding whether or not railroad right-of-way would be fenced.

Cultural Resources: State officials note that archaeological inventories and testing have occurred at Yucca Mountain itself, as part of site characterization activities; however, historic property surveys meeting the Secretary of Interior's standards have not been conducted for the railroad corridors. The question of whether any of the rail routes were used historically as transportation routes has not been answered. This means that direct impacts would occur as a result of the construction of new rail lines, and yet DOE has not identified potential effects on historic or cultural landscapes from rail line construction. The same situation exists for highway corridors and intermodal transfer sites. DOE has not provided sufficient data to determine the location and number of historic properties that would be impacted by spent fuel and HLW shipping routes and modes. DOE must consult with the State Historic Preservation Office and must prepare a new programmatic agreement that details how it would identify, evaluate, and treat historic properties and how the consultation process would occur. This process must be accomplished before Nevada can assess the environmental and fiscal impacts of HLW transportation on cultural resources.

Vegetation and Soils: Since DOE has avoided a detailed analysis of the rail line corridors and heavy-haul transportation routes for moving spent fuel and HLW to a repository in Nevada, there has not been a rigorous analysis of potential impacts caused from the spread of noxious weeds or invasive plant species. The disruption of soils that would result from rail spur construction, heavy-haul highway improvements, and other activities that facilitate or promote the proliferation of noxious weeds and invasive plants are issues of significant concern in Nevada. Once a population of noxious weeds is in place, Nevada's open range can become highly susceptible to repeated occurrences of wild land

fires. When this occurs, the highly fragile ecological balance between natural vegetation and soils is lost.

Groundwater: DOE has avoided a discussion of groundwater impacts associated with the transportation of spent nuclear fuel and HLW to a repository in Nevada. Most of the rail corridors proposed by DOE traverses rugged terrain where significant cuts would be required. While these cuts could intercept groundwater flow, DOE has not provided sufficient information on the actual routes and the location and depth of cuts to assess these potential impacts. In addition, DOE has yet to recognize the fact that an accident during waste transport could result in long-term impacts to surface water and groundwater resources.

Leaseable Minerals & Energy Resources: DOE has yet to evaluate the costs and environmental impacts of obtaining material for rail bed construction. To maintain required grades for a rail line, significant cut and fill would be required. Cut material would be used as fill; however, additional fill requirements (sub-ballast) would likely require development of borrow areas outside of the rail line right-of-way. In cases where terrain crossed by rail lines is relatively flat (e.g., the Carlin route), significant borrow material would be needed to construct the rail bed. DOE has not, however, identified a source for sub-ballast material; moreover, while such material is usually obtained locally from gravel pits, this would likely not be the case in many remote areas of central and southern Nevada. In some situations, obtaining borrow materials could affect groundwater resources as well, thus triggering permitting for reclamation actions. Once again, none of these issues have been adequately address by DOE.

In terms of energy resources, DOE has acknowledged that the existing electric power services are inadequate to serve a repository at Yucca Mountain. The environmental impacts of obtaining power upgrades have simply not been defined or evaluated in terms of costs and/or environmental impacts.

Land Use: DOE has not accurately identified or assessed the land use impacts of HLW transportation alternatives in Nevada. Even where DOE has identified land use impacts, the Department has understated the nature and severity of the impacts. The failure by DOE to accurately describe a proposed action in the repository DEIS for moving spent nuclear fuel and HLW to a repository in Nevada severely limits state and local authorities in developing an adequate assessment of land use impacts. For example, the land use impacts associated with the development of sand and gravel resources, solid waste disposal facilities, construction lay-down areas, and construction staging areas cannot be assessed until these areas are identified.

For linear facilities such as a rail line, an assessment of land use impacts must include costs associate with right-of-way and private land acquisitions as well as an evaluation of the impacts of bisecting current and future land uses. Splitting an area with a rail line can have significant impacts on the entire area, not just the area within the right-of-way. This is particularly true for ranching and mining operations.

Since DOE has not selected a proposed rail route, the State cannot define land use impacts at roads and rail crossings, at construction initiation points, and at construction camps. In addition, a new rail line across Nevada would require construction of major structures such as bridges across drainages and highway grade separations. Most of these construction activities would involve the placement of pre-cast concrete structures – yet DOE has not identified locations for siting concrete pre-cast plants.

While DOE has identified a number of land use conflicts with the proposed rail line, the Department has not accurately characterized the impacts. Examples include potential rail corridors through the Simpson Park Habitat Management Area (Carlin rail alternative), the Old Spanish Trail/Mormon Road Recreation Area (Jean rail alternative), and other special use areas such as wilderness study areas and wildlife range (i.e., the Desert National Wildlife Range -- Valley Modified rail alternative). A rail line through any of these special land use areas would have significant impacts on the purpose and use of these special areas, yet DOE has not even discussed these impacts.

In terms of highway transportation of spent nuclear fuel and HLW, DOE has assumed that 0.04 square kilometers could be needed to construct a bypass near Beatty, Nevada. However, the Department has not assessed nor admitted that two additional bypasses would also be required. To avoid risks associated with accident free radiological exposures and transportation accidents, bypasses would need to be constructed to avoid the towns of Tonopah and Goldfield, Nevada. DOE has never considered the requisite environmental impacts or costs associated with construction of these bypasses.

Floodplain and Wetlands: DOE has yet to adequately study the potential surface water impacts of either rail or the heavy-haul transportation alternatives for shipping spent fuel and HLW to a repository at Yucca Mountain. In fact, DOE openly admits that no field searches or formal delineations of wetlands have been conducted along any of the proposed transportation routes. State officials note that some of the alternative rail corridors are known to cross or be near significant springs, groups of springs, streams designated as riparian areas, or reservoirs associated with wetlands.

In addition, potential impacts to wetlands have not been delineated for the intermodal transfer station sites identified by DOE in the repository DEIS. In Nevada, wetlands and riparian areas are unique, scarce resources and are generally considered irreplaceable. While DOE has stated that impacts to wetlands and riparian areas would be mitigated, State officials contend that any loss of these limited resources cannot be replaced or replicated in most areas because of Nevada's arid climate and fragile groundwater and spring sources. Hence, assigning impact assessment costs to lost wetland resources may be impossible.

Impact Assessment and the NEPA Process: The State of Nevada has long opposed DOE's interpretation and implementation of the National Environmental Policy Act (NEPA)

requirements for assessing the Yucca Mountain project, including alternative transportation routes and modes for shipping spent nuclear fuel and HLW (see State of Nevada DEIS comments dated 02/2000). State officials note the DEIS failed to integrate NEPA documentation for the Yucca Mountain project with other ongoing and anticipated federal activities. For example, only biota and soils were addressed in the DEIS, the former only at the population and community levels. Ecosystems were avoided, as was their role in the regional landscape. Consequently, impact analysis was not performed in the context of regional plans to assess the carrying capacity of the region's resources as well as the cumulative effects that could occur from the transportation of HLW to Yucca Mountain.

In fact, DOE's failure to designate a preferred rail access corridor violates the National Environmental Policy Act. NEPA procedures are designed to "insure that environmental information [including information on the human environment as well as public health and safety] is available to public officials and citizens before decisions are made and before actions are taken." DOE's approach for the DEIS denied the affected public a meaningful opportunity to participate in the rail corridor evaluation process before DOE prepares the Final EIS for Yucca Mountain. Moreover, DOE's refusal to narrow the choice of corridors extends the region of influence of the Proposed Action in the DEIS to thirteen Nevada counties traversed by the five rail corridors and their existing mainline rail connections. This means that virtually the entire population of Nevada is being held hostage by DOE's indecision. Yet the Secretary of Energy, per the Nuclear Waste Policy Act, expects Nevada to submit a comprehensive impact assessment report as part of the site recommendation process -- when DOE has yet to adequately evaluate and/or choose a preferred transportation route or modal mix.

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Intergovernmental Institutional Impacts: By not assessing the transportation routes for shipping HLW and spent nuclear fuel to Yucca Mountain, DOE has created a significant impact on other public agencies at the federal, state, and local levels. Without definitive knowledge of DOE's transportation plan, state and local agencies cannot engage in planning practices that would minimize harm in the event of an accident resulting in a radiological release. Such plans should be prepared in accordance with the Statewide Planning/Metropolitan Planning regulations. These statutes require a continuing, comprehensive, and coordinated transportation planning process in the State and metropolitan areas.

Conclusion

Since DOE has not evaluated in detail all potential highway or rail routes in Nevada for waste shipments to Yucca Mountain, with the same level of information and analysis for each, the Secretary cannot consider the minimum and maximum risks to the human and natural environment. Without such consideration, the State of Nevada contends that it is premature to recommend Yucca Mountain as suitable for development as repository for disposal of spent fuel and HLW.

3.8 Transportation Impacts

The transportation of spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain repository site in southern Nevada has the potential to dramatically and significantly impact communities throughout Nevada and across the nation. Depending on assumptions about the mix of shipping modes, handling and shipping capabilities at points of origin (e.g., reactor sites), size of the shipping canister or cask, and other factors, a Yucca Mountain repository, if constructed and opened, would receive between 23,500 and 96,300 shipments[1] of spent nuclear fuel from civilian nuclear power plants and high-level radioactive waste from DOE weapons facilities. The repository would also receive an unknown number of shipments of so-called "miscellaneous wastes requiring geologic disposal," adding to the overall number of radioactive waste shipments that would be required.

Nuclear waste transportation would be the most visible and dramatic "driver" of potential repository impacts. Tens of thousands of shipments would directly impact communities in Nevada and throughout the nation.

Transportation issues are critically important to the State and local Nevada communities. Nuclear waste transportation would be the most visible and dramatic "driver" of potential repository impacts. Despite this fact, DOE has done almost nothing to evaluate impacts, either in Nevada or nationally. The few feeble attempts DOE has made to address the transportation issue, as in the Yucca Mountain DEIS, have been wholly inadequate and designed to obfuscate risks and impacts rather than deal with them forthrightly.

The DEIS identified seven potential highway routes within the State of Nevada for legal- weight truck (LWT) shipments to Yucca Mountain; two existing railroads and five new rail spur corridors for direct rail shipments; and five potential highway routes for heavy-haul truck (HHT) transport of rail casks delivered to three intermodal transfer facilities near existing railroads. Ten of Nevada's sixteen counties could be directly impacted. Tables 3.8.1 – 3.8.3 show potential shipments through southern Nevada when the DEIS routing options are combined with the mostly truck, mostly rail, and current capabilities transportation scenarios. Tables 3.8.4 – 3.8.6 show potential shipments through northern Nevada.

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[1] Under a scenario where most of the waste is shipped using legal-weight trucks, there would be 96,000 truck shipments plus 300 Naval spent fuel shipments that would have to come by rail from Idaho National Engineering and Environmental Laboratory, due to the size and configuration of the Navy packaging. Under a scenario where most waste is transported by rail, there would be 19,800 rail shipments plus 3,700 truck shipments from reactors that are not rail capable. (Both of these shipment scenarios are taken from DOE's Draft Environmental Impact Statement for the Yucca Mountain Repository project, released in August 1999.) Due to the fact that there is no rail access to Yucca Mountain or the Nevada Test Site and the cost of constructing such access could exceed $1 billion, the State of Nevada considers it much more likely that spent fuel and high-level waste would be transported to the site by legal-weight truck.

Table 3.8.1 Potential Shipments Through Nevada Counties, 2010 - 2048: Southern Nevada Routes, Mostly Truck Scenario

County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	95,957	300		300
Carson City				
Churchill				
Clark	95,957			
Douglas				
Elko				
Esmeralda				
Eureka				
Humboldt				
Lander				
Lincoln				
Lyon				
Mineral	95,957			
Nye				
Pershing				
Storey				
Washoe				
White Pine				

Table 3.8.2 Potential Shipments Through Nevada Counties, 2010 - 2048: Southern Nevada Routes, Mostly Rail Scenario

County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	3,701	19,845	19,845	19,845
Carson City				
Churchill				
Clark	3,701	19,845	19,845	19,845
Douglas				
Elko				
Esmeralda			19,845	19,845
Eureka				
Humboldt				
Lander				
Lincoln		19,845	19,845	19,845
Lyon				
Mineral				
Nye	3,701		19,845	19,845
Pershing				
Storey				
Washoe				
White Pine				

Table 3.8.3 Potential Shipments Through Nevada Counties, 2010 - 2048: Southern Nevada Routes, Current Capabilities Scenario

County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	26,375	14,179	14,179	14,179
Carson City				
Churchill				
Clark	26,375	14,179	14,179	14,179
Douglas				
Elko				
Esmeralda			14,179	14,179
Eureka				
Humboldt				
Lander				
Lincoln		14,179	14,179	14,179
Lyon				
Mineral				
Nye	26,375		14,179	14,179
Pershing				
Storey				
Washoe				
White Pine				

Table 3.8.4 Potential Shipments Through Nevada Counties, 2010 - 2048: Northern Nevada Routes, Mostly Truck Scenario

County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	95,957	300		300
Carson City				
Churchill	5,344			
Clark				
Douglas				
Elko	95,957			
Esmeralda	95,957			
Eureka	5,344			
Humboldt	5,344			
Lander	5,344			
Lincoln				
Lyon				
Mineral				
Nye	95,957			
Pershing	5,344			
Storey				
Washoe	5,344			
White Pine	95,957			

Table 3.8.4 Potential Shipments Through Nevada Counties, 2010 - 2048: Northern Nevada Routes, Mostly Rail Scenario

County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	3,701	19,845	19,845	
Carson City				
Churchill	44			
Clark				
Douglas				
Elko	3,701	15,707		
Esmeralda	3,701		19,845	
Eureka	44	19,845	19,845	
Humboldt	44	4,138		
Lander	44	4,138	19,845	
Lincoln				
Lyon				
Mineral				
Nye	3,701		19,845	
Pershing	44	4,138		
Storey				
Washoe	44	4,138		
White Pine	3,701			

Table 3.8.6 Potential Shipments Through Nevada Counties, 2010 - 2048: Northern Nevada Routes, Current Capabilities Scenario

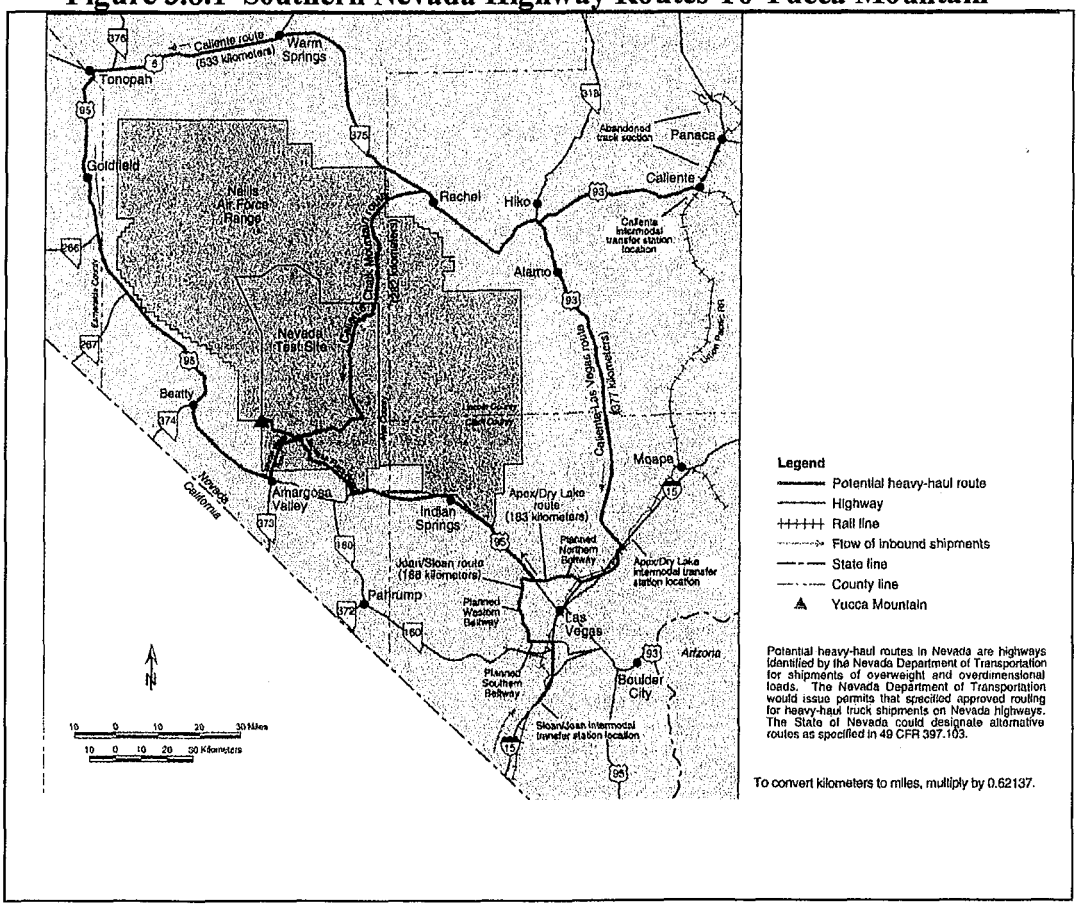
County	LWT	Rail Casks, Existing Lines	Rail Casks, New Access Spur	HHT
State Total	26,375	14,179	14,179	
Carson City				
Churchill	1,352			
Clark				
Douglas				
Elko	26,375	10,384	14,179	
Esmeralda	26,375		14,179	
Eureka	1,352	14,179	14,179	
Humboldt	1,352	3,795		
Lander	1,352	3,795	14,179	
Lincoln				
Lyon				
Mineral				
Nye	26,375		14,179	
Pershing	1,352	3,795		
Storey				
Washoe	1,352	3,795		
White Pine	26,375			

Nevada Highway Impacts

Highway impacts in Nevada would be greatest under the DEIS mostly truck transportation scenario, involving 96,000 legal-weight truck (LWT) shipments of SNF, HLW, and miscellaneous radioactive wastes over 38 years. There would be about 2,526 truck shipments per year, or 7 trucks per day. Under the current capabilities scenario, there would be about 26,400 LWT shipments, an average of 695 truck shipments per year or about 2 per day. The lowest number of truck shipments, under DOE's mostly rail scenario, would be 3,700 LWT shipments over 38 years, or 97 truck shipments per year.

The only highway route currently available for truck shipments to Yucca Mountain under U.S. Department of Transportation's regulations governing route selection for SNF and HLW shipments is I-15 to US 95 via the downtown Las Vegas interchange known as the Spaghetti Bowl. The DEIS assumes that shipments would also use the planned Northern, Southern, and Western Las Vegas Beltways (I-215), although there is debate over the legality of making shipments over these county-funded roadways. The DEIS also identified and partially evaluated six alternative routes that would avoid downtown Las Vegas (see Figure 3.8.1).

Figure 3.8.1 Southern Nevada Highway Routes To Yucca Mountain



This report evaluates the impacts of truck shipments using I-15 and US 95 through downtown Las Vegas. It also evaluates one of the alternative routes identified in the DEIS, referred to as NDOT Route B, by reference to its designation in a 1989 report prepared for the Nevada Department of Transportation [Ardila-Coulson, 1989]. NDOT Route B enters Nevada from Utah on I-80, travels south on U.S. 93A and U.S. 93, west on U.S. 6, and south again on U.S. 95. The route travels through the cities of West Wendover and Ely and the towns of McGill, Tonopah, Goldfield, and Beatty. The distance from the Nevada state line to Yucca Mountain by this route is about 430 miles.

Radiological Impacts Of Routine Highway Shipments

Overall radiological impacts of incident-free shipments would be greatest under the "mostly truck" national transportation scenario. If the Yucca Mountain repository project goes forward, this may be the operative transportation system. Yucca Mountain currently lacks rail access. Construction of a new rail access spur would be difficult and costly, as would heavy-haul truck delivery of rail casks from an intermodal transfer station. All 77 utility and DOE storage sites can ship SNF and HLW by legal-weight truck, and LWT transport is economically competitive with rail transport. DOE's "hot repository" thermal loading strategy, coupled with many utilities' desire to ship SNF to the repository directly from wet storage, particularly favors LWT transport during the first 10 to 20 years of operation.

Radiation exposures allowed under existing regulations, coupled with the large number of LWT shipments, would result in substantial worker exposures, up to 8.5 rem (8,500 mrem) for workers that come in regular contact with shipments.

Truck shipments to Yucca Mountain would contribute to the total radiation exposures received by Nevada transportation workers and by some members of the public along Nevada highway routes. This section of the report, like the DEIS, expresses radiation exposures (effective dose equivalents) in terms of rem or millirem (one-thousandth of a rem). According to the DEIS, the Nevada average annual background radiation from natural sources (radon, rocks and soil, outer space, food and water) ranges from 330 to 390 millirem (mrem), compared to the national average of 300 mrem. [DEIS, Table 3-28, p. 3-81] The average American also receives about 65 mrem annually from medical X-rays and treatments, consumer products, and miscellaneous sources. [DEIS, Figure F-1, p. F-5]

Shipping casks operate under Nuclear Regulatory Commission (NRC) regulations that allow a routine dose rate of 10 millirem (mrem) per hour at 2 meters from the cask surface. One hour of exposure at 2 meters (6.6 feet) produces about the same dose that a person receives from a whole body medical X-ray. For this reason, shipping casks have been called "portable X-ray machines that can't be turned off." The DEIS argues that the actual dose rate from LWT casks would be "50 to 70 percent of the regulatory limits." [DEIS, p. J-48] However, most of the SNF shipped by truck would likely be cooled less than 20 years, with an expected dose rate equal to the regulatory rate. Truck casks fully

loaded with some SNF cooled 10 years or less would exceed the regulatory limit by 20 to 40 percent. [DEIS, Table J-7]

This report assumes that truck shipments to Yucca Mountain would operate at the regulatory dose rate of 10 mrem/hour at 2 meters. This dose rate results in near-cask exposures of about 2.5 mrem per hour at 5 meters (16 feet) and 0.2 mrem per hour at 20 meters (66 feet). Exposures of this magnitude are of great concern to transportation workers and certain members of the public and can result in adverse health effects. This dose rate also results in measurable exposures (about 0.01 mrem per hour) at 25-30 meters (82-98 feet), and calculated exposures (0.000002 mrem per hour) at 800 meters (one-half mile) from the cask surface. Moreover, the very fact that these exposures occur is a major contributor to the stigmatizing effects of the Yucca Mountain shipping campaign, resulting in adverse socioeconomic impacts discussed above, such as loss of property values, even though the dose levels are well below the established thresholds for cancer and other health effects.

The amount of radiation exposures allowed under existing regulations, coupled with the large number of LWT shipments, would result in substantial worker exposures. State safety inspectors could, in theory, receive doses up to 8.5 rem (8,500 mrem) per year. Fulltime truck drivers could receive annual doses exceeding 4 rem per year. DOE calculates that these exposures over 24 years would increase lifetime cancer risk by at least 8 percent for the maximally exposed worker. Nevada studies estimate that cancer risks would be 50% higher than DOE estimates and that other health risks ignored by DOE, such as risks to pregnant female workers, could be 7-10 times higher than cancer risks. NRC and DOE regulations currently restrict occupational exposures to 5 rem per year. The DEIS states that health risks should be further reduced by restricting worker exposures to 2 rem per year.[2]

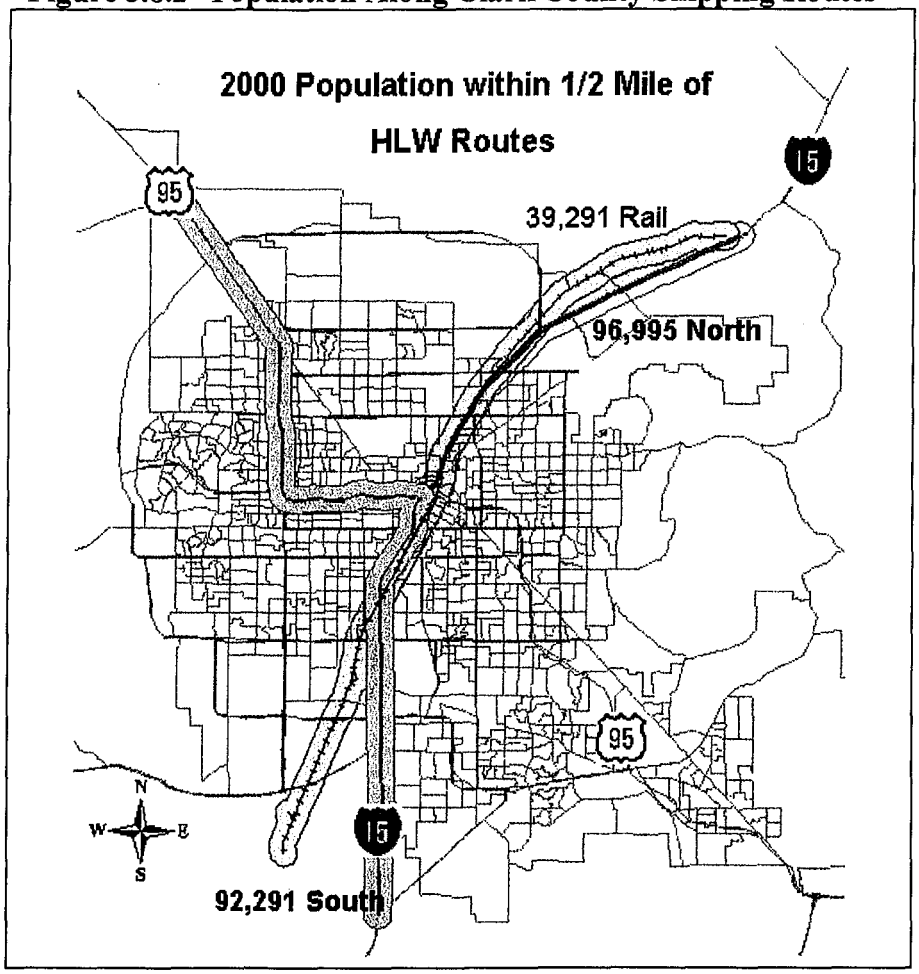
Service station attendants, who are considered members of the public, could receive doses well in excess of the NRC and DOE regulations. Along the most likely Nevada highway routes, a service station attendant who regularly fuels and services SNF/HLW trucks could receive a dose of 500-1,000 mrem per year. The resulting increased lifetime cancer risk, as calculated by DOE's method, would be relatively small, less than 2 percent over 24 years. But the slightly higher annual cancer risk would be more than 5 times higher than the average annual risk for death in an automobile accident, a risk that is considered intolerable and compels intense efforts by many state and Federal agencies directed to lower the risk.

Other members of the public could receive radiation doses while sharing the roadway with SNF/HLW trucks. In urban Clark County, traveling on a multilane

[2] The precise relationship between low-level radiation exposures and adverse health effects is a matter of continuing debate within both the medical and the health physics communities. Advocates of the linear no threshold hypothesis believe that all radiation exposures may result in adverse health effects. Many other experts believe that no significant health effects occur until exposures exceed 300-1,000 mrem, and that additional chronic exposures up to 1,000 rem increase cancer risks proportionately. The International Commission on Radiological Protection recognizes different radiation health risks for different groups among the public, including young children and pregnant women. For repository transportation activities, NRC and DOE regulations restrict annual exposures to 100 mrem for members of the public.

highway in heavy traffic next to an SNF/HLW cask could result in doses of 4-8 mrem per hour. The occupants of a vehicle stuck in traffic gridlock next to a SNF/HLW truck for four hours could receive up to 40 mrem. On rural, two-lane highways, where escorts in separate vehicles are not currently required, the driver of a vehicle traveling one truck-length (20 meters) directly behind a SNF/HLW truck would receive a dose of about 0.1 mrem per hour. Tailgating the SNF/HLW truck could increase the dose rate to about 1 mrem per hour.

Figure 3.8.2 Population Along Clark County Shipping Routes



The routine radiation dose to residents along highway routes through urban areas is a major concern because of the large number of shipments under the mostly truck scenario (see Figure 3.8.2). The Nevada Agency for Nuclear Projects (NANP) and Clark County selected three potential route segments through Las Vegas for impact analysis: I-15 South from SR604 (Las Vegas Blvd.) to the Spaghetti Bowl; I-15 North from SR146 (Lake Meade Blvd.) to the Spaghetti Bowl; and US 95 West from the Spaghetti Bowl to SR157 (Kyle Canyon Rd.). According to the 2000 Census, about 120,000 people resided within one-half mile of the potential routes to Yucca Mountain. When the resident

population is combined with the school population, estimated average daily workers, and estimated hotel/casino guests, the average daily exposed population within one-half mile of the routes is currently about 188,000 (see Table 3.8.7).

Table 3.8.7 Population Within 1/2-Mile of Highway Routes to Yucca Mountain through Las Vegas

Route Segment Data	I-15 South from SR604 to US95	I-15 North from SR146 to US95	US95 West from I-15 to SR157
LWT Shipments/year	2187	338	2525
Corridor Length (miles)	16	16	17
2000 Resident Population	25,186	19,981	74,470
Total Employment	15,702	86,397	9,579
Est. Avg. Daily Hotel/Casino Guests	475	25,532	43
School Population	441	166	4,478
Est. Avg. Daily Exposed Population	31,336	74,478	82,190

Source: Clark County Nuclear Waste Division

A separate analysis of the DOE proposed route, which uses the planned I-215 Beltways to bypass the Spaghetti Bowl, was not performed. However, if current development plans proceed and past growth rates continue, the potentially exposed population with one-half mile of DOE's proposed route is expected to be similar to the routes analyzed for this report by 2010-2020.

There are locations along the highway routes through Clark County where residents within 30 meters (98 feet) of passing truck casks could receive doses of 0.2-0.3 mrem or more per year. The vast majority of residents would be expected to receive annual doses less than 0.2 mrem per year. The DEIS estimates of routine radiological impacts in Clark County are wholly inadequate. An expert review concluded that the DEIS may have underestimated these impacts by a factor of 8 to a factor of 50. Nevada is currently evaluating alternative methods for more precisely modeling collective and maximum routine doses along these routes, and the resulting health effects.

What is not disputed is the certainty that tens of thousands of Clark County residents and properties along transportation routes would be exposed to small additional radiation doses as a result of truck shipments to Yucca Mountain. Moreover, these shipments could continue for a period of four decades or more.

Tens of thousands of Clark County residents and properties along transportation routes would be exposed to radiation doses as a result of truck shipments to Yucca Mountain.

In preparation for this report, State researchers also studied the potential routine radiological impacts along routes that avoid Clark County. LWT shipping scenarios and routes that present the greatest risks for routine exposures were examined. These studies also analyzed locations where exposures would be maximized by proximity to casks during required transport vehicle stops

and/or travel at slow speeds. The selected locations included residential and commercial buildings, parking lots, sidewalks, and pedestrian crosswalks. While members of the public are frequently present at these locations, these analyses estimated the maximum annual dose at a particular location without regard to the actual presence of an exposed individual or individuals at that location.

One of the alternative routes identified in DOE's DEIS is the "NDOT Route B." The DEIS assumed that this route could be used by all LWT shipments, an average of 2,525 per year for 38 years. NANP believes that NDOT Route B could reasonably be used for shipments from all sites identified in the DEIS except five reactor sites in Arizona and California. For this analysis, NANP assumed that about 87,600 LWT shipments of SNF and HLW, 94% of the total LWT shipments to the repository, would use this route. This would result in an average of 2,305 SNF and HLW shipments per year, or 6.3 shipments per day. There would also be about 80 LWT shipments per year of miscellaneous radioactive wastes.

For the DEIS mostly truck scenario, NANP found that annual exposures at certain locations near intersections ranged from 46 mrem (at 10 meters) to 4 mrem (at 21 meters). A location near a pedestrian crosswalk requiring brief stops (15 seconds) received an annual dose of 47 mrem (at 4 meters). Near-route locations where trucks slowed down, but did not stop, received annual exposures ranging from 28 mrem (at 4 meters) to 6 mrem (at 4 meters). The estimated annual doses for each location are shown in Table 3.8.8.

Table3.8.8 Estimated Annual Doses at Locations Along LWT Routes to Yucca Mountain.

Location	Distance from Cask (meters)	Stop Time (seconds)	Travel Speed (miles/hour)	Annual Dose (millirem)
W. Wendover #1	10	38 – 52	15 - 25	22 - 30
Ely #1	10	24 – 72	20 – 35	18 - 43
Ely #2	10	24 – 72	20 – 35	20 - 46
Ely #3	21	24 – 72	20 – 35	4 - 11
Ely #4	4	0	3	28
Goldfield #1	4	0	20	6
Goldfield #2	4	15	20	47
Goldfield #3	4	0	11	11

Source: State of Nevada, Agency for Nuclear Projects

The DEIS estimates that a resident living 30 meters (98 feet) from a route used by all shipments to Yucca Mountain would receive up to 5.4 mrem over 24 years, an average of 0.2 mrem per year. The DEIS made no effort to assess routine radiological impacts along specific Nevada highway routes where unique local conditions could result in doses much higher than DOE's generic approach. The DEIS borrowed its maximally exposed resident along route example from the 1995 DOE Programmatic EIS and Idaho National Engineering and Environmental Laboratory Final EIS [DOE/EIS-0203-F, p. I-52].

Nevada's preliminary assessment identified locations along the NDOT Route B where annual doses could exceed DOE's estimated 24-year dose by a factor of 8 or more. Moreover, the analyses prepared for this report may have significantly underestimated routine doses by ignoring the impacts of inclement weather, traffic congestion, installation of new traffic signals, and other factors on stop times.

While additional studies are needed, the preliminary estimates of annual doses on private properties along the NDOT Route B constitute a major finding. The large number of shipments projected under the mostly truck transportation scenario combine with unique local conditions to produce doses of unprecedented magnitude. The truck shipments to Yucca Mountain would clearly create elevated radiation exposure zones on private properties along the route. Further analysis of socioeconomic impacts needs to consider the extent to which the SNF and HLW shipping campaign associated with the Yucca Mountain program constitutes an actual 'taking' of property rights, both in terms of lost value and involuntary assignment of risk of radiological exposure.

Severe Truck Accidents

Each truck shipment to Yucca Mountain would carry an enormous inventory of deadly radioactive materials. Each cask would contain enough strontium-90 to contaminate Lake Mead, and enough cesium-137 to contaminate the City of Las Vegas. Casks are not designed to withstand all credible highway accidents. An accident that released even a small fraction of a truck cask inventory could cause catastrophic health and economic impacts.

The Yucca Mountain DEIS did not consider the potential consequences of a worst case truck accident in Nevada. The DEIS did evaluate what DOE considered to be a maximum reasonably foreseeable truck accident (Category 6) at a generic urban location. DOE's truck accident would release and disperse enough radioactive materials to give 1800 people a 5 rem dose and cause about 5 latent cancer fatalities. DOE estimated the probability of such an accident at 1.9 in 10 million per year. Less severe truck accidents (Category 5), also resulting in releases, had estimated probabilities ranging from 4 in 100,000 to 3 in 10 million per year.

Between 204 and 1,306 latent cancer fatalities would result from exposure to radiation from a severe truck accident in Las Vegas. Costs of clean up could reach $28 billion. In rural Nevada, a comparable truck accident would cause between 194 and 1,243 latent cancer fatalities and cost over $500 million to clean up.

Previous studies sponsored by the State of Nevada concluded that the DEIS systematically underestimated the likely human health impacts of severe truck accidents. Moreover, the DEIS completely ignored the potential economic impacts of severe accidents. The cost of cleanup, evacuation, and business loss resulting from a severe accident in a generic urban area can range from several billion to several hundred billion dollars.

For this impact report, the State of Nevada commissioned Radioactive Waste Management Associates (RWMA) to undertake a more realistic study of credible worst case truck accidents at representative urban and rural locations along potential Nevada highway routes. RWMA used the same Modal Study accident severity categories considered in the DEIS, but assumed that the accidents involved hotter SNF (5 year-cooled PWR) and used higher (more conservative) cesium gap inventory estimates. Table 3.8.9 compares the RWMA and DEIS accident scenarios.

Table 3.8.9 Comparison of RWMA and DEIS Accident Scenarios

Yucca Mountain DEIS	RWMA
"Maximum Reasonably Foreseeable" accident scenario based on probability	No estimate of probability
Risk and Consequence Assessments performed	Consequence Assessment only
Estimated consequences for severity Category 6 truck accidents in urban locations and a severity Category 6 truck accident in a rural location	Estimated consequences for severity Category 5 and 6 truck accidents in urban and rural locations
26-year-cooled PWR fuel having a burnup of 39,560 MWD/MTU assumed	5-year-cooled PWR fuel having a burnup of 39,560 MWD/MTU assumed
0.3% of cesium inventory assumed in Fuel-Clad Gap	9.9% of cesium inventory assumed in Fuel-Clad gap
Meteorological conditions based on national averages	Site-specific meteorological averages used
CRUD inventory not explicitly modeled	Assumes that all CRUD is released to environment in the event of a rod failure
No discussion of economic impacts	Economic impacts, including cost of decontamination and evacuation, discussed

For each accident scenario, RWMA provided two separate consequence assessments: a Category 5 and Category 6 accident. The Category 6 accident scenario is considered by DOE to be the most severe accident that could credibly happen en route to the Yucca Mountain repository. For the specific accident locations chosen in this study, RWMA concentrated on the category 5 accident scenarios, after judging them to be the most credible severe accidents. Therefore, the accidents postulated in the RWMA report are not "worst-case" scenarios since even more serious situations are possible. Rather, they are severe, yet credible, accidents, with the understanding that they are meant to be representative of the types of severe accidents that could readily happen in different areas of Nevada and the country.

The RWMA study was a consequence assessment for a hypothetical truck accident occurring at a specific location in order to more realistically estimate damages and to test the capacity of emergency response. The RWMA study was not intended to predict the precise location of an accident, its severity, and the meteorological conditions at the time of the accident.

The interchange of US 95 and I-15 in Las Vegas, referred to as the "Spaghetti Bowl," was selected as the location for the urban truck accident. Specifically, the scenario involved a truck traveling on I-15 going into the Spaghetti Bowl. Speeds at this location can approach 70 miles per hour, and there is the possibility of a severe crash into a bridge abutment, a fall from an elevated highway structure, and/or collision with other vehicles hauling gasoline or other hazardous materials. Wind data from the McCarran International Airport was employed to obtain an average wind direction, speed, and stability category.

I-80 at the West Wendover exit, near the Utah/Nevada border was identified as the location for the rural truck accident. At this location, trucks can be expected to travel at fairly high speeds, allowing the possibility of a severe impact scenario. Truck speeds at this location approach 75 mph. The narrow median strip and absence of dividers between the east- and westbound lanes creates the possibility for high-speed, head-on collisions. Rocky outcroppings along the westbound highway wayside create the possibility of an impact collision onto a hard surface. Wind data was obtained from the Wendover Air Field in Utah, very close to the potential accident location.

Two computer programs, RISKIND and HotSpot, were used to develop contaminant plumes for the two truck accident scenarios. Both use standard Gaussian plume dispersion equations to estimate airborne concentrations and ground deposition of radionuclides. The spent nuclear fuel inventory obtained from RISKIND was used to develop the spent fuel inventory for use in both computer simulations. Figure 3.8.3 shows the plume and 24-hour dose for the hypothetical truck accident in Las Vegas.

Figure 3.8.3 Dispersal Pattern for Hypothetical Truck Accident in Las Vegas

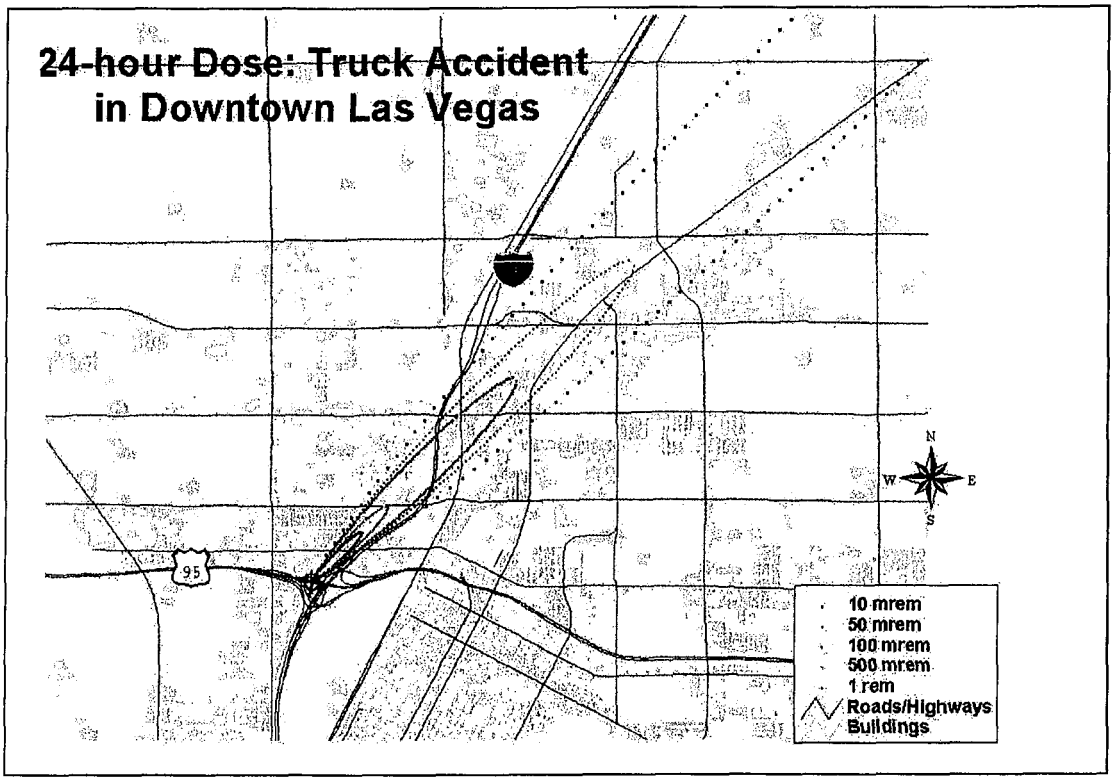
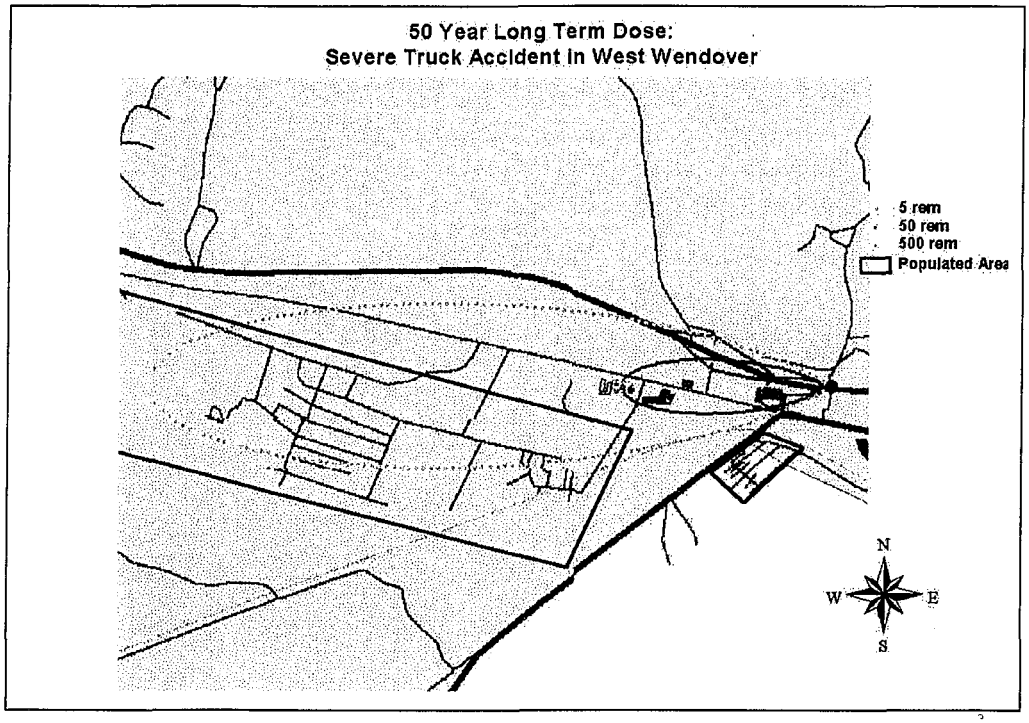


Figure 3.8.4 shows the plume and 24-hour dose for the hypothetical truck accident near West Wendover.

Figure 3.8.4 Dispersal Pattern for Hypothetical Truck Accident in W. Wendover



Following the truck accident, acute radiation doses due to inhalation of a passing radioactive cloud could exceed 100 rems close to the release location. This is several hundred times what a person receives from background radiation in a year. In Las Vegas, thousands of people are likely to be in the downwind path. Persons indoors would also be exposed. If ventilation systems were not shut off, radioactive particulates would settle within hotels and other buildings, contaminating rugs, furniture, beds, and causing a radiation dose to those inside.

Discussions with emergency personnel in Las Vegas and Clark County clearly indicate the accident would overwhelm local response capabilities. Before local emergency responders could accurately assess the problem, the radioactive plume would have already contaminated an extensive area. Radioactive particulates settling on roads and highways are likely to be spread by traffic, possibly contaminating distant locations and extending the area of contamination well past that assumed in this study. This may result in the contamination of many more people than were estimated in this report.

Given the high number of people exposed, local responders would not be able to identify, let alone effectively quarantine, contaminated people. Thus, it would be extremely difficult to stop the spread of contamination. Initial decontamination efforts

would probably be limited to emergency responders and people in the nearest proximity to the accidents. Decontamination of the affected population in general would be a massive effort.

Evacuation would be difficult at best. Spontaneous evacuation by people not in the contaminated area would probably occur in great numbers, making the targeted evacuations much more difficult to complete. At a minimum, the evacuation of highly contaminated areas would be necessary. In both Las Vegas and West Wendover, evacuation would be complicated by the need to close the segments of I-15 and I-80 contaminated by the plume.

In the case of an accident in Las Vegas, consideration would have to be given to closing McCarran airport in order to prevent the migration of contaminated persons. Alternately, all passengers would have to be screened for contamination. This would require a huge amount of resources that could be better utilized dealing with the major issues.

The incident would quickly overwhelm the capability of the local medical community. Blood and urine samples of contaminated people should be taken to track the levels of contamination and exposure, but this would be very difficult given the number of contaminated and potentially contaminated individuals. Mental health resources would be overwhelmed as well.

Unless radionuclides, particularly cesium, were removed from surfaces, remaining residents would be exposed for long time periods. Complete decontamination would be prohibitively expensive and would also expose workers; a balance would take place between clean-up costs and long-term radiation exposures. RWMA chose the EPA's Protective Action Guide as a criteria for decontamination; assuming that a person should not receive more than 5 rems over a 50-year period, including initial inhalation due to the passing cloud.

If areas are not decontaminated, RWMA estimated between 204 and 1,306 latent cancer fatalities would result from exposure to radiation resulting from the truck accident in Las Vegas, depending on the risk model. If radioactive contaminants were not remediated, there would be continuous direct gamma exposure to remaining residents and the potential stigmatization of the area. This would result in an extraordinary concomitant economic cost to the tourist industry, as discussed in Section 2.1 of this report.

Using the economic model of RADTRAN 5, evacuation and decontamination costs in Las Vegas were estimated to exceed $2 billion for the Category 5 accident evaluated by RWMA. The same costs for the Category 6 truck accident described in the DEIS could exceed $28 billion.

An accident in West Wendover on I-80 would also have serious consequences. RWMA did not separately calculate decontamination costs for West Wendover, but the

relative area requiring cleanup suggests costs of about $500 million. If areas were not decontaminated, between 194 and 1,243 latent cancer fatalities would result in West Wendover from exposure to radiation from the truck accident. I-80 is the main route into and out of West Wendover, as well as a major cross-country thoroughfare. An accident that spreads radioactive contamination could cut off the exit and either leave cars trapped or have vehicles spread the contamination for miles along the highway.

The RWMA study concludes that the consequences of an accident leading to the release of radioactive material from a truck cask would be disastrous and extremely costly. The tables below summarize the findings of the RWMA study. Table 3.8.10 presents a comparison of the Las Vegas truck accident with the urban 'maximum reasonably foreseeable' accident scenario listed in the DEIS. Table 3.8.11 presents a comparison of the West Wendover truck accident with the rural 'maximum reasonably foreseeable' accident scenario listed in the DEIS. The consequences estimated by RWMA are significantly higher than those estimated in the DEIS, primarily due to the assumption of a higher population density and an increased release fraction for cesium.

Table 3.8.10 Comparison of RWMA and DEIS Urban Truck Accident Consequence Assessments

	Urban Truck Accident			
	State of Nevada, Cat.5	State of Nevada, Cat.6	YM DEIS, Cat. 5	YM DEIS, Cat. 6
Acute (24-hour) Population Dose (person-rem)	846	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	0.42-2.7	Not calculated	Not calculated	Not calculated
1-year Population Dose (person-rem)	29,514	Not calculated	Not calculated	9,400
Expected Latent Cancer Fatalities	15-94	Not calculated	Not calculated	5
50-year Population Dose (person-rem)	407,024	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	204 - 1,306	Not calculated	Not calculated	Not calculated
Dose to Maximally Exposed Individual (rem)	3.9	38.5	Not calculated	4
Area contaminated to greater than 5 rem long-term dose (km^2)	11.1	192.2	Not calculated	Not calculated

Table 3.8.11 Comparison of RWMA and DEIS Rural Truck Accident Consequence Assessments

	Rural Truck Accident			
	State of Nevada, Cat.5	State of Nevada, Cat.6	YM DEIS, Cat. 5	YM DEIS, Cat. 6
Acute (24-hour) Population Dose (person-rem)	799	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	0.4-2.6	Not calculated	Not calculated	Not calculated
1-year Population Dose (person-rem)	27,886	Not calculated	Not calculated	430
Expected Latent Cancer Fatalities	14-89	Not calculated	Not calculated	0.2
50-year Population Dose (person-rem)	388,326	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	194-1,243	Not calculated	Not calculated	Not calculated
Dose to Maximally Exposed Individual (rem)	1.73	17.1	Not calculated	3.9
Area contaminated to greater than 5 rem long-term dose (km^2)	3.4	33.1	Not calculated	Not calculated

Impacts Of Terrorism Or Sabotage Against Truck Shipments

SNF/HLW truck shipping casks are especially vulnerable to terrorist attack and sabotage. DOE and NRC testing in the 1980s demonstrated that a high-energy explosive device (HED) such as a military demolition charge could breach the wall of a truck cask. DOE sponsored a 1999 study of cask sabotage by Sandia National Laboratories (SNL) in support of the DEIS. The SNL study demonstrated that HEDs are "capable of penetrating a cask's shield wall, leading to the dispersal of contaminants to the environment." [DEIS, p. 6-33] The SNL study also concluded that a successful attack on a truck cask would release more radioactive materials than an attack on a rail cask. [DEIS, p. 6-34]

Studies show that a successful terrorist attack on a truck cask in the Las Vegas urban area could result in as many as 165 latent cancer fatalities, with a maximum individual acute dose of 324 rem. Cleanup costs and other economic impacts could exceed $20 billion.

The DEIS estimated that a successful attack on a GA-4 truck cask in an urbanized area under average weather conditions would result in a population dose of 31,000 person-rem, causing about 15 cancer fatalities among those exposed to the release of radioactive materials. The maximally exposed individual would receive a dose of 67 rems. The DEIS did not evaluate any environmental impacts other than health effects. In particular, the DEIS ignored the economic impacts of a successful act of sabotage, which

have been dramatically demonstrated by the September 11th World Trade Center and Pentagon attacks.

An analysis prepared for Nevada by RWMA estimated sabotage impacts would be at least ten times greater than DOE's estimate. RWMA replicated the DEIS sabotage consequence analysis, using the RISKIND model for health effects and the RADTRAN model for economic impacts, the SNL study average and maximum inventory release fractions, and a range of population densities and weather conditions. Under average weather conditions, RWMA estimated that the same sabotage incident would result in 6-104 latent cancer fatalities, and a maximum individual acute dose of 196 rems. Under worst case weather conditions, there would be 14 - 165 latent cancer fatalities and a maximum individual acute dose of 324 rem. Cleanup costs and other economic impacts ranged from $3.1 - 13.5 billion (2000$) for average weather conditions, and $10.1 - 20.9 billion (2000$) for worst case weather conditions.

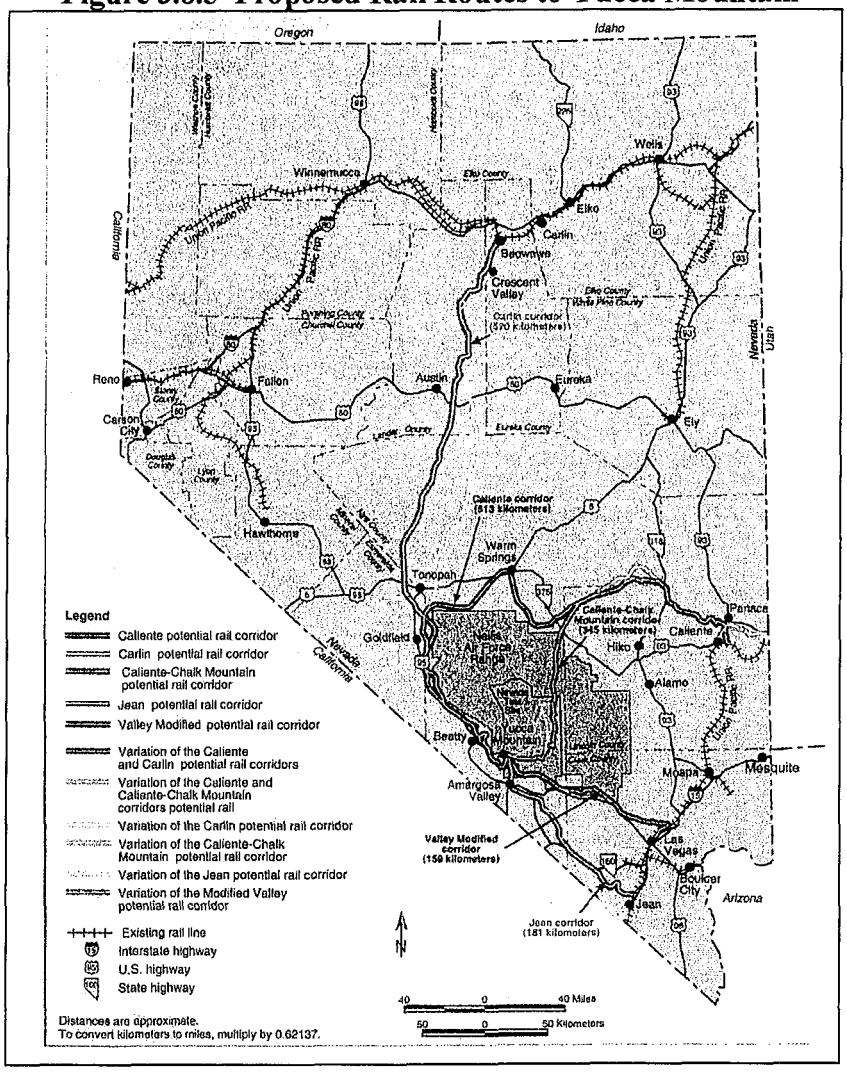
Other terrorism and sabotage scenarios could result in even more severe impacts. The Sandia study assumed that the reference weapon would not completely penetrate the cask. Full perforation would increase the release and resulting consequences by a factor of ten. The impacts would have also been substantially greater if the cask was assumed to be carrying 5-year-old SNF. (DOE assumed 26-year-old SNF.) DOE also failed to consider credible attack scenarios involving use of more than one penetrating weapon, use of an incendiary device in conjunction with a penetrating weapon, and use of commercial shaped charges that are more efficient metal penetrators than the M3A1 military demolition device evaluated by SNL.

The social and economic impacts of an attempted act of terrorism or sabotage, whether successful or unsuccessful, deserve special attention. An incident involving an intentional release of radioactive materials, especially in a heavily populated area, would cause widespread social disruption and substantial economic losses, even if there were no immediate human casualties and few projected latent cancer fatalities. Local impacts would be amplified by national and international media coverage. Adverse economic impacts would include the cost of emergency response, evacuation, decontamination and disposal; opportunity costs to affected individuals, property owners, and businesses; and economic losses resulting from public perceptions of risk and stigma effects.

Nevada Rail Impacts

Rail impacts in Nevada would be greatest under the DEIS mostly rail transportation scenario, involving 19,800 rail shipments of SNF, HLW, and miscellaneous radioactive wastes over 38 years. There would be about 520 rail shipments per year. Under the current capabilities scenario, there would be about 14,100 rail shipments, an average of 370 shipments per year. The lowest number of rail shipments, under DOE's mostly truck scenario, would be 300 shipments over 38 years, or about 8 shipments per year.

Figure 3.8.5 Proposed Rail Routes to Yucca Mountain



There is currently no railroad to Yucca Mountain. The DEIS identified five potential corridors for construction of a new rail access spur (see Figure 3.8.5). The DEIS also identified three locations for intermodal transfer stations (rail to heavy-haul truck). Four of the rail access spurs would originate from the Union Pacific (UP) mainline across southern Nevada. All of the intermodal transfer stations would use the same UP mainline. The Beowawe access corridor would originate from the UP mainline across northern Nevada.

This section of the report evaluates the impacts of SNF and HLW rail shipments on existing mainlines and on the proposed new rail access spur. The impacts of rail spur construction are addressed later in this section.

The DEIS assumes that SNF/HLW rail casks would be shipped in general freight service, although the railroads and many stakeholders believe that all SNF/HLW

shipments should be made by dedicated train. Indeed, many experts believe DOE would be forced to use dedicated trains. However, for purposes of evaluating a credible maximum impact scenario, this report assumes each rail cask would be shipped to Nevada separately by general service in a different train.

Radiological Impacts Of Routine Rail Shipments

The "mostly rail" national transportation scenario would result in lower overall radiological impacts of incident-free shipments. However, certain groups of workers and residents near rail stop locations would receive significant radiation exposures from routine rail operations. General aspects of background radiation levels and radiation health effects are discussed in the highway impacts section of this report.

This report assumes that rail shipments to Yucca Mountain would operate at the regulatory dose rate of 10 mrem/hour at 2 meters. This dose rate results in near-cask exposures of about 2.5 mrem per hour at 5 meters (16 feet) and 0.2 mrem per hour at 20 meters (66 feet). Exposures of this magnitude are of great concern to transportation workers and certain members of the public. This dose rate also results in measurable exposures (about 0.01 mrem per hour) at 25-30 meters (82-98 feet), and calculated exposures (0.000002 mrem per hour) at 800 meters (one-half mile) from the cask surface. Even these relatively small exposures can result in adverse health affects for some workers and some members of public. Moreover, the very fact that these exposures occur may cause adverse socioeconomic impacts, such as loss of property values, even though the dose levels are well below the established thresholds for cancer and other health effects.

Even without an accident, rail shipments of SNF and HLW would expose workers and members of the public to significant amounts of radiation. Rail safety inspectors could receive up to 6.3 rem (6,300 mrem) annually, with train crew members receiving annual doses in excess of 2 rems.

The regulatory dose rate, coupled with the number of rail shipments and the duration of rail stops, results in substantial exposures for some workers. A state safety inspector could, in theory, receives up to 6.3 rems (6,300 mrem) per year. Train crew members could receive annual doses exceeding 2 rems per year. A rail shipment escort following the cask car in a chase vehicle could receive an annual dose of 1.4 rem. Rail yard crew members would receive annual doses of about 180 mrem.

DOE calculates that these exposures over 24 years would increase lifetime cancer risk by 6 percent for the maximally exposed worker. Nevada studies estimate that cancer risks would be 50% higher than DOE estimates, and that other health risks ignored by DOE, such as risks to pregnant female workers, could be 7-10 time higher than cancer risks. NRC and DOE regulations currently restrict occupational exposures to 5 rems per year. The DEIS states that health risks should be further reduced by restricting worker exposures to 2 rem per year.

For repository transportation activities, NRC and DOE regulations restrict annual exposures to 100 mrem for members of the public. The DEIS estimates that a resident living 200 meters (660 feet) from a switchyard used by all shipments to Yucca Mountain would receive up to 310 mrem over 24 years, an average of 12.9 mrem per year. The DEIS estimates that a resident living 30 meters (100 feet) from a rail route used by all shipments to Yucca Mountain would receive up to 3 mrem over 24 years, an average of 0.125 mrem per year.

The DEIS made no effort to assess routine radiological impacts along specific Nevada rail routes where unique local conditions could result in doses much higher than DOE's generic approach. Again, the DEIS borrowed its maximally exposed resident along route examples from the 1995 DOE Programmatic EIS and Idaho National Engineering Laboratory FEIS [DOE/EIS-0203-F, p. I-52].

In preparation for this report, M.H. Chew and Associates (CAI) conducted a study to evaluate routine radiological impacts at maximum exposure locations along one of the existing Nevada rail routes that could be used for shipments to Yucca Mountain. From the DEIS, a rail shipping scenario and route that would maximize opportunities for routine exposures were selected, together with locations where exposures would be maximized by proximity to casks during planned and unplanned stoppages. The selected locations included parking lots and entrances to major commercial buildings (see Figure 3.8.6). While members of the public are frequently present at these locations, the CAI analysis estimated the maximum annual dose at a particular location without regard to the actual presence of an exposed individual or individuals at that location.

Figure 3.8.6 Clark County Government Center. The railroad crosses diagonally from the lower left-hand side of the picture and passes adjacent to the parking lot area.

The Union Pacific mainline through Las Vegas between Apex Siding on the north and Arden Siding on the south was selected for analysis. This rail segment is about 36 miles long. According to the 2000 Census, more than 39,000 people reside within one-half mile of the rail line. A number of large hotel-casinos are also located within one-half mile. When the resident population is combined with the school population, estimated average daily workers, and estimated hotel/casino guests, the average daily exposed population within one-half mile of the routes is currently about 86,000.

Table 3.8.12 Population Within 1/2-Mile of Union Pacific Railroad through Las Vegas

Route Segment Data	Union Pacific Mainline through Las Vegas
Shipments/year	457
Corridor Length (miles)	35.74
2000 Resident Population	39,291
Total Employment	83,976
Est. Avg. Daily Hotel/Casino Guests	18,032
School Population	597
Est. Avg. Daily Exposed Population	85,912

Source: Clark County Nuclear Waste Division

The heaviest routine rail transportation impacts on downtown Las Vegas would likely result from the Jean rail spur or Sloan/Jean intermodal transfer options. DOE's rail routing analysis for Jean indicates that about 87% of all rail shipments to Yucca Mountain would use the Union Pacific mainline through downtown Las Vegas. There would be 17,364 rail cask shipments through Las Vegas over 38 years, an average of 457 cask shipments per year. SNF/HLW rail casks would be shipped in general freight service.

There are a number of locations in downtown Las Vegas along the Union Pacific where entire trains and groups of freight cars are routinely stopped for varying periods of time. For the CAI analysis, NANP selected two such locations near large casino hotels and one location near a major government building.

The DEIS provides few details about expected rail operations, other than the decision that dedicated trains would not be required. Train stops occur for many reasons. Stops for carrier interchange or train assembly could require from 2 to 24 hours. Stops for crew changes, car changes, engine refueling, train maintenance, regulatory inspections, and traffic control could range from 15 minutes to more than 2 hours. In planning for receipt of casks shipped by general freight service, DOE has indicated its intention to

take advantage of USDOT regulations that allow stoppage of railcars carrying SNF/HLW for periods up to 48 hours (DEIS, p. 2-50).

CAI evaluated exposures under two rail-stop scenarios: (1) A one-time cask car stoppage at the designated location for 48 hours, the regulatory maximum; and (2) the cumulative annual exposure assuming that each cask shipment stops at the designated location one time for one-hour only (a total of 457 hours per year).

CAI calculated routine doses at the rail route locations selected by NANP using the code RISKIND 1.11. The cases of 48 hour and 457 hour stops were examined. Since RISKIND does not allow calculations for stop times greater than 100 hour, the 48 hour doses were multiplied by (457/48) to give the doses for the longer time. Since the doses are only reported to two significant figures, this may slightly degrade the accuracy of the results for the 457-hour doses due to round-off problems. Because the stop doses would be considerably larger than passing doses, the latter were not examined. The cask was assumed to be the large (21 PWR) MPC. Table G.4 in the RISKIND users manual gives a length of 5.29 meters and a radius of 1.086 meters. No gamma fraction was listed, so the value of 0.83 was taken. The loading is assumed to give a dose of 10 mrem/hr at a distance of 2 meters from the cask surface.

Table 3.8.13 reports the results obtained by CAI. The cumulative annual doses (457 hours) in the hotel parking lots ranged from 200 mrem (at 15 meters) to 36 mrem (at 35 meters). The cumulative annual doses (457 hours) at hotel-casino entrances ranged from about 28 mrem (at 40 meters) to about 1 mrem (at 160 meters). At the Government Center, the cumulative annual dose (457 hours) is 114 mrem in the parking lot (at 20 meters), about 50 mrem at the nearest entrance (at 30 meters), and about 3 mrem at another entrance (at 100 meters). The 48-hour doses ranged from 21 mrem (at 15 meters) to 0.1 mrem (at 160 meters).

Table 3.8.13. Estimated Doses at Locations Along Las Vegas Rail Route

Location	Distance from Cask (meters)	48 hour dose (mrem)	457 hour dose (mrem)
Hotel/Casino A, Loc #1	40	2.9	27.6
Hotel/Casino A, Loc #2	15	21	200
Hotel/Casino B, Loc #1	35	3.8	36.2
Hotel/Casino B, Loc #2	160	0.11	1.05
Govt. Center, Loc #1	20	12	114
Govt. Center, Loc #2	30	5.2	49.5
Govt. Center, Loc #3	100	0.36	3.43

Source: CAI, July 2001, Table 1.

Tens of thousands of Clark County residents and their real properties would be exposed to small additional radiation doses as a result of rail shipments to Yucca

Mountain. Moreover, these shipments could continue for a period of four decades or more.

While additional studies are needed, the preliminary estimates of annual doses on private properties along rail routes constitute a major finding. The rail shipments to Yucca Mountain would clearly create elevated radiation exposure zones on private properties along the route. Further analysis of socioeconomic impacts would consider the extent to which DOE's proposed action constitutes a taking of property rights.

Severe Rail Accidents

Each rail cask shipped to Yucca Mountain would carry four to six times as much highly radioactive material as a truck cask. DOE's representative large rail cask loaded with 26-year-cooled SNF would contain a total activity of about 2 million curies, including 810,000 curies of cesium-137. Casks are not designed to withstand all credible rail accidents. A severe rail accident resulting in a release of cask contents could have adverse health and economic impacts many times greater than a truck accident.

Each rail cask shipped to Yucca Mountain would carry four to six times as much highly radioactive material as a truck cask. A severe rail accident in urban Las Vegas would cause between 6,000 and 41,000 latent cancer fatalities, with clean up costs in the tens or even hundreds of billions of dollars.

The Yucca Mountain DEIS did not consider the potential consequences of a worst case truck accident in Nevada. The DEIS did evaluate what DOE considered to be a maximum reasonably foreseeable rail accident (category 6) at a generic urban location. DOE's rail accident would release and disperse enough radioactive materials to give 12,000 people a 5 rem dose and cause about 31 latent cancer fatalities. DOE estimated the probability of such an accident at 1.4 in 10 million per year. Less severe rail accidents (category 5), also resulting in releases, had estimated probabilities ranging from 4 in 100,000 to 7 in 10 million per year.

Previous studies sponsored by the State of Nevada concluded that the DEIS systematically underestimated the likely human health impacts of severe rail accidents. Moreover, the DEIS completely ignored the potential economic impacts of severe accidents. The cost of cleanup, evacuation, and business loss resulting from a severe accident in a generic urban area can range from several billion to several hundred billion dollars.

For this impact report, Radioactive Waste Management Associates (RWMA) conducted a study of credible worst case rail accidents at representative urban and rural locations along potential Nevada highway routes. Using the same Modal Study accident severity categories considered in the DEIS, RWMA evaluated Category 5 rather than Category 6 accidents. RWMA assumed that the accidents involved hotter SNF than the DEIS and used higher cesium gap inventory estimates. Current rail cask designs assume shipment of 10-year-cooled SNF. RWMA assumed that 5-year-cooled fuel, which has a

30 percent higher fission product inventory, represents a credible worst case accident source term. Table 3.8.14 compares the RWMA and DEIS accident scenarios.

Table 3.8.14 Comparison of RWMA and DEIS Accident Scenarios

Yucca Mountain DEIS	RWMA
"Maximum Reasonably Foreseeable" accident scenario based on probability	No estimate of probability
Risk and Consequence Assessments performed	Consequence Assessment only
Estimated consequences for severity Category 6 rail accidents in urban locations and a severity category 6 rail accident in a rural location	Estimated consequences for severity Category 5 and 6 rail accidents in urban and rural locations
26-year-cooled PWR fuel having a burnup of 39,560 MWD/MTU assumed	5-year-cooled PWR fuel having a burnup of 39,560 MWD/MTU assumed
0.3% of cesium inventory assumed in Fuel-Clad Gap	9.9% of cesium inventory assumed in Fuel-Clad gap
Meteorological conditions based on national averages	Site-specific meteorological averages used
CRUD inventory not explicitly modeled	Assumes that all CRUD is released to environment in the event of a rod failure
No discussion of economic impacts	Economic impacts, including cost of decontamination and evacuation, discussed

For each accident scenario, RWMA provided two separate consequence assessments: a Category 5 and Category 6 accident. The Category 6 accident scenario is considered by DOE to be the most severe accident that could credibly happen en route to the Yucca Mountain Repository. For the specific accident locations chosen in this study, RWMA concentrated on the Category 5 accident scenarios, after judging them to be the most credible severe accidents. Therefore, the accidents postulated in the RWMA report are not "worst-case" scenarios in the sense that one could not imagine a worse situation happening. Rather, they are severe, yet credible, accidents, with the understanding that they are meant to be representative of the types of severe accidents that could happen in different areas of Nevada and the country.

For the urban accident evaluation, a location was identified on the Union Pacific (UP) rail line between Flamingo Avenue and Spring Mountain Road in Las Vegas. Along this stretch, the UP goes underneath I-15 and at one point is approximately 20 feet from the parking lot of a hotel. Potential accident scenarios include derailment of a runaway train and/or collision with a train hauling explosive or flammable materials. There is a petroleum pipeline running alongside the railroad tracks at this point, creating the possibility for a severe thermal environment in the event of an accident. The same meteorological data used in the Las Vegas truck accident scenario was employed here.

A rural rail accident location was also identified on the Union Pacific line that runs near I-80 in Elko County at the entrance to the Carlin Tunnel. This accident location was chosen because it is upwind of farming areas, a major river, and the City of Elko. An accident at this location would also likely cause the closure of I-80. Hazardous

materials are routinely shipped along this route, including tanker shipments of propane to a terminal at Beowawe. In the event of a derailment involving cars containing flammable materials, the tunnel creates the possibility of a long-duration fire. Wind data were obtained from the Elko Airport in Elko, approximately 20 miles to the northeast of the proposed accident location.

Two computer programs, RISKIND and HotSpot, were used to develop contaminant plumes for the two rail accident scenarios. Both use standard Gaussian plume dispersion equations to estimate airborne concentrations and ground deposition of radionuclides. The spent nuclear fuel inventory obtained from RISKIND was used to develop the spent fuel inventory for use in both computer simulations.

RWMA assumed average, site-specific meteorological conditions and wind speeds. RWMA further assumed a severe impact would lead to a ground level puff release of radioactive particulates. The release estimates did not consider the accident scenario involving "fire-only" conditions, which would result in a more protracted release of material and a higher effective release height.

Figure 3.8.7 shows the plume and 24-hour dose for the hypothetical accident in Las Vegas.

Figure 3.8.7

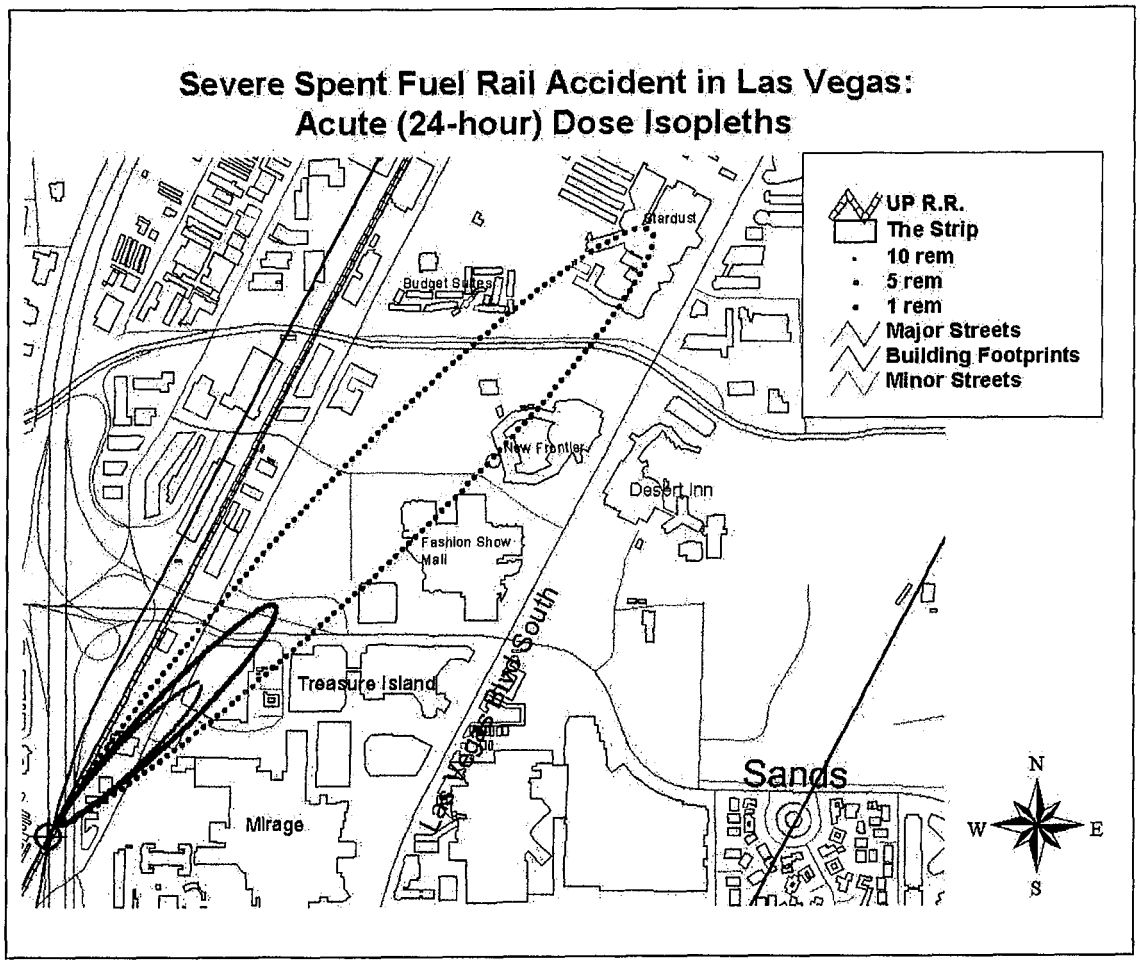

Severe Spent Fuel Rail Accident in Las Vegas:
Acute (24-hour) Dose Isopleths
UP R.R.
The Strip
10 rem
5 rem
1 rem
Major Streets
Building Footprints
Minor Streets
Stardust
Budget Suites
New Frontier
Desert Inn
Fashion Show Mall
Treasure Island
Las Vegas Blvd South
Sands
Mirage
N
W
E
S

Figure 3.8.8 shows the plumes and 50-year dose for the severe hypothetical rail accident in Las Vegas.

Figure 3.8.8

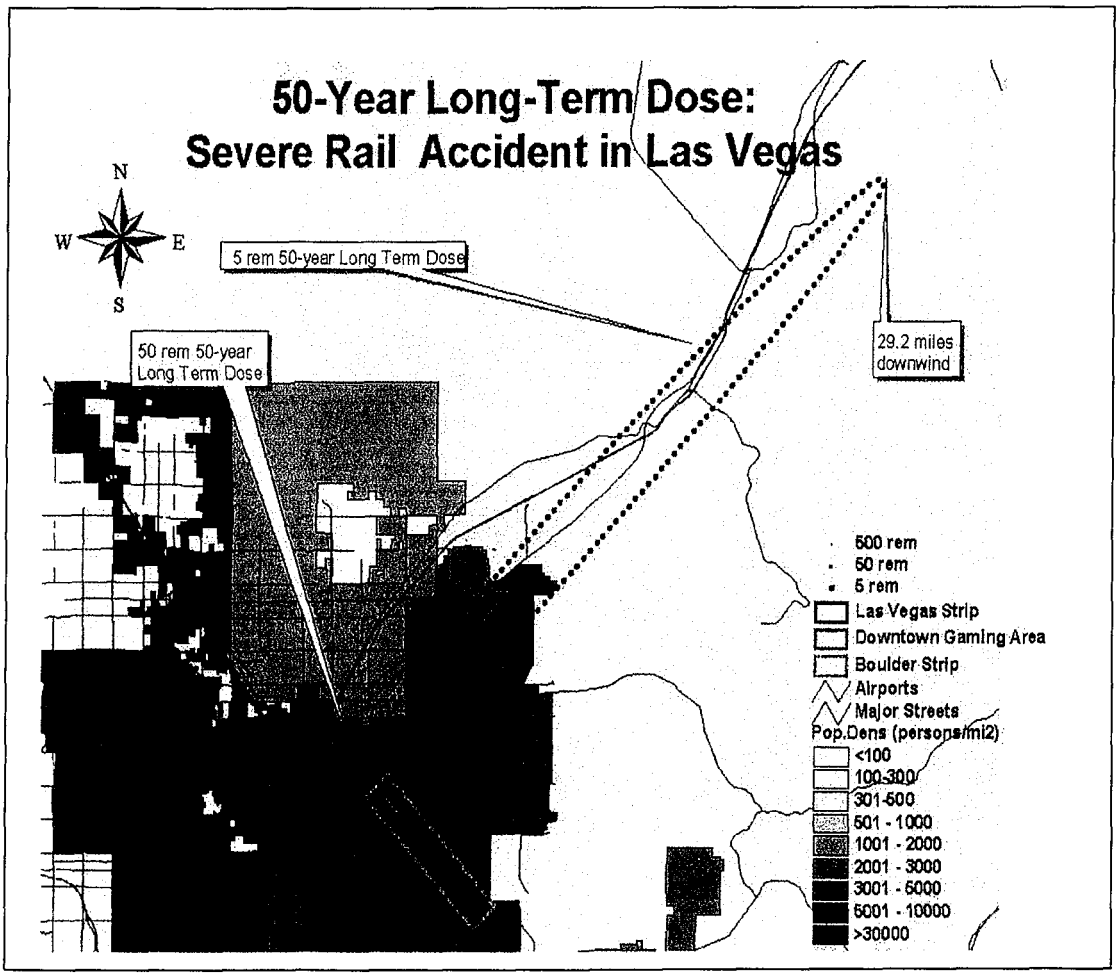


Figure 3.8.9 shows ground contamination near the Las Vegas Strip following the hypothetical rail accident in Las Vegas.

Figure 3.8.9

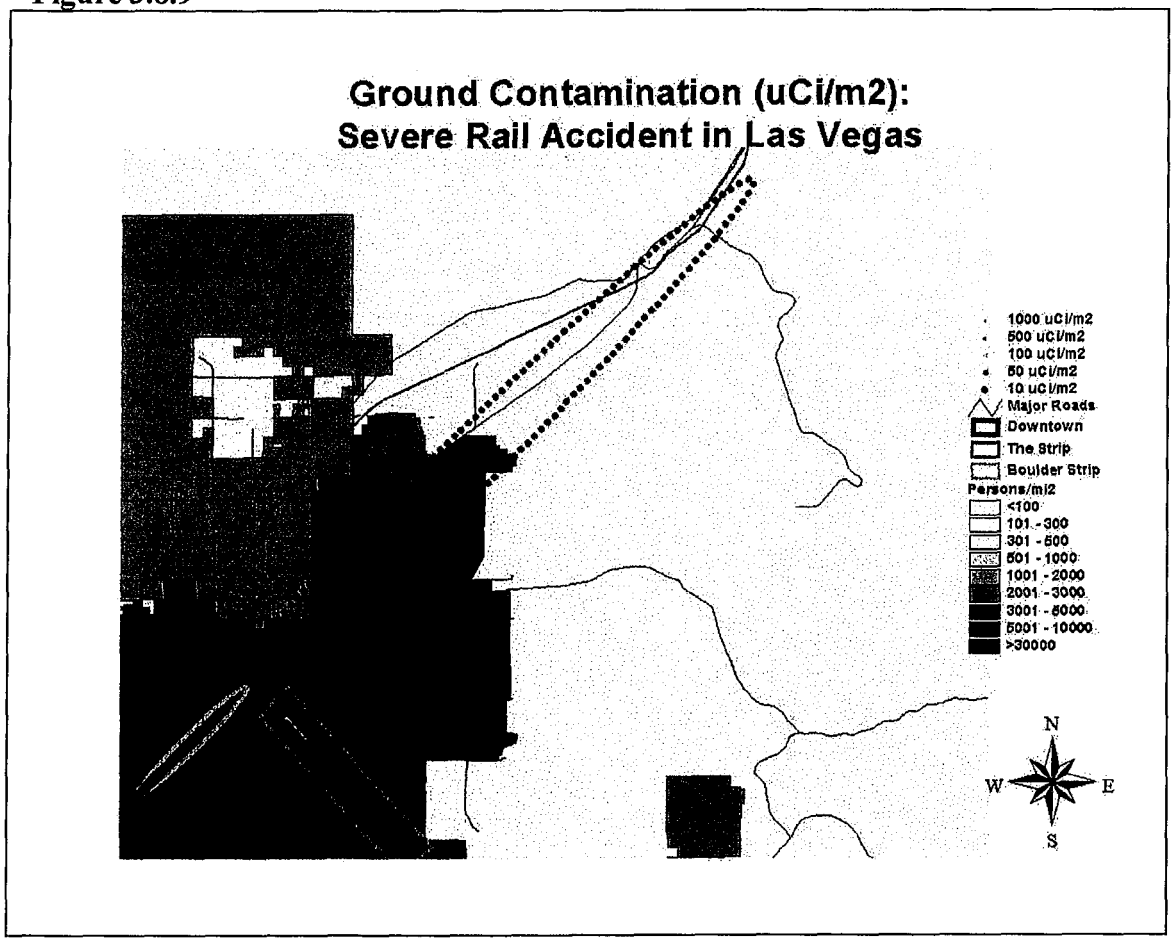


Figure 3.8.10 shows the plume and 24-hour dose for the hypothetical rail accident at the Carlin Tunnel in Elko County.

Figure 3.8.10

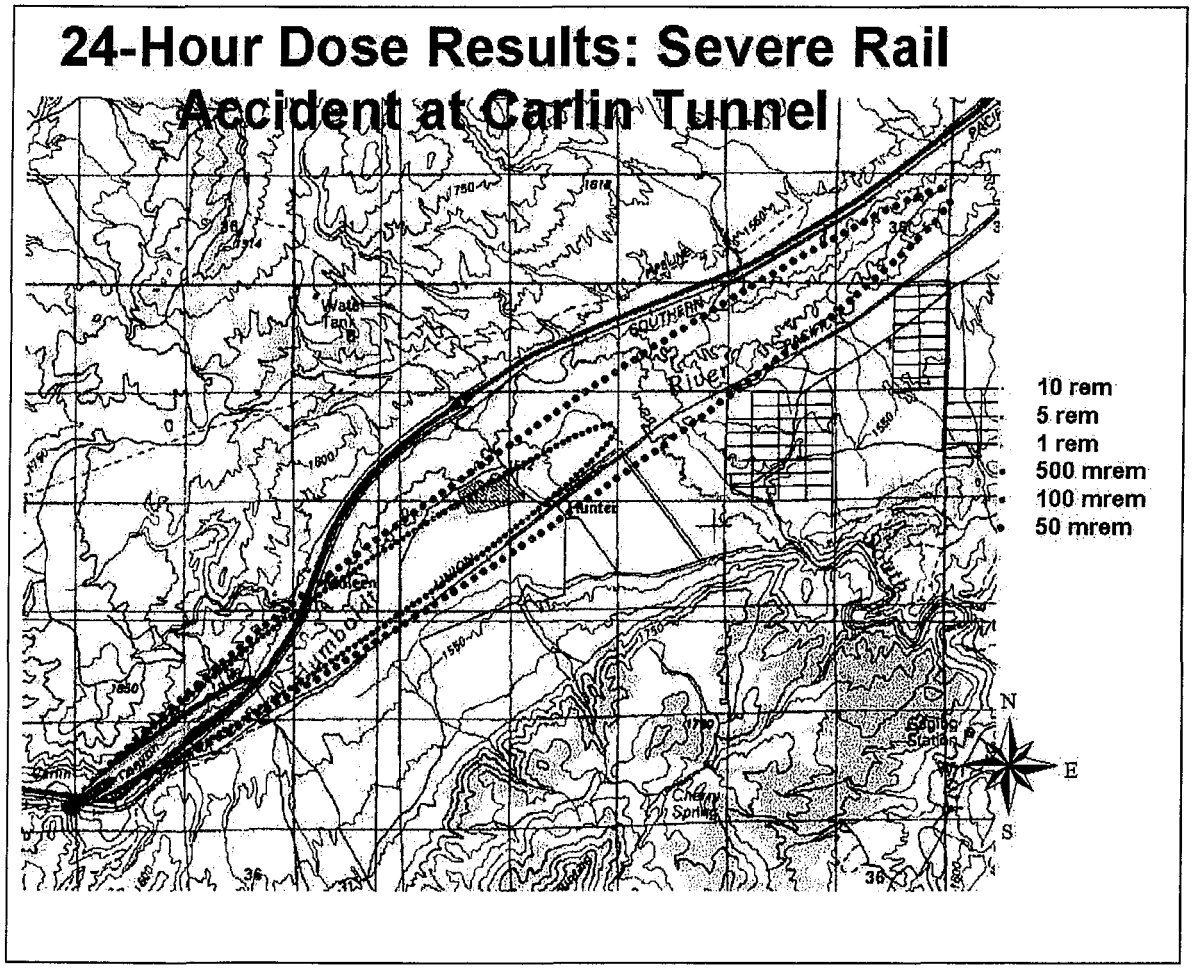
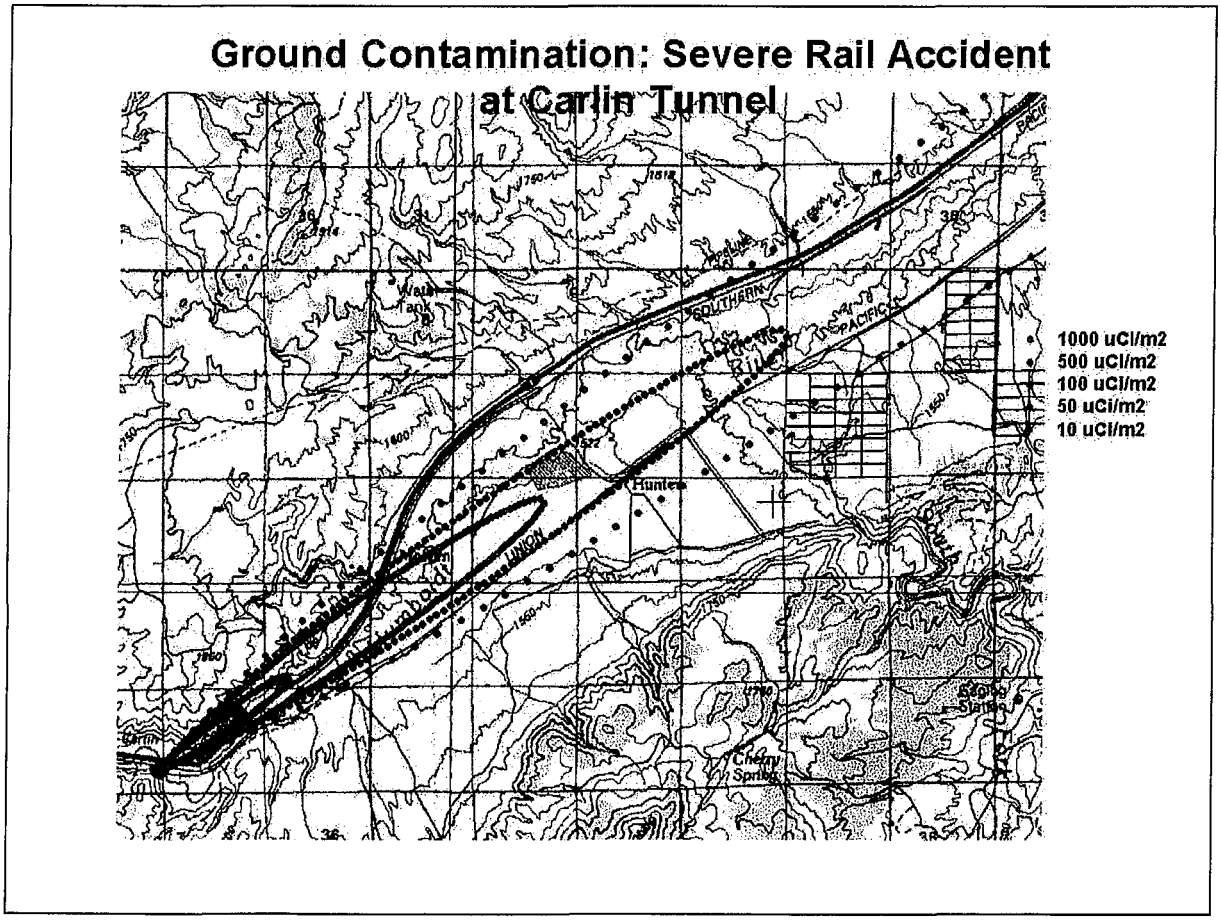


Figure 3.8.11 shows ground contamination following the hypothetical rail accident at the Carlin Tunnel in Elko County.

Figure 3.8.11



Following a rail accident at either location, acute radiation doses due to inhalation of a passing radioactive cloud would be in the hundreds of rems close to the release location. This is a thousand times what a person receives from background radiation in a year. Thousands of people are likely to be in the downwind path. RWMA estimated that over 138,000 persons would be affected by a severe rail accident releasing radioactive material in Las Vegas. Persons indoors would also be exposed. If ventilation systems were not shut off, radioactive particulates would settle within hotels and other buildings, contaminating rugs, furniture, beds, and causing a radiation dose to those inside.

Discussions with emergency personnel in Las Vegas and Clark County clearly indicate the accident would overwhelm local response capabilities. Before local emergency responders could accurately assess the problem, the radioactive plume would have already contaminated an extensive area. Radioactive particulates settling on roads

and highways are likely to be spread by traffic, possibly contaminating distant locations and extending the area of contamination past that assumed in this study. This may result in the contamination of many more people than was estimated in the report.

Given the high number of people exposed, local responders would not be able to identify, let alone effectively quarantine, contaminated people. Thus, it would be extremely difficult to stop the spread of contamination. Initial decontamination efforts would probably be limited to emergency responders and people in the closest vicinity of the accidents. Decontamination of the affected population in general would be a massive effort.

Evacuation would be difficult at best. Spontaneous evacuation by people not in the contaminated area would probably occur in great numbers, making the targeted evacuations much more difficult to complete. At a minimum, the evacuation of highly contaminated areas would be necessary. For a rail accident, evacuation would have to be in a radius greater than one kilometer; this would represent a large number of people if the accident took place near the Las Vegas Strip. In both Las Vegas and Elko, evacuation would be complicated by the need to close the segments of I-15 and I-80 contaminated by the plume.

In the case of an accident in Las Vegas, consideration would have to be given to closing McCarran airport in order to prevent the migration of contaminated persons. Alternately, all passengers would have to be screened for contamination. This would require a huge amount of resources that could be better utilized dealing with the major issues.

The incident would overwhelm the capability of the local medical community. Blood and urine samples of contaminated people should be taken to track the levels of contamination and exposure, but this would be very difficult given the number of contaminated and potentially contaminated individuals. Mental health resources would be overwhelmed as well.

Unless radionuclides, particularly cesium, were removed from surfaces, remaining residents would be exposed for long time periods. Complete decontamination would be prohibitively expensive and would also expose workers; a balance would take place between clean-up costs and long-term radiation exposures. RWMA chose the EPA's Protective Action Guide as the criteria for decontamination that assumed a person should not receive more than 5 rems over a 50-year period, including initial inhalation due to the passing cloud. If areas are not decontaminated, RWMA estimated between 6,000 and 41,000 latent cancer fatalities would result from exposure to radiation resulting from the accident in Las Vegas, depending on the risk model. If radioactive contaminants were not remediated, there would be continuous direct gamma exposure to remaining residents. Further, this would result in a tremendous concomitant economic cost to the tourist industry. Social stigma costs are beyond the scope of this report.

Using the economic model of RADTRAN 5, evacuation and decontamination in Las Vegas would cost $15.4 billion for the Category 5 accident evaluated by RWMA. The same costs for the Category 6 accident described in the DEIS would be $189.7 billion. These potential costs greatly exceed the amount of insurance coverage held by nuclear utilities or the Department of Energy. This raises the question of how such an expensive endeavor would be financed. Government financing of cleanup would require an act of Congress, which would significantly delay remedial action.

A rail accident near the Carlin tunnel in Elko County would also have serious consequences. RWMA did not separately calculate decontamination costs for the Elko County accident, but previous studies indicate cleanup could cost as much as $500 million to $1 billion. [Sandquist, et al., 1985] If areas were not decontaminated, between 100 and 600 latent cancer fatalities would result from exposure to radiation resulting from the rail accident.

I-80 is the main route across Northern Nevada, as well as a major cross-country thoroughfare. A rail accident that spread radioactive contamination could force closure of I-80 and either leave cars trapped or have vehicles spread the contamination miles down the highway. A rail accident near the Carlin tunnel, in a canyon adjacent to the Humboldt River, would result in contamination of the riverbed and water for miles downstream and lead to accumulations in slowly moving sections of the river. Use of the river for recreation or drinking water would be curtailed for years to come.

The RWMA study shows the potentially disastrous consequences of an accident leading to the release of radioactive material from a spent fuel transportation cask. It also underscores the importance of preparation of emergency response for such an accident. Acknowledgement of the potential for disaster, even if the probabilities are not high, is important in attempting to prepare for an unprecedented spent fuel transportation campaign.

The tables below summarize the findings of the RWMA study. Table 3.8.15 presents a comparison of the Las Vegas rail accidents with the urban 'maximum reasonably foreseeable' accident scenarios listed in the DEIS. Table 3.8.16 presents impact estimates for the Elko County accidents. DOE did not evaluate a rural 'maximum reasonably foreseeable' accident scenario in the DEIS. The consequences estimated by RWMA are significantly higher than those estimated in the DEIS, primarily due to the assumptions of a higher population density and an increased release fraction for cesium.

Table 3.8.15 Comparison of RWMA and DEIS Urban Rail Accident Consequence Assessments

	Urban Rail Accident			
	State of Nevada, Cat.5	State of Nevada, Cat.6	YM DEIS, Cat. 5	YM DEIS, Cat. 6
Acute (24-hour) Population Dose (person-rem)	26,171	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	13-444	Not calculated	Not calculated	Not calculated
1-year Population Dose (person-rem)	915,968	Not calculated	Not calculated	61,000
Expected Latent Cancer Fatalities	458-2,931	Not calculated	Not calculated	31
50-year Population Dose (person-rem)	12,771,207	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	6,386-40,868	Not calculated	Not calculated	Not calculated
Dose to Maximally Exposed Individual (rem)	22.5	224	Not calculated	26
Area contaminated to greater than 5 rem long-term dose (km^2)	104.7	1208.4	Not calculated	Not calculated

Table 3.8.16 Comparison of RWMA and DEIS Rural Rail Accident Consequence Assessments

	Rural Rail Accident			
	State of Nevada, Cat.5	State of Nevada, Cat.6	YM DEIS, Cat. 5	YM DEIS, Cat. 6
Acute (24-hour) Population Dose (person-rem)	393	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	0.2-1.3	Not calculated	Not calculated	Not calculated
1-year Population Dose (person-rem)	13,760	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	7-44	Not calculated	Not calculated	Not calculated
50-year Population Dose (person-rem)	191,859	Not calculated	Not calculated	Not calculated
Expected Latent Cancer Fatalities	96-614	Not calculated	Not calculated	Not calculated
Dose to Maximally Exposed Individual (rem)	26.9	267	Not calculated	Not calculated
Area contaminated to greater than 5 rem long-term dose (km^2)	118.6	1202	Not calculated	Not calculated

Impacts Of Terrorism Or Sabotage Against Rail Shipments

Rail shipping casks for SNF and HLW are vulnerable to terrorist attack and sabotage. DOE sponsored a 1999 study of cask sabotage by Sandia National Laboratories (SNL) in support of the DEIS. The SNL study demonstrated that HEDs are "capable of penetrating a cask's shield wall, leading to the dispersal of contaminants to the environment." [DEIS, p. 6-33] The SNL study also concluded that the radioactive release from a rail cask, following a successful attack, would be less than the release from a truck cask, even though the amount of SNF/HLW in a rail cask could be six times greater than in a truck cask. [DEIS, p. 6-34]

DOE estimated that a successful attack on a rail cask in an urban area would result in a population dose of 4,900 person-rem, 2.4 fatal cancers, and a maximum individual dose of 11 rems. The DEIS did not evaluate any environmental impacts other than health effects. In particular, the DEIS ignored the economic impacts of a successful act of sabotage.

An analysis prepared for Nevada by RWMA estimated rail cask sabotage impacts would be at least ten times greater than DOE's estimate. RWMA replicated the DEIS sabotage consequence analysis, using the RISKIND model for health effects and the RADTRAN model for economic impacts, the SNL study average and maximum inventory release fractions, and a range of population densities and weather conditions. Under average weather conditions, RWMA estimated that the same rail cask sabotage incident would result in 1-17 latent cancer fatalities, and a maximum individual acute dose of 34 rems. Under worst case weather conditions, there would be 2 - 27 latent cancer fatalities, and a maximum individual acute dose of 56 rem. Cleanup costs and other economic impacts ranged from $0.5-2.0 billion (2000$) for average weather conditions, and $2.2-6.7 billion (2000$) for worst case weather conditions.

As was the case with DOE's truck cask analysis, other rail cask terrorism and sabotage scenarios could result in even more severe impacts. The selection of the reference weapon is extremely important. Maximum damage to a large rail cask requires a weapon capable of penetrating layered shield walls containing 4-6 inches of stainless steel and 2 inches of depleted uranium. The Sandia study was constrained by the military definition of man-portability rather than the NRC's design basis threat in selecting the reference weapons used in the analysis. As a result, Sandia failed to consider larger, state-of-the-art anti-tank weapons such as the TOW and Milan missiles, which are designed to penetrate 24 to 38 inches of armor. Sandia also ignored the use of more than one penetrating weapon, use of an incendiary device in conjunction with a penetrating weapon, and use of commercial shaped charges. Assuming full perforation of a rail cask would increase both the DOE and RWMA release estimates, and the resulting health and economic consequences, by at least a factor of ten.

The impacts would have also been substantially greater if the rail cask was assumed to be carrying 10-year-old SNF. DOE assumed 26-year-old SNF. Assuming 10-

year-cooled SNF would result in a 30 - 40 percent increase in the release of cesium-137, a particularly important radionuclide in determining acute radiation doses.

As with the truck cask analysis, the social and economic impacts of an attempted act of terrorism or sabotage, whether successful or unsuccessful, deserve special attention. An incident involving an intentional release of radioactive materials, especially in a heavily populated area, could cause widespread social disruption and substantial economic losses, even if there were no immediate human casualties and few projected latent cancer fatalities. Local fears and anxieties would be amplified by national and international media coverage. Adverse economic impacts would include the cost of emergency response, evacuation, decontamination and disposal; opportunity costs to affected individuals, property owners, and businesses; and economic losses resulting from public perceptions of risk and stigma effects.

Rail Spur Construction and Operation Impacts

Operation of the Rail Line

The impacts of the construction and operation of the proposed rail corridor may be greatly influenced by design and operating criteria. DOE has used a wide range of assumptions that make it difficult to accurately identify the impacts.

Use of general freight would result in significant delays during shipping, will require shipments to pass through many rail yards that could be avoided, and will probably result in shipments being switched in the UP rail yard near Las Vegas. These actions increase potential exposure to workers and the general population and increase the probability of accidents in yards in general and during switching activities.

Impacts Outside of Identified Corridors

DOE's impact assessment was limited to assessing impacts within a set distance of the identified corridor. Railroad yards, borrow areas, areas for disposal of surplus fill, staging areas, construction camps, lay down areas, access roads to construction initiation points, and other construction activities will result in impacts outside of the identified corridors.

Support Facilities

Support facilities, such as interchange tracks, turning tracks, and maintenance facilities, will be required at the interchange points where the cars loaded with radioactive waste will be transferred from the Union Pacific to the new rail line.

These facilities will require a significant area at the connection point. The exact size and location has not been specified.

Borrow and Fill Areas

Significant quantities of cut and fill material will be required for roadbed construction. In many areas, the amount of cut and fill will not balance within reasonable hauling distances, requiring disturbance of up to 2,400 additional acres for borrow and fill areas outside of the corridor. Construction of the railroad in any of the proposed rail corridors will require up to 1,736,000 cubic yards of sub-ballast.

Land Use

DOE's corridor selection study is flawed. The first selection criteria used by DOE to select potential routes was land use compatibility based on using public land to minimize land-use conflicts. Most of the private land in the West has gentle topography. By using land ownership for the first selection criteria, DOE's selection process actually favored more rugged terrain where construction of the proposed rail line will be more difficult. This creates many additional land use impacts due to the extensive cuts and fills required by unfavorable topography.

Land ownership does not accurately reflect land use. Most western ranching operations are based on a combination of privately owned fee land and grazing leases on publicly owned lands. Splitting an existing operation with a rail line that will limit access to the leased land can have significant adverse effects on the operation of the ranch. If the rail line right-of-way is fenced, the splitting of ranching operations will be perhaps the most significant impact to the residents of Nevada.

Barrier to Movement

The rail line will bisect many local roads. Grade-separated crossings will be limited to major roads. Only a few of the at-grade crossings will be signaled. For example, there are 123 crossings on the Caliente route. Two are grade-separated, one is a signaled at-grade crossing, and 120 are at-grade non-signaled crossings.

Ranching operations will be the most affected by the barrier to movement created by the proposed rail lines. Box culverts and bridges are commonly used to provide underpasses under railroad tracks for the movement of livestock and equipment. Underpasses will be limited to locations where underpasses can be constructed based on the topography and the profile of the proposed rail line. The degree of impact is a combination of the proposed at-road crossings (either at-grade or grade-separated) and proposed drainage structures. For the Caliente/Carlin route, the average distance between potential crossing locations is 19.2 miles. The longest distance is 39 miles. The distances between crossings are similar for other routes.

Land Use Constraints

There are a number of land use conflicts with the proposed rail line. It is particularly difficult to understand why DOE has not eliminated the Caliente-Chalk Mountain alternative. The U.S. Air Force has unequivocally stated that this alternative is unacceptable due to its impacts on the Nellis Air Force Range.

Many of the areas crossed by potential rail corridors are currently remote, undeveloped areas. Much of the area is currently roadless, including Wilderness Study Areas.

The land-use impacts associated with the development of ballast and sub-ballast quarries, solid waste disposal facilities, construction lay-down areas, and construction staging areas cannot be assessed until these areas are identified.

From a land-use perspective, the only rail alternative that does not have serious land-use conflicts is the Caliente corridor. Even this corridor could impact the Nellis Air Force Range. All other rail alternatives cross or impact areas designated as special purpose land-use, including Bates Mountain Antelope Release Area, Simpson Park Habitat Management Area, Old Spanish Trail/Mormon Road Special Recreation Management Area, Stateline Wilderness Area, the Desert National Wildlife Range, Quail Spring WSA, Nellis AFB small arms range, and Indian Springs Auxiliary Field facilities.

Land Ownership

Although the percentage of private land crossed is low overall, most of this land is concentrated in a few areas, primarily flat land along streams and rivers. Ranch homesteads, hay fields, and other primary components of a ranching operation are usually located in these areas.

Community Growth Areas

Proposed rail line corridors also cross areas of potential future community growth for North Las Vegas and Las Vegas. Both cities have proposed land transfers from the Bureau of Land Management in the area for future community development. Other community growth areas include Pahrump in Nye County and Beowawe and Crescent Valley in Eureka County.

Solid Waste

Significant volumes of solid waste will be generated by rail line construction in comparison to the capacity of waste disposal facilities in rural Nevada. Given the remote, sparsely populated areas crossed by the proposed rail line, solid waste disposal facilities probably do not have sufficient capacity to handle waste generated during rail construction. Commonly, construction waste is not compatible with the waste handling facilities at existing sites.

Water Resources

Some of the rail corridors are known to cross or be near significant springs, groups of springs, streams designated as riparian areas, or reservoirs associated with wetlands. Wetlands and riparian areas are a valuable resource in Nevada. Most of the rail corridors cross rugged terrain where significant cuts will be required. These cuts could intercept groundwater flow.

Biological Resources

The rail corridors pass through or adjacent to many significant biological resource areas, including critical habitat and migration corridors. The construction and operation of the rail line would reduce the value of these areas, resulting in significantly greater losses in resources than just the area physically within the rail line right-of-way.

Critical habitat is absolutely necessary for wildlife. Human activity, such as the operation of a rail line, in or even near critical habitat can seriously degrade the value of that habitat for wildlife. This is especially true of linear facilities, such as a rail line, that pass through habitat areas. Without undisturbed access to critical habitat, the wildlife using that habitat may abandon large areas. Critical habitat crossed by or near to rail corridors includes bighorn sheep crucial winter range, mule deer crucial winter range, pronghorn winter range, sage grouse strutting areas, sage grouse nesting areas, chuckar crucial habitat, and quail crucial habitat. Corridors also cross migration corridors for big game. Linear facilities such as rail lines can significantly impact the movement of big game, particularly in areas where steep cuts or fills are required.

The Valley Modified corridor crosses the Desert National Wildlife Refuge (DNWR) in several places. The DNWR, set aside primarily for desert bighorn sheep, provides habitat for mule deer, other desert mammals, and migratory birds. The Corn Creek area contains an environment filled with trees, pasture, and spring-fed ponds that attract a large number of migrating birds not common to the desert environment. The ponds are home to the endangered Pahrump poolfish.

Depending on the types and locations of fencing, the proposed rail line could create significant impacts to wildlife, particularly where the proposed corridors cross critical habitat areas.

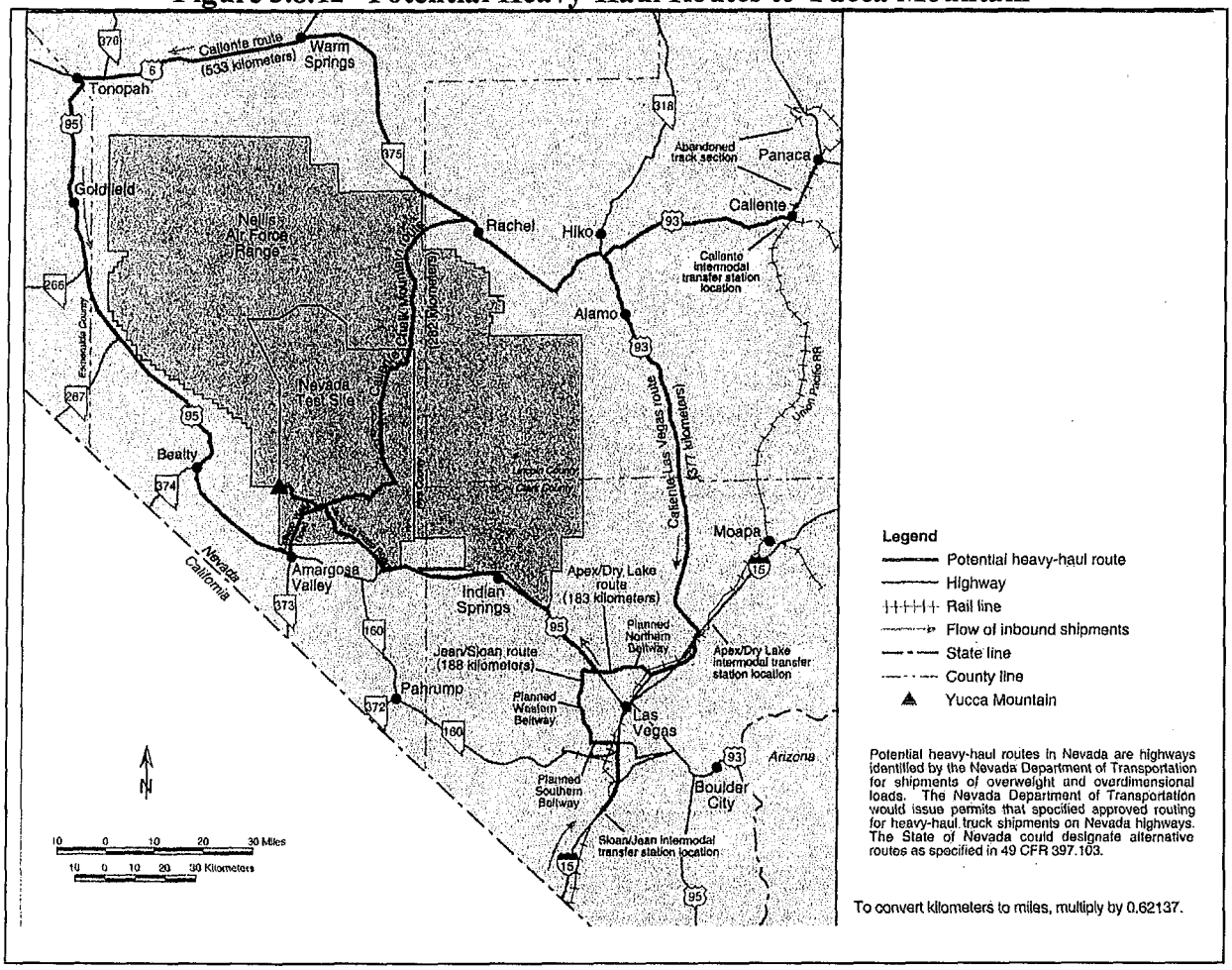
Soils

The proposed rail corridors pass through many areas where soil types will make reclamation difficult. Several of the corridors pass through playa deposits that consist of finer grained sediments and alkali flats. These soil types are generally more difficult to re-vegetate following disturbance. Re-vegetation will also be difficult due to the arid climate. Construction of the rail line will result in loss of soils through wind erosion, with some degradation of air quality as a result.

Heavy-Haul Truck Impacts In Nevada

The U.S. Department of Energy is considering using heavy-haul trucks on existing highways as one option for delivering spent fuel and high-level nuclear waste to the proposed repository at Yucca Mountain. Under this option, nuclear waste casks would be delivered to Nevada primarily by rail. At an intermodal transfer station, the casks would be unloaded from the rail cars and transferred to heavy-haul tractor-trailers. Under this option, there would be no rail access provided to Yucca Mountain.

Figure 3.8.12 Potential Heavy-Haul Routes to Yucca Mountain



DOE has proposed three possible locations for the intermodal transfer station. These are Caliente, located in Lincoln County; Apex/Dry Lake, located north of Las Vegas; and Sloan/Jean, located south of Las Vegas. Five possible routes along existing highways are being considered from these intermodal transfer station sites to Yucca Mountain, as described below.

Caliente: From the intermodal transfer station at Caliente, shipments would follow U.S. 93 to State Route (SR) 375, SR 375 to Warm Springs, U.S. 6 to Tonopah,

U.S. 95 to the Lathrop Wells road to Yucca Mountain. The total length of this route is 331 miles. Travel time would be 10 hours at 35 mph.

Caliente/Chalk Mountain: From the intermodal transfer station at Caliente, the shipments would follow U.S. 93 to SR 375 near Rachel, then through Nellis Air Force Base to Yucca Mountain. The total length of this route is 175 miles.

Caliente/Las Vegas: From the intermodal transfer station at Caliente, the shipments would follow U.S. 93 to I-15, I-15 to the proposed North Las Vegas Beltway, the proposed Beltway to U.S. 95, and U.S. 95 to Yucca Mountain. The total length of this route is 234 miles.

Apex/Dry Lake: From the intermodal transfer station at Apex/Dry Lake, the shipments would follow I-15 to the proposed North Las Vegas Beltway, the proposed Beltway to U.S. 95, and U.S. 95 to Yucca Mountain. The total length of this route is 114 miles.

Sloan/Jean: From the intermodal transfer station at Sloan/Jean, the shipments would follow I-15 to the proposed Southern Las Vegas Beltway, the proposed Beltway to U.S. 95, and U.S. 95 to Yucca Mountain. The total length of this route is 117 miles. (DOE, p. 2-54)

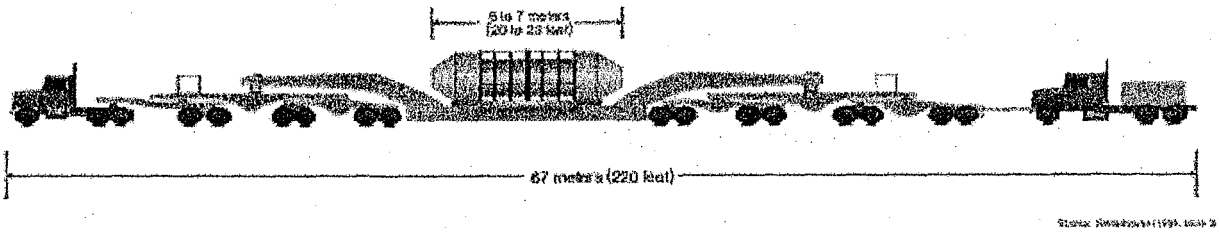


Figure 3.8.13 Heavy Haul Rig for Use With Yucca Mountain Shipments

The tractor-trailer rig used for these shipments would be a custom rig built specifically for this project. The custom built trailer is required because the proposed spent fuel casks create a more concentrated load than used on existing heavy-haul trailers. The tractor-trailer would be designed for maximum axle loads of 20,000 pounds for single axles and 34,000 pounds for tandem axles. For the proposed 125-ton spent fuel casks, the trailer would be 148 feet long. With tractors, the vehicle would be 220 feet long, with an unloaded weight of the vehicle of 200,000 pounds. According to DOE, the unit would operate at an average speed of 20 to 30 mph.

There would be a total of 19,800 shipments over 38 years, with an average of 521 shipments per year. Shipments would be allowed only during daylight hours, Monday through Friday.

Uncertain Feasibility Of Heavy-Haul Transport In Nevada

The use of heavy-haul trucks on Nevada highways requires that DOE obtain overweight truck permits for each truck from the Nevada Department of Transportation. The issuance of an overweight permit is dependant on the determination that the load is a non-divisible load. A regulatory analysis prepared for NANP concluded that DOE would have great difficulty meeting the Federal Highway Administration definition (23 CFR 658) of non-divisible load. Because the transport vehicle would be 220 feet in length, an oversize vehicle permit would also be required.

Since the use of rail casks is clearly optional and the waste could be shipped in legal-weight casks, DOE's proposed use of rail casks transported on overweight and oversize vehicles clearly does not meet the definition of non-divisible load and does not qualify for an overweight and oversize permit. The State of Nevada would therefore not be required to issue the permits needed to make HHT a feasible option in Nevada.

Heavy-haul of the magnitude and duration on State highways proposed by DOE has little precedent, raising questions concerning the feasibility of the operation. There is little, if any information regarding the performance over time of bridges, structures, culverts, and pavement subjected to heavy loads of this magnitude and frequency. Specific obstacles to DOE's proposed HHT plan of operations include day-of-week and time-of-day travel restrictions, frost restrictions, bridge weight restrictions, route closure during resurfacing operations, limited safe parking areas, and limited turning areas large enough for HHTs to turn around.

Southern Nevada experiences extreme heat during summer months. The heavy-haul trucks could cause severe rutting of asphalt surfaces during times of excessive heat. In areas that experience winter snowfall, snowmelt could create saturated roadbed conditions, resulting in pavement damage from heavy-haul trucks. The feasibility of some heavy-haul route options depends on upgrades required to remove frost restrictions on some road segments. There is also inadequate information to demonstrate that the heavy-haul trucks would not significantly reduce the expected life of pavement surfaces.

All of the proposed HHT routes through Clark County involve severe traffic and safety impacts. The extreme length of the heavy-haul vehicle and its slow speed would result in a significant impact to traffic flow on all the highways considered.

DOE believes that this problem could be reduced once the planned Las Vegas Beltway is completed. This very well might not be the case. Studies have demonstrated that in growing urban areas, growth takes place along transportation corridors, negating any improvement in traffic flow from route improvements. This was recently demonstrated for the Denver urban area where studies of an extensive improvement planned for the highways in that area predicted insignificant changes in traffic flow.

DOE's plan to construct climbing lanes only where grades exceed four percent and turnout lanes every 5 to 20 miles, depending on traffic volumes, is inadequate. The

average speed of the transport vehicle is 30 mph. At a length of 220 feet, with two escort vehicles and two Highway Patrol escorts, the "convoy" would be over 400 feet in length. If another vehicle attempts to pass the convoy at an average speed of 45 mph, it would take over a quarter of a mile to pass the convoy. Safe passing by triple-trailers (115 feet in length) would require a one-mile passing lane every five miles.

Radiation Exposures From Heavy-Haul Transport

In preparation for this report, CAI studied the potential routine radiological impacts along routes that could be used for HHT transportation of SNF and HLW to Yucca Mountain. An HHT shipping scenario and route that would maximize opportunities for routine exposures were selected from the DEIS, and locations in Nevada where exposures would be maximized by proximity to casks during required transport vehicle stops and/or travel at slow speeds were identified. The selected locations include sidewalks and road shoulders near residential and commercial buildings, and pedestrian crosswalks. While members of the public are frequently present at these locations, the CAI analysis estimated the maximum annual dose at a particular location without regard to the actual presence of an exposed individual or individuals at that location.

NANP selected for analysis a segment of US 95 through Goldfield that could be used for shipments from an intermodal transfer facility in Caliente to Yucca Mountain. Under DOE's mostly rail scenario, over 38 years, an average of 521 HHTs and 96 LWTs per year could traverse Goldfield on US 95. HHTs would likely operate at substantially slower speeds than LWTs, about 10-15 mph in towns. The restricted hours of operation could increase the number of shipments required to stop for pedestrians in cross walks. The size and weight of the HHT would increase stop and restart times.

CAI calculated cumulative annual doses at the HHT route locations selected by NANP using the code RISKIND 1.11, supplemented with analytical modeling. Total doses for the HHT scenario represent the sum of the doses for 521 HHT shipment and 96 LWT shipments per year.

CAI found that a location near a pedestrian crosswalk requiring brief stops (30 seconds) received an annual dose of 30 mrem (at 3.4 meters). Near-route locations (at 3.4 meters from the cask) where trucks slowed down, but did not stop, received annual exposures ranging from 3.4 mrem to 5.8 mrem. The estimated annual doses for each location are shown in Table 3.8.17.

Table 3.8.17 Estimated Annual Doses at Locations Along HHT Route to Yucca Mountain

Location	Distance from Cask (meters)	Stop Time (seconds)	Travel Speed (miles/hour)	Annual Dose (millirem)
Goldfield #1	3.4	0	10 - 15	3.4
Goldfield #2	3.4	30	10 - 15	30.0
Goldfield #3	3.4	0	5 - 6	5.8

Considering the lack of precedents for large-scale HHT operations, the analyses prepared for this report may have underestimated routine doses by a factor of 2 or 3. The State is currently evaluating alternative methods of more precisely estimating maximum routine doses along HHT routes and the resulting health effects.

While additional studies are needed, the preliminary estimates of annual doses on private properties along the HHT constitute a major finding. HHT shipments to Yucca Mountain would clearly create elevated radiation exposure zones on private properties along the route. Further analysis of socioeconomic impacts would consider the extent to which DOE's proposed action constitutes a taking of property rights.