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Risk-Induced Social Impacts: The Effects of the Proposed Nuclear Waste Repository on residents of the Las Vegas Metropolitan Area

by

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The Nevada Agency for Nuclear Projects/Nuclear Waste Project Office was created by the Nevada Legislature to oversee federal high-level waste activities in the State. Since 1985, it has dealt largely with the U.S. Department of Energy's siting of a high-level nuclear waste repository at Yucca Mountain in southern Nevada. As part of its oversight role, NWPO has contracted for studies designed to assess the socioeconomic implications of a repository and of repository-related activities.

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EXECUTIVE SUMMARY

This report examines important and major impacts of the proposed high-level nuclear waste repository on Las Vegas metropolitan residents. The data utilized in the report consist of interview data collected in the 1988, Urban Risk Survey and data for Clark County residents collected as part of the 1989 Nevada Telephone Survey. The use of two different data sets which were collected at two distinct points in time permit for not only determinations of the consistency of opinions and risk perceptions, but also result in a compelling consistency of findings demonstrating the types of impacts described in the report.

The first area investigated in the report deals with the public's perception of the repository program. In both the Urban Risk Survey and the Nevada Telephone Survey data there is strong evidence of a high level of awareness of the repository project, strong negative images of the repository, majority opposition to the building of the facility, and a great deal of concern about possible health and safety effects from the proposed project. In addition, the urban residents evidence substantial fatalism concerning nuclear waste transportation accidents and their harmful consequences, and residents express little confidence that government mitigation activities will be successful in reducing the impacts of these accidents. Finally, a large majority of urban residents not only oppose construction of the facility but believe the entire siting process has been unfair and inequitable. In addition, far fewer residents in 1989 than in 1988 believed the siting in Nevada was inevitable. In this context, one could hardly imagine a distribution of images, opinions and risk perceptions about a facility which was less supportive or receptive to its siting.

Not all urban residents view the repository in a similarly negative fashion. In examining urban residents' risk perceptions significant differences are evident between genders. An interactive analysis was conducted to determine if gender and other socio-demographic variables interact with each other in order to identify subgroups of the population with substantially different views of the repository. This interactive analysis identifying subgroup differences was accomplished by constructing risk perception indices along six different risk perception dimensions in each survey. That is, different dimensions of risk about the repository were identified and indices constructed for each survey. This analysis found significant differences in risk perceptions of the repository process based upon gender with females showing significantly greater concern about health and safety, the unlikelihood that mitigation activities will be successful, and the belief that transportation accidents involving waste transportation are inevitable. In both data sets, females view the repository in significantly different ways than do males. In addition, the interactive analysis discovered that gender and age do interact especially for younger urban residents (18-25 and 26-30). Younger females view the repository process with far greater concern and have far higher risk perceptions concerning the project than do younger males.

Another area of investigation in the report specifically addressed residents' perceptions of the transportation component of the repository process. A framework of perceived vulnerability from the transportation of high-level nuclear waste was developed to guide the analysis. The framework suggests that perceived vulnerability is a function of several factors including not only perceptions of

the inevitability of transportation accidents and their consequences, but also basic attitudes held by residents regarding hazardous materials transportation. In addition, the perceived ability of government to manage and mitigate the risks of transportation accidents affects the overall perceived risk of transporting nuclear waste materials. These different perceptions of transportation risk are also associated with socio-demographic differences. The analysis based on this framework finds that the perceived risks of transporting high-level nuclear waste and the perceptions of management and mitigation efficacy can be combined to provide a perceived vulnerability of residents to transportation of these waste materials. Indeed, the perceptions of the risk of shipping nuclear waste materials was found to be among the most salient concerns expressed by residents regarding the repository program with larger percentages of the urban population expressing high risk perceptions over transportation issues then the repository facility itself.

A third area of investigation examined political trust and its relationship to repository risk perceptions. The importance of the level of political trust in both the federal government and the agencies which play leading roles in the repository siting process can not be overestimated given the recent report by the Commission on Geosciences, Environment, and Resources of the National Research Council which emphasized the importance of political credibility, especially of the regulating agencies, to the success of the repository program. Yet, analysis data from both surveys reveals that urban residents express the least trust in these federal agencies and the federal government. Among all agencies of the federal government examined, the Department of Energy and the Nuclear Regulatory Commission evidence the lowest trust levels recorded by residents. Using three indices of trust developed for both surveys, moderately strong relationships were found between trust and the repository risk indices. Especially strong relationships were discovered for mitigation efforts likelihood of success, safety and the likelihood of accidents, and the transportation indices. For the federal trust indices higher trust levels are associated with lower risk perceptions of the repository program. Yet, there are very low levels of trust for these federal agencies among the urban population. In addition, the analysis of the relationship between trust indices for the state and local governments and repository risk perceptions yields findings which are the opposite to those found for the federal agencies. That is, higher trust levels in state and local government is associated with higher repository risk perceptions. These findings are not only consistent with the adversarial relationship which has developed between the state and federal lead agencies, but also serve to reemphasize the importance of political credibility to the likelihood of success of the siting process.

Both the Urban Risk Survey and the Nevada Telephone Survey examined the minimum distance urban residents would be willing to live and work from a set of hazardous industrial facilities. These distances act as a gradient of perceived risk with higher distances indicating respondents associate greater risks to the facility. Consistent with two other studies, the analysis of the surveys demonstrates that a high-level nuclear waste repository is ranked the highest of all facilities on the distance measures. These data strongly suggest that a clear distinction may be made between hazardous industrial facilities and nuclear waste repository in terms of risk perceptions and perhaps dread. In addition, the substantial proportion of the urban residents who say that the repository can not be made acceptably safe, and the lack of trust in government to manage the project and mitigate potential accidents and impacts suggests that traditional

compensation strategies to gain public acceptance of a facility, if used, may not find as much success in dealing with this type of facility.

Finally, analysis of the Urban Risk Survey data involving three scenarios of the repository operations and processes, a benign scenario with no accidents of any significance at the facility, and a moderate and high transportation risk scenario involving accidents of varying significance in the transportation of waste, substantial impacts or shifts of opinion, risk perceptions and intended behaviors were discovered between pre/post scenario comparisons. Specifically, significant shifts were found in perceptions of one's quality of life and other well-being indicators, as well as behavioral intentions about investments and intentions of moving from the area. In addition, political activism directed at the repository program would increase sharply when compared to general levels of participation over the last four years.

The consistency of the findings between the two surveys is compelling. There is no question that the repository is perceived in extremely negative terms and is associated with a high level of perceived risk by a substantial segment of the population. The consistency of these perception over time suggests that they are deep-rooted and will not easily shift. Information programs aimed at shifting these opinions and minimizing the risk of the repository program will have difficulty in being accepted by Las Vegas area residents.

The repository is viewed as an extremely dangerous facility where accidents are perceived as inevitable, and the consequences may result in catastrophic impacts. Over the last few years, the negative imagery of the repository, coupled with the view that the area may become stigmatized has amplified the perceived risks over the benefits. In addition, Las Vegas valley residents have little trust in the agencies empowered to ensure their safety and to mitigate the impacts from the facility. In this context it is difficult to believe that the federal agencies can regain much credibility among Clark County residents, or that the major impacts outlined in the report if the Yucca Mountain project becomes a reality will not come about.

1.0 INTRODUCTION TO REPOSITORY IMPACTS ON RESIDENTS OF THE LAS VEGAS METROPOLITAN AREA

1.1 Structure of the Report

The purpose of this report is to summarize some of the key findings related to the impacts of the proposed nuclear waste repository on residents of the Las Vegas metropolitan area. A substantial effort has been directed at developing methodologies and carrying out analyses to determine the range and magnitude of socioeconomic effects of the repository on the metropolitan area. This summary report is only the first step in bringing together this large set of studies directed at urban socioeconomic impacts. It is, however, limited to addressing the risk-induced effects of the repository on residents by focusing on the public responses found in the Urban Risk Survey, implemented in 1988, and the Clark County portion of the Nevada State Survey, undertaken in 1989.

Other studies addressing the urban impacts of the repository in Clark County include analyses of intergovernmental impacts, fiscal and economic effects, urban ethnographic analysis, political impacts, and tourist behavioral patterns. The next phase in reporting on the urban impacts is to synthesize and integrate the findings from the various investigations. For now, the objective is to identify the salient socioeconomic impacts of the project, to show the linkages between sources of impact and the nature/magnitude of the effects, and to determine the degree of consistency between the two data sets. If the project will create substantial public concern and lessen the quality of life, we want to understand the nature of the effects, their distribution, and their attribution to specific elements of the repository program.

As an industrial project, the siting, development, and operation of the repository will produce changes to the existing socioeconomic environment that are typical of other large industrial investments. There will be obvious increases in employment and demands placed on the provision of local goods and services. Demands for increased housing supply and expansion of social and other public services are typical challenges facing urban areas under rapid industrial development. These "standard effects" also include social impact measurements, effects on well-being, and changes in other community social processes.

Because these "standard effects" are dealt with elsewhere in the project, the focus of this summary report is on the effects of the repository on residents as a result of the risks inherent in the repository technology and program. The proposed siting of a high-level nuclear waste repository has engendered difficult problems in assessing impacts to the urban area.

Unlike the more traditional impact analysis, the measurement of impacts due to a repository has challenges that have to do with uncertainty. Substantial uncertainty continues to exist in project design, the transportation system, risk assessments, and other items that typically provide the driving variables for impact projections. Uncertainties also are inherent in the hazardous properties of the repository program and in the risk analyses. We are uncertain about the type of risk future the repository will produce. These uncertainties are related to the impacts of perceived risks and projections of impacts of unintentional risk events.

Impacts can result from public perceptions of risk, concerns over the hazardous properties of the repository, and behavioral adjustments to avoid or to minimize risk. Risk-induced effects also have the potential to diminish quality of life creating perceptions that could affect individual lives and community well-being. Heightened perceptions of risk may also result in changes in behaviors that may produce substantial socioeconomic impacts. In the Urban Risk Survey, intended behaviors that were addressed included the likelihood of increased out-migration, reduced investment in Southern Nevada, and increased political participation. We asked whether risk-induced effects can materialize over a 50-year nuclear waste emplacement period and the direction and scope of these effects.

The summary of the impacts addressed in this report is structured as follows. The report first provides an overview of the key findings related to public response and concerns of the repository program. These include the level of awareness, concern about harmful effects, benefits versus risks, and repository imagery. The findings are compared between the two surveys (Section 2.0).

Public concern is rooted in the perceptions residents have of the risks. Findings relevant to risk perceptions are reviewed and factors influencing the perceptions are discussed. Sociodemographic variables are then analyzed to test their association with various risk perception dimensions. Where crosswalks were available, the risk perception data in the two studies were also compared (Section 2.0).

Recent studies have shown that trust in government and confidence in regulatory agencies to manage nuclear programs play an important role in risk perception. The findings address the role of political trust in repository risk perceptions. Political trust and perceptions of management capabilities were examined for the major repository risk clusters, and for transportation risks specifically (Sections 3.0 and 6.0).

One area of substantial concern of Clark County residents is the transportation of nuclear waste to the proposed repository. The findings regarding responses to transportation risk address four major areas:

- Basic attitudes toward hazardous materials transportation;
- Risk perceptions of nuclear waste shipments;
- Perceptions of governmental efficacy in managing safety; and
- Sociodemographic explanations for variation in these perceptions.

The findings address the relationships among these clusters and the discussion addresses the question of whether transportation impacts are any different from repository facility-specific effects (Section 3.0).

Section 4.0 of the report addresses the question of the relative risks of the repository and provides a risk context for the repository. The instruments in the two surveys asked respondents the minimum acceptable distance they were willing to live by a variety of hazardous facilities, including a nuclear waste repository. The analysis compares the repository to other facilities in a context in terms of public acceptability and relative industrial risks.

Lastly, to assess possible future impacts of an operating repository, the findings addressed residents' responses to a set of repository risk scenarios. The methodology is

described in Section 1.3. Pre- and post-intervention data are compared to determine the size and direction of possible changes in perceived quality of life and behavioral intentions to migrate from the area, invest in Southern Nevada, and participate in political activities over the repository siting. If behavioral changes are plausible as a result of the repository operations, then this assessment allows us to identify the conditions under which such changes will be made.

1.2 Data From Two Surveys

This impact report on risk-generated effects was based primarily on data from the Urban Risk Survey (Mushkatel, et al., 1989). Where crosswalks were available, findings from the Urban Risk Survey were compared to the Clark County sample of the Nevada State Survey (Flynn, 1989). The Urban Risk Survey was conducted over a 10-week period in 1988. The Nevada State Survey was implemented in 1989. Several similar questions were asked in both surveys in order to have longitudinal response data.

The purpose of the Urban Risk Survey was to assess the potential impacts of the high-level nuclear waste repository at Yucca Mountain on the general well-being and behavior of residents in the Las Vegas metropolitan area. The "Las Vegas metropolitan area" was defined to include the cities of Henderson, Las Vegas, North Las Vegas, and the contiguous Clark County area which is urban.

A random digit dialing procedure (RDD) was used to select households for inclusion in the study. The sample was based on the proportionate distribution of residential households within the 62 telephone prefixes that serve the geographic sampling area. A total sample size of 755 telephone numbers were computer-generated. Contacts which identified a "non-sample" telephone number (i.e., one that was non-residential or not within the geographic boundaries) were replaced immediately. Contacts that did not initially result in an "in-sample" designation were not replaced until after at least 10 callbacks had been attempted at different times, on different days, over a four-week period.

Once a household was determined to be in-sample, a short telephone interview was conducted with an adult informant. A modified Kish (1949) selection procedure was used to then identify the appropriate random adult respondent in the household, and a face-to-face interview was scheduled with that household member. The telephone portion of the interview took approximately 10 minutes to complete; the face-to-face interview took between 50 minutes to two hours. A final response rate of 74.5 percent was achieved, allowing generalizability to the metropolitan population.

The Nevada State Survey was conducted during the period September 25 and October 15, 1989. The sample size was 677, of which 500 completed interviews were obtained for a response rate of 73.8 percent. The margin of error was $\pm$4.4 percent. The statewide phase included sample cases from all of the counties, but in order to generalize, other samples were drawn from the counties of Nye, Lincoln, Esmeralda, and Clark. For Clark County, the same size was 360, with a response rate of 73.9 percent. The resulting data yielded a $\pm$7.1 percent margin of error.

1.3 Methodologies and Approaches Employed For Measuring Impacts

The surveys which compose the data for this report provide us with an opportunity to examine risk perceptions and impacts of residents of the Las Vegas metropolitan area at different points in time. For example, the Urban Risk Survey was carried out in the spring and early summer of 1988 and the Nevada Telephone survey was completed in the fall of 1989. The use of these data in this fashion will allow us to track risk perceptions to determine if, and in what direction such perceptions may evidence change.

Of equal importance to the quasi-longitudinal nature of the data is that the surveys administered to urban residents of Clark County all contained some cross-walks. That is, efforts were made to utilize some of the same questions in each survey which dealt with perceived impacts of the repository, and what, if any actions residents might take if the repository were constructed. As a result, the data provide a robust test to determine consistency of perceptions, as well as for the impact findings. Yet, while these different surveys permit the triangulation of findings, they also mean that a variety of methodologies must be employed to analyze the data sets.

1.3.1 Independent Variables

Obviously in data sets as rich as the ones being examined, there are a large number of variables which might be utilized to examine and explain repository risk perceptions. The original model which guided the Urban Risk Survey, for example, suggested that a host of variables, including sociodemographic factors, political trust, hazard experience, experience with the Nevada Test Site, political efficacy, trust in science and technology, and others might all be related and help explain risk perceptions of residents. These risk perceptions it was felt might then explain residents' intended behaviors with regard to political actions, economic investment decisions, out-migration from the area, a lowering of social well-being and other changes which could be ascribed to the proposed project. The intended behaviors or potential impacts were measured through data collected in the interviews in the Urban Risk Survey after four scenarios were administered on a random basis to respondents (discussed later). The key question which needed to be answered was which variables would be used in the first part of analysis which related the independent variables to risk perceptions?

Implicit in all of the studies using surveys is the assumption that the repository will have a differential impact on residents. That is, not all urban residents of Clark County will perceive the proposed project in similar terms. Only certain members of the community may perceive the project as a risk which would alter their actions or change their satisfaction with their community. The key to understanding the independent variables which were selected for this report is understanding that the initial analysis was conducted to determine which sociodemographic variables were related to differential impacts and perceptions. Questions like do males and females view repository risk in significantly different ways, and do higher income members of the area view the risk differently than do lower income groups guided the sociodemographic analysis.

Yet, analysis should also be guided by theory and hypotheses, and in examining sociodemographic differences there was a large body of literature which suggested systematic differences along these variables might be evidenced (Kasperson, et al., 1979; Van Liere and Dunlap, 1981; Dillman and Christenson, 1975; and Mushkatel, et al., 1990). Indeed, some of the early analysis of the data did lead to the conclusion that some

significant differences in risk perceptions of the project existed based upon different sociodemographic characteristics (Mushkatel, et al., 1989; and forthcoming 1990).

While the substantiation of sociodemographic differences in risk perceptions of the proposed project would be interesting and a significant finding in its own right, it would not be sufficient for this type of impact report. What is needed in addition to these types of findings is an investigation into interactive effects which might exist. For example, if repository impacts are shown to significantly vary by gender with females associating higher levels of risk with the project, the question which needs to be addressed is which females have these risk perceptions. Hence, the analysis below will also attempt to characterize any interactive effects which exist because they allow us to determine which groups in the urban population are most likely to be impacted by the repository. (Because of the lack of sufficient urban cases in the Nevada Telephone Survey, only the Urban Risk Survey data are used to examine interactive effects.) For example, we may be able to suggest that females between the ages of 45 and 65 are most likely to be impacted by the repository. If interactive effects are found, then the scenarios described below can at some later date be utilized to "test" hypotheses concerning the likely impact of the project on subgroups of the urban population. The approach utilized in this report will be to first describe these sociodemographic differences, discuss the strength of these relationships and then test for interactive effects.

1.3.2 Dependent Variables

In this analysis, urban residents' repository risk perceptions form the dependent variables for the first part of the impact analysis. The surveys contain a large number of items designed to gauge respondents' risk perceptions of various aspects of the proposed project, as well as items in which respondents indicated if they favored or opposed building the project. These items are used as dependent variables during the first part of the analysis. Then the items are clustered into indices of several different dimensions of risk. That is, individual items are clustered around a facet of the risk perceived from the project. For example, for the Urban Risk Survey, dependent indices deal with perceived risk of transporting nuclear high-level waste, the risk of transporting hazardous materials, the safety and health facet of risk associated with the project, the perceived effectiveness of mitigation activities, and the costs and benefits perceived to be associated with the project. As will be seen, the dependent indices which can be constructed from the Nevada Telephone survey differ from these indices for the Urban Risk Survey. These dependent variable indices composed of several questions each provide greater clarity to the data when examining the relationship of the independent variables to risk perceptions. The indices also provide insight into the different facets of Repository risk perceptions, and allow for comparisons between the two different data sets.

1.3.3 The Scenario Methodology

In the Urban Risk Survey, repository risk scenarios were utilized during the interviewing. These scenarios differed in the degree or amount of risk stimulus associated with the repository. One scenario presented the future project's operation as totally benign (negligible low risks and some economic benefits). The other three scenarios varied in the degree of risk associated with the project once it was in operation. Each scenario characterized the risk future associated with the project along

both its operation and the transportation system. The benign future scenario characterized the future of the project as having no operational or insignificant transportation mishaps. The moderate risk scenario had a transportation emphasis with a moderately disruptive transportation accident with the potential for some radiation emission. The severe risk scenario for transportation had a major transportation accident associated with it involving radiological contamination and injury. Finally, the severe risk scenario with an operational emphasis was characterized by a major repackaging accident at the site involving radiological contamination and injury. The first three scenario impacts are analyzed in this report. Each component of the scenario was presented to the respondents in two forms; one a script which was read by each interviewer, and the second was a summary of the script which the respondent used for reference in answering questions dealing with the hypothetical risk futures.

Many of the risk perception items were repeated during the interviews after the respondents received one of the four scenarios. The answers to these questions provide a rich database for assessing not only future intended behaviors of urban residents, but also for testing the interactive effects discussed above. First, the scenarios may induce different responses by some of the residents. If this is the case then these differences can be described and intended behavior patterns delineated and significant differences in intended behavior noted. Second, the interactive effects discovered in the earlier phase of the analysis can be tested using the post-scenario database. For example, if age and gender interact and are strongly related to repository risk perceptions, then after the scenarios one can examine age and gender to determine if the scenarios had their greatest impact upon those age and gender categories where interaction was discovered earlier in the analysis. In this manner the data will permit us to delineate subgroups of the population where the repository is most likely to have its major impacts. An alternative finding might be that the scenarios impact upon all groups significantly resulting in fairly uniform risk perceptions. If the later is found then one might conclude that the repository futures are sufficient to produce similar risk impacts among the entire urban populations. In short, the scenarios provide us with a quasi-experimental design using them as an intervention and permit the measuring of impacts on the urban population in two different manners.

2.0 PUBLIC RESPONSE TO THE PROPOSED REPOSITORY

The presentation of urban impact findings will progress in the following order. First, the major findings from the different surveys regarding repository risk perceptions will be presented. Second, comparisons of findings regarding repository risk perceptions over time will be offered. Third, the significant sociodemographic findings as they relate to risk perceptions will be discussed. Fourth, the findings from the interactive effects analysis will be reviewed. Finally, based on these analyses, the major potential urban impacts will be depicted. The reader is reminded that this is an urban impact analysis report and the key focus is to review and present the major significant impacts. The intention is not to review all the survey data which has been collected and discussed in various other reports and papers (Mushkatel, et al., 1989; Mushkatel and Pijawka, 1989a, Mushkatel, et al., 1990; Mushkatel, et al., 1990a) Flynn, et al., 1989).

In addition, despite efforts to ensure ample cross-walks among the various surveys, in many cases the exact questions were not utilized in the various survey instruments. As a result, the data are not exactly comparable. When questions are not exactly the same and affect the comparisons being made, the reader is cautioned. The analysis has attempted to demonstrate trends and patterns in resident's perceptions of the repository and its potential impacts. As a result, exact duplication of instrument items across the surveys, while desirable, is not essential.

2.1 Summary of Findings Related to the Repository

This section of the report uses simple marginal frequencies from the Urban Risk Survey to describe the various perceptions of the repository that Clark County residents possess. In the spring of 1988, only 11 percent of urbanized Clark County residents had not heard of, or knew something about the repository, and 83 percent of the residents indicated they had either a great deal or some interest in the project (Mushkatel, et al., 1989: 117). In addition, only 20 percent of the urban residents would definitely or probably build the repository at Yucca Mountain if it were their decision (ibid.: 137). In short, the 1988 survey of Clark County residents discovered a considerable amount of awareness and interest in the issue, and considerable opposition to it (69 percent indicated they would probably or definitely not build the project if it were their decision).

Perhaps of more importance is the high level of concern about the repository project expressed by urban residents. Only 8 percent of the urban residents in 1988 who were aware of the project expressed no concern at all about the repository producing harmful effects in the Las Vegas area. Over 78 percent of the residents indicated they were either very or somewhat concerned about such harmful effects (ibid.: 121). When residents are asked to provide terms that they associate with the high-level nuclear waste facility, over 45 percent of them respond with some mention of danger, threat or some other problem. In addition, 16 percent of the residents specifically mentioned repository-related accidents (ibid.: 122). In short, these 1988 responses indicate the urban population was very concerned about harmful effects of the project and a large minority of the residents associated the project with danger or accidents.

Because many residents had negative images of the repository, it was important to determine whether they believed, if the project were built, it would result in negative consequences for themselves or their community. The data revealed that residents were very likely to think the project would produce harms to their community (61 percent). Indeed, just over 40 percent of the urban residents believed that the project would personally harm them (ibid.: 126). The urban residents were finally asked to provide an overall evaluation of the project in terms of its costs and benefits. Just over 53 percent of the residents believed the harms from the project outweighed the benefits, and another 30 percent felt the harms and benefits were about equal. Finally, only 17 percent of the residents believed that the benefits from the project would outweigh any harms associated with it. In short, urban residents perceived substantial harms to their community and themselves from the project, and on the whole felt the costs of the project outweighed any benefits.

Perhaps the key to understanding urban residents' negative images of the repository, as well as their evaluations of the costs and benefits of the project, are urban residents' risk perceptions. Residents of Clark County view repository-related activities as posing a major risk to Las Vegas area residents. For example, only 8 percent of the residents interviewed felt that activities at the repository posed no serious risk ("not serious at all") to the health and safety of residents in the Las Vegas area. Yet, 23 percent of the residents on a seven point scale indicated they felt the risk to health and safety was very serious (the most extreme category) and another 13 percent felt it was somewhat serious (category 2). Residents of the urban area felt the transportation of nuclear waste to the repository was an even greater risk to their health. While only 3 percent of the residents felt the risk from transporting the waste was not a serious health risk, over 34 percent felt it was. Additionally another 19 percent felt the risk was somewhat serious (category 2). In short the health risks from repository-related activities are viewed as very or somewhat serious by substantially more residents than those who view the risk as not serious or not serious at all (ibid.: 128).

One way of mitigating the impact of these residents' concerns over threats to their health and safety from the project would be for these residents to have high levels of confidence in how the repository will be managed. That is, resident fear and high levels of risk perceptions concerning aspects of the Yucca Mountain repository might be lessened if they had confidence that the government and scientists who will manage could do so effectively and reduce any threat to their health and safety. Several items in the Urban Risk Survey all strongly suggest that Clark County residents do not have great confidence in how the project will be managed. For example, 41 percent of the residents believe the repository can not be constructed and operated to make it acceptably safe (ibid.: 131). Almost one-half (47 percent) of the urban residents feel it is not very likely or not likely at all that the construction and operation of the facility can be made totally safe (ibid.: 131). Yet, this substantial minority view that the project can not be managed safely does not reflect residents' views about the engineers and technicians who will manage the project. Only 14 percent of the urban residents feel these engineers and technicians can not be trusted much of the time or never to operate the facility safely.

The key to understanding urban residents' perceptions of the lack of safety in the operation and management of the repository is not in their views of the engineers and technicians, but rather it can be understood in how residents' view the government's role in the management of the project and a strong sense of fatalism about any accident involving nuclear waste. For example, 56 percent of the urban residents strongly or somewhat agree that a transportation accident involving nuclear waste will involve widespread damage to health and property whether the government prepares for it or not

(ibid.: 134). Only 18 percent of the urban residents are very confident that the government will have the knowledge to respond to nuclear accidents (ibid.: 134). Finally, 28 percent of the urban residents strongly or somewhat agree that if the government takes precautions against accidents they will not work, compared to 24 percent who strongly or somewhat agree that such precautions will work.

In short, substantial minorities of urban residents are greatly concerned about health and safety threats from the repository. In addition, substantial minorities of residents do not feel the government can or will effectively manage the project. Finally, many residents are fatalistic about the likelihood of accidents and also feel the government even if it takes precautions will not be able to effectively lessen the impact of these accidents. The key roles that trust and confidence in government play in residents' perceptions of the project are further discussed below.

The Urban Risk Survey of 1988, found high awareness among residents of the project, an overwhelming majority of residents indicating they would not build the project if the decision were theirs to make, concern over negative health and safety impacts from the repository, a majority of residents evaluating the costs of the project outweighing the benefits, substantial levels of fatalism among residents regarding the likelihood of accidents and the belief among a substantial minority of urban residents that mitigation and planning will not be adequate to lessen the impact. In the context of these views one might argue the perceived fairness of the process the government used to select Yucca Mountain as the site is critical. That is, urban residents, despite their concerns and fatalism, and despite their lack of confidence in the governments' ability to manage the project, might be willing to accept the project if they thought the selection process had been equitable. Unfortunately, urban residents view the site selection process used by the government as most unequitable. Only 8 percent of the residents felt the process had been very fair compared to 24 percent who believed it had been very unfair. In addition, while 27 percent of the urban sample felt the site selection process was fair, over 41 percent of them felt it was unfair. In summary, not only do urban residents feel their are substantial risk associated with the process which many feel can not be mitigated, but they also feel the process of selecting the site has been inequitable, and 64 percent felt that despite this lack of fairness the project would definitely or probably be built at Yucca Mountain (ibid.: 137). Yet, perceptions of processes and projects change over time, and it is essential to examine additional survey data collected on Clark County residents 15-18 months after the Urban Risk Survey was completed to determine if any trends can be identified.

2.2 Quasi-Longitudinal Comparisons of Repository Attitudes

The Nevada Telephone survey was conducted in the fall of 1989, and while the entire state was surveyed the analysis reported on here only utilizes the responses from residents of Clark County. There are not as many direct cross-walks or duplication of items between the two surveys as might be desirable, but both surveys do deal with similar issues. By examining urban residents' responses to various items we can determine if attitudes and perceptions of the project have shifted, and if so in what direction. In addition, the two surveys' results can be compared to determine the level of consistency which exits concerning urban residents' risk perceptions of the project. The comparisons will demonstrate a high degree of consistency between responses and perceptions of the project. As a result, the confidence we have in the survey findings should be increased.

The urban residents, in 1989, were asked how they would vote if the residents' approval were needed for the project to be sited at Yucca Mountain. Only 16 percent of the Clark County residents indicated they would vote in favor of siting the project at Yucca Mountain. An additional 7 percent indicated they would not vote, and 8 percent said they were unsure as to how they would vote. Yet, 68 percent of the residents indicated they would vote against siting the project at Yucca Mountain (Flynn, et al., 1989a: 7). There appears to major opposition to the siting of the project at Yucca Mountain by Clark County urban residents. While this question was not asked in the 1988 survey, residents were asked if the decision were theirs to make would they build the project at Yucca Mountain. As noted above over 69 percent of the urban residents indicated they definitely not or probably not build it. In short, both surveys using different questions find similar major opposition to the siting of the project at Yucca Mountain.

The Nevada Telephone Survey questioned urban residents concerning what they thought the state should do regarding the proposed project. Asked if they thought the state should do all it can to stop the federal government from locating the plant in southern Nevada, almost 78 percent felt the state should (Flynn, et al.,1989: 37). The two surveys both show high levels of opposition to the project, and the Nevada Telephone Survey also indicates that a substantial majority of urban residents want the state to do all it can to stop it. Once again, we need examine respondents' risk perceptions and images of the repository to determine if they are consistent with the strong opposition of residents to the project.

The Urban Risk Survey discovered that about 45 percent of the residents' associated some danger or threat of accident to the repository. Almost 56 percent of the Nevada Telephone survey urban residents express similar associations of danger and threat to the project (Flynn, et al., 1989: 16). In addition, 33 percent of the urban residents associate some form of pollution to the project. In short, both surveys find residents associating danger and threat to the project; both negative images. As Flynn and others have noted, "The findings of the 1989 Nevada State Survey and the Phoenix (1988) survey make it difficult to imagine a more negative array of mental images than those produced by an Underground Nuclear Waste Repository," (1989: 19).

If the images that urban residents have of the repository portray a notably negative image, then the risks that they associate with it are equally grave. First, in the Urban Risk Survey of 1988, it was found that about 53 percent of residents felt that the costs of the proposed project outweighed the benefits. In the Nevada Telephone Survey, almost 68 percent of the urban residents disagreed, or disagreed strongly with the statement that benefits from the project would outweigh the possible risks or harms. These questions ask for the same evaluation even though they are worded slightly differently. The results of the two questions show a majority of residents feel the risks or possible harms of the project outweigh the benefits. In addition, this perception of risks outweighing benefits may be increasing among residents.

Second, the Nevada Telephone Survey asked urban residents six additional questions regarding possible costs and benefits and risk which might accrue from the project (Questions 32-37). Flynn and others reported means on these items (10 point scales), and concluded there was a slight tendency for Clark County residents to feel that the project would result in the creation of new jobs in Southern Nevada, residents felt it was less likely that it would increase revenues to state and local governments (1989: 25-26). Flynn (et al.,) also found that the mean on this 10 point scale for the item suggesting it

would cause fear among residents about nuclear operations in Nevada was 7.1 for Clark County residents indicating a tendency for respondents to feel the repository would increase fear and anxiety among residents.

If one examines responses to this item one finds that just over 34 percent of the residents feel that this fear is likely (10 on the 10 point scale). In short, over one-third of the residents feel it is a virtual certainty that increased fear and anxiety about nuclear operations will result from the project.

The same finding can be discovered if one looks at the item which asks residents to indicate their agreement or disagreement with the statement that the project will result in Nevada being labeled a "Nuclear Dump Site." While the mean for this item among urban residents is 7.7 indicating a tendency to agree with the statement, over 43 percent of the urban residents felt it was most likely to occur (category 10 the extreme category). Hence, both of these items indicate that a substantial minority of the urban residents view the project as having substantial costs (increased fear, stigmatization) associated with it. Taken as a whole, the items dealing with costs and benefits from the project indicate a slight tendency for urban residents to see some economic benefits from the project, but to also see increased fear, and possible stigmatization of the state from the project.

Both the Urban Risk Survey and the Nevada Telephone Survey had numerous items dealing with perceived risk from the Yucca Mountain repository. One problem which develops in sorting these findings out is that the first survey used 7 point scales or categories and the second survey used 10 point scales. Yet, if one is willing to assume that the first points on each scale composes the very likely or very unlikely group comparisons can be made. The portrayal of urban residents perceptions of risk is most interesting.

First, 55 percent of the urban residents in the Urban Risk Survey agreed with the statement that accidents in transporting hazardous materials were inevitable (Mushkatel, et al., 1989: 111). As was discussed above, 53 percent of the urban residents surveyed in this study also believed that transportation accidents involving nuclear waste posed a serious risk to urban residents. The Nevada Telephone survey asked respondents whether they agreed with the statement that transporting the waste to Yucca Mountain would lead to serious accidents. Just over 33 percent of the residents indicated they thought such accidents were very likely (ibid, 1989: 28). In addition, over 74 percent of the urban residents agreed that accidents in transporting the waste to the repository will occur (ibid., 1989: 31). In short, a majority of urban residents believe that accidents are inevitable, that transporting nuclear waste poses a serious risk to urban residents, and a substantial minority of the urban residents feel serious accidents involving the waste is very likely.

The Nevada Telephone Survey also asked residents to evaluate several other possible risks associated with the project including: accidents in handling the waste that might contaminate workers; the release of radioactivity due to sabotage or terrorists activities; accidental exposure of radioactive wastes due to digging into the site by future generations; future earthquakes which might result in radioactive releases; and radioactive contamination of groundwater. In each case at least a majority of urban residents believed that such events were likely to occur. In fact, almost 80 percent of the urban residents believed future radioactive releases were likely as a result of volcanic or earthquake activities (ibid., 1989: 31-32). In short, urban residents in both

surveys perceive a variety of risks from the project as being likely to occur and serious in their consequences.

The Nevada Telephone Survey also attempted to illicit perceptions of residents about the likely management of the project. Sixty one percent of the urban residents do not believe that DOE will do any better in operating the repository than it has in building and operating other nuclear facilities. In addition, 77 percent of the urban residents disagreed with the statement that DOE could be trusted to provide prompt and full disclosure of accidents or serious problems with the repository program. In both cases, the data are consistent with the findings from the Urban Risk Survey. A strong majority of urban residents do not have confidence in the government to effectively and equitably manage the high-level waste repository.

The review of the marginal frequencies from the two surveys reveals a strikingly consistent pattern of opinions and risk perceptions. Urban residents in the Las Vegas area have high levels of awareness of the proposed project. These urban residents also are very concerned about the possible health and safety effects of the proposed project. In addition, their images of the project are filled with fear and the perceptions of danger and harm. On the whole, a large majority of residents feel the costs of the project outweigh the benefits. There appears to be a substantial degree of fatalism among residents concerning the likelihood of accidents (transportation in particular), and their is little confidence that government mitigation activities will be successful in reducing the impacts of these accidents.

Indeed, there is little confidence that government is even capable of building and operating the facility efficiently and effectively. Finally, the survey data demonstrate that a very large majority of residents not only oppose construction of the high-level nuclear waste facility, but also believe that the entire siting process has been unfair and inequitable.

The survey data portray an urban population with a high degree of concern and fear over the facility and its operation. The opposition and desire to fight the siting seems to have grown between 1988 and 1989, as witnessed by the large majority who want the state to continue fighting the siting. Far fewer urban residents in 1989 than in 1988 believed the building of the facility was inevitable. One can hardly imagine a distribution of opinions, images, and risk perceptions about a facility which was less supportive or receptive to a facility. In this context, it would be difficult to provide a scenario in which there were not major impacts from the repository on the urban population of Clark County.

While the review of these two surveys have provided an overview of urban residents' perceptions related to the project, it has not provided us with insight into which groups of residents are the most likely to possess such perceptions. It is now appropriate to examine which sociodemographic characteristics are related to these repository perceptions.

2.3 Repository Perceptions and Sociodemographic Characteristics

This section of the analysis will first examine the simple bivariate relationships between some of the sociodemographic factors and various components of repository risk perception. First, the bivariate relationships will be displayed for both the Urban Risk

Survey and the Nevada Telephone Survey. After these relationships are analyzed, indices of different elements of repository risk are created and related to sociodemographic factors.

The final component of the investigation examines the Urban Risk Survey findings for evidence of interactive effects among components of the sociodemographic explanatory variables. That is, gender will be shown to be a moderately powerful predictive variable for repository risk perceptions with women having greater concern about health and safety effects from the project. Yet, there is little reason to believe that all women view the project in a similar light. The interactive analysis attempts to determine if women in certain age or income groups are even more sensitive to these concerns than the overall sample. These interactions permit us to dissect the urban population's risk perceptions to the point where we can specify the element of the population with certain subgroup characteristics which are most likely to be impacted by the project.

2.3.1 Summary of Findings Regarding Sociodemographic Factors

Several reports have investigated the importance of the sociodemographic factors on repository risk perceptions (Mushkatel, et al., 1989a,b, 1990; Flynn, et al., 1989). This analysis is aimed at determining what differential impacts on repository risk perceptions there might be. That is, some groups within the urban population may view the repository process in very different terms than the urban population as a whole. In such instances, one might expect the repository siting to have a different impact on these groups of urban residents that on others. For example, if it were found that the older urban residents were more fearful about their health and safety if the facility were built than the younger residents were, one might anticipate that the older residents might manifest this concern by engaging in different political and economic behavior. The initial question to be investigated is what is the relationship (simple bivariate) between sociodemographic variables and repository risk perception.

Tables 2-1 and 2-2 provide measures of association between four sociodemographic factors and various items dealing with repository risk perception in the two surveys. The risk items have been grouped into categories which will correspond to the indices of risk which will be discussed shortly. As can be seen from Table 2-1, gender produces the highest measures of association and the most relationships which are statistically significant with the dependent variables. Indeed, only 3 of the 17 relationships characterized between gender and the risk perception dependent variables are statistically insignificant. The direction of the relationships are immaterial at this point in that they are an artifact of the direction of the response categories. The analysis of the cross-tabulations which are not displayed in this table, reveal that females are consistently (although not always significantly) more concerned over the repository and perceive greater risk to safety and health from the proposed facility than are males.

Table 2-2 reveals a similar pattern of findings for the sociodemographic variables and their relationship to repository risk perceptions in the Nevada Telephone Survey. That is, the relationship of gender to risk perceptions is the strongest of those displayed. While gender's relationship to risk is not as strong for the Nevada Telephone Survey data as it is in the Urban Risk data, 5 of the 13 relationships are statistically significant. In short, of the sociodemographic variables gender seems to have the most consistent and strongest relationship to repository risk perception.

TABLE 2-1

BIVARIATE RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS AND RISK PERCEPTIONS IN THE URBAN RISK SURVEY (1988)

Risk Perception Item	Gender	Race	Age	Income
Safety and Health Threat				
Nuclear accidents services, threat to safety in Las Vegas area (Q. 59)	0.07	0.14*	-0.04	-0.01
Underground testing of nuclear weapons, future health risks (Q. 66)	0.10*	0.08	-0.03	-0.08
Yucca Mountain future threat to health and safety (Q. 87A)	0.12*	0.10*	-0.04	-0.04
Repository Safety and Likelihood of Accident				
Repository can be operated safely (Q. 89)	0.03	0.05	-0.04	0.03
Repository acceptably safe (Q. 90)	0.10*	0.01	0.06	0.06
Nuclear waste transported safely (Q. 92)	0.21*	0.03	0.04	0.01
Mitigation				
Proportion of accidents reported to the public (Q. 93)	0.16*	0.06	0.02	-0.02
Government technical know-how to respond to accidents (Q. 94)	0.13*	-0.01	-0.05	-0.03
Government precautions against accidents will work (Q. 95C)	0.11*	-0.02	-0.03	-0.01
Costs and Benefits				
Community will benefit from repository (Q. 81)	0.18*	0.06	0.03	-0.03
Likelihood benefits to Las Vegas area (Q. 83)	0.13*	0.06	0.03	0.05
Ratio of benefits to harms for Las Vegas (Q. 86)	0.15*	0.20*	0.07	-0.06

TABLE 2-1 (continued)

BIVARIATE RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS AND RISK PERCEPTIONS IN THE URBAN RISK SURVEY (1988)

Risk Perception Item	Gender	Race	Age	Income
Transportation of Hazardous Materials				
Never transport hazardous materials through populated areas (Q. 56B)	0.11*	0.09	0.05	-0.04
Safe to transport hazardous materials (Q. 56C)	0.17*	0.07	0.02	-0.04
Current methods of transport are safe (Q. 56E)	0.09*	0.04	0.05	-0.03
Risk of Transportation Accidents				
Seriousness of risk of transportation accident (Q. 87B)	-0.13*	-0.13*	0.01	0.05
Transportation accident will cause widespread health and property damage (Q. 95B)	-0.07	-0.00	-0.02	0.06

*Statistically significant at α LE 0.01.

TABLE 2-2

BIVARIATE RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS AND RISK PERCEPTIONS (TAUS) IN THE NEVADA TELEPHONE SURVEY (1989)

Risk Perception Item	Gender	Race	Age	Income
Economic Benefits				
New jobs in Southern Nevada (Q. 32)	0.07	0.01	-0.16*	0.04
Increased revenues to State and local governments (Q. 34)	0.02	0.03	-0.09	-0.001
Mitigation				
DOE provides objective and scientifically sound studies for Yucca Mountain (Q. 52)	0.07	-0.07	-0.12	-0.15
Federal government will do better at operating Repository than running other nuclear facilities (Q. 59)	-0.09	-0.01	0.07	0.05
Risks and Costs				
Tourists avoid coming to Nevada (Q. 37)	-0.14*	-0.04	0.04	.004
Benefits outweigh risks and harms (Q. 53)	0.20*	-0.02	-0.12	-0.09
Risk of Transportation Accidents				
Lead to serious accidents transporting nuclear waste (Q. 35)	-0.16*	-0.09	-0.03	-0.06
Highway and rail accidents will occur in transport of nuclear waste (Q. 40)	-0.10	-0.02	0.09	-0.06
Safety and Health Risk				
Buried waste will not contaminate underground water supplies (Q. 43)	0.02	-0.09	-0.04	-.04
Accidents in handling and burial lead to contamination of workers and releases (Q. 44)	0.19*	-0.04	-0.02	-0.01
Repository will not pose any more risk to people than already exposed to in Southern Nevada (Q. 47)	0.13	-0.03	0.04	-0.08

TABLE 2-2 (continued)

BIVARIATE RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS AND RISK PERCEPTIONS (TAUS) IN THE NEVADA TELEPHONE SURVEY (1989)

Risk Perception Item	Gender	Race	Age	Income
State Action				
State should do all it can to stop Federal government from locating Repository in Southern Nevada (Q. 46)	-0.17*	-0.11	0.02	-0.05
State should do all it can to oppose Repository (Q. 60)	0.20*	-0.02	-0.12	-0.09

*Statistically significant at α LE 0.01.

While race does have some statistically significant relationships with repository risk perceptions (Table 2-1) in the Urban Risk Survey data set, it does not fare well in the Nevada Telephone data. Finally, age and income do not appear strongly or statistically significantly related to risk perceptions in either survey.

The findings regarding the importance of gender, despite their moderate measures of association, to repository risk perception are not unexpected. A large body of research has examined the relationship between gender and perceptions of environmental risk (Kasperson, et al., 1979; McStay and Dunlap, 1983 and Van Liere and Dunlap, 1980). The findings from these studies concerning the importance of gender in understanding risk perceptions have been inconsistent. For example, Kasperson and others (1979: 274) suggested that, "Perhaps the single most noteworthy characteristic of public response to nuclear energy is the difference between men and women." McStay and Dunlap (1983) in reviewing the findings in this field concerning gender differences suggest the research conclusions are weak and inconsistent primarily because the research has relied upon one-item questions to measure general concern about environmental risks.

Arcury and others (1987) build on this critique of the research and suggest that weak and inconsistent findings regarding the importance of gender differences are a function of both one-item questions, as well as questions which deal only with general concern over the environment. They suggested that not only was it necessary to use multi-item questions to tap the multi-dimensional environmental concern concept, but it was also likely that different sociodemographic characteristics might be associated differentially with a variety of different environmental issues.

Mushkatel et al. (1990) have taken these criticisms a bit further and suggested that various sociodemographic factors might interact with gender to produce some of the inconsistent findings which characterize the research literature. That is, it would be unwise to assume that all women or men have the same views of environmental risks. Rather it is likely that different socialization processes and generational differences might produce different risk perceptions. Hence, gender needs to be examined for interactive effects with other sociodemographic factors to determine if there are interactions. For example, if gender and age interact one might find that older women have significantly different environmental risk perceptions than do older men, or younger women. These differences would be the result of an interaction between gender and age.

The research literature suggests that the above bivariate analysis is not sufficient to allow for the understanding of the importance of gender or the other sociodemographic factors. Rather, multi-item measures of repository risk perception must be utilized. In addition, the data sets must be examined for potential interactive effects to allow us to determine the real impact of gender on repository risk perceptions.

The remainder of the section of the report first describes the methods used to build multi-item measures of repository risk and discusses the relationship of the multi-item indices to the sociodemographic factors. Then, the report discusses the findings from the interactive analysis. The analysis will reveal that their are substantial gender differences in repository risk perceptions, and that gender and age do have an interactive impact on risk perceptions. In short, the some urban residents are (e.g., older women) likely to have distinctly greater perceptions of the risk associated with the repository. As such, it may be that these urban residents are far more adversely impacted by the facility than are other urban residents. This type of analysis will permit us to identify certain characteristics among some urban residents which may lead to differential impacts from the project.

2.3.2 Group Differences In Repository Risk Perceptions

In order to determine if there were interactive effects and follow the suggestions of the research literature, it was necessary to construct indices (multi-item measures) of the dependent variables repository risk perception. These indices were constructed for both survey's data by first grouping the interview and survey items together based on how during the construction of the questionnaires we believed the items would congregate. That is, the dependent variable items were clustered according to the different dimensions of repository risk the investigators thought the items were tapping. Inter-item correlations were then obtained for items within each of the clusters. This procedure resulted in dispensing with of the items in each of the clusters. Tables 2-3 and 2-4 displays the inter-item correlations for each of the measures in each of the indices.

As can be seen from Table 2-3, for the Urban Risk Survey the inter-item correlations are quite strong and all are statistically significant. The inter-item correlations permit us to form six indices (simple additive indices) of the dependent variable dimension of repository risk perception. Careful examination of Table 2-3 will reveal several important facts. First, the inter-item correlations are all strong and statistically significant. They provided confidence that at least six dimensions can be extracted from the dependent variable construct of environmental concern and repository risk perception. The fifth dimension, transportation of hazardous materials, is technically not a part of repository risk perceptions. Yet, it loads so well with the dependent variable it has been included in the analysis. Finally, examining the table shows that the dimensions of the dependent variable deal with safety and health threat from the facility, the likelihood of accidents, whether mitigation measures are perceived as being effective ways to lessen the impacts of accidents, the perceived costs and benefits of the project, the risk of transportation accidents involving high-level nuclear waste, and the hazardous waste transportation dimension discussed above and elsewhere in the report. Hence, following the suggestions of the research literature, multi-item measures have been developed which do not just deal with general levels of concern. As a result, based on the work of McStay and Dunlap (1983) and Arcury and others (1987), these multi-item indices should result higher levels of association and more consistent statistically significant relationships between gender and risk perceptions.

The same procedure was used on the Nevada Telephone Survey data to produce six multi-item indices of repository risk perception (Table 2-4). The inter-item measures of association are quite strong and all are statistically significant. While some of the dimensions in this data parallel those found in the Urban Survey some are quite different. For example, the state action index has no comparable dimension in the Urban Risk Survey data base. In fact, strictly speaking this state action component is not really a risk perception. Rather, the two items in this index focus on what the state should do with regard to the facility (i.e., fight federal efforts or cut a deal). In this context, the index is most interesting in that it contains a action component to residents' feeling toward the repository.

TABLE 2-3

ENVIRONMENTAL RISK PERCEPTION INTER-ITEM CORRELATION
FOR THE URBAN RISK SURVEY
(By Dimension)*

Dimension	Question	Question
Safety and Health Threat from Nuclear		
Nuclear accidents are a serious threat to safety of Las Vegas area (Q. 59)	0.45 (Q. 66)	0.41 (Q. 87A)
Underground testing of nuclear weapons future health threat (Q. 66)		0.41 (Q. 87A)
Yucca Mountain future health threat (Q. 87A)		
Safety and Likelihood of Accident		
Repository can be operated safely (Q. 89)	0.49 (Q. 90)	0.49 (Q. 92)
Repository operation acceptably safe (Q. 90)		0.49 (Q. 90)
Nuclear waste can be transported safely (Q. 92)		
Mitigation		
Proportion of accidents reported to public (Q. 93)	0.57 (Q. 94)	0.57 (Q. 95C)
Government technical know-how to respond to accidents (Q. 94)		0.65 (Q. 95C)
Costs and Benefits		
Community will benefit from repository (Q. 81)	0.43 (Q. 83)	0.34 (Q. 86)
Likelihood of benefits to Las Vegas area (Q. 83)		0.39 (Q. 86)
Ratio of benefits to harms for Las Vegas (Q. 86)		

TABLE 2-3 (continued)

ENVIRONMENTAL RISK PERCEPTION INTER-ITEM CORRELATION
FOR THE URBAN RISK SURVEY
(By Dimension)*

Dimension	Question	Question
Transportation of Hazardous Materials		
Never transport hazardous materials through populated area (Q. 56B)	-0.35 (Q. 56C)	0.25 (Q. 56E)
Safe to transport hazardous materials (Q. 56C)		0.48 (Q. 56E)
Current methods of transport are safe (Q. 56E)		
Risk of Nuclear Waste Transportation Accident		
Seriousness of risk from transportation accident (Q. 87B)		-0.46 (Q. 95B)
Transportation accident will cause widespread health and property damage (Q. 95B)		

*All measures of association are statistically significant at α LE 0.01.

TABLE 2-4

ENVIRONMENTAL RISK PERCEPTION INTER-ITEM CORRELATION
FOR THE NEVADA TELEPHONE SURVEY
(By Dimension)*

Dimension	Question	Question
Economic Benefits		
New jobs in Southern Nevada (Q. 32)		0.43 (Q. 34)
Increased revenue to State and local governments (Q. 34)		
Mitigation		
DOE provides objective and scientifically sound studies for Yucca Mountain (Q. 52)		-0.46 (Q. 59)
Federal government will do better operating Yucca Repository than other nuclear facilities (Q. 59)		
Risks and Costs		
Tourists avoid coming to Nevada (Q. 37)		-0.51 (Q. 53)
Benefits outweigh risks and harms (Q. 53)		
Risk of Transportation Accident		
Lead to serious accidents transporting nuclear waste (Q. 35)		0.50 (Q. 40)
Highway and rail accidents will occur in transport of nuclear waste (Q. 40)		
Safety and Health Risk		
Buried waste will not contaminate underground water supplies (Q. 43)	0.36 (Q. 44)	0.55 (Q. 47)
Accidents in handling and burial lead to contamination of workers and releases (Q. 44)		0.37 (Q. 47)
Repository will not pose any more risk to people than already exposed to in Southern Nevada (Q. 47)		

TABLE 2-4 (continued)

ENVIRONMENTAL RISK PERCEPTION INTER-ITEM CORRELATION
FOR THE NEVADA TELEPHONE SURVEY
(By Dimension)*

Dimension	Question	Question
State Action		
State should do all it can to stop federal government from locating Repository in Southern Nevada (Q. 46)		0.55 (Q. 60)
State should do all it can to oppose Repository (Q. 60)		

*All measures of association are statistically significant at α LE 0.01.

The next step in the analysis is to examine the relationships among the dependent repository risk indices. The inter-index correlations are displayed in Tables 2-5 and 2-6 for the two data sets. The items in each of the indices parallel those listed in the previous two tables. The indices were constructed by simply adding the scores for each item in the index together after having standardized the direction of the items. As can be seen from Table 2-5, almost all of the relationships are statistically significant and the measures of association are usually fairly strong. The variation in some of the inter-index measures of association lends further argument to the notion that the indices are tapping different dimensions of risk perception and concern about safety. For example, the costs and benefits index does not seem to be that strongly related to some of the indices which deal specifically with safety and risks of accidents. The Nevada Telephone inter-index measures of association reveal a similar, although less strong pattern. These measures of association are weaker overall and a few are statistically insignificant. Once again, the costs and benefits indices seem to have the weakest relationship with the other indices.

If Kasperson and others (1979) are correct, when these indices are examined against the sociodemographic variables the strongest relationships should be between gender and those dimensions dealing with safety issues. In addition, because we are using multi--item measures of repository concern, the relationships between the sociodemographic variables and risk perceptions should be stronger than those originally observed in Tables 2-1 and 2-2.

Tables 2-7 and 2-8 display the measures of association and levels of significance between the repository risk indices and the sociodemographic factors in each of the surveys. As can be seen from Table 2-7, the relationship between gender and repository risk perceptions has strengthened by using the multi-item indices (Table 2-1 for comparison). In addition, only one of the relationships between gender and the indices is not statistically significant while five are. While the measures of association are not as strong as one might hope, they do form a pattern of moderately strong relationships. Indeed, in each case when the percentages of females versus males are examined in the extreme risk perception cells (not displayed in the table) a strong pattern emerges. For example, while 17 percent of the males fall into the highest index score on the first dimension (indicating perceptions of high risk associated with the repository or threats to health from nuclear accidents), 23 percent of the women fall into this category. Similarly, the second dimension dealing with safety and the likelihood of an accident finds 18 percent of the men feeling that such accidents are likely or that safety can not be assured, as opposed to 35 percent of the women. In short, in the Urban Risk Survey data, the use of multi-item indices increases our understanding and insight into what are clear gender differences in repository and environmental risk perceptions.

To carry the examination a bit further, the mitigation index is most revealing. Mitigation activities are designed to lessen the impact of an event or accident should it occur. While 16 percent of the males feel the government will report such accidents or that their precautions will lessen an accident's impact, only 7 percent of the females have similar views. In every case the direction of the gender differences are in the predicted direction with females perceiving high levels of risk associated with the repository. None of the other sociodemographic factors display much significance with or association with repository risk perception in the Urban Risk Survey.

TABLE 2-5

INTER-INDICES CORRELATION FOR THE URBAN RISK SURVEY*

Dependent Dimension	Repository Safety & Likelihood of Accidents	Mitigation	Costs & Benefits	Transportation of Hazardous Waste	Risk of Transportation Accidents
Safety & Health Threat	0.54	0.64	0.34	0.41	0.64
Repository Safety & Likelihood of Accidents		0.63	-0.03		-0.51
Mitigation			0.34	0.44	-0.64
Costs & Benefits					
Transportation of Hazardous Waste				0.32	-0.30
Risk of Transportation Accidents					

* All measures of association are significant at α LE 0.01 (except one noted at α = 0.03.

TABLE 2-6

INTER-INDICES CORRELATION FOR THE NEVADA TELEPHONE SURVEY*

Dependent Dimension	Mitigation	Risks & Costs	Risks of Transportation Accidents	Safety & Health Risk	State Action
Economic Benefit	-0.14	0.08 (N.S.)	-0.26	-0.18	0.21
Mitigation		-0.03 (N.S.)	0.50	0.30	0.30
Risks & Costs			-0.15	0.22	-0.31
Risk of Transportation Accidents				-0.61	0.46
Safety & Health Risk					-0.51
State Action					

*All measures of association are significant at α LE 0.01 (except 2 relationships noted as "N.S.").

TABLE 2-7

RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS
AND THE RISK PERCEPTION INDICES
URBAN RISK SURVEY

Dependent Dimensions Indices	Gender	Race	Age	Income
Safety and health threat from nuclear	0.13*	0.08	0.13*	0.10
Safety and likelihood of accidents	0.11*	0.04	0.02	0.08
Mitigation	0.17*	0.05	0.02	0.01
Costs and benefits	0.13	0.01	0.13	0.12
Transportation of hazardous materials	0.20*	0.00	0.08*	0.03
Risk of nuclear waste transportation accident	0.12*	0.01	0.06	0.07

*Measures of association are statistically significant at α LE 0.01.

TABLE 2-8

RELATIONSHIPS BETWEEN SOCIODEMOGRAPHIC FACTORS
AND THE RISK PERCEPTION INDICES
NEVADA TELEPHONE SURVEY

Dependent Dimensions Indices	Gender	Race	Age	Income
Economic Benefits	-0.07	0.03	0.02	0.01
Mitigation				
Risks and Costs	-0.06	0.01	-0.15*	0.02
Risk of Transportation Accidents	-0.16*	0.03	0.04	-0.08
Safety and Health Risk	0.13**	-0.01	-0.06	-0.06
State Action	-0.26*	0.01	0.01	-0.01

*Statistically significant at α LE 0.01.

**Statistically significant at α LE 0.02.

The measures of association and statistical significance for sociodemographic factors and repository risk perception for the Nevada Telephone Survey data are displayed in Table 2-8. As can be seen from this table the same pattern observed for the relationships in the Urban Risk Survey data seem to hold for this survey. Gender is the single sociodemographic factor which exhibits more than one statistically significant relationship with the risk indices. Once again it is females whose risk perceptions of the repository are associated with safety and health threats and accidents, rather then males. Interestingly the highest measure of association in the table is between gender and support for the state's opposition and continued fighting of the repository siting (-.26). Females are twice as likely to support the state's continued opposition and resistance to making a deal to permit the siting than are males. Yet, none of the other sociodemographic variables seems to hold much promise as an explanatory variable for risk perceptions.

The final step in determining if some of the sociodemographic factors interact with gender is to examine the relationships between repository risk perception while controlling for each sociodemographic factor. If gender interacts with age, for example, then some of the age categories should demonstrate significant measures of association with the dependent variable repository risk perception indices. Previously none of the repository risk perceptions were significantly related to age in the Urban Risk Survey data set. These interactive effects can not be tested for in the Nevada Telephone Survey data set because of the smaller number of urban residents which would result in cell sizes which were too small.

Table 2-9 presents the relationships between gender and the risk perception indices while controlling for each sociodemographic factor's categories. As can be seen from this table several interactive effects between gender and the sociodemographic factors are present when examining repository risk perceptions. Age appears to interact strongly with gender, especially for the youngest two groups in the sample (18-25 and 26-30). For example, women in these two age groups are more likely to perceive higher safety and health risks from the repository than are men in the same age groups. Younger women are very different from younger men in their assessments of the likelihood of an accident from the repository with health harms (Dimension 2). Yet, older women (ages 46-59 and above 60) are not very different than older men in their assessments of the likelihood of such an accident. In the case of mitigation activities, only older women do not differ significantly from their male age counterpart in their assessment of whether governmental action can reduce harm and costs of an accident.

In short, age seems to interact strongly with gender to produce statistically significant differences in risk perceptions between similarly aged males and females. On the transportation and mitigation dimensions, the differences between males and females almost holds for all age groups. Analysis was undertaken to determine if there were significant between group differences or interaction effects. That is efforts were made to determine if differences existed not only between genders in the same age groups but also within genders in different age groups. That is, as women and men grow older do risk perceptions change for either males or females, or for both groups leading to the lack of difference observed between older males and females. This analysis was limited by the small cell sizes which were encountered, but one finding did emerge: older males tend to view the environmental and repository risk as higher than do their younger male counterparts. Yet, it is not possible to determine if males and females as they move through the life-cycle adopt similar risk perceptions or other unidentified factors result in the lack of difference in their risk perceptions. It is clear that age and gender do interact, and that younger females have very different risk perceptions than do younger males.

TABLE 2-9

THE RELATIONSHIP BETWEEN SOCIODEMOGRAPHIC FACTORS AND THE RISK PERCEPTION MEASURES WHILE CONTROLLING FOR GENDER IN THE URBAN RISK SURVEY

	Age					Race		Income				
Dependent Dimension Indices	18-25	26-30	31-45	46-59	60+	White	Non-White	<$20K	$20-29K	$30-39K	$40-49K	$50K+
Safety and health threat from nuclear	0.19*	0.15	0.08	0.21*	0.16	0.17*	-0.02	0.11	0.04	0.11	0.20*	0.26*
Safety and likelihood of accident	0.22*	0.33*	0.03	0.07	0.18	0.17*	-0.17	0.15	0.03	0.17	0.13	0.15
Mitigation	0.21*	0.28*	0.07	0.21*	0.22*	0.18*	0.10	0.07	0.19*	0.25*	0.17	0.18
Costs and Benefits	0.21	0.31*	0.11	0.21*	-0.15	0.14*	0.13	-0.07	0.23*	0.40*	0.09	0.03
Transportation of hazardous materials	0.39*	0.19*	0.14*	0.25*	0.15	0.24*	0.01	0.11	0.10	0.20*	0.49*	0.21*
Risk of nuclear waste transportation accident	0.24*	0.12	-0.03	0.29*	-0.26*	-0.18*	0.18	-0.11	-0.10	-0.05	-0.21*	-0.19*

*Measures of association are statistically significant at α LE 0.01.

Table 2-9 also displays clear interactive effects between race and gender in their relationship to repository risk perceptions. To set the context for this discussion of this interactive effect one should know that non-whites tend to view the repository as less safe and more risky than do whites. The interactive effect in Table 2-9, between gender and race suggests that white females are very different from white males in their risk assessments (across all six dimensions of repository risk perceptions). In each case white females tend to feel the repository is less safe or the risk is higher than do white males.

There is no evidence from the table of any interactive effect between race and gender for non-whites. This suggests that non-white males do not view the repository significantly differently than non-white females. Finally, the table displays the relationship between gender and income as they relate to risk perceptions. No clear pattern of interactive effects is revealed. It does appear that there is a slight interaction with higher income residents and gender suggesting that higher income females are different than higher income males in their risk assessments. Yet, the pattern is not a strong one.

The analysis of the relationship between sociodemographic factors and repository risk perceptions has revealed some moderate relationships which are statistically significant. The analysis has traced the differences in risk perceptions between males and females and examined interactive effects between for younger females, as well as white and higher income females. The analysis points out that urban residents will not all be affected by the repository in the same way. That is, females with those characteristics described above are more fearful and perceive greater risk from the repository than do their male counterparts. In this context, it seems likely that any impacts of the facility on urban residents will not be spread equally across the urban population. Rather, the data suggests that those urban residents who perceive the repository as having significant health and safety risks which government will not effectively mitigate, are the residents who will be most impacted by the project. The data suggest that these residents may be the ones who may alter their political, social and economic behavior as a result of the facility. Finally, the sociodemographic factors relationships to the different dimensions of repository risk perceptions have been strengthened by using multi-item indices. Yet, they are not as strong (as judged by the measures of association) as one might have hoped based on the review of the research literature. Section 6 of this report examines one of the factors, political trust, which does play a more important analytic role in explaining repository risk perceptions.

3.0 RISK PERCEPTIONS OF TRANSPORTING NUCLEAR WASTE

3.1 Framework for Measuring Perceptions

It was clear from several national polls and public hearings on the nuclear waste repository that the transportation of nuclear waste was a salient issue in the public acceptability of the repository. In fact, the issue of shipping high-level nuclear waste to Yucca Mountain brought the issue to national attention as corridor states expressed concerns over risk, equity, safety management, and state rights. Preliminary results from the Urban Risk Survey (Mushkatel et al., 1989a) suggested that residents of the Las Vegas urban region were especially concerned over the risks of nuclear waste shipments through the metropolitan area.

The analysis of the social impacts of transporting nuclear waste in this report is based on a framework shown in Figure 3-1. Urban residents have expressed serious concerns over nuclear waste shipments. A major source of these public expressions of concern are the perceived risks inherent in nuclear waste transportation technology. The data indicate that the public perceives a high likelihood of transportation accident events and that these events may have serious or catastrophic consequences.

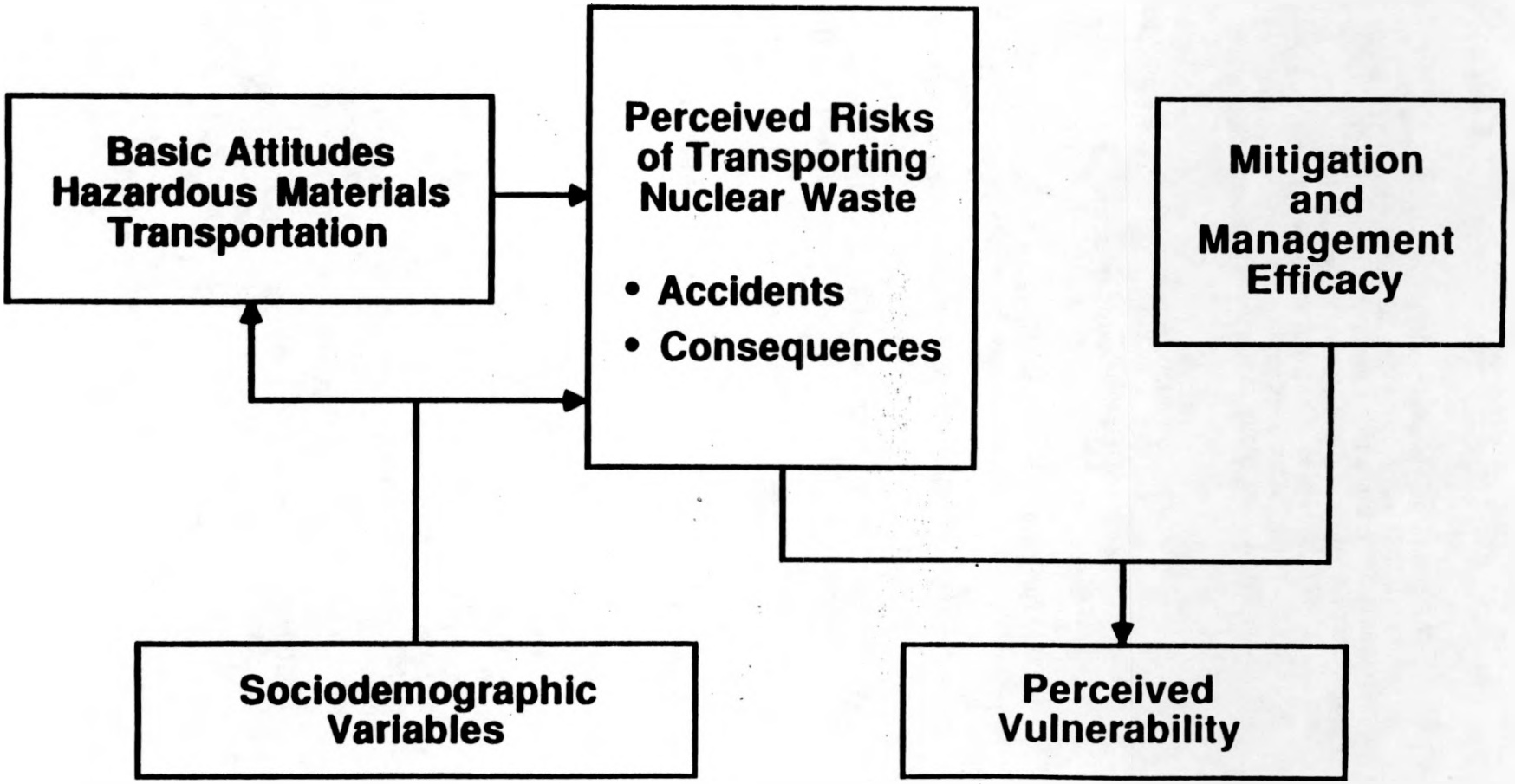
Another source of concern is the perception that government is ill-equipped to manage effectively the problems posed by nuclear waste transportation. Prevention of accidents and mitigation of accident consequences by government are not viewed by most residents as something government can do to their satisfaction. The perceived lack of governmental efficacy in managing risk is embedded in growing distrust of agencies authorized to regulate the repository program.

Concerns expressed by the public are a product of perceived risks and government's ability to prevent, respond, and mitigate accident events and non-accidental risk (exposure to radioactive materials). The combination of the two elements results in a level of "perceived vulnerability." The data also suggest a very strong relationship between perceived management efficacy and perceived risk. The low level of trust in the government to intervene to reduce what is considered to be serious risks amplifies the threat of transporting nuclear waste.

The perceived risks of transporting nuclear waste is influenced by certain basic attitudes held by residents regarding hazardous materials transportation. These include attitudes toward the inevitability of accidents, transporting materials through populated areas, and the degree of control over decisions to transport dangerous goods. The perceived risks of transporting hazardous materials, and nuclear waste specifically, have been shown to be influenced by sociodemographic variables, particularly gender differences. This section of the report addresses residents' attitudes toward hazardous materials transportation, perceived risks of nuclear waste transportation, management efficacy, and sociodemographic variables affecting perceptions.

Figure 3-1

PERCEIVED VULNERABILITY FROM THE TRANSPORTATION OF HIGH-LEVEL NUCLEAR WASTE



3.2 Attitudes Toward Hazardous Materials Transportation

The social psychological literature and research on societal adjustments to hazards have found that underlying broad cultural beliefs about safety and risk influence how individuals or communities perceive probabilities of accidents and their consequences (see, for example, Burton, I., R. Kates, and G. White, 1978; Mitchell, J.K., 1974; Sorenson, J., et al., 1987). Several questions were developed to ascertain the nature of attitudes or beliefs regarding hazardous materials transportation. Four attributes of generally-held attitudes about hazardous materials transportation were addressed:

- The degree to which hazardous materials accidents are inevitable;
- The attitude that hazardous materials should not be transported through populated areas;
- The extent to which people feel that they have no control over decisions to transport hazardous materials through communities; and
- The degree to which it is safe to transport hazardous materials.

Table 3-1 shows that on a 1 to 7 attitude agreement scale, 54.2 percent of the population were in very strong agreement with the attitude that hazardous materials transportation accidents are inevitable (levels 1 and 2 on the agreement scale). A significant proportion of the metropolitan population held strong public attitudes regarding the inevitability of such accidents. More substantial public support was held for the attitude of not permitting shipments of hazardous materials through populated areas. Almost 75 percent of the sample population very strongly agreed (1 and 2 on the agreement scale) with this sentiment.

The literature on perception and adjustment choice to natural hazards and the more recent work on technological risk perceptions show the importance of the "personal control" factor in making adjustments to reduce potential impacts of the hazard. Controllability of a technology was found to be a critical factor in perceived risk. Lack of control of a technology was strongly related to perceptions of high risk. Almost 60 percent of the population expressed the view that there was little control over decisions to transport hazardous materials. In a sense, hazardous materials transportation may be viewed by the public as an involuntary risk. The work by Slovic and Lowrance has suggested that involuntary risks are associated with higher risk perceptions and public concerns than are voluntary risks and associated perceptions of control over hazardous technology (Slovic and others, 1983; and Lowrance, W., 1976).

Although residents of the metropolitan area expressed strong attitudes toward the inevitability of transportation accidents involving hazardous materials, the lack of personal control over shipments and to not transport hazardous materials through populated areas, a relatively smaller (but still sizeable) percentage of persons expressed the attitude that it was not safe to transport hazardous materials. Approximately 40 percent of the population strongly disagreed (6 and 7 on the scale) with the attitude that it is safe to transport such material. Only 17.5 percent agreed that it was safe to transport such materials.

TABLE 3-1

BASIC ATTITUDES TOWARD HAZARDOUS MATERIALS ACCIDENTS

	Strongly Agree 1	2	3	4	5	6	Strongly Disagree 7
Hazardous materials accidents are inevitable	40.5	13.7	14.7	10.6	8.8	6.4	5.3
Never transport through populated areas	61.7	12.8	7.7	7.7	3.9	2.4	3.9
No control over decision to transport hazardous materials through community	34.7	15.4	9.0	13.6	7.7	10.5	9.2
It is safe to transport hazardous materials	6.8	10.7	15.6	15.4	11.6	11.0	28.9

Two factors are suggested that may help us understand the higher public tolerance of hazardous materials transportation in general, despite attitudes of accident inevitability and lack of control over decisions surrounding the routing of shipments. Residents may feel that the economic advantages outweigh the risks of such transportation and, subsequently, accept those risks as economic reality. In addition, transportation accident events involving dangerous goods may be perceived as highly random occurrences that may have an extremely low probability of impacting any one individual. Moreover, the literature on both natural and technological hazards has observed strong denial tendencies of the hazard or its personalization by individuals with strong religiosity, those with lack of awareness of the event, and by risk takers. The fact that hazardous materials transportation accidents resulting in spills and fatalities are relatively rare may reinforce the perception of safety through randomness and personalization of effects. Overall, however, a larger percentage of people believe hazardous material transportation is not safe than those who feel it is safe. Although most residents do not want dangerous goods shipped through populated areas, a large minority feel that such transportation is generally safe.

A recent study of public attitudes toward hazardous materials transportation in Canada suggested that familiarity with hazardous materials shipments, i.e., those living adjacent to transportation routes, allowed more acceptance of the risks (Transport Canada, 1987). To test this finding, we analyzed transportation risk perceptions and attitudes of the sample population by distance they lived from the major routes over which hazardous materials are currently shipped. The data show that concerns and risk attitudes do not vary by distance from these routes within 5 miles of the routes. However, since the entire sample population resided within 5 miles of the routes over which hazardous materials are carried, we have no evidence that shows that risk perceptions diminish outside of 5 miles, which would be a reasonable expectation. The data show that within 5 miles of a route, concern over risks does not vary in any meaningful way on the basis of distance alone. Familiarity as a factor in explaining higher-than-expected risk tolerance of hazardous materials transportation is questionable and other factors need to be investigated.

3.3 Risk Perceptions of Nuclear Waste Transportation

Slovic and colleagues have argued that nuclear technology and facilities evoke concerns and heightened perceptions of risk despite evidence of low probability events of this technology (Slovic et al., 1978). They have demonstrated that these subjective risk perceptions should not be viewed as irrational, but rather as a result of certain perceived dimensions of risk that characterize such technologies. Controllability, reversibility of effects, impact to future generations, dread, and catastrophic consequences are attributes of the technology that, singly or in combination, affect the perception of the risk.

In a study examining group perceptions specifically within the transportation risk domain, Slovic and Kraus (1987) found that the transportation of hazardous materials and shipments of nuclear waste would result in the highest perceived risks relative to all other types of transportation shipments. The placement of these types of shipments into a high perceived risk space was due to the interrelationships of high psychometric scores found among several risk dimensions which included: involuntariness, uncontrollability, catastrophic potential, and inequity. The risks of shipping chemical and nuclear waste

materials were viewed as controllable but potentially catastrophic in case of accident events.

Based on these studies, it is likely that both hazardous materials transportation and nuclear waste transportation, specifically, would result in high perceptions of risk. While accident events may be perceived as low in probability of occurrence and random, public attitudes show strong expressions of the inevitability of such events and lack of personal control. If these two factors combine with event consequences that are perceived as serious and catastrophic, then high perceptions of the risks of nuclear waste transportation by the public and expressions of serious concern may be expected, despite protestations of negligible objective risk in such transportation.

Table 3-2 shows that on a scale of 1 to 7 representing the seriousness of the risk to health and safety from the transport of nuclear waste, almost 70 percent of the population perceived the risk as serious (1, 2, and 3 on the scale), and 53 percent as an extremely serious risk (1 and 2 on the scale). A median value of 2.0 on the scale was observed, where "1" is high risk and "7" is low risk. This measure suggests that the urban population perceives the transportation of nuclear waste to present a very serious risk to health to the Las Vegas urban region.

TABLE 3-2

RISK PERCEPTION OF LAS VEGAS RESIDENTS
OF NUCLEAR WASTE TRANSPORTATION

Level of Perceived Risk		Frequency	Percent
High Risk	1	166	34.2
	2	91	18.8
	3	82	16.9
	4	51	10.5
	5	44	9.1
	6	34	7.0
Low Risk	7	17	3.5
Median	2.0	485	100.0

Residents were also asked to rate the extent to which they agreed with the statement that a transportation accident involving nuclear waste would cause "widespread damage to health and property whatever the level of preparedness." Strong agreement (scores of 1 and 2) with this statement was shown by 56.2 percent of the population. These data are shown in Table 3-3.

TABLE 3-3

PERCEPTION OF CONSEQUENCES OF TRANSPORTATION ACCIDENTS INVOLVING NUCLEAR WASTE

Agreement with Statement That Accident Would Cause Widespread Health and Damage Even If Government is Prepared		Frequency	Percent
Strongly Agree	1	188	38.8
	2	84	17.4
	3	63	13.0
	4	46	9.5
	5	39	8.1
	6	35	7.2
Strongly Disagree	7	29	6.0
		484	100.0

In addition to the perception of serious health risks resulting from possible transportation accidents involving nuclear waste, the urban residents also expressed concern that they would not be able to protect themselves in the case of an accident. Respondents were asked their level of agreement with this statement: "There is nothing I can do to protect myself if an accident takes place." A strong expression of fatalism was expressed by a relatively large segment of the population: over 50 percent of the respondents strongly agreed with the statement (rating of 1 and 2 on the 7-point scale of agreement).

Because the repository is proposed to be sited around 120 miles from Las Vegas, and the possibility exists that nuclear waste shipments could utilize local highways, it was hypothesized that the perceived seriousness of the risks to health and safety could be higher for transportation compared to activities at the fixed site. The data in Table 3-4 show this to be the case. Approximately 37 percent of the population perceived the risks of the repository as extremely serious (values of 1 and 2). This contrasts with 53 percent of the population who perceived extremely serious risks (values of 1 and 2) with nuclear waste transport. Data were not available to compare the perceived risk of nuclear waste shipments with other societal risks in this study. But within the context of the repository program, it seems that the perceived risks of transporting nuclear waste exceeds that of the repository itself, at least for the urban Las Vegas residents.

The distance from the repository (120 miles) for Las Vegas area residents may serve as a psychological barrier that may attenuate, to some degree, the concern of an unintentional release of radioactive material from the facility when compared to transportation accidents which can occur locally. This assertion, however, should not detract from the fact that the perceived seriousness of the risks of the repository are very high in their own right. When compared to other hazardous facilities, a nuclear waste repository is the least acceptable facility based on public responses to minimally acceptable distances (see Section 4.0).

TABLE 3-4

RISK PERCEPTION OF LAS VEGAS RESIDENTS
TO YUCCA MOUNTAIN REPOSITORY ACTIVITIES

Perceived Risk Level		Frequency	Percent
High Risk	1	111	22.9
	2	64	13.2
	3	85	17.6
	4	73	15.1
	5	59	12.2
	6	54	11.2
Low Risk	7	38	7.9
		484	100.1

Moreover, the data also indicate that the perception of transportation risks is significantly related with risk perceptions of the repository. For example, of those individuals who perceived the highest level of risk in transporting nuclear waste, approximately 61 percent perceived very serious risks to health from repository activities (Tau B of 0.42). The reverse is also true. Therefore, the importance of transportation risk perceptions in the formation of risk beliefs and perceptions regarding the repository should not be underestimated. If nuclear waste transportation risk issues were resolved, the data suggest there may be an adjustment in the pattern of public concern and perceptions over the repository for the urban Las Vegas area residents. The magnitude and direction of such an adjustment is uncertain given the strong interrelationships between the two repository elements. The strength of the perceptual risk factor of the repository, and the extreme negative symbolism/imagery the repository evokes as a hazardous facility would tend to sustain substantial public concern, fear, and opposition to the repository alone.

3.4 Perception of Management Efficacy

Several recent studies related to siting hazardous facilities have addressed trust in government as a salient factor that can partially explain public concern over risk (see, for example, Cook, B., J. Emel, and R. Kasperson, 1990). There is growing evidence that distrust of regulatory agencies and government to manage hazardous technology and safety programs is strongly related to high perceived risk and public expressions of concern over siting noxious facilities. Section 6.0 of this report shows that highly significant relationships exist between trust variables to mitigate risk and risk perception factors.

Several questions addressed the issue of the perceived efficacy of government agencies' ability to deal with the nuclear waste transportation hazard. The findings of the study on Canadian attitudes toward the transport of dangerous goods show that although most people believe that safety should be the responsibility of transportation experts, the public, nevertheless, doubts the credibility of industry and also wants greater

direct public input into decisions about transportation safety. In fact, 36 percent of the Canadian population surveyed agreed that they had difficulty in believing governmental safety reports on transportation accidents (Transport Canada, 1987).

In the Urban Risk Survey, when asked whether nuclear waste can be transported in a way that is "acceptably safe," around 34 percent of the population stated that nuclear waste could not be transported in an acceptably safe manner (Table 3-5). That is, the existing and proposed management programs, monitoring, and mitigation safety procedures would not be able to reduce risks to levels that would be viewed as acceptable. The public is not confident that the safety system for managing nuclear waste transportation would be reasonably safe. Generally, there seems to be a very low acceptance by a sizeable proportion of the population that government could develop and sustain a nuclear waste transportation system that would assure reasonable acceptable risks to the public.

TABLE 3-5

NUCLEAR WASTE CAN BE TRANSPORTED IN AN ACCEPTABLY SAFE MANNER

	Frequency	Percent
Yes	293	53.4
No	64	34.0
Not Answered	85	12.6
Total	549	100.0

Why does such a sizeable percentage of people feel that nuclear waste transportation could not be made safe to a point where it would be acceptable? First, as Table 3-6 shows, only 18 percent of the population is "very confident" that government will have the technical know-how to respond to accidents involving nuclear waste. In contrast, 40 percent of the population was "not very confident" and "not confident at all" in the government's capabilities to respond and mitigate the hazards of an accident event.

The general lack of confidence expressed by the public in the efficacy of governmental response to accident events is reinforced by the finding that approximately 40 percent of the population also disagrees with the idea that government precautions against accidents would work. Table 3-7 shows that only 8.5 percent of the urban population strongly supported this idea. The fact that a large percentage of persons disagreed with the principle that the transportation of nuclear waste can be made acceptably safe may be partially explained by the findings that among many urban residents there is a lack of confidence in government's know-how to respond to transportation accidents and that even if governmental precautions and mitigatory actions are taken to prevent accidents, they would not work. These attitudes relate back to the public's sense of inevitability regarding hazardous materials transportation accidents. This sense of inevitability or fatalism is a strongly held attitude by a large number of persons when it comes to transportation risks, despite governmental mitigatory activities to reduce and minimize risk.

TABLE 3-6

DEGREE OF CONFIDENCE THAT GOVERNMENT WILL HAVE TECHNICAL KNOW-HOW TO RESPOND TO ACCIDENTS

Degree of Confidence	Frequency*	Percent
Very confident	88	18.1
Somewhat confident	201	41.4
Not very confident	140	28.9
Not confident at all	54	11.1
Total	483	99.5

*The frequency is based on the number of respondents answering this question and does not include respondents who did not answer.

TABLE 3-7

RESPONSE TO GOVERNMENT PRECAUTIONS AGAINST ACCIDENTS

Level of Agreement			
Government Precautions Against Accidents Almost Certainly Would Work		Frequency	Percent
Strong Agreement	1	41	8.5
	2	77	15.9
	3	84	17.4
	4	85	17.6
	5	62	12.8
	6	66	13.6
Strong Disagreement	7	69	14.3
Total		484	100.1

Preliminary analysis of the survey data suggests a relatively strong inverse relationship between transportation attitudes and trust in several regulatory agencies. That is, the less trust one has in an agency to manage safety, the higher the perceived risks, the greater the agreement with the attitudes that accidents are inevitable and that hazardous wastes should not be transported through populated areas. Table 3-8 shows that of those persons with no or low levels of trust toward the Department of Energy, high agreement was found with attitudes regarding high inevitability of hazardous materials accidents, seriousness of the risks of transporting nuclear waste, and not to transport hazardous material through a populated area.

However, trust in the U.S. Environmental Protection Agency and the U.S. Department of Transportation was found not to explain variation in basic hazardous materials transportation attitudes nor in nuclear waste transportation risk, specifically. Trust in the Department of Transportation was not related to safety or perceived seriousness of the risks. However, trust in the Department of Transportation did relate to the perceived confidence people have in its know-how to respond to accidents and that government precautions would work. For example, those with less trust in the Department of Transportation would be likely to have less confidence in the ability of government to mitigate and respond to transportation hazards. The relationship, however, is much stronger for the U.S. Department of Energy. Those people who distrust the U.S. Department of Energy had much stronger sentiments regarding lack of confidence in government's management capabilities to handle safety matters. Table 3-9 shows the proportion of accidents the public believes that the government reports. Approximately 40 percent believe that very few accidents are reported to the public, and another 29.3 percent feel that the government reports only some accidents.

3.5 Trust, Efficacy, and Perceived Risk

There are very strong relationships between the set of underlying attitudes toward hazardous materials transportation and risk of nuclear waste transportation. For example, of those persons who held the strongest agreement that hazardous materials accidents are inevitable, around 64 percent expressed the highest level of perceived seriousness of the risks of transporting nuclear waste. High risk perceptions of nuclear waste shipments have also been shown to be very strongly related to perceived risks of the repository. Transportation risk and how it is perceived is a key factor in people's attitudes and perceptions about the repository program. Alternatively, those with extreme concerns over the repository also share high risk perceptions and concerns over transportation risks.

With respect to risk perceptions of transporting nuclear waste and trust in the Department of Energy, the relationship is very strong. The less trust in the Department of Energy to manage risk, the larger the likelihood of high risk perceptions. For example, of those who have little or no trust in the federal agency, 71.1 percent hold the most serious risk perceptions of nuclear waste transportation. Of those residents with complete trust in the agency, only 30 percent perceive similar high perceptions of the transportation risks (Table 3-8).

TABLE 3-8

TRUST ATTITUDES TOWARD THE U.S. DEPARTMENT OF ENERGY
AND ATTITUDES TOWARD HAZARDOUS MATERIALS TRANSPORTATION

Strong Agreement (Value of 1 of Scale of 7)	No Trust 1	2	3	4	5	6	Complete Trust 7
Hazardous materials accidents are inevitable	75.6	59.5	38.8	35.6	32.0	30.0	28.0
Never transport through a populated area	82.2	66.7	64.7	62.7	57.6	50.7	55.0
Seriousness of risk of transporting nuclear waste	71.1	42.9	31.8	37.8	16.7	18.7	30.0

TABLE 3-9

PROPORTION OF ACCIDENTS
PUBLIC BELIEVES GOVERNMENT REPORTS

Reporting Frequency	Frequency	Percent
All Accidents	21	4.3
Most Accidents	124	25.6
Some Accidents	142	29.3
Very Few Accidents	192	39.6

3.6 Sociodemographic Factors and Risk Perception

Four sociodemographic factors were examined to explain variation in perceived risk of transporting nuclear waste and in attitudes toward hazardous materials transportation. An earlier section in this report showed that variation in perceptions of the repository were related to gender, age, ethnicity, and income factors. Ethnicity was found to be moderately related to repository perceptions, but gender was a consistent and strong factor explaining risk perception. This study and others as indicated in Section 2.0 have shown significant gender differences in perceived risks of hazardous technology. The differences have been in the direction of higher risk perceptions among females. Age, ethnicity, and income variables were found not to be strong explanatory factors for variation in the perception of transportation risks specifically. Gender differences were moderately related to hazardous materials transportation attitudes and the risks of nuclear waste transportation.

Significant gender differences were observed in all the principal elements of the framework--general attitudes toward hazardous materials transportation, risk perception of nuclear waste transportation, and governmental capabilities/efficacy. Females view the risks of transporting nuclear wastes as more serious and threatening than males and are less tolerant of accepting the risks inherent in a transportation management system.

3.7 Corroboration of Results from Other Studies

As part of the overall Nevada study to measure the social impacts of the repository, three additional surveys of public attitudes were conducted in the fall of 1989 and reported in May, 1990. (See *Information from Three Surveys: Frequency Distributions and Preliminary Analyses for Selected Environmental and Repository Questions*, by James Flynn.) Two survey sample populations were from the State of Nevada and California, and the third survey was based on a national sample.

Several questions addressed the impacts of transporting nuclear materials and the results corroborate the findings from the Urban Risk Survey regarding transportation concerns. Residents of Nevada and those in the national survey indicated that transportation accidents are likely to occur and that the repository program is likely to result in a serious accident in nuclear waste transportation. Around three-quarters of the state residents indicated that a highway or rail accident in nuclear waste shipments was likely to occur. Residents in the Urban Risk Survey held similar perceptions: very high percentage of residents perceived that serious accidents would occur no matter the level of preparedness taken by government agencies.

The Flynn surveys also addressed the issue of public concern over possible sabotage of nuclear waste shipments. This issue was not addressed in the Urban Risk Survey. Of the Nevada residents, 61.4 percent disagreed with the statement that the shipments of nuclear wastes would be safe from sabotage or attack by terrorists. When compared to the national survey, 52.6 percent of the households in the survey disagreed. The results suggest that a majority of the population in Nevada and in the country are concerned with the potential for sabotage.

The Urban Risk Survey results showed a low level of trust by residents in the government's ability to effectively manage safety and in reducing the risks of

transportation accidents. Moreover, the U.S. Department of Energy was given low marks by the public in level of trust. Data from the Nevada and national surveys also show distrust of the agency in risk management. Almost 70 percent of the national survey and 75 percent of the Nevada survey residents disagreed with the statement that the U.S. Department of Energy should be trusted to provide prompt and full disclosure of any accidents or serious problems with the nuclear waste management program.

3.8 Potential Social Amplification Effects Under Benign Transportation Risk Conditions

The preliminary Urban Risk Survey report (Mushkatel, et al., 1989a) discussed the use of risk scenarios to measure anticipated or possible perceptual and behavioral responses to the repository program. Three of the four scenarios addressed transportation risks as part of the nuclear waste repository program. The "Benign" scenario envisioned a 30-year repository program with several small transportation incidents resulting in no release of radioactive material. The scenario data are consistent with transportation risk studies published by the U.S. Department of Energy and the agency's contractors.

Responses to the "Benign" negligible risk transportation risk scenario suggest potential amplification effects regarding small transportation events related to nuclear waste shipments. Small events as those described in the scenario may have a tendency to sharply increase concerns over health impacts of the repository and transportation of nuclear waste specifically. Of the residents who answered the scenario questions, 75 percent indicated that their own views/perceptions of an operating repository program were different from the one portrayed in the scenario. Of these individuals, 85 percent indicated that the "Benign" scenario of transportation events was substantially milder than their own images of the frequency and consequences of hazard events related to the repository program and transportation. The data suggest that the events themselves, although relatively risk-free in terms of releases of radioactive materials, would trigger much higher levels of concern than the events themselves may warrant. This may be the result of deep-rooted images and perceptions of risk that includes the potential for catastrophic events. Thus, small events may portend larger, more serious events to follow.

When asked to respond to the "Benign" scenario, 44.5 percent of the urban population expressed serious concern that harmful effects could be produced in the Las Vegas area from the repository. In addition, almost 52 percent expressed the view that the transportation of nuclear wastes would be a serious risk to the health of residents in the Las Vegas area. Despite the fact that most residents hold higher perceptions and images of risk than depicted in the scenario, responses to the scenario conditions were as high or higher than the pre-scenario response for most measures. Providing information based on extremely low risk and benign hazard events may not necessarily reduce concerns or lessen risk perceptions, partly because of pre-existing perceptions which are difficult to alter and of the possibility that small, benign events may represent the possibility of larger, more serious events. Under the hypothetical events described, approximately 73 percent of the urban population would be concerned "about the possibility that a harmful nuclear accident could affect the Las Vegas area."

The "Benign" transportation scenario had the effect of reducing the minimum acceptable distance people are willing to live from routes carrying nuclear waste shipments. Table 3-10 shows the decline in risk acceptance with the scenario intervention

despite a scenario that apparently was viewed as less threatening than currently-held perceptions. Currently, only 38.1 percent of the population is willing to live within 20 miles of a route that would carry nuclear waste shipments. Under the "Benign" scenario, only 21.8 percent of the population would be willing to live at that distance.

TABLE 3-10

CUMULATIVE MINIMUM ACCEPTABLE DISTANCE
RESIDENTS ARE WILLING TO LIVE
FROM A NUCLEAR WASTE SHIPMENT ROUTE

Miles	Cumulative Percent[1]	Cumulative Percent[2]
<5	18.9	1.5
<10	31.3	15.8
<20	38.1	21.8
<50	57.0	36.8
<75	58.5	38.3
<100	78.0	67.7
<200	82.0	69.9

[1]Data based on current perceptions of the repository program and nuclear waste transportation risks without the scenario.

[2]Data based on post-scenario perceptions regarding transportation risks.

4.0 ACCEPTABLE DISTANCE AND HAZARDOUS FACILITIES: A CONTEXT FOR THE NUCLEAR WASTE REPOSITORY

4.1 Background

Public opposition to the siting of hazardous waste facilities and industries handling toxic materials can often be based on the distribution of perceived risks and perceived benefits in addition to the prevailing values held by communities. Concerns over health risks and safety may generally be more intense for communities with closer proximity to these facilities because the risks are concentrated and the benefits diffuse.

In the Urban Risk Survey, only 17 percent of the residents held the view that the benefits of the repository would outweigh the risks, while 53 percent indicated that the risks would exceed any benefits. The distribution of the perceived risks and benefits may help explain the large percentage of urban residents opposed to the waste repository in the Las Vegas area.

Because risks to health from waste disposal facilities are often perceived to increase closer to these facilities, minimum acceptable distances people are willing to live to these facilities has been used as a measure of acceptable risk. With respect to nuclear power plants, Lindell and Earle suggest that percentages of support from the site can be viewed as a "gradient of perceived risk" based on distance from the facility (Lindell and Earle, 1983). What distances does the public perceive to be acceptably safe from various hazardous technologies and facilities? If distance can be used as a surrogate for acceptable risk, then facilities can be ranked on the basis of the percent of the population willing to live certain distances from those facilities.

The larger the percent of people willing to live closer to a particular facility, the more acceptable that facility tends to be in terms of perceived risk. The rank order of facilities based on mean acceptable distances was also found to be related to perceived risk characteristics or dimensions of the facilities (Lindell and Earle, 1983). Two separate studies completed in 1980 found that gradients of perceived risk based on distance are related to the type of facility. The national survey by Resources for the Future (discussed in Lindell and Earle, 1983) showed that around 10 percent of the population would live within a mile or less of a nuclear power plant or a hazardous waste disposal facility. With respect to a coal-fired plant, the percentage willing to live within one mile increased to 25 percent of the national population. In comparing their study to the Resources for the Future findings, Lindell and Earle found strong similarity in responses for three facilities used in both studies. The percent willing to live within 10 miles of a coal-burning plant, toxic chemical facility, and a nuclear power plant, was 56, 24, and 21 percent, respectively (Lindell and Earle, 1983). Table 4-1 shows the rank ordering of percentages of urban residents in a 1980 survey that were willing to live or work within 10 miles of various hazardous facilities. The least acceptable facilities included nuclear power plants, a toxic chemical disposal facility, and a nuclear waste disposal facility (Lindell and Earle, 1983). These were also the facilities characterized by high risk, catastrophic consequences, high dread, and other risk perception attributes that would tend to underlie public concerns over safety.

TABLE 4-1

PERCENTAGE OF URBAN RESIDENTS
WILLING TO LIVE OR WORK
WITHIN 10 MILES OF HAZARDOUS FACILITIES

Facility	Percentage of Urban Residents
Natural Gas Power Plant	67.5
Oil Power Plant	56.4
Coal Power Plant	55.9
Oil Refinery	45.9
LNG Storage Area	46.4
Nuclear Power Plant	21.5
Toxic Chemical Disposal Facility	24.1
Nuclear Waste Disposal Facility	14.7

The Urban Risk Survey included a section which addressed the minimum acceptable distance persons were willing to live or work from various hazardous facilities based on health and safety considerations. Several facilities were identical to the 1980 studies in order to be able to make longitudinal comparisons among the studies.

A cautionary note is needed however. The 1980 Resources for the Future acceptable distance study was part of a national poll and the Lindell and Earle study was based on a sample of groups selected on the basis of predispositions toward risks associated with industrial facilities. Therefore, the focus of the sampling methodology in the Lindell and Earle study was to make comparisons among groups rather than to generalize to the population. The sampling methodology in the Urban Risk Survey focused on the generalization of the Las Vegas metropolitan area.

Differences in results among the studies will be strongly influenced by differences in the sampling frame and focus, the decade that passed between the two national studies and the Urban Risk Survey, and the specificity of the political saliency of the repository siting issue in Nevada. We hypothesized that the political saliency of the repository issue would amplify concerns over the safety of siting noxious facilities. As a result, people would tend to want to live further from these facilities. That is, acceptable distances from industrial/hazardous facilities would increase for larger segments of the population under conditions of locational conflict over the risks of any one facility.

In the Urban Risk Survey, the respondents were asked to indicate the number of miles they would prefer to live or work from a list of facilities considering health and safety matters. These facilities included a sanitary landfill, a nuclear power plant, a plant that manufacturers pesticides, an oil refinery, a landfill for disposing of chemical wastes, and an underground storage facility for nuclear wastes. Four facilities--an oil refinery, a chemical disposal facility, a nuclear waste disposal facility, and a nuclear power plant--are similar to the facilities evaluated in the Lindell and Earle study.

4.2 Findings from the Urban Risk Survey

Table 4-2 shows the minimum acceptable distances urban residents are willing to live and work from a set of six hazardous facilities. The percentages are cumulative percentages based on distance from the facilities. At a distance of 10 miles from the facilities, the percentage of people willing to live by them varies by a range of 6.0 percent to 42.8 percent. The minimum acceptable distances fall into four groupings.

Within 10 miles of the facilities, the facility with the largest percentage of acceptance is a landfill, with 42.8 percent of the population willing to live within 10 miles. The second group of facilities includes an oil refinery and a pesticide plant, with 23.7 percent and 16.9 percent of persons willing to live within 10 miles of these facilities, respectively. Almost 13 percent of the population is willing to live within 10 miles of a nuclear power plant, and this facility represents a grouping between industrial plants and chemical waste disposal sites. A smaller percentage of people are willing to live within 10 miles of a chemical waste disposal facility and a nuclear waste repository than other hazardous facilities. Only 6.0 percent of the population accepted a minimum distance of 10 miles or less for a chemical waste disposal facility, and a mere 4.9 percent of the population would be willing to live at that distance from a nuclear waste repository. A substantially fewer number of people are willing to live near a nuclear waste repository than an operating nuclear power plant.

At 50 miles from the facilities, the pattern of acceptance remains similar to the pattern established at 10 miles. Within a distance of 50 miles, 87.4 percent of the population would be willing to live by a landfill, while 64.8 percent and 48.8 percent would be willing to do so when the facilities are an oil refinery and a pesticide plant, respectively.

Within a distance of 50 miles, 36.2 percent of the population would accept the risks of a nuclear power plant indicated by their willingness to live by one at that distance. Again, the lowest levels of acceptance are for a chemical waste disposal facility and a nuclear waste repository. Twenty-six percent of the population would be willing to live within 50 miles of a chemical waste site, and 18.4 percent would be so willing in the case of a nuclear waste repository.

Figure 4-1 shows the cumulative percentage of people willing to live by six hazardous facilities on the basis of distance. The rank order of facilities in terms of a risk gradient remains constant over distance. In order of most acceptable facility to least acceptable, the facilities are a landfill, an oil refinery, a pesticide plant, a nuclear power plant, a chemical waste disposal site, and a nuclear waste repository. At a distance of 100 miles, only 42.8 percent of the population indicated they would be willing to live with a nuclear waste repository. More than 30 percent of the population indicated that even a distance of 500 miles from a nuclear waste repository would not be considered a minimum acceptable distance.

TABLE 4-2

CUMULATIVE PERCENTAGES OF PERSONS WILLING TO LIVE AT VARIOUS DISTANCES FROM HAZARDOUS FACILITIES

Facilities	Distance from Facilities									
	5	10	20	50	75	100	200	300	400	500
Landfill	19.5	42.8	65.0	87.4	88.2	94.4	95.8	95.8	96.0	97.1
Nuclear Power Plant	9.8	12.9	17.5	36.2	39.3	61.4	70.9	73.4	74.1	78.5
Pesticide Plant	8.0	16.9	25.3	48.8	51.7	74.3	79.2	80.7	82.0	87.6
Oil Refinery	13.3	23.7	39.3	64.8	67.2	84.5	87.4	88.7	88.9	92.5
Chemical Waste Disposal Facility	3.1	6.0	10.7	26.0	28.4	49.2	60.3	63.9	64.1	73.2
Nuclear Waste Repository	2.4	4.9	8.2	18.4	21.1	42.8	54.1	58.5	58.8	67.6

FIGURE 4-1

CUMULATIVE PERCENT OF POPULATION WILLING TO LIVE AT ACCEPTABLE DISTANCES FROM SIX HAZARDOUS FACILITIES
URBAN RISK SURVEY
1988

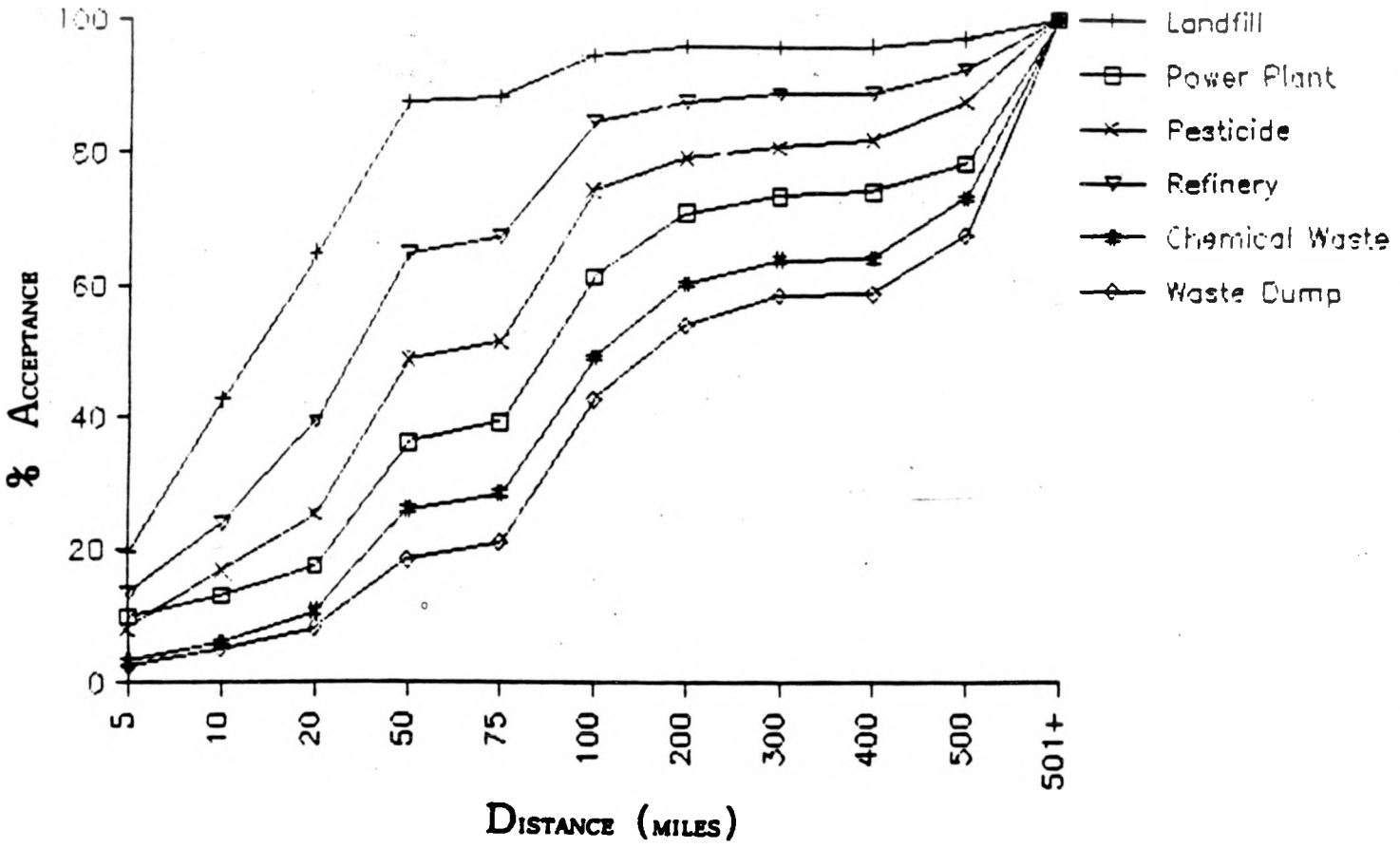


Figure 4-1 also shows the effects of distance on acceptability of hazardous facilities. Within 20 miles of a pesticide plant, a nuclear power plant, a chemical waste disposal site, and a nuclear waste repository, the range of acceptability is relatively small--around 15 percent. Overall, less than 20 percent of the population is willing to live 20 miles or less from these facilities. A major shift towards greater public acceptance is observed at 50 miles and 100 miles from these facilities. A greater range of acceptable levels were also found at these distances.

Almost 70 percent of the urban population indicated that they are willing to live within 500 miles of a repository. This percentage would accept a nuclear power plant at 150 miles, and a pesticide plant at 85 miles, as Table 4-3 indicates.

TABLE 4-3

MINIMUM ACCEPTABLE DISTANCE EQUIVALENTS
FOR HAZARDOUS FACILITIES

Facility	Minimum Acceptable Distance Equivalents (Miles)
Nuclear Waste Repository	500
Chemical Waste Disposal Site	425
Nuclear Power Plant	150
Pesticide Plant	85
Oil Refinery	75
Landfill	20

4.3 Gender and Acceptable Distances

The Lindell and Earle (1983) study demonstrated that minimum acceptable distances to a given hazardous facility varied by membership in group organizations that have expressed interests in industrial safety and development. Because gender differences were significant with respect to perceived risks of the repository, gender differences were addressed in the analysis of minimum acceptable distances.

In order to make comparisons among the hazardous facilities, Table 4-4 shows the percent of the population willing to live 10 miles or less from each of the facilities. The table also shows the differences between males and females in terms of their acceptable distance safety preference.

For the total population, the percent willing to live within 10 miles of these facilities shows remarkable variation as shown earlier. The largest percentage of persons willing to live within 10 miles of any of these facilities is the 42.8 percent who are willing to do so with respect to a landfill. The least acceptable facilities were a chemical disposal dump and a nuclear waste repository. Between 4 and 6 percent of the population would be willing to live within 10 miles of these two facilities.

TABLE 4-4

PERCENT OF MALES AND FEMALES WILLING TO LIVE
10 MILES OR LESS FROM HAZARDOUS FACILITIES

Facility	Male (%)	Female (%)	Total Population (%)	Ratio Male/Female
Landfill	54.0	33.3	42.8	1.6
Nuclear Power Plant	20.5	6.7	12.9	3.1
Pesticide Plant	27.4	8.4	16.9	3.3
Oil Refinery	35.9	13.7	23.7	2.6
Chemical Disposal Site	10.0	2.7	6.0	3.7
Nuclear Waste Repository	8.8	1.7	4.9	5.2

The data show that gender differences with respect to minimum acceptable distance is apparent for every facility. These differences are more pronounced at closer distances (less than 10 miles) to the facilities than at distances further out. A significantly lower percentage of females than males are willing to live closer to these facilities. As minimum acceptable distance increases for the total population for certain facilities--nuclear power plants, chemical waste facilities, and a nuclear waste repository, a significantly greater percentage of males than females are willing to live closer to these hazardous facilities.

Table 4-4 shows that as the percentage of residents accepting individual facilities at the 10-mile distance declines, the ratio of the male-to-female percentage of acceptance increases. For example, while 42.8 percent of the population is willing to live within 10 miles of a landfill, 54 percent of the males and 33.3 of females are willing to do so. The ratio of males to females is 1.6. In contrast, while 8.8 percent of the males are willing to live within 10 miles of a nuclear waste repository, only 1.7 percent of females would do so. This difference represents a 5.2 male-female ratio of acceptability.

The data suggest an interesting hypothesis: the higher the perceived risk to health and safety associated with a hazardous facility, by an urban population, the greater will be the minimum acceptable distance, and the larger the male to female ratio of acceptability at the closest distances. Gender differences in minimum acceptable distances varied by facility. Small differences were found for landfills (1.6), moderate differences for industrial plants (2.6 and 3.2), and large gender differences with respect to a nuclear waste repository.

4.4 Acceptable Distance and the Nevada Test Site (NTS)

The question of minimum acceptable distance from the Nevada Test Site was also addressed. Proponents of the repository have argued that despite some minor opposition to nuclear weapons testing at the NTS, the public has generally accepted the testing

facility in Nevada. If that is the case, it is argued then that the repository will also be accepted in time. The data, however, suggest the opposite: the minimum distance the public is willing to tolerate the NTS is not dissimilar to the pattern of acceptability found with the nuclear waste repository. Both facilities represent a group at the lowest points in a risk gradient of public acceptability of industrial facilities. Table 4-5 shows the percent of the urban population willing to live at various distances from the NTS if they had the choice. At a distance of 50 miles, an NTS facility would not be acceptable by around 80 percent of the urban population.

The fact that a large proportion of the population, given a choice, would not be willing to live within 100 miles of the NTS is reinforced by the concerns over potential adverse health impacts related to activities at the NTS.

Three questions were utilized to ascertain how urban residents perceived health harms which might be associated with the NTS (Q. 64, 66, 68). The first question asked respondents to indicate along a 7-point scale (where 1 was not at all likely to 7 which was extremely likely) how likely it was that above-ground testing at NTS in the past caused harmful health problems for people in the Las Vegas area. Table 4-6 displays the results of this question. As can be seen from the table, 25 percent of the residents believe it is extremely likely that such past above-ground testing has caused harmful health problems in the area.

Another 14 percent of the sample indicated level 6, which is the next most likely category. That is, almost 40 percent of the sample believe it is quite likely that above-ground testing has resulted in harmful health problems in their urban area. Yet, 13 percent of the residents felt health problems were not at all likely from such testing, with another 10 percent indicating the second least likely category. It is clear that a substantial portion of the urban residents believe such harmful effects have occurred and are a result of above-ground testing in the past.

Respondents were also asked to indicate how likely it was that underground testing at NTS would cause harmful health problems in the future for Las Vegas area residents (Q.66). Table 4-6 displays the results to this question. As can be seen from the table, 14 percent of the urban residents believe that such harmful health problems are extremely likely to occur as a result of the underground testing, and another 11 percent of the residents indicated the next most likely category in responding to the question. That is, 25 percent of the residents feel such health problems are most likely to occur in the future. Yet, 15 percent of the residents feel such health harms are not at all likely to occur. Residents were asked why they felt the way they did. Almost 11 percent of those responding felt the NTS was safe as it was operating only below ground, and another 15 percent felt it was safe because underground testing did not permit any escape of radioactivity. Yet, almost 23 percent of those responding felt there had been soil contamination which endangered the area, and another 7 percent felt there might be some water contamination from the testing.

The last question used to obtain residents' views of possible health problems from the NTS asked respondents how likely the activities at the NTS would cause them future health problems (Q.68). As can be seen from Table 4-6, only 4 percent of the residents felt it was extremely likely they would personally suffer such health problems from the activities, and another 4 percent thought it was most likely. Yet, 29 percent of the sample felt it was not at all likely such health problems would be personally suffered, and another 22 percent thought it was most unlikely. In short, while residents view above-ground testing as most likely to cause health problems in the urban area and are less

TABLE 4-5

PERCENTAGES (CUMULATIVE) OF PERSONS WILLING TO ACCEPT
THE NEVADA TEST SITE AND THE NUCLEAR WASTE REPOSITORY AT VARIOUS DISTANCES

	Distance from Facility									
Facility	5	10	20	50	70	100	200	300	400	500
Nuclear Test Site	2.4	4.0	6.6	20.2	23.9	51.5	64.1	67.9	68.5	75.0
Nuclear Waste Repository	2.4	4.9	8.2	18.4	21.1	42.8	54.1	58.5	58.8	67.6

TABLE 4-6

NTS ACTIVITIES AND HEALTH PROBLEMS

		Above-Ground Harms in Past (Q.64) (%)	Underground Harms in Future (Q.66) (%)	Activities Cause Personal Health Ills (Q.68) (%)
Not at all likely:	1	13	15	29
	2	10	18	22
	3	9	14	13
	4	14	13	19
	5	16	14	10
	6	14	11	4
Extremely likely:	7	25	14	4
Total Percent		101*	99*	101*
Total Number		517	520	520

*Total does not equal 100 percent because of rounding error.

likely to see below-ground testing as causing any health problems in the future, they are least likely to see either type of activity as causing them personally any health problems. In contrast, this study found that the repository and the transport of waste to the repository was perceived to be able to cause serious and personal health impacts.

4.5 Comparing Clark County Surveys

Longitudinal data regarding minimum acceptable distances and hazardous facilities in Clark County are available. Two surveys in Clark County addressed this question. These surveys included the Urban Risk Survey (1988) and the Nevada State Survey (1989). Results from the Urban Risk Survey and the State Survey of 1989 are compared in Table 4-7. The cumulative percent of the Clark County population (State Survey, 1989) willing to live by the facilities at various distances is also shown in Figure 4-2.

TABLE 4-7

COMPARISON OF THE URBAN RISK SURVEY WITH THE NEVADA STATE SURVEY OF 1989 FOR CLARK COUNTY

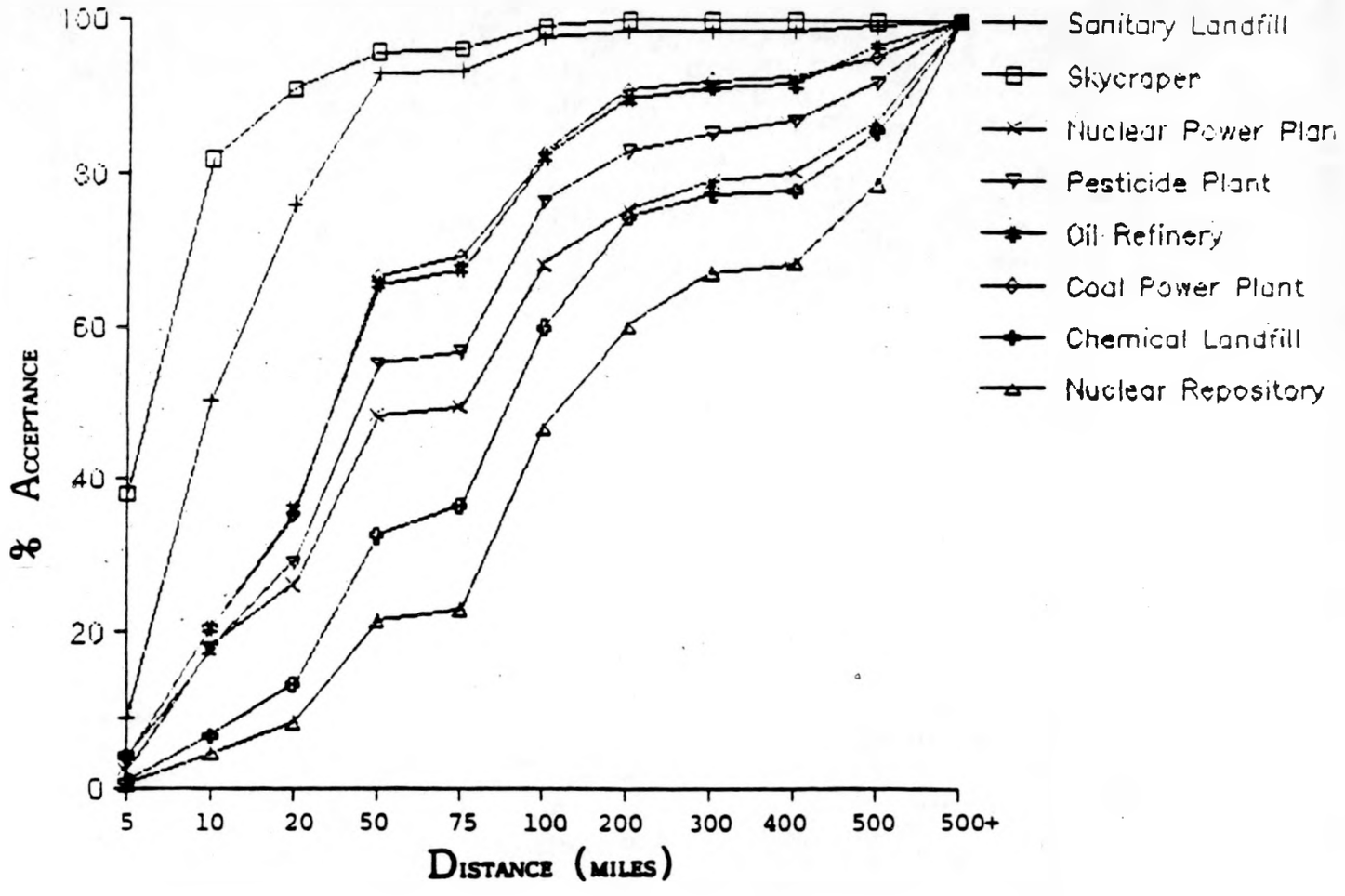
	Minimum Acceptable Distances					
	20 Miles		50 Miles		100 Miles	
Facility	I	II	I	II	I	II
Landfill	65.0	76.1	87.4	93.0	94.4	97.7
Skyscraper	---	91.0	---	95.7	---	99.0
Nuclear Power Plant	17.5	26.3	36.2	48.3	61.4	68.3
Pesticide Plant	25.3	29.1	48.8	55.1	74.3	76.5
Oil Refinery	39.3	36.0	64.8	65.6	84.5	82.2
Coal Power Plant	---	35.4	---	66.5	---	82.7
Chemical Landfill	10.7	13.4	26.0	32.6	49.2	60.0
Nuclear Waste Repository	8.2	8.4	18.4	21.5	42.8	46.6

*"I" represents data from the Urban Risk Survey and "II" are data from the Nevada State Survey (1989) for Clark County.

The results from the two surveys show a remarkable consistency in the urban population's response to hazardous facility locations. The rank order of facilities in terms of minimum acceptable distances remains constant between the two surveys. However, Clark County residents in the Urban Risk Survey were slightly less accepting of hazardous facilities than were respondents from the more recent survey but the differences were not significant and characterized by only small percentages. These small differences may be the result of the slightly different wording of the question in the State Survey.

FIGURE 4-2

CUMULATIVE PERCENT OF POPULATION WILLING TO LIVE
AT ACCEPTABLE DISTANCES FROM SIX HAZARDOUS FACILITIES
CLARK COUNTY
1989



The findings point to a very strong consistency in public perceptions of risk regarding industrial/hazardous facilities and minimum acceptable distances from these facilities. In both studies, the nuclear waste repository was viewed as the least receptive type of hazardous facility represented by the lowest percentage of population willing to accept it at any distance relative to other hazardous facilities.

4.6 Minimum Acceptable Distances and Perceived Risk Characteristics

The respondents in the Lindell and Earle study (1983) were asked to rate each hazardous facility on 13 dimensions of risk. Based on these perceived risk dimensions, the facilities were grouped into clusters. The high risk facilities consisted of a nuclear waste disposal facility, a nuclear power plant, and a chemical disposal facility. Low-risk facilities included a natural gas power plant, an oil refinery, and an oil-burning plant.

Risk dimensions characterizing the high-risk cluster included high levels of perceived threats, less well-known risks, catastrophic accidents, and dread risks. Low-risk facilities were characterized by perceived risks that were relatively well-known, preventable, and non-catastrophic. The rank order in the percent of the respondents willing to live within 10 miles of the facilities were similar to the rank ordering of the mean ratings on the perceived risk dimensions. Those facilities which were associated with the least acceptable distance were also those with high perceived risk values. The nuclear waste repository has the highest perceived risk characteristics on the following dimensions--dread, catastrophic potential, affects future generations, relative to the other hazardous facilities, and also the least acceptable distance values.

Table 4-8 shows the rank order of facilities in the Urban Risk Survey based on minimum acceptable distances and the rank order of the perceived risk of facilities from other studies. The comparative results show a strong consistency in similarity of the rank orderings of the facilities based on minimum acceptable distances and dimensions of perceived risk. This consistency in perceptions of hazardous facilities has been sustained over at least a decade and across various sampled populations.

The results suggest that these perceptions of risk of hazardous waste disposal facilities underlie the public's concern and fear of siting these facilities and that these perceptions are deep-rooted and difficult to change. There is some uncertainty, however, over which specific perceived risk dimensions can best explain acceptable distances. The data, however, suggest that the least acceptable facilities--a chemical disposal site and a nuclear waste repository--are characterized by high levels of perceived risk, catastrophic potential, and dread dimensions of perceived risk that produces special worries and concerns among the public. In his taxonomy of hazards, Kasperson has shown that radioactive wastes fall in the group of "multiple extreme hazards" which include radiation (nuclear war), nerve gas (accidents), pesticides (toxic effects), and recombinant DNA. He argues that the concerns over radioactive and other hazardous wastes result from awareness of the properties of these hazards.

TABLE 4-8

PERCEIVED RISK DIMENSIONS AND MINIMUM ACCEPTABLE DISTANCE FOR VARIOUS HAZARDOUS FACILITIES

	Urban Risk Survey	California Study[2]		Battelle Study[3]		National Survey[4]	
Facilities	Rank Order[1]	Risk Score	Rank Order	Rank Order (Risk)	Rank Order (Dread)	Median	Rank Order
Landfill	1	--	--	--	--	10	1
Nuclear Power Plant	4	6.1	2	2	3	60	4
Pesticide Plant	3	--	--	--	--	50	3
Oil Refinery	2	4.3	1	1	1	30	2
Chemical Waste Disposal Site	5	7.9	3	4	2	100	5
Nuclear Waste Repository	6	7.9	4	3	4	200	6

[1]The rank order is derived from the categories of minimum acceptable distances from each facility. The repository is the least acceptable facility from a distance perspective.

[2]Data taken from an ongoing study of a decommissioned nuclear facility in Northern California. The risk score is the mean rating of facilities on a perceived risk scale of 1 to 10 where 10 is the riskiest facility (Pasqualetti and Pijawka, forthcoming).

[3]The rank orders are derived from the Lindell and Earle study (1980). Respondents were asked to rate facilities on various risk dimensions. The rank orders are based on "riskiness" and "dread" dimensions of perceived risk, respectively.

[4]Data taken from a national survey regarding attitudes toward the Nevada Nuclear Waste Repository by Flynn et al., 1989. Median scores represent the median minimum acceptable distances from each facility.

4.7 Findings

The Urban Risk Survey provides data that strongly support the concept of a perceived risk gradient based on minimum acceptable distances from various hazardous facilities. The willingness to accept industrial facilities varies by distance and type of facility. For the urban population as a whole, industrial facilities can be grouped in terms of the proportion of the population that is willing to live with the facilities at certain distances from them. Minimum acceptable distances are the shortest for landfills and industries. The largest acceptable distances were found for chemical waste sites and a nuclear waste repository.

The rank order of acceptable distances from industrial facilities has remained consistent over time and across locations for which studies were undertaken. The rank order of acceptable distances for facilities in the Urban Risk Survey is similar to rank orders found in studies by Lindell and Earle (1980), the Resources for the Future (1980), the Nevada State Survey (1989), and the National survey of attitudes toward the nuclear waste repository (1989). The least acceptable facility measured by the percentage of population willing to live at various distances from it was the nuclear waste repository.

If a hypothetical nuclear waste repository is to be sited 300 miles from the urban population, only 58 percent may be willing to accept it. This does not include the ancillary activities associated with the repository, such as nuclear waste shipments. Over 30 percent of the urban population would not want a repository even if it was sited at a distance of 500 miles.

The rank order of facilities on the basis of acceptable distances remains strongly consistent over time and across several studies. The rank order of facilities is also similar to the rank order of perceived risk scores on various hazard dimensions developed by Paul Slovic in his studies of risk perceptions. The two facilities least accepted by the public because of potential health hazards are a chemical waste disposal facility and a nuclear waste repository. These two facilities were rated highest on the following psychometric risk dimensions: dread, catastrophic consequences, impacts on future generations, affects public nearby, and comparative risk.

The data suggest that siting a nuclear waste repository would not generally be acceptable to most urban residents unless the distance is extreme. For a large minority of residents, the repository itself would not be acceptable under any conditions. The siting of chemical waste disposal facilities including nuclear waste is not viewed in similar ways to the siting of other industrial facilities and a risk-distance gradient exists that tends to group various types of industrial facilities.

Chemical and nuclear waste disposal sites are the least publicly acceptable facilities. The biophysical properties of these types of facilities make these sites vulnerable to strong public opposition. The lack of public acceptability of these facilities by urban residents, coupled with the low level of trust in agencies authorized to regulate them, will result in acute and persistent difficulties in resolving risk-related issues. Expressions of high perceived risk with catastrophic potential of these facilities are deep-rooted and consistent over time and place. It is anticipated that siting controversies over the nuclear waste repository will not be easily resolved through traditional methods utilizing compensation and mitigation tools.

5.0 ASSESSING RISK-INDUCED EFFECTS: THE USE OF RISK SCENARIOS

5.1 Introduction

The proposed siting of a high-level nuclear waste repository in the State of Nevada has engendered difficult problems in assessing current, and especially, future socioeconomic impacts. Unlike the more traditional impact analysis, the measurement of impacts due to a repository has several special problems for the impact assessment process that have to do with risk and uncertainty. Substantial uncertainty exists in all areas of project description--the amount of waste, the repository design, the risk assessments, schedule, and the transportation system. These project-related factors typically provide the driving variables for projecting social and economic impacts. Therefore, indirect approaches have to be developed and utilized in order to ascertain the range of impacts that are possible.

Uncertainties also stem from the hazardous nature of the high-level radioactive waste and the risk analyses. These uncertainties relate to the occurrences of risk-related events and impacts resulting from the public perceptions of risk. How will the public respond to a repository risk future given uncertainties in that future, and what is the possible range of impacts given various risk futures?

Risk-induced effects of the repository have the potential to affect the State in several ways. The repository may diminish perceived quality of life that could affect individual and community well-being. Heightened perceptions of risk may also result in changes in individuals' sense of well-being and in intended behaviors that may increase out-migration, reduce investment in the State, and increase political participation. The projections of such possible behaviors is problematic. It requires that innovative methodologies be developed to project risk-induced impacts of the repository. We are asked to ascertain whether risk-induced effects can materialize over a 50-year waste emplacement period and the direction and magnitude of such effects.

The purpose of this section of the study is to report on findings from the survey on the range of possible impacts of having the nuclear waste repository operate. The results of the survey are not projective in the sense that certain impacts will occur but rather are suggestive. Impacts will likely result from repository events and will differ under various operating and management futures. This section of the urban impact report examines possible perceptual and behavioral responses to a range of repository futures.

5.2 Approach

The first step in this analysis was to develop alternative, plausible "risk futures" for the repository. These risk scenarios were then assigned to the sample population in order to assess whether different "risk futures" result in changes of residents' perceptions of future satisfaction with the communities they live in,

life satisfaction, and various intended behaviors. Social impacts were operationalized to include changes in patterns of behavior that would be attributed to a repository scenario. The behaviors that were investigated included: the propensity to leave the area; to economically invest in Southern Nevada; and to participate politically over repository issues.

Our hypothesis was that higher levels of risk and more serious hazard events in the repository program and represented by the risk scenarios would result in greater shifts from existing perceptions and behavioral intentions. This approach obviates the need for precise projections of the magnitude of potential impacts, but rather suggests the potential for change in direction under different future histories of the repository.

The use of risk scenarios to measure the potential for behavioral changes was an innovative approach to assess the social impacts of unique, one-of-a-kind facilities. Of primary concern was the evaluation of the impacts the repository could have on the social well-being of Las Vegas area residents and on their behaviors once the facility is in operation. The focus is on the anticipated impacts the repository would have on well-being (operationalized as community and life satisfaction) and possible behavioral adjustments to avoid or reduce risk. An important question addressed in the study was: At what level of stimuli (i.e., risk associated with the repository) is it possible to discern significant well-being and intended behavioral changes in an individual's response to the repository? If the level of stimuli that produces an observable response can be identified, it is then possible to specify the conditions under which the repository could produce behavioral change.

A variety of plausible risk futures were developed, ranging from a Benign future (i.e., negligible low risks and some economic benefits) to low-probability, high-consequence accidents involving the release of radioactive materials. Because of the uncertainty involved in predicting which of these futures is most likely and because it is important to identify the repository-associated conditions that could create intended behavioral changes, an experimental design was developed. The scenarios are found in the Background Report of the Urban Risk Survey (Mushkatel, et al., 1989).

Following the collection of existing risk perceptions and behavioral data, respondents were presented with one of four possible scenarios, each representing a different "risk future." The results in this study report on the first three scenarios which focus on transportation events. Each scenario included a description of the location of the proposed facility, its physical characteristics, how it would be operated, and information about the nuclear waste transportation. Each scenario also described operational and transportation systems that would characterize various risk futures. The three scenarios can be characterized as: (1) Benign - almost no operational or transportation mishap; (2) Moderate - a minor transportation accident with the potential for release of radioactive materials; and (3) Severe - a major transportation accident involving radiological contamination. The "Severe" scenario was not developed as a "worst case" future, but as an illustration of a credible, although low-probability, event.

5.3 Findings

The social impacts resulting from the repository that are addressed here are those in three distinct areas. First, the repository's effect on individual's quality of life and satisfaction in the community was gauged. Second, changes in behaviors were evaluated and included changes in intentions to invest in the area or to move away. The third focus for social impacts was on the potential for increased political activity. With respect to investment impacts, respondents were asked about their present intentions to invest (in such properties as second homes, rental properties, land, and businesses), and were then asked about their "intentions to invest" under the risk scenarios. It was hypothesized that the higher the future risk (as depicted in the scenario), the greater would be the overall shift in risk, life satisfaction, and intended behaviors from existing predispositions.

5.3.1 Social Well-Being

On every dimension of satisfaction and well-being addressed in the survey, the findings show a very positive perception toward their community life and life in the Las Vegas area. These positive attitudes also held when residents were asked to assess the desirability of residing in their community over the next several years. Over 75 percent indicated that their community would become "more desirable" in the future or would retain the same high level of desirability.

Of all the indicators of potential changes resulting from the repository, the social well-being dimension demonstrates the largest negative change. The magnitude of these shifts in residents' perceptions about their well-being were partly due to existing positive feelings. But, even under the low-risk, or Benign future, there was an approximately 27 percent decline in high community satisfaction among urban residents who currently hold the greatest level of satisfaction (Table 5-1), indicating a lessening of community satisfaction with just the presence of a repository. The repository would also increase the percentage of persons in the low-satisfaction level from 3 percent to 16 percent under the Benign risk future. Under the Benign scenario, around 37 percent of the population would continue to hold high levels of satisfaction with community life. This percentage would decline to 23 percent and 19 percent under the Moderate and Severe risk scenarios, respectively. A similar pattern of decline is seen in perceived quality of life. Currently, 69 percent expressed high satisfaction with life in general. This would drop to 22 percent under the High risk scenario.

5.3.2 Behavioral Intentions

Change in Mobility Decisions

Residents were asked about the likelihood that they would move from the Las Vegas area in the next five years. On the average, around 30 percent suggested that they would "definitely" or "probably" move. As Table 5-2 shows, under a Benign risk future, residents would not likely increase their likelihood of moving. However, under the Moderate risk and High risk scenarios, residents indicated a

TABLE 5-1

OVERALL SATISFACTION WITH ONE'S COMMUNITY AND ONE'S LIFE UNDER PRESENT CONDITIONS AND THREE RISK SCENARIOS

	RISK SCENARIOS					
	Benign (%)		Moderate (%)		High (%)	
	Pre[1]	Post[2]	Pre	Post	Pre	Post
Satisfaction With Community						
High Satisfaction	63.6	37.3	56.9	23.0	54.5	18.8
Moderate Satisfaction	33.4	46.8	38.2	51.1	40.3	48.9
Low Satisfaction	3.0	15.9	4.9	25.9	5.2	32.3
Total %	100.0	100.0	100.0	100.0	100.0	100.0
Total N	129	129	144	144	135	135
With Life in General						
High Satisfaction	69.0	40.9	65.3	30.3	63.0	21.7
Moderate Satisfaction	27.9	42.6	30.6	44.4	29.6	57.4
Low Satisfaction	3.1	16.5	4.1	25.3	7.4	26.9
Total %	100.0	100.0	100.0	100.0	100.0	100.0
Total N	129	129	144	144	135	135

[1]The "Pre" scenario results represent current attitudes.
[2]The "Post" scenario results represent findings responding to each of the three scenarios.

TABLE 5-2

CHANGES IN INTENTIONS TO MOVE

	RISK SCENARIOS					
	Benign (%)		Moderate (%)		High (%)	
	Pre	Post	Pre	Post	Pre	Post
Definitely Move	14.7	9.4	10.4	16.9	10.4	24.4
Probably Move	17.1	22.7	18.8	28.2	17.9	31.3
Probably Not Move	40.3	46.0	40.3	36.6	39.6	37.4
Definitely Not Move	25.6	21.9	29.9	18.3	31.3	6.9
Do Not Know	2.3	---	0.6	---	0.8	---
Total %	100.0	100.0	100.0	100.0	100.0	100.0
Total N	129	129	144	144	135	135

greater likelihood of moving. Approximately 30 percent of the population presently would probably or definitely move. Under a Moderate risk future, this would increase to approximately 45 percent, and 56 percent when a High risk future is a possibility. While the existence of a repository alone without accident events would lessen significantly the social well-being and satisfaction of living in area communities and lower quality of life, it would likely require conditions under at least a Moderate risk future to increase the likelihood of actually leaving the area. A serious transportation accident event may increase the out-migration rate by 35 percent over current levels.

Investment Decisions

Questions were also asked of the respondents regarding current investment plans and preferences and future levels of investment under the three risk scenarios. The hypothesis was that the repository could reduce the likelihood that residents would invest in Southern Nevada because of perceived business risks under accident event conditions and a business climate that could deteriorate as a consequence of declining investment. Residents were asked about intentions to invest under the three risk futures, and their answers were compared to current intentions.

The survey results show substantial changes in investment intentions under all three repository risk scenarios (Table 5-3). Under the Benign scenario, a 21 percent decline is seen in the percentage of persons that would definitely invest. This percentage continues to decline with higher orders of risk. Conversely, only 9 percent of the population would not invest today. However, under the Moderate risk future, this would increase to 35 percent and 38 percent under the High risk future.

TABLE 5-3

CHANGES IN LIKELIHOOD OF INVESTING IN SOUTHERN NEVADA

	RISK SCENARIOS					
	Benign (%)		Moderate (%)		High (%)	
	Pre	Post	Pre	Post	Pre	Post
Definitely Invest	32.0	11.4	36.9	13.0	35.1	8.4
Probably Invest	32.8	42.3	29.1	26.1	26.9	23.7
Probably Not Invest	25.8	26.0	18.4	26.1	20.9	29.7
Definitely Not Invest	9.4	20.3	15.6	34.8	17.1	38.2
Total %	100.0	100.0	100.0	100.0	100.0	100.0
Total N	129	129	144	144	135	135

Change in Level of Political Activity

Another measure used to gauge social impact is the degree to which individuals would alter political participation rates. In this study, political activity was measured by the number of political activities in which the respondent indicated he/she would participate over repository issues. The current level of political activity in the Las Vegas area is relatively low, with a reported average of 1.98 activities (of 7) in which they have participated during the past four years. Under different risk futures, a pattern seen previously recurs--virtually no change in political activity is found under the Benign scenario, but intended changes in increased participation is observed with the other two higher risk scenarios.

It should be noted that all political activities reported during the preceding four years cover actions taken for any reason, not just those that are related to the repository. The political activities that people indicate they intend to take under different risk futures are all specifically related to the repository. These political intentions, therefore, can be used to gauge the extent to which proportions of the electorate are likely to become mobilized under various operational conditions associated with the repository. Table 5-4 provides a profile of the various repository-specific political activities people in Las Vegas would become involved in under each risk future.

TABLE 5-4

INTENDED POLITICAL ACTIVITIES RELATED TO THE REPOSITORY UNDER DIFFERENT RISK FUTURES

	Future Activities Assuming the Repository					
	Benign (%)		Moderate (%)		High (%)	
	Pre	Post	Pre	Post	Pre	Post
Talk to a Federal or State Official	40	37	42	59	35	58
Talk to a County/City Official	30	34	29	50	28	49
Attend a Community Meeting	33	41	28	48	27	64
Work for a Group or Organization	19	26	19	42	18	43
Contribute Money	28	21	29	37	29	31
Participate in a Demonstration	9	11	12	23	7	22
Contact a Government Agency or Institution	41	28	44	42	40	44

5.4 Conclusion

Residents of the Las Vegas area were asked about their current levels of satisfaction of living in their community and life in general. In addition, current attitudes about moving from the area, investing in Southern Nevada, and participating in political activities were measured. Based on three risk scenarios related to repository operations and nuclear waste transportation, anticipated changes in these social behaviors from current levels were assessed. The findings suggest that even under a negligible risk future, serious declines in social well-being will result. In addition, increases in the likelihood of out-migration from the Las Vegas area may result under conditions characterized in the Moderate and High risk futures. Declines in investment are likely, with substantial declines possible under Moderate and High risk conditions. Responses to the scenarios are not predictive in terms of changes in actual behavior, but the changes observed in behavioral intentions strongly suggest their possibility. The direction and magnitude of such behavioral changes, if they were realized, would have substantial adverse impacts on the economy and quality of life of the Las Vegas area.

6.0 THE ROLE OF POLITICAL TRUST IN REPOSITORY RISK PERCEPTION

While the sociodemographic analysis found moderately strong relationships between some sociodemographic factors and repository risk perceptions, there are obviously a large number of other variables which may also contribute to our understanding of these risk perceptions. One potentially important factor is political trust. A recent paper found political trust to be a key factor in understanding Repository risk perceptions (Mushkatel, et al., 1989c). Indeed, the earlier discussion suggested that in the Urban Risk Survey data a strong minority of residents did not have much faith in the government's ability to manage the project or report accidents. The Nevada Telephone Survey marginal frequencies revealed that a majority of urban residents wanted the state to oppose the repository and turn down any benefit offers by the federal government. The analysis undertook an examination of the importance of political trust in understanding repository risk perceptions.

6.1 The Nature of Political Trust and Repository Perceptions

Since the early voting studies of the 1950s, it has been recognized that citizen trust in government is a strong predictor of various forms of political participation. More recently, studies have suggested that citizens' trust in governmental agencies that are empowered to regulate the operation of potentially hazardous facilities is related to their support for similar new facilities. For example, Stoffle, and others (1988) found that the level of trust in the agencies involved in previous projects can become a key public risk perception factor, "...especially when there is a lack of scientific agreement about the probability of assessed risks." Mushkatel and others (1989c) in a preliminary study of the relationship between trust and repository risk perception that there was variation in the level of trust that urban residents had in different federal and state agencies, and that these trust levels were related to the degree to which residents believed various mitigation measures might be successful.

This examination of political trust will first involve examining the frequency distributions to determine general trust levels for various agencies of the federal government, as well as specific administrative and regulatory agencies among urban residents in both the Urban Risk Survey and the Nevada Telephone Survey. Indices of trust are then developed and related to the various indices of repository risk perception developed and discussed earlier. Finally, in order to determine some of the impacts on urban residents' perceptions of the repository, various sociodemographic factors related to the trust indices will be examined.

The Urban Risk Survey examined the urban residents' levels of trust in both the different levels (federal, state and local-county) of government's political institutions like the Congress, and state legislature, as well as in different federal and state and local agencies (DOE, EPA, etc.). The higher the trust levels in government and its specific agencies and institutions, it was hypothesized, the more likely urban residents would trust these governmental institutions to protect them from any perceived risk from the repository.

As can be seen from Table 6-1, the trust of different federal and state institutions and offices to make decisions that will protect the public safety differs among urban residents. As can be seen from the table, none of the institutions were given overwhelming trust ratings by urban dwellers. The Governor of the state of Nevada was perceived as being most trustworthy with 40 percent (categories 6 and 7) indicating complete or very high trust. The President and Congress, both of which play key federal roles in the siting decisions for the repository are viewed with a fair amount of mixed trust and distrust. The lowest percentage of urban residents indicate they have complete or high trust in Congress (18 percent) to make decisions which protect public safety, and the President does not fare much better with 16 percent of the urban residents indicating they have no trust or little trust in this office. The state and local governments receive mixed reviews on the trust dimension. While the Governor is the most trusted official or institution among urban residents, and the state legislature is ranked relatively high, the City/County governments receive the second lowest trust rankings.

Table 6-2 displays the percentages of urban residents indicating various levels of trust in federal and state agencies to protect the public safety. These federal and state agencies have been designated and empowered to play the most influential roles in the siting process. Yet, the table shows that the lead federal agency in the repository process, the Department of Energy (DOE), and the federal agency which has the responsibility to license the project, the Nuclear Regulatory Commission (NRC) were ranked lowest in trust of all the agencies examined. If the complete trust rank of 7 is combined with the great trust rank of 6, then only 18 percent of the urban residents have complete or great trust in DOE to protect the public's safety. Only the Environmental Protection Agency (EPA), which has 30 percent of the residents indicating they have complete or great trust in it, has relatively high trust ratings. The Nevada Nuclear Waste Project Office also was not ranked high on trust to protect the public safety. Yet, this may be because respondents did not recognize the office, or because in 1988, only a small percentage of urban residents felt the state could do anything to stop the project from being sited in Nevada (this is discussed earlier in Section 2.1).

Just as low levels of trust were discovered among urban residents in the Urban Risk Survey, similar results were found in the Nevada Telephone Survey. As Flynn and others (1989) report, urban residents in the 1989 survey most trusted the state's governor to do the right thing with regard to the nuclear waste repository. While the questions used in this survey differ from those used in the Urban Risk Survey, the underlying dimension remains the trust that urban residents have toward specific agencies, institutions and offices of government. While the Urban Risk Survey's referent was trust to protect the public safety, the Nevada Telephone Survey's referent was the doing the right thing with regard to the repository. On a ten point trust scale, the Nuclear Regulatory Commission and Congress received the lowest trust mean rankings (4.2 and 4.3, respectively). The DOE was the next lowest ranked governmental institution with a ranking (mean) of 4.7.

TABLE 6-1

TRUST THAT DECISIONS WILL PROTECT THE PUBLIC SAFETY
THE URBAN RISK SURVEY

Trust Level		President	Congress	Governor	State Legislature	City/ County
No Trust	1	9%	6%	6%	3%	5%
	2	7%	7%	5%	6%	8%
	3	9%	15%	7%	9%	14%
	4	17%	26%	20%	25%	25%
	5	24%	28%	24%	31%	28%
	6	22%	14%	26%	20%	15%
Complete Trust	7	12%	4%	14%	6%	6%
Total Percent		100%	100%	100%	100%	100%
Total Number		545	545	536	535	540

TABLE 6-2

TRUST THAT AGENCY DECISION WILL PROTECT THE PUBLIC SAFETY
THE URBAN RISK SURVEY

Trust Level		DOE	EPA	DOT	NRC	NWP
No Trust	1	8%	7%	5%	10%	9%
	2	8%	9%	5%	12%	8%
	3	16%	13%	12%	14%	15%
	4	25%	20%	28%	23%	24%
	5	25%	22%	27%	23%	23%
	6	14%	22%	19%	13%	16%
Complete Trust	7	4%	8%	5%	5%	5%
Total Percent		100%	101%*	101%*	100%	100%
Total Number		535	537	537	535	503

*Total does not equal 100% because of rounding.

The Nevada state institutions received the greatest amount of trust from urban residents with the Governor leading the way followed by the Nevada state legislature and Nevada officials/agencies (6.5, 5.5 and 5.0, respectively). While these means are not indicative of overwhelming trust in the state institutions, compared to the NRC and DOE the means leave little doubt about which level of government's institutions they trust in the repository process. The lowest rated state or local institution or agency is the Clark County Commissioners (5.0). It is unclear as to why urban residents rate the Commissioners so low on the trust scale.

The frequency distributions on the trust items indicate that the agencies given the major responsibilities in implementing the Nuclear Waste Policy Act and the subsequent Amendments, are the very agencies and institutions which urban residents of Las Vegas have the least trust to protect their safety and do the right thing when it comes to the repository. In such a situation, it seems likely that trust in these agencies should show some strong relationships with repository risk perceptions. In order to explore these relationships, it is first necessary to construct some indices of trust.

6.2 Indices of Trust

In order to facilitate the examination of the relationship between trust and repository risk perception, three trust indices were constructed for each of the two data sets. The trust indices were constructed by grouping the trust questions together based upon whether the question asked about trust in the federal government such as the President and Congress, federal agencies such as DOE, NRC, and EPA, or the state and local agencies and offices such as the governor, state legislature, and city and county officials. The trust indices which were constructed were simple additive indexes. In the Urban Risk Survey data the indices consisted of the Federal trust index (Q. 55 A and B), Agency Trust (Q. 55C, D and F), and State and Local Trust (Q. 23 and 25). In the Nevada Telephone Survey the indices included Federal Trust (Q. 22 and 23) Agency Trust (Q. 24, 25 and 26), and State and Local Trust (Q. 27-31). While the trust indices titles are parallel not all of the questions in each index for each survey correspond. For example, the State and Local trust index for the Urban Risk Survey data consists of only two items which deal with state trust, while the State and Local trust index for the Nevada Telephone Survey has four items dealing with both state and local trust perceptions.

The indices were constructed after examining inter-item correlations. These measures of association varied between .64 and .71 (all were significant at the .01 level) in the Nevada Telephone Survey, and between .48 and .61 for the Urban Risk Survey items (all were significant at the .01 level). Table 6-3 provides the inter-index measures of association for the trust indices in each survey. As can be seen from this table, the highest measures of association are between the Federal Trust index and Agency Trust in both surveys. The negative signs in the associations measures for the relationships between Federal and Agency Trust and State and Local Trust in the Urban Risk Survey are quite interesting. These signs for this database should be interpreted to mean that the higher the trust in the federal government and its agencies, the lower the trust in state and local government to protect the safety of residents. Conversely, the higher the trust

in state and local governments to protect the safety of residents, the lower the trust in the federal government and the agencies to do what is right with regard to the repository. While the signs have been standardized for the Nevada Telephone Survey indices, this pattern in the trust index relationships holds for this data set as well.

TABLE 6-3

INTER-INDICES TRUST RELATIONSHIPS FOR THE URBAN RISK SURVEY AND THE NEVADA TELEPHONE SURVEY*

	Urban Risk Survey		Nevada Telephone Survey	
	Agency Trust	State & Local Trust	Agency Trust	State & Local Trust
Federal Trust	.57	-.33	.66	.42
Agency Trust		-.28		.45
Local Trust				

*All measures of association are statistically significant with $\alpha \leq 0.01$.

In short, the measures of association among the indices which are all statistically significant, strongly suggests that trust in state and local government is associated with lower trust in the federal government and agencies to do what is right regarding the repository, or protect the safety of the public. This finding has major ramifications potentially for the siting of the facility. Given the lower levels of trust observed in general for federal agencies (see above discussion) to either protect the health and safety of residents or do what is right regarding the project, the significant and high measures of association suggest that residents who do have lower trust in the federal government or its agencies, may also have higher risk perceptions of the project. It is to this issue that our attention now turns. This was shown to be the case with respect to risk perceptions of transporting nuclear waste (see Section 3.0).

6.3 Trust and Repository Risk Concerns

The key to understanding the repository's impacts on the urban population as it relates to political trust can be understood by examining Tables 6-4 and 6-5. Table 6-4 displays the relationship between the Political Trust indices and the repository risk perception indices (used in the analysis in Section 2.3.2). The measures of association found between the Political Trust indices and the repository risk indices are much higher than they were between the sociodemographic factors and the repository risk indices. In each case where the relationships for federal political trust are found to be significant in Table 6-4, the greater the political trust the less risk is perceived from the facility. Conversely, less political trust in agencies is related to greater risk perceptions associated with

TABLE 6-4

THE RELATIONSHIP OF TRUST AND REPOSITORY RISK PERCEPTIONS IN THE URBAN RISK SURVEY

Risk Perception Indices	Federal Trust	Agency Trust	State & Local Trust
Mitigation	-.32	-.44	.26
Repository Safety & Likelihood of Accidents	-.33	-.38	.18
Risk of Transportation Accidents Occurring	.24	.31	-.12
Costs and Benefits	-.14* (α = .02)	-.13* (α = .02)	.09*
Transportation of Hazardous Materials	.27	.33	-.14
Safety and Health Threat	-.27	-.34	.17

*Noted measures are insignificant at the 0.01 level of significance.

TABLE 6-5

THE RELATIONSHIP OF TRUST AND REPOSITORY RISK PERCEPTIONS IN THE NEVADA TELEPHONE SURVEY

Risk Perception Indices	Federal Trust	Agency Trust	State & Local Trust
Economic Benefits	-.08*	.01*	.10*
Mitigation	.28	.27	.08
Risks and Costs	.14	.26	.17
Risk of Transportation Accidents	-.10*	-.17	-.01*
Safety and Health Risk	.15	.26	-.01*
State Action	-.12*	-.16*	.01*

*Noted measures are insignificant at the 0.01 level of significance.

the facility. The low levels of political trust found earlier in the federal government and the federal agencies suggests that substantial portions of the urban population perceive high risks associated with the project and do not trust the federal agencies charged with ensuring their health and safety. In such a situation, the federal government and its agencies must find a way to increase urban residents' political trust for them or the risk perceptions associated with the project will remain negative and hinder agencies' efforts in siting the project.

The more moderate measures of association found in Table 6-4 for the relationship between State and Local political trust and the Risk Perception Indices is most interesting. In this case, the signs of the relationships seem to indicate that the higher the political trust in state and local governments, the higher the perception of risk from the facility. This positive relationship (the opposite of the federal trust indices relationships) suggests that state and local positions on the repository which have characterized the potential risks associated with the project as being larger than those suggested by the federal agencies, seem to be credible with urban residents. Hence, in the case of state and local governmental trust; high political trust is associated with higher risk perception levels which reflects the continuing opposition of the state and local municipalities to the facility. In this situation, where governmental agencies are providing opposing views of the same project, urban residents must decide which governmental entities to believe. Given the political trust distributions we have observed, it seems unlikely that the federal agencies will "win the hearts and minds" of Nevada's urban residents without some rapprochement with the state and local governments.

Table 6-5 displays the relationships of the Political Trust indices with the Risk Perception indices for the Nevada Telephone Survey data. These relationships offer additional support for the findings from Table 6-4, but the measures are weaker and less often statistically significant. The strongest relationships observed in Table 6-5, are for Federal and Agency Trust and the Mitigation index. Once again these relationships should be interpreted as meaning that the higher the trust in the federal government and its agencies to do the right thing with regard to the repository, the greater the perception that mitigation measures will work and the federal government will operate the facility well. The Risks and Costs index may be interpreted to mean the same thing; the higher the trust in the federal government and its agencies the more likely the benefits of the facility outweigh the costs. The State Trust index does not seem to have much statistical significance in its relationship to these repository risk perception indices.

The findings from these analyses of political trust and repository risk are most significant and imply that urban residents will continue to view the risks associated with the facility in very grave terms until their level of trust in the federal government and its agencies can be increased. Given the opposition of the state and local governments to the project and the higher levels of trust urban residents have for these agencies, trust of federal agencies may be slow in coming. If the residents with low trust levels are also those most predisposed to political participation (not examined in the report), the federal government may be confronted with a substantial number of mobilized anti-repository residents. The final issue to be examined is the relationship of political trust to the sociodemographic factors. This analysis will permit us to determine if subgroups within the urban population tend to possess either higher or lower levels of

political trust which has been shown to be strongly related to repository risk perceptions.

6.4 Sociodemographics and Political Trust

Only a preliminary analysis of the relationship between political trust and the sociodemographic factors for urban residents in both surveys has been accomplished to date. Only age seems to have any significant relationship, and this tends to be quite weak. There is a slight tendency for older urban residents to be less trusting of federal and state agencies than are younger residents. In addition, we analyzed the data to determine if any interactive effects existed between the sociodemographics and political trust in the Urban Risk Survey data. While the cell sizes are too small to permit any confidence in the results, there does appear to be a slight interaction between gender and age when relating these factors to political trust. Specifically, older females tend to display significantly less trust in the federal government and its agencies than do older males.

The results of the analysis of the data examining the relationships between sociodemographic factors and political trust results in the conclusion that only age is moderately related to political trust. The next step in this analysis is to run regression equations on the data to determine the relative importance of the sociodemographic variables and political trust indices in explaining each dimension of the repository risk dependent variables. These analyses will be included in studies that are currently proposed.

7.0 SUMMARY OF FINDINGS AND IMPLICATIONS

7.1 Summary of Findings

The following outlines the key findings regarding impacts to the urban population of siting the repository at Yucca Mountain.

7.1.1 Public Response to the Proposed Repository

There is a high level of awareness of the proposed repository by urban residents and interest in the issue has remained consistently high. Opposition to the repository has also been consistent and approximately 50 percent of the population indicated they would not build the project if it were their decision.

An even greater percentage (78 percent) of the urban population are concerned about the possible harmful effects the repository could produce. Public concern is associated with extreme negative imagery of the repository. Despite a concerted campaign by the U.S. Department of Energy to discount the risks of the repository program over the past few years, data from the surveys show that the negative imagery has been sustained by the population. Over 60 percent of the population believe that the project would harm the community, and a large minority (40 percent) indicated that the repository would personally harm them.

The repository is not merely viewed as a noxious facility, but a facility that will have direct adverse health and economic consequences to individual families. The personalization of potential impacts is an important finding and may explain the consistency of high levels of public concern over time. The various surveys also showed a consistent pattern of perceptions regarding the tradeoff between risks and benefits of the project. Although most residents were aware of economic benefits resulting from the repository, the majority of residents viewed the risks of the project as exceeding any potential benefits.

Expressions of concern and opposition to the repository are rooted in high perceptions of risk. Only 8 percent of residents perceived no serious risk to the health and safety of Las Vegas area residents. The transportation of nuclear waste to the repository was perceived to pose even greater risks to health. Approximately 53 percent of the population felt that the risks of transporting nuclear waste was very serious. Despite U.S. Department of Energy protestations that the risks of accidents are extremely small, the urban population perceives that accidents are highly likely and that the potential exists for an accident with catastrophic consequences.

7.1.2 Perceptions of Government's Ability to Manage Safety

One way of mitigating residents' concerns over threats to health and safety from the repository would be to have high levels of confidence in how the repository will be managed. Unfortunately, Clark County residents do not have confidence in how the project will be managed. Of importance is the fact that 41

percent of the population feel that the repository can not be made acceptably safe. Even with preparedness, 56 percent strongly agree that a nuclear transportation accident will cause devastating damages. Only a very small percentage of the residents is confident that government has the ability or knowledge to respond to nuclear waste accidents.

Three key factors combine to produce a perception of very high vulnerability regarding the repository program. These are: (1) a substantial level of fatalism among the population that accidents at the repository are highly likely (and "inevitable" for nuclear waste transportation); (2) a perception that accidents can cause serious and possible catastrophic consequences; and, (3) a belief that mitigation activities by government to reduce risk and lessen consequences will not work.

7.1.3 Consistency of Results

The results from the two surveys--the Urban Risk Survey (1988) and the Nevada Telephone Survey (1989)--show a high degree of consistency which increases the confidence in our findings. Opposition to the building of the repository continues to be supported by a substantial percentage of the population. In the 1988 survey, 68 percent of the residents stated they would vote against the project. In the 1989 survey, 69 percent indicated they would not build the repository if the choice was theirs to make.

Both surveys found a substantial percentage of residents associating extreme negative images with the repository. The Urban Risk Survey found that 53 percent of residents perceived the risks of the project to outweigh the benefits. In 1989, the percentage that feels that the risks are greater than the benefits increased to 68 percent. Despite a multi-year effort by the federal government to portray the repository program as producing low-risk and large economic and social benefits, the urban population has de-emphasized the benefits over time, and a greater number have found the risks to be greater relative to any advantages the repository could provide.

An important finding in both surveys is that residents feel that their area will become stigmatized as a "Nuclear Waste Dump." Over 43 percent of the Clark County population felt that it was extremely likely to occur (category 10 on a 1 to 10 scale of agreement). Although there is a slight tendency for urban residents to see some economic benefits from the project, they also perceive that the project will instill fear and anxiety among residents and will stigmatize the area. The perceived costs to a community with a population experiencing a future with reduced quality of life (fear), stigmatized with negative nuclear imagery, and with a high perceived vulnerability to hazard, will likely see a large imbalance between risks and benefits of the project.

The surveys portray an urban population with a high degree of concern and fear of the proposed facility. Concern seems to have grown rather than diminish over time. Far fewer residents now feel that the building of the repository is inevitable and opposition to the site has grown. The evidence from the risk scenario analysis shows a very high potential of increased political participation to stop the repository under conditions of mismanagement and the occurance of small, non-radiological events related to the repository program. Nuclear waste

transportation issues in particular have a very high potential for political amplification.

7.1.4 Differential Impacts to Social Groups

The data from the surveys show that some groups within the urban population view the repository and its impacts in different terms than the urban population as a whole. When sociodemographic variables were examined against perceptions of risks of the repository, gender differences produce the highest measures of association. Females are consistently more concerned over the repository than males and perceive greater risks to safety and health from the proposed facility. Race was found to have some statistically significant relationships with repository risk perceptions in the Urban Risk Survey. Non-whites tend to view the repository as less safe than do whites. Age and other demographic factors were found not to have strong associations with repository concerns.

Females perceive relatively higher levels of risk associated with the repository than males. This pattern of response also appears when mitigation is addressed. While 16 percent of the males feel the government will report accidents or that their precautions will lessen an accident's impact, only 7 percent of the females held similar views. Females are also twice as likely to support the state's opposition to the facility.

7.1.5 Impacts from Transporting Nuclear Wastes

The transportation of nuclear waste has surfaced as a particularly fearful aspect of the repository program for many urban residents, and high levels of perceived risk are associated with it. In fact, a larger percentage of the population expressed high risk perceptions over nuclear waste shipments than the repository. This does not mean, however, that the risks of the repository operation were downplayed; both transportation and repository activities were associated with concern and high perceived risks. A strong significant association between the risks of the repository and nuclear waste shipments was found.

Concerns over the shipments of nuclear waste are partially based on attitudes about hazardous materials transportation in general. Most residents expressed strong attitudes toward the inevitability of transportation accidents involving hazardous materials, the lack of personal control over shipments, and to not transport hazardous materials through populated areas.

With respect to nuclear waste shipments specifically, almost 70 percent of the population perceived the risks to health as very serious risks. In addition, almost 60 percent indicated that a transportation accident involving nuclear waste could be catastrophic, causing "widespread damage to health and property whatever the level of preparedness." Associated with high risk perceptions of nuclear waste transportation mishaps was the strong expression of fatalism expressed by a relatively large segment of the population regarding transportation accidents.

The Las Vegas area population expressed concerns regarding the lack of confidence in government to manage the risks of the repository. This concern is particularly acute in the area of transportation risk. A large minority of the

population (34 percent) stated that nuclear waste could not be transported in an acceptably safe manner. Only 18 percent of the population felt confident that the government would be able to respond to a transportation accident, and 40 percent indicated that they were not confident that precautions against accidents would work. The survey found that trust in governmental agencies is strongly associated with risk perceptions, perceptions of management efficacy, and attitudes toward transportation of hazardous materials. The urban population had the least trust in the U.S. Department of Energy, compared to other federal agencies, to manage transportation safety as part of the repository program.

7.1.6 Acceptable Distance and the Nuclear Repository

Both the Urban Risk study and the Nevada State Survey asked residents of Clark County the minimum distance they would be willing to live or work from a set of hazardous industrial facilities, including a nuclear waste repository. The data from both surveys show that the nuclear waste repository is the least acceptable type of facility relative to other hazardous waste facilities and industrial plants. Within 50 miles from six facilities listed, 87 percent of the population would be willing to live by a landfill, 65 percent by an oil refinery, and 49 percent by a pesticide plant. Only 36 percent would accept a nuclear power plant within 50 miles, and the percentage falls to 26 percent for a chemical waste disposal facility. Around 18 percent of the population indicated acceptance of a repository within a distance of 50 miles.

A remarkable consistency was found in the rank order of facilities between past studies and the two recent surveys of Clark County residents. The rank order of facilities based on minimum acceptable distances is strongly associated with the perceived risks of these facilities. The risks of the nuclear waste repository were characterized as dread, high risks, catastrophic, and affecting future generations. The data suggest that there is a clear distinction made between hazardous industrial facilities and a nuclear waste repository. The nature of the biophysical hazards attributed to a nuclear waste repository and high levels of risk perception place the nuclear waste repository in a siting category of its own. It is questionable whether traditional siting policies using compensation and mitigation strategies to gain public acceptance would be workable for a nuclear repository given the high level of public skepticism expressed by a substantial segment of the population over whether the repository could even be made acceptably safe. The lack of trust that the government's precautions could prevent a serious accident from occurring reinforces this finding.

7.1.7 Impacts to Quality of Life and Anticipated Socioeconomic Behavior

Based on responses to a set of repository risk scenarios the data suggest that serious and substantial socioeconomic impacts may result from risk-induced anticipated behaviors.

Under a plausible, negligible risk future of repository operations, the overall satisfaction with living in the Las Vegas area would decline significantly. Currently, 57 percent of the population indicated they were highly satisfied with the community. Under the negligible risk future, the level of satisfaction with living in the Las Vegas area would decline to 37 percent. Under a high-risk

repository future, satisfaction with quality of life would drop to 19 percent. One of the key impacts of the proposed repository was found to be the reduction in future expectations of a satisfactory quality of life and satisfaction with living in the area. Under any risk future, at least 50 percent of the respondents stated that their community would have a less desirable future once the repository is in operation than they currently foresee their community without the project.

In addition to possible impacts to quality of life and well-being, the analysis also addressed impacts in terms of behavioral intentions. These behaviors included changes in mobility decisions (intentions to move), decisions to invest in Southern Nevada, and in changes in propensity for political participation/ activism over the repository.

Current behavioral intentions show that around 30 percent of the population would definitely or probably move within 5 years. Under a moderate risk scenario and a high risk scenario, a greater percentage of persons would likely move, 45 percent and 56 percent, respectively. Residents indicated that they would more likely move out of Southern Nevada or the state under increasingly risky futures.

The survey also shows substantial changes in investment intentions under repository risk futures. Compared to pre-scenario intentions to invest, where 36 percent of the population would probably not invest over the next five years, 46 percent would likely not invest under the low risk future, 62 percent under a moderate risk future, and 68 percent would not invest under the high risk future. The survey data also indicated that political activism directed at the repository program would increase sharply under all three repository risk futures.

Although behavioral intentions cannot be used for projections of impacts, they do suggest the potential for substantial impacts to the economy and social life of the Las Vegas area with repository operations. While behavioral intentions can be questioned as to their magnitude of occurrence under real situations, the changes in expressed intended behaviors are so substantial, that the possibility exists for at least some of them to be realized under the scenario conditions. Even under a negligible risk future, the repository may produce substantial impacts as a result of changes in risk-produced socioeconomic adjustments.

7.2 Implications of the Findings

There is no question that the proposed repository is perceived as extremely negative and is associated with high perceived risk by a substantial segment of the population. The fact that these perceptions are consistent over time suggests that they are deep-rooted and will not easily shift. Information programs aimed at minimizing the risks of the repository program and accentuating the benefits will have difficulty in being accepted by Las Vegas area residents.

The repository is viewed as an extremely dangerous facility, accidents are perceived as inevitable, and the consequences may result in catastrophic impacts. Over the last few years, the negative imagery of the repository, coupled with the view that the area may become stigmatized, has amplified the perceived risks over the benefits.

Public concern over repository risks will persist unabated and will be heightened as information of federal agency mismanagement of other nuclear facilities occurs. The repository program, especially nuclear waste transportation, is particularly vulnerable to social and political amplification effects. We can expect to see greater concerns rather than lesser concerns expressed over the next few years.

The nature of the perceived risks of the repository program are such that proposed safety and mitigation programs may not directly lessen the high levels of existing perceived risk. Traditional industrial siting policies of negotiation and mitigation may not easily work with respect to the repository. A large segment of the population continues to find the risks unacceptable, no matter what the level of compensation. A large percentage of the Clark County population stated that accidents will occur, that these accidents may have catastrophic consequences, and that the government cannot prevent their occurrence. As a result of these predispositions, we can anticipate greater political involvement/activism on the part of Clark County residents as long as the lack of confidence in federal government capabilities in managing nuclear safety continues at its current level.

The fact that the transportation of nuclear waste has surfaced as a particularly critical concern among Las Vegas area residents amplifies the perceived risks of the repository program. The possible emergence of transportation issues in corridor states will only have the effect of accentuating this issue locally. Even small events in the transportation of nuclear materials is likely to trigger heightened expressions of concern and possible behavioral changes.

The Nevada Test Site has been used by some as an argument to suggest that, like the NTS, the repository will be accepted in time. The data, however, suggest that this will not be the case. The NTS is viewed by many residents as having caused serious health impacts in the Las Vegas area from past weapons testing and is considered to be one of the least acceptable facilities. However, while the population generally has not personalized the health risks of the NTS, they have done so with the proposed repository. A substantial percentage of the urban residents feel that they personally will be harmed by the repository and by the transportation of nuclear waste. This suggests that the two facilities are not necessarily comparable, and that public response and concerns over the repository may be quite different from that of the NTS.

There is some likelihood that if the repository begins to be built, major behavioral shifts will occur in the area. The fear of potential accidents and the possible stigmatization of the area may result in outmigration and declines in local investments. Where problems surface in the repository program, these adjustments are likely to be substantial and create instability in the socioeconomic environment for some time. There is every indication that the future with a repository is perceived by most urban residents as a future with a lessened quality of life and a seriously reduced level of life satisfaction. Ultimately, the loss of optimism about the future quality of community life may result in the most serious and irreversible socioeconomic impacts.

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