7 Perceived Risk and Attitudes Toward Nuclear Wastes: National and Nevada Perspectives

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Risk Perceptions

Introduction

Fundamental to a sound understanding of people's viewpoints toward a high-level nuclear waste repository (HLNWR) is an understanding of their perceptions of the risks associated with such a facility. Perceptions, representing sensory experiences that have become recognized or that have gained meaning, stand between simple, reflexive responses and complex behavior. As such, they are *at* the foundation of, if not themselves *the* foundation of, beliefs, values, opinions, attitudes, and behaviors—all the human responses relevant to the siting of a repository. The principal focus of this chapter is on risk perceptions associated with a HLNWR: their seriousness, their most important characteristics, how they are conditioned by institutional factors and personal characteristics, and their acceptability.

The goal of the research presented here is not only to deepen our understanding of perceptions associated with complex, risky technologies such as waste repositories but also to provide useful input for public policy decisions. Research such as this, representing a conjuncture between basic and applied goals, presents unusual challenges in research design. On the one hand is the need to address fundamental processes so that findings are robust and generalizable to a wide variety of settings. On the other is the need to take into account the unique history and other special features of the repository setting because these factors, doubtless, influence perceptions of repository risks, too.

Preliminary Activities

The approach taken to address the two design challenges of this research comprised three complementary activities: (1) development of an inventory

of concerns; (2) focus group sessions; and (3) implementation of a survey. As a first step toward taking into account the historical and political context of the repository siting, we developed an inventory of concerns. The inventory was developed by closely monitoring the popular press, other news media, and public comments on the repository. As a second step, focus group sessions were held with groups in three locales expected to be impacted by the repository. The results from the focus groups were combined with the step one inventory concerns in order to develop the instrument for the survey. The crafting of the first two steps' combined results into the survey instrument ensured that the surveys would not overlook important issues and that the survey questions would be understandable to respondents. Before implementation, the survey instrument also took into account the cumulative body of research on risk perceptions (Fischhoff et al., 1981; Slovic, Fischhoff, and Lichtenstein, 1985; Slovic, 1987), thereby ensuring consideration of fundamental features of risk perception. Finally, two telephone surveys, one in the state of Nevada and one national (excluding Nevada), were implemented. (A more detailed discussion of these procedures can be found in Desvousges, Kunreuther, and Slovic, 1987).

Conceptual Framework

The risk surveys involve complex conceptual and empirical issues. In part, this complexity stems from their defiance of traditional boundaries of scientific inquiry. Sociological, psychological, and economic factors interact in ways that are only vaguely understood. Further confounding those interactions are the influences of social and political institutions. To organize systematically the variety of issues to be included in the complex analysis, we developed a conceptual framework, presented as Figure 7-1.

The conceptual framework builds upon the cumulative findings in risk perception, decision processes, and policy analysis pertaining to the siting of noxious or risky facilities. It also incorporates key economic, social, and political factors presumed, on the basis of cumulative evidence, to influence risk decisions. Finally, it includes siting-specific variables, such as previous experience with nuclear facilities and the proximity of residence to the repository. The framework, in brief, argues that perceived risk of a high-level nuclear waste repository is a function of: knowledge of repository issues and previous experience with nuclear issues; a variety of attitudes; subjective characteristics of the repository risk; and background and other individual characteristics. Of particular importance among the attitudes is trust in the federal government, the political body responsible for siting and managing the repository. The subjective risk characteristics, derived from the established taxonomy in the psychometric research tradition, include

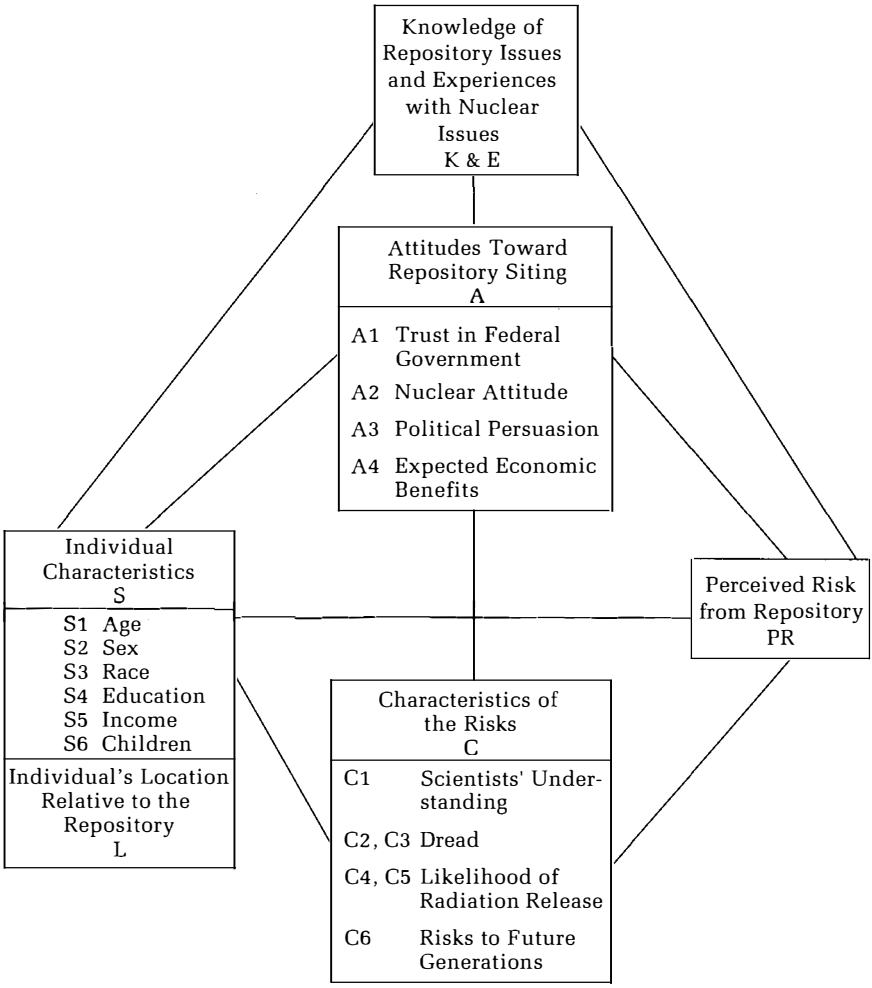

Figure 7-1 Conceptual framework of risk perceptions.

the factors of dread, controllability, scientific understanding, and risks to future generations. The individual characteristics consist mostly of socio-economic background variables. While this outline suffices to introduce the framework, its operational translation into specific variables for modelling purposes is explicated more fully in a later section.

The remainder of this chapter is devoted to the results of the two telephone surveys conducted in 1987. To our knowledge this was the first attempt to assess perceptions of technological or environmental risks among a large sample of respondents across the entire United States (the national

survey reported in chapter 3 occurred later). The surveys, therefore, moved risk perception research from the laboratory to "real" risk situations. The results demonstrate the usefulness of survey techniques in obtaining risk perception data. They also permit an assessment of the external validity of previous psychometric findings, almost all of which have been from data collected on small subpopulations, such as students. And, of course, they shed light on the factors shaping perceptions and attitudes toward the siting of a high-level nuclear waste repository.

Data Collection

Two telephone surveys, one of Nevada households with telephones and one of households with telephones within the continental United States but excluding Nevada, provide the data for this study. The samples were drawn from the target populations by using standard random digit dialing techniques.

The questionnaires for the survey evolved as one part of the state of Nevada's socioeconomic impact assessment. As described above and in Kunreuther, Desvousges, and Slovic (1988), the questionnaire development process included focus groups, reviews by various researchers on the impact assessment team, and survey experts who were not associated with the project. After coordinated training sessions, survey groups at the Gordon Black Corporation (national sample) and the University of Nevada-Las Vegas (Nevada sample) conducted the surveys in March and April of 1987.

For the Nevada survey, 5954 telephone numbers were included in the initial sample. Of these, 3887 were residential numbers in service. No contact was made with the target respondent for 1173 (30.2 percent) of these residential numbers, either because of continual busy signals or because, in spite of repeated attempts, the telephone was not answered. Of the 2676 households in which an eligible respondent was reached, 1001 (37.4 percent) provided complete interviews. For the national survey, of the 3419 telephone numbers at which a potential respondent was reached, 1201 (35.1 percent) yielded completed interviews.

Because of the low response rates, our findings must be viewed with caution. Some scholars may object that these response rates are too low to provide useful results. We disagree on various grounds and believe the data do provide insight into the nature of perceptions and attitudes toward the repository. For example, opposition to the repository was so high and widespread, often reaching 80 percent, that populations from which samples are drawn can be assumed to be fairly homogeneous. With homogeneous populations, nearly any sample will be somewhat representative of the parent population. Furthermore, because results from the two separate samples,

Nevada and national, reported in this chapter are so similar, there is lessened concern about nonresponse bias.[1] Despite our position that the results are meaningful, caution is still warranted. In particular, our findings should not be used to guide policy decisions on nuclear waste without considering additional confirmatory evidence, such as that in the other chapters of this volume. Fortunately, as will become apparent, our results are very compatible with those reported in the other chapters, increasing our faith in their validity.

Comparative Perceptions

Seriousness of Pollution Sources

Peoples' perceptions about the risks posed by a HLNWR are related to their attitudes toward nuclear waste. Since there are no absolute standards against which to compare these attitudes, they can best be interpreted in a comparative context. Our surveys asked respondents to rate the pollution problems from a variety of sources, including radioactive wastes from nuclear power plants, on a scale of 1 to 10, with 1 being "not at all serious" and 10 being "very serious." This comparative question preceded any introduction or mention of nuclear wastes in the questionnaires. This procedure was followed to ensure that respondents' ratings were not clouded by a context of nuclear waste information and problems. The results are presented in Table 7-1.

For ease of comparison, mean scores (simple averages) were computed for each pollution source by sample. These results are at the bottom of Table 7-1. For the national sample, water pollution from toxic chemicals, not radioactive wastes from nuclear power plants, had the highest average seriousness rating. National respondents, on average, assigned a seriousness rating of 7.9 to water pollution and 7.4 to radioactive wastes. The average rating for air pollution from cars and factories, the third highest in the sample, was 7.1. Garbage from landfills had the least serious average rating, 6.1.

For the Nevada sample, air pollution received the highest average seriousness rating. Nevadans assigned an average rating of 7.9 to air pollution from cars and factories. Such high ratings for air pollution problems may reflect population clustering in Clark County (Las Vegas) and residents' concerns about air pollution in that area. The rapid increase in population growth, the corresponding increase in motor vehicles, and climatic conditions have all contributed to the air pollution problem in Las Vegas. Nevadans rated water pollution as the second most serious pollution source, with an average rating of 7.8, and garbage from landfills the lowest, with a rating of 5.4. They rated radioactive wastes from power plants an average 6.9—a full

Table 7-1 Frequency Distribution of Seriousness of Various Sources of Pollution: National Sample vs. Nevada Sample (percent)

How Seriously Rated	Sources of Pollution											
	Garbage from Landfills		Air Pollution from Cars and Factories		Radioactive Wastes from Nuclear Power Plants		Water Pollution from Toxic Chemicals		Acid Rain from Power Plants		Radiation from Nuclear Weapons Testing[a]	
	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada
Not at all serious												
1	3.6	6.4	2.1	1.0	5.2	8.4	1.6	1.7	4.0	3.8	NA	11.4
2	3.6	6.7	2.0	1.6	4.5	7.9	1.5	1.7	2.4	4.4	NA	10.3
3	8.0	11.4	3.3	1.6	5.5	5.1	2.2	3.3	4.8	5.3	NA	7.4
4	8.4	9.7	4.1	2.2	4.9	5.1	2.6	4.0	4.8	5.2	NA	7.2
5	23.8	25.4	12.8	8.1	9.2	9.2	6.9	9.8	14.3	14.7	NA	11.3
6	10.8	8.8	10.3	7.2	3.4	4.6	7.9	6.3	10.3	7.6	NA	4.5
7	11.2	9.3	18.8	13.2	6.0	7.1	12.5	10.8	10.9	9.7	NA	4.5
8	12.5	10.8	19.1	23.6	10.3	8.5	17.9	17.2	16.9	15.6	NA	7.6
9	4.9	2.6	9.8	10.9	8.8	5.7	11.5	7.7	10.0	6.9	NA	5.0
10	13.3	9.0	17.8	30.5	42.3	38.5	35.4	37.5	21.5	26.9	NA	30.8
Very serious												
Average rating	6.1	5.4	7.1	7.9	7.4	6.9	7.9	7.8	6.9	6.9	NA	6.1

Actual Survey Question: "I'm going to read a list of several sources of pollution. On a scale from 1 to 10, with 1 meaning 'not at all serious' and 10 'very serious,' please tell me how serious a problem you think each source of pollution is for the United States as a whole."

[a] Respondents in the national sample were not asked to rate the seriousness of radiation from nuclear weapons testing.

scale point below the average for their most serious concern, air pollution. Radiation from nuclear weapons testing was also included as a pollution source on the Nevada questionnaire and received a seriousness rating of 6.1, second lowest of the six pollution sources rated.

Another way of comparing the seriousness of the pollution sources is to examine the percentage of respondents who assign each source the highest rating—a 10 rating—meaning "very serious." For both samples, water pollution and radioactive wastes from nuclear power plants were regarded as the most serious problems. More than 42 percent of national respondents and 38 percent of Nevada respondents assigned the highest seriousness rating to radioactive wastes from nuclear power plants. Water pollution was considered "very serious" by 35 percent of the national and 37 percent of the Nevada respondents.

Nevadans assigned somewhat lower ratings to radioactive wastes than did respondents in the national sample. Increased familiarity among residents of Nevada with radioactive materials may explain this difference. As hosts to the nation's nuclear weapons testing facility, Nevada residents are likely more knowledgeable about radioactive materials and the risks they pose than is the general population. As will be demonstrated in a later section of this chapter, increased knowledge about a risk can result in lower risk perceptions.

Salience and Knowledge of HLNWR Issues

Previous research has shown that risk perceptions and attitudes are related to levels of awareness and knowledge (see, for example, Slovic, 1987). Figure 7-2 provides an assessment of salience by comparing the level of awareness about nuclear wastes between the two samples. As seen in Figure 7-2, twice the numbers in the Nevada sample (35 percent) recalled having read or heard about high-level nuclear wastes more than ten times in the three months before the survey as in the national sample (17 percent). Location of the nuclear weapons testing facility in Nevada and the state's nomination as a possible site for the HLNWR no doubt increased residents' cognizance of nuclear issues. It is not surprising, therefore, that nuclear waste was a more salient issue for Nevada residents than for the nation as a whole.

The surveys also asked how respondents obtained information about high-level nuclear waste issues. Of the respondents who had read or heard about wastes during the previous three months, more than 58 percent in the Nevada sample and almost 49 percent in the national sample had bought a newspaper or magazine or watched a television program specifically to learn about high-level nuclear wastes. Even higher percentages of respondents

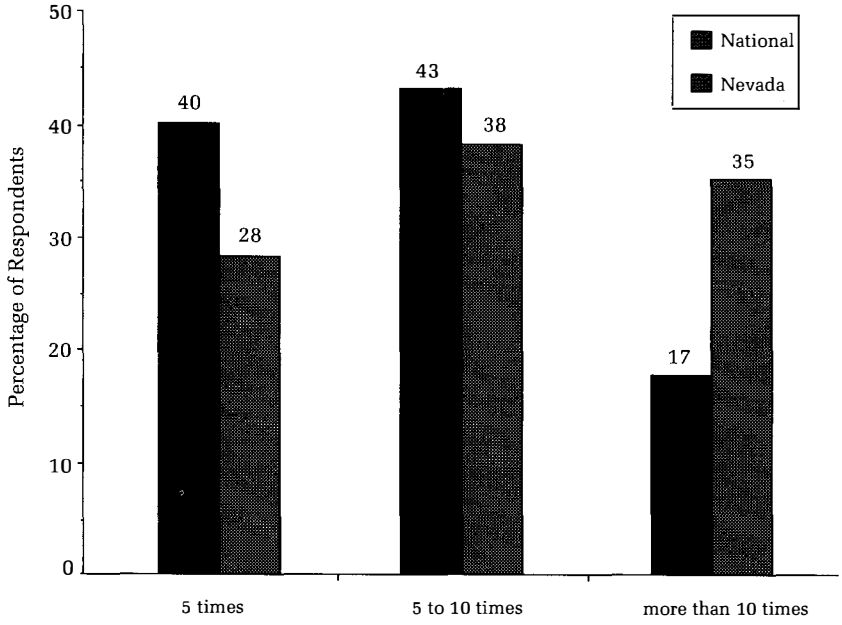

Figure 7-2 Number of times read or heard about high-level nuclear wastes in past three months.

who indicated awareness about high-level nuclear wastes had discussed the issues with friends or relatives.

Relatively few respondents attended public meetings to obtain information. Less than 10 percent of the respondents in either the Nevada or the national sample had attended a public or neighborhood meeting about high-level nuclear wastes. This finding underscores research by Regan, Desvousges, and Creighton (1990) that indicates that public meetings alone are not an effective way to communicate information.

Our expectation that salience of HLNWR issues would lead to higher levels of knowledge was not borne out by the data. We developed three factual questions that addressed important aspects of high-level nuclear waste disposal. Far fewer respondents answered at least two of these questions correctly than might be expected from the previous results showing high levels of awareness. The first of the three questions asked: "Do you think most of the high-level wastes are now stored (a) at the power plants that produced them, (b) at regional processing centers, (c) at one temporary storage site, or (d) don't know?" Only about 20 percent of each sample answered correctly

that most high-level wastes are now stored at the power plants that produced them. Far more consistent with expectation was that strong majorities knew that underground disposal is the method being considered seriously in the United States today: 75 percent of the Nevada sample and 64 percent of the national sample. When asked about the length of time for storing high-level nuclear wastes, respondents again demonstrated only meager knowledge; only 27 percent of the Nevada sample and 18 percent of the national sample knew that the repository would store wastes for longer than 1000 years.

General Attitudes Toward the Repository

To capture respondents' overall viewpoints toward the repository, the survey questionnaires asked a wide range of questions assessing attitudes about the repository, its potential benefits and costs, and the equity of developing only a single repository. Answers to these survey questions are summarized in Table 7-2.

Respondents were asked to indicate the extent to which they agreed or disagreed with each of the listed statements. The responses produced an interesting picture of the respondents' views about the repository; highlights of that picture follow:

—Sizable proportions of both the national (48 percent) and Nevada (53 percent) samples agreed or strongly agreed that a repository was the best way to store high-level nuclear wastes. The proportions among only those expressing an opinion was even stronger: 55 percent of the national sample and 68 percent of the Nevada sample strongly agreed or agreed.

—Sizeable proportions, too, strongly agreed or agreed that each region of the country should have a repository: 46 percent of the national sample and 56 percent of the Nevada sample.

—A noticeably small proportion (23 percent) of Nevada residents thought that Nevada was the safest place in the United States for the repository.

—Only about 30 percent of Nevada residents thought that Nevada was the best site for a repository because the weapons testing site was in Nevada.

—The two samples were sharply divided in expectations about the economic growth in nearby communities: only 27 percent of the national sample strongly agreed or agreed that such economic growth would be stimulated, whereas nearly half of the Nevada sample did.

—Few national respondents (25 percent) and few Nevada respondents

Table 7-2 Respondent's Overall Attitudes Toward the Repository: National Sample vs. Nevada Sample (percent)

	Repository Is Best Storage Method[1]		Each Region Should Have a Repository[2]		Nevada Is Safest Place[3]		Nevada Is Best Place[4]		Repository Stimulates Economic Growth[5]		Economic Benefits Outweigh Costs[6]	
Attitude	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada
Strongly agree	8.8	7.4	12.0	16.3	NA	2.9	NA	3.6	3.3	6.2	2.4	3.6
Agree	39.8	45.5	33.9	39.8	NA	20.5	NA	27.0	23.6	38.8	22.7	24.5
Disagree	18.8	19.5	32.1	30.4	NA	40.8	NA	42.3	48.1	40.2	49.0	49.1
Strongly disagree	7.8	4.8	17.2	8.5	NA	22.1	NA	20.0	17.0	6.7	19.2	14.6
Don't know	24.2	22.3	4.7	4.4	NA	12.9	NA	6.5	8.0	7.5	6.5	7.8

Actual Survey Questions:

[1] A repository is the best way to permanently secure high-level nuclear wastes.

[2] Each region of the country should have a repository.

[3] Nevada is the safest place in the United States for a repository. (Respondents in the national sample were not asked this question.)

[4] Nevada is the best place for the repository because the nuclear weapons test site is already here. (Respondents in the national sample were not asked this question.)

[5] A repository would stimulate economic growth in nearby communities.

[6] The economic benefits to nearby communities from a repository would greatly outweigh the risks.

(28 percent) thought that the economic benefits would greatly outweigh repository risks.

Despite majority agreement that a repository was the best storage method, the overall evaluation of the HLNWR was rather negative. National respondents assessed the repository as a bad economic deal; they did not think it would stimulate growth in nearby communities or yield benefits in excess of the risks. Nevada survey respondents seemed unconvinced that their state was the safest place for the HLNWR and seemed somewhat more optimistic about its economic potential, but not to the extent that such potential would outweigh the risks.

Perceived Seriousness of Risks

Previous studies of perceived risks have shown that risk perceptions can be measured using quantitative methods (Slovic, 1987; Fischhoff et al., 1981; and Slovic, Fischhoff, and Lichtenstein, 1985). These studies have produced cognitive maps of risk attitudes and perceptions, which show perceptions to be influenced by two main factors: dread risk and unknown risk. Nuclear power and nuclear waste risks rated highly on both the dread and unknown dimensions. Although these studies have not been based on national samples or other general population samples, they suggest high levels of perceived seriousness for the risks from a HLNWR.[2]

Survey respondents were asked to rate the perceived seriousness of seven risks they personally face each year. Included on the list were several nuclear risks as well as such common risks as "an accident at home." The ratings were made on a scale from 1 to 10, with 1 being "not at all serious" and 10 being "very serious". Table 7-3 shows the results for both the Nevada and national samples. Nevada residents rated the risks for a repository that would be located at Yucca Mountain, while national respondents rated risks from a repository that would be located 100 miles from their homes. Generally, Nevada residents ranked all the health and safety risks slightly lower than did the national respondents.

With an average rating of 6.2, national respondents perceived the potential risks from a high-level waste repository as more serious than any of the other risks included in the survey. Perceived risks from exposure to hazardous chemicals from abandoned landfills had the second highest average rating for the national sample, at 5.8, followed by nuclear power risks, at 5.2. Accidents at home (4.3) and at work (3.9) received the lowest average ratings in the national sample.

In addition to rating the same risks posed to national respondents, Ne-

Table 7-3 Frequency Distribution of Seriousness of Various Health and Safety Risks: National Sample vs. Nevada Sample (percent)

How Seriously Rated	Sources of Risk													
	Accident at Home		Accident on the Job		Nuclear Power Plant		Exposure to Hazardous Chemicals from Abandoned Landfill		High-Level Nuclear Waste Repository[1,2]		Nuclear Weapons Testing Site[3]		Transport of High-Level Nuclear Wastes[4]	
	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada
Not at all serious														
1	13.6	20.4	16.7	23.9	16.2	33.2	10.8	20.9	7.8	17.1	NA	25.4	NA	14.2
2	16.0	15.8	13.4	12.3	11.2	11.8	8.4	8.8	7.6	9.4	NA	10.9	NA	8.5
3	15.3	14.8	11.9	11.3	10.0	7.0	8.9	7.9	6.9	8.1	NA	8.3	NA	7.3
4	9.6	7.4	8.2	8.9	7.7	5.8	7.0	6.5	7.5	3.7	NA	5.8	NA	4.9
5	21.6	19.9	18.4	18.2	13.5	10.1	13.5	12.5	13.8	13.1	NA	13.2	NA	12.3
6	5.4	6.0	8.5	5.3	5.2	3.6	6.7	5.1	6.4	5.6	NA	4.6	NA	7.8
7	5.5	4.3	7.8	5.6	6.2	4.3	8.7	6.9	10.4	5.9	NA	8.8	NA	5.6
8	5.0	5.5	6.8	6.7	8.3	6.3	10.3	9.3	12.7	9.5	NA	4.7	NA	10.1
9	3.2	1.0	3.2	2.9	3.9	2.3	6.3	4.1	7.5	4.8	NA	2.5	NA	5.2
10	4.9	4.8	5.1	4.9	17.8	15.5	19.4	17.9	19.3	22.8	NA	15.8	NA	24.1
Very serious														
Average rating	4.3	3.9	3.9	3.6	5.2	4.3	5.8	5.2	6.2	5.6	NA	4.7	NA	5.9

Actual Survey Question: "On a scale from 1 to 10, with 1 being 'not at all serious' and 10 being 'very serious,' how serious are the risks you personally face each year from . . ."

[1] Respondents in the national sample were asked about the risks from a high-level repository if it were located 100 miles from their homes.

[2] Respondents in the Nevada sample were asked about the risks from a high-level repository if it were located at Yucca Mountai which for most residents of Nevada, is approximately 100 miles from their homes.

[3] Respondents in the national sample were not asked about the risks from a nuclear weapons testing site.

[4] Respondents in the national sample were not asked about the risks from the transportation of high-level nuclear wastes.

vadans were asked to rate the seriousness of risks from transporting wastes to Yucca Mountain and from testing nuclear weapons. The average rating of the transportation risks, 5.9, was the highest, followed closely by risks from the repository itself, at 5.6. The other nuclear activities were perceived as somewhat less serious, with the average rating for weapons testing at 4.7 and the rating for nuclear power plants at 4.3. Accidents at home (3.9) and on the job (3.6) also received the lowest average ratings from the Nevada sample.

Overall, on a comparative basis, responses from both the national and Nevada samples perceived a HLNWR as posing fairly high levels of risk. Interestingly, Nevada respondents viewed transporting radioactive wastes to the repository as even more of a risk than the repository itself.

Risk Characteristics

Complex technologies, such as nuclear waste repositories, are multidimensional and comprise a variety of risk characteristics. Assessing the various characteristics associated with repository risks is, therefore, an important step toward understanding risk perceptions and their cognitive mappings. To assess key risk characteristics, the survey included questions on six characteristics that have proven important in previous psychometric studies of risk perception (Slovic, 1987; Slovic, Fischhoff, and Lichtenstein, 1985):

—Accidents at the repository would involve certain death.
—Accidents at the repository would be catastrophic—they would kill many people at one time.
—Scientists understand the risks of repositories.
—People living near the repository could control the risks.
—People would dread living near the repository.
—Repositories pose a serious risk for future generations.

Results from both surveys, national and Nevada, indicate that perceptions of the risks associated with the HLNWR were consistent with previous studies. These results are presented in Table 7-4.

Dread, typically a pivotal factor in risk perceptions, appears to have had a significant role in the formation of perceptions about the repository. Roughly 80 percent of the respondents in both samples either agreed or strongly agreed that people would dread living near the repository. More than 70 percent of both samples thought that an accident at the repository would involve certain death. Moreover, 80 percent of both samples thought that an accident would be catastrophic.

The unknown dimension, frequently emerging as an important factor

Table 7-4 Perceived Risk Characteristics: National Sample vs. Nevada Sample (percent)

	Risk											
	Accident Would Involve Certain Death		Accident Would Kill Many People at One Time		Scientists Understand the Risks		People Living Near the Repository Could Control the Risks		People Would Dread Living Near the Repository		Repository Poses a Serious Risk for Future Generations	
Attitude	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada
Strongly agree	24.3	24.3	28.7	26.8	13.2	9.0	1.5	1.0	24.9	21.2	32.7	27.6
Agree	49.6	51.6	53.9	54.3	50.3	49.8	8.4	12.0	55.7	56.8	47.9	43.1
Disagree	23.4	21.1	15.7	16.2	29.1	34.0	61.3	65.8	17.4	20.5	16.5	26.0
Strongly disagree	2.7	3.1	1.7	2.8	7.5	7.2	27.8	21.2	2.0	1.6	2.9	3.3

Actual Survey Question: "I am now going to read some statements about the risks from a high-level nuclear waste repository in the United States. Please tell me the extent to which you agree with each."

in previous research, also figured into risk perceptions about the HLNWR. Roughly 37 percent of the national respondents and 41 percent of the Nevada respondents either disagreed or strongly disagreed that scientists understand the risks involved with a repository. Thus, the unknown nature of repository risks also appeared important to respondents but somewhat less strongly than in previous research.

The surveys also clearly indicate that respondents doubted that people who live near the repository could control its risks. Nearly 90 percent of all respondents either disagreed or strongly disagreed with the statement that local people could control the risks. In the focus group sessions that preceded the actual surveys, we found that people had difficulty articulating their concerns about technological control. Since the surveys contained only one question about control, this may not have provided an adequate opportunity for respondents to express their opinions. We suggest that future research efforts explore the dimensions of local control more fully.

Because the wastes in the repository would be stored for very long periods of time, perhaps thousands of years, concern for future generations seems particularly relevant. Such concern was evident in both samples: roughly 70 percent of the Nevada sample and 80 percent of the national sample agreed or strongly agreed that the repository would pose a serious risk for future generations.

The likelihood of accidental large releases of radiation from the repository is another important dimension of perceived risk. Both survey instruments queried respondents about the likelihood of large releases of radiation during the first five or twenty years that the repository would be open (different time periods were randomly assigned to respondents). Respondents were asked to indicate the likelihood of large releases due to each of four causes: an accident at the repository, leakage into ground water, a transportation accident, and terrorist sabotage. Our results were unaffected by the time period, with radiation releases perceived to be just as likely in the first five years as in the first twenty years.

As shown in Table 7-5, a majority of respondents in both samples thought that a large radiation release from any of these sources was somewhat or very likely. The two sources of radiation releases considered to be most likely by both samples were transportation accidents and contamination of underground water. For the national sample, almost 80 percent of respondents thought releases due to transportation accidents were somewhat or very likely, and almost 75 percent thought the same about groundwater leaks. The results for the Nevada sample are identical. Taken together, the results show remarkably high expectations for accidental releases of large amounts

Table 7-5 Perceived Likelihood of Large Accidental Releases of Radiation from Repository: National Sample vs. Nevada Sample (percent)

	Event							
	Accident at the Repository		Repository Wastes Leaking into Groundwater		Wastes Being Transported to Repository		Terrorist Sabotage	
Attitude	Nation	Nevada	Nation	Nevada	Nation	Nevada	Nation	Nevada
Very likely	21.5	23.7	35.7	39.3	31.3	35.7	25.2	24.5
Somewhat likely	41.1	38.0	39.1	34.8	47.0	44.5	33.3	33.0
Somewhat unlikely	23.9	23.6	16.8	15.6	15.5	14.2	24.6	27.5
Very unlikely	13.6	14.6	8.4	10.3	6.2	5.6	16.8	15.1

Actual Survey Question: "The federal government is planning to make the repository as safe as possible. But there is always some chance that radiation could be released. I'm going to read a list of various ways that a large amount of radiation could be released into the environment from a repository. I'd like you to think about how likely or unlikely each might be. During the first (5 or 20) years a repository would be open, how likely do you think it is that a large amount of radiation could be released from . . ."

of radiation. Indeed, these perceived likelihoods are orders of magnitude greater than estimates provided by technical experts (Peters, 1983).

Risk Perception Models

To evaluate the framework of perceptions and attitudes of risks associated with the HLNWR presented in the introduction, we translated the framework into mathematical models. The aim of the models is to predict perceived risks. The models operationalize the framework's principal concepts into variables that are postulated to be related according to the equation:

$$PR = f(A, K, C, E, L, S)$$

where,

PR = perceived risk from the repository

A = individual's attitudes toward repository siting (and probably nuclear-related issues in general)

K = knowledge about the repository issues

C = characteristics of the risk

E = experiences associated with repository or nuclear issues

L = individual's location relative to the repository
S = individual's socioeconomic characteristics

We used this scheme as the basis for a series of regression models to estimate respondents' perceived seriousness of the risks associated with the HLNWR. This modelling is a first step in beginning to understand the formation of risk perceptions about a repository. Identical models are presented for both the national and the Nevada samples. The models predict the respondent's perceived seriousness of the risks associated with the repository as expressed on a ten-point scale, with 10 as the "most serious" and 1 as the "least serious" rating. The wording of the question eliciting perceived seriousness of the repository and the distribution of ratings, as discussed above, are presented in Table 7-3.

The reported coefficients for the continuous variables are standardized and represent the change in the standard deviation of the scale point rating of perceived risk that results from a one standard deviation change in the independent variable, all other things being equal. Coefficients for qualitative explanatory variables, however, cannot be expressed in this manner and are left unstandardized. These variables either have a value of 0 or 1, which makes it meaningless to standardize their coefficients. Since risk perception is expressed on a scale with the endpoints limited at 1 and 10, two-limit tobit models are the appropriate form for estimation. The tobit procedure, however, produced results very similar to ordinary least squares. We have chosen to present ordinary least squares models because of widespread familiarity with the technique and ease of interpretation.

The variables used in the regression models are defined in Table 7-6. These variables are related to the conceptual framework in Figure 7-1 and Table 7-7, but we need to note a few discrepancies between our conceptual framework and the regression models. In particular, two of the conceptual models' variables are omitted from the regression models. As a consequence, the regression results are tests of a slightly abbreviated model. For the models predicting perceived seriousness of repository risks, there is no variable to correspond with L, the individual's location relative to the repository. This was due to the fact that all respondents were asked to consider that the repository would be located at either Yucca Mountain (Nevada survey) or, equivalently, 100 miles from their homes (national survey). In a subsequent model of voting behavior, we did consider residence in either of two counties closest to the proposed repository site. None of the regression variables corresponds to E, experiences associated with repository or nuclear issues. While it would have been difficult to include experiences with a high-level repository, since no such repositories currently exist, our analysis could

Table 7-6 Description of Variables

Variable	Description
Perceived risk from HLNW repository	A variable that indicates the seriousness of respondent's perceived risk from the location of a HLNW repository near his or her home. (In the national survey, respondents were told that the repository would be located 100 miles from their home. In Nevada, the repository would be located at Yucca Mountain, which is approximately 100 miles from the most populous center of the state.) Response is expressed on a scale of 1 to 10, with 1 being "not at all serious" and 10 being "very serious." In the risk perception models, this is the dependent variable.
Knowledge of HLNW	A scalar variable with values ranging from 0 to 3 that indicates how many of the following questions the respondent answered correctly: —"Do you think most of the high-level wastes are now stored . . . a. at the power plants that produced them, b. at regional processing centers, c. at one temporary storage site, or d. don't know?" —"Which method for disposing of high-level nuclear wastes is the option being considered most seriously in the United States today? a. putting the wastes on the ocean floor b. burying them deep underground c. shooting them into space, or d. don't know?" —"Do you think the high-level nuclear waste repository will be designed to store wastes for . . . a. 1 to 10 years, b. 10 to 100 years, c. 100 to 1000 years, d. longer than 1000 years, or e. don't know?"
Trust in federal government	A variable that the level of trust that the respondent places in federal government officials to make the HLNW as safe as possible. Response is expressed on a scale from 1 to 10, with 1 meaning "no trust" and 10 meaning "complete trust."
Scientists understand risks	A dummy variable that indicates respondent's agreement with the following statement: "Scientists adequately understand the risks from a repository." 1 = strongly agree 0 = all other responses

Table 7-6 *Continued*

Variable	Description
Moderate amount of dread	A dummy variable created to measure respondent's dread of living near a HLNW repository. 1 = strongly agreed with 1 or 2 of the following statements 0 = did not strongly agree with any of the following statements "An accident at a repository usually would involve certain death." "An accident at a repository would kill many people." "People would dread living near a repository."
High amount of dread	A dummy variable created to measure respondent's dread of living near a HLNW repository. 1 = strongly agreed with 3 of the following statements 0 = did not strongly agree with 3 of the following statements "An accident at a repository usually would involve certain death." "An accident at a repository would kill many people." "People would dread living near a repository."
Moderate likelihood	A dummy variable created to measure how likely respondent considered large accidental releases of radiation from certain sources associated with a repository. 1 = respondent thought that 1 or 2 of the following radiation sources would very likely release large amounts of radiation 0 = respondent did not think that any of the following radiation sources would very likely release large amounts of radiation "An accident happening at a repository." "The wastes leaking into underground water." "The wastes being transported to a repository." "Terrorist sabotage at a repository."
High likelihood	A dummy variable created to measure how likely respondent considered large accidental releases of radiation from certain sources associated with a repository. 1 = respondent thought that 3 or 4 of the following radiation sources would very likely release large amounts of radiation 0 = respondent did not think that 3 or 4 of the following radiation sources would very likely release large amounts of radiation "An accident happening at a repository." "The wastes leaking into underground water." "The wastes being transported to a repository." "Terrorist sabotage at a repository."
Future risk	A dummy variable that indicates whether or not respondent strongly agrees with the statement: "A repository would pose serious risks for future generations in Nevada."

Table 7-6 *Continued*

Variable	Description
	1 = strongly agree 0 = all other responses
Nuclear attitude	A dummy variable that indicates whether or not respondent is in favor of nuclear power. 1 = does not favor nuclear power 0 = favors nuclear power
Liberal	A dummy variable that reports respondent's self-described political persuasion. 1 = very liberal or somewhat liberal 0 = all other responses
Economic benefits	A scalar variable that indicates how many of the following statements the respondent strongly agreed with: "A repository would stimulate economic growth in nearby communities." "The economic benefits to nearby communities from a repository would greatly outweigh the risks."
Age	A variable that reports the midpoint of respondent's self-reported age grouping.
Sex	A dummy variable that indicates respondent's sex. 1 = male 0 = female
Race	A dummy variable that indicates respondent's race. 1 = nonwhite 0 = white
Children	A variable that reports the number of children in the respondent's household under age 12.
Income	A variable that reports midpoint of respondent's self-reported income grouping.
Education	A variable that reports the approximate number of years of education completed by respondent.
Development view	A dummy variable that indicates that respondent either strongly agreed or agreed with both of the following statements: "People have the right to change the environment to meet their needs." "There are no limits to growth for advanced countries like the United States." 1 = strongly agreed or agreed with both statements 0 = all other responses

Table 7-6 Continued

Variable	Description
Lincoln	A dummy variable that indicates whether or not Nevada respondent is a resident of Lincoln County. 1 = resident 0 = nonresident
Nye	A dummy variable that indicates whether or not Nevada respondent is a resident of Nye County. 1 = resident 0 = nonresident
Vote	A dummy variable that indicates whether or not respondent would vote for a repository to be located at Yucca Mountain. In one voting model, "vote" is the dependent variable.
Vote with grant	A dummy variable that indicates whether or not respondent would vote for a repository to be located at Yucca Mountain if his or her community would receive a large grant for improved public services as compensation for the repository's location. In one voting model, "vote with grant" is the dependent variable.

have included a measure of familiarity with other nuclear issues. This is an area that merits further consideration in subsequent studies. The focus group results suggest that experience is likely to be an important influence on risk perceptions (Desvousges and Frey, 1989), as do the results reported by Mushkatel, Nigg, and Pijawka in chapter 9.

Results from the models are presented in Table 7-8 (national sample) and Table 7-9 (Nevada sample). Both the F values for the models and the adjusted R^2 values indicate that the models are reasonably good predictors of perceived seriousness of risks associated with the HLNWR. The adjusted R^2 of 40 percent in the final Nevada model is very encouraging.

Model 1 demonstrates the contribution of the variables that represent knowledge of nuclear waste and repository issues and trust in the federal government. In both the national and Nevada models, these variables are significant and negative; increased knowledge of nuclear and repository issues and higher levels of trust in the federal government to operate the repository safely decrease the perceived risk of the repository. As more variables are added in subsequent models, knowledge and trust continue to be significant and negative, but their relative influences on risk perceptions decrease. Both trust and knowledge are potentially affected by risk communication activities related to the siting of the repository. Our results suggest that helping respondents become more knowledgeable about nuclear wastes and

Table 7-7 Relationship between Conceptual and Actual Risk Perception Models

Conceptual Risk Perception Model		Variables from Regression Models
PR	Perceived risks from repository	Risk
A	Attitudes toward repository siting	A_1 Trust federal government A_2 Nuclear attitude A_3 Liberal A_4 Economic benefits
K	Knowledge about the repository issues	Knowledge of HLNW
C	Characteristics of the risk	C_1 Scientists understand risks C_2 Moderate amount of dread C_3 High amount of dread C_4 Moderate likelihood C_5 High likelihood C_6 Future risk
E	Experiences associated with repository or nuclear issues	
L	Individual's location relative to repository	Lincoln Nye All respondents in the national sample are assumed to live within 100 miles of repository
S	Socioeconomic characteristics	S_1 Age S_2 Sex S_3 Race S_4 Education S_5 Income S_6 Children

increasing the trust in the federal government to handle wastes effectively would lead to somewhat lower perceived risks. Developing higher levels of trust would, however, require a markedly different process for siting the HLNWR, encompassing much higher levels of public involvement (Regan, Desvousges, and Creighton, 1990).

Perceived characteristics of repository risk are added to the regression in Model 2. Two dichotomous variables, *Moderate Amount of Dread* and *High Amount of Dread*, indicate the degree of dread the respondent expressed of the repository. Construction of these variables is defined in Table 7-6.[3] Their coefficients indicate how much the intercept of the regression changes if the respondent is in either the moderate dread or high dread category in-

Table 7-8 Regression Models on National Data

Dependent Variable: Perceived Risk from HLNW Repository	Model 1 Standardized Coefficients (*t*-values)	Model 2 Standardized Coefficients (*t*-values)	Model 3 Standardized Coefficients (*t*-values)	Model 4 Standardized Coefficients (*t*-values)	Model 5 Standardized Coefficients (*t*-values)
F-value	41.314	37.492	32.542	24.029	35.017
Adjusted R^2	.066	.215	.243	.284	.274
Intercept	0.000	0.000	0.000	0.000	0.000
	(39.940)	(22.713)	(20.535)	(12.491)	(13.549)
Knowledge of HLNW	***−0.133	***−0.101	***−0.110	***−0.075	***−0.075
	(−4.658)	(−3.716)	(−4.117)	(−2.687)	(−2.815)
Trust in federal government	***−0.222	***−0.085	**−0.061	**−0.060	**−0.071
	(−7.767)	(−2.958)	(−2.167)	(−2.070)	(−2.553)
Scientists understand risks [1]		**−0.551	*−0.429	−0.329	
		(−2.251)	(−1.783)	(−1.333)	
Moderate amount of dread [1]		***0.864	***0.778	***0.610	***0.636
		(4.593)	(4.195)	(3.220)	(3.528)
High amount of dread [1]		***1.283	***1.086	**0.819	**0.794
		(4.157)	(3.563)	(2.583)	(2.678)
Moderate likelihood [1]		***1.076	***1.040	***1.00	***0.946
		(5.953)	(5.863)	(5.492)	(5.381)
High likelihood [1]		***1.856	***1.771	***1.651	***1.561
		(7.652)	(7.433)	(6.554)	(6.481)
Future risk [1]		***0.946	***0.806	***0.827	***0.838
		(4.884)	(4.211)	(4.247)	(4.461)
Nuclear attitude [1]			***1.046	***0.919	***0.907
			(6.238)	(5.303)	(5.480)
Liberal [1]			0.161	0.257	
			(0.910)	(1.431)	
Economic benefits			**−0.061	**−0.058	**−0.055
			(−2.283)	(−2.129)	(−2.117)
Age				−0.032	
				(−1.196)	
Sex [1]				***−1.018	***−1.003
				(−6.227)	(−6.412)
Race [1]				***0.817	**0.726
				(2.633)	(2.461)

Table 7-8 Continued

Dependent Variable: Perceived Risk from HLNW Repository	Model 1 Standardized Coefficients (*t*-values)	Model 2 Standardized Coefficients (*t*-values)	Model 3 Standardized Coefficients (*t*-values)	Model 4 Standardized Coefficients (*t*-values)	Model 5 Standardized Coefficients (*t*-values)
Children				*0.046	
				(1.682)	
Income				0.009	
				(0.345)	
.ducation				**−0.062	**−0.057
				(−2.124)	(−2.085)

Significance levels for *t*-values using two-tailed tests: ***$p \leq .01$, **$p \leq .05$, *$p \leq .10$.

[1]Unstandardized coefficients reported.

stead of the low dread category. The coefficients for both dread variables are significant and positive for national and Nevada data in Model 2 and all subsequent models. Thus, respondents who indicated moderate or high dread of the repository had higher risk perceptions for the repository than did those who had low dread. The coefficient for the high dread group is larger than for the moderate dread group, which also conforms to expectations.

Similarly, *Moderate Likelihood* and *High Likelihood* indicate the respondents' expressions of the likelihood of large accidental releases of radiation from the repository. Both likelihood variables are also significant and positive. The strength of their contributions indicates a definite link between the perceived likelihood of radiation releases and the perceived risk of the repository.[4] The perception that the repository presents risks for future generations is also a positive and significant influence on perceived risk. We have not included future generations into the dread composite because that variable attempts to tap a different dimension of risk—the possible effects on subsequent generations. The different time dimension implied by this variable also influenced our decision to leave it as a separate variable.

In the national sample, the variable that measures respondents' belief that scientists understand the risks associated with a HLNWR (*Scientists Understand the Risks*) is negative and significant in Model 2 but becomes insignificant in other models when additional variables are introduced. This variable is negative but insignificant in all the models run on the Nevada data. The variable was a rough attempt to measure the "known" dimension of perceived risk that Slovic, Fischhoff, and Lichtenstein (1985) found to be important. The lack of significance in the model may reflect our inability

Table 7-9 Regression Models on Nevada Data

Dependent Variable: Perceived Risk from HLNW Repository	Model 1 Standardized Coefficients (t-values)	Model 2 Standardized Coefficients (t-values)	Model 3 Standardized Coefficients (t-values)	Model 4 Standardized Coefficients (t-values)	Model 5 Standardized Coefficients (t-values)
F-value	75.638	67.339	54.745	29.097	61.329
Adjusted R^2	.138	.374	.399	.393	.404
Intercept	0.000	0.000	0.000	0.000	0.000
	(36.077)	(17.385)	(16.395)	(8.403)	(16.451)
Knowledge of HLNW	***−0.244	***−0.169	***−0.162	***−0.124	***−0.150
	(−7.972)	(−6.217)	(−6.057)	(−4.187)	(−5.556)
Trust in federal government	***−0.256	**−0.074	*−0.051	*−0.057	**−0.056
	(−8.360)	(−2.556)	(−1.797)	(−1.897)	(−1.978)
Scientists understand risks[1]		−0.348	−0.195	−0.280	
		(−1.077)	(−0.610)	(−0.840)	
Moderate amount of dread[1]		***1.197	***1.072	***1.096	***0.0147
		(5.703)	(4.179)	(5.018)	(5.127)
High amount of dread[1]		***2.334	***2.072	***2.152	***0.163
		(6.358)	(5.705)	(5.539)	(5.521)
Moderate likelihood[1]		***2.603	***1.392	***1.260	***1.378
		(6.935)	(6.391)	(5.567)	(6.355)
High likelihood[1]		***1.198	***2.394	***2.151	***2.331
		(9.691)	(9.017)	(7.670)	(8.790)
Future risk[1]		***0.142	***0.885	***0.845	***1.053
		(4.652)	(3.910)	(3.539)	(3.699)
Nuclear attitude[1]			***1.138	***1.033	***1.986
			(5.422)	(4.642)	(5.233)
Liberal[1]			−0.022	−0.081	
			(−0.106)	(−0.377)	
Economic benefits			***−0.081	**−0.070	***−0.077
			(−3.061)	(−2.500)	(−2.905)
Age				−0.040	
				(−1.282)	
Sex[1]				***−0.591	**−0.473
				(−3.018)	(−2.562)
Race[1]				−0.350	
				(−1.095)	

Table 7-9 *Continued*

Dependent Variable: Perceived Risk from HLNW Repository	Model 1 Standardized Coefficients (*t*-values)	Model 2 Standardized Coefficients (*t*-values)	Model 3 Standardized Coefficients (*t*-values)	Model 4 Standardized Coefficients (*t*-values)	Model 5 Standardized Coefficients (*t*-values)
Children				0.015	
				(0.508)	
Income				−0.032	
				(−1.072)	
Education				−0.041	
				(−1.374)	
Lincoln[1]				−0.167	
				(−0.535)	
Nye[1]				0.077	
				(0.264)	

Significance levels for *t*-values using two-tailed tests: $^{***}p \leq .01$, $^{**}p \leq .05$, $^{*}p \leq .10$.
[1]Unstandardized coefficients reported for these variables.

to develop questions that adequately measure this risk characteristic rather than the importance of the characteristic on risk perception. Because of the time limitations in a telephone interview, it was not possible to pursue all risk characteristics with equal thoroughness.

Various attitudinal indicators are introduced to the regression in Model 3. Not surprisingly, the variable that indicates the respondent's position on nuclear power (*Nuclear Attitude*) makes a large, positive, and significant contribution to risk perceptions in the national and Nevada samples in Model 3 and all subsequent models. Opponents of nuclear power have higher risk perceptions for the repository than supporters. *Liberal*, which indicates the respondent's political persuasion, does not appear to be statistically significant in either the national or Nevada samples. *Economic Benefits*, the variable that measures the respondent's perception of the economic benefits associated with the repository, tends to decrease risk perceptions significantly for all models where it was entered. The economic variable has a stronger influence in the Nevada sample, which may reflect the greater overall optimism of at least some Nevadans about the possible economic benefits associated with the repository.

Model 4 includes standard socioeconomic variables in the regression. The respondent's sex is a significant influence on risk perceptions in both the national and Nevada samples. Females tend to perceive the repository risks

to be more serious than do males, all other things being equal. This finding is consistent with previous research about attitudes toward nuclear power in particular (see chapter 2 of this volume by Rosa and Freudenburg), and risks in general (Mitchell, 1984 and Desvousges et al., 1990). As for the other socioeconomic variables, they play a moderate role in the formation of risk perceptions for the nation as a whole but barely any role for respondents from Nevada. In the national sample, respondent's race and level of education are significant at the .05 level. Nonwhites tend to view the repository risks as more serious than do whites, and each year of education lowers the respondent's risk perceptions. Neither of these variables, however, is significant for the Nevada sample. The respondent's income, a commonly considered socioeconomic variable, does not appear to be statistically significant for either the national or Nevada sample. This was also true when income was included in other model specifications, implying that risk perceptions for these respondents are not influenced by income levels.

For the Nevada sample, Model 4 also includes two dichotomous variables, *Lincoln* and *Nye*, which indicate whether the respondent was a resident of either of the two counties closest to the proposed Yucca Mountain site. Both of these variables are insignificant, which suggests that the risk perceptions of respondents in the two counties nearest the site were no different from those of other Nevada residents in our sample.

Model 5 includes only the significant variables from Model 4 for each sample. The major differences in Model 5 between the samples lie with the socioeconomic variables. The national model includes the two significant socioeconomic variables, race and education, while the Nevada model does not. Otherwise, the data indicate that respondents from the national sample and from the Nevada sample form risk perceptions very similarly. As implied by our conceptual framework, attitudes about the repository and nuclear waste issues (*Trust in the Federal Government, Nuclear Attitude,* and *Economic Benefits*), knowledge about nuclear waste issues (*Knowledge of* HLNWR), and risk characteristics (*Moderate Amount of Dread, High Amount of Dread, Moderate Likelihood, High Likelihood,* and *Future Risks*) are important influences in the formation of risk perceptions. Proximity and socioeconomic factors appear to be less important.

Position on the Repository

The survey asked respondents: "If a vote were held today on building a permanent repository, would you vote for locating a repository at (a) Hanford in Washington State, (b) Yucca Mountain in Nevada, (c) Deaf Smith County in Texas, or (d) none of the above?" Nevadan's self-projected voting behav-

ior is reported in Table 7-10. Approximately 24 percent indicated that they would vote to locate the repository at Yucca Mountain. More than 40 percent said they would not vote to locate the repository at any of the three proposed sites. Nevada respondents were also asked if they would vote for the location of the repository at Yucca Mountain if their community would receive a large grant for improved public services as compensation. More than half, 59 percent, said they would not vote for the repository even under those conditions.

We have developed a voting-behavior model to explain these results. The model contends that voting behavior is based on risk perception, perceived risk characteristics, attitudes toward the repository, and location. The model predicts the likelihood of an affirmative vote for the repository at Yucca Mountain. Because the dependent variable in the model is dichotomous, that is, can only take either of two values, probit rather than ordinary least squares regression models are appropriate. In these models, the reported coefficient is proportional to the change in probability of voting for the location of the repository at Yucca Mountain that results from one unit of change in the independent variable.[5] In Table 7-11, the dependent variable is the likelihood of voting for the location of the repository at Yucca Mountain.

In Model 1, we use a single explanatory variable, perceived risk, to predict

Table 7-10 Voting Behavior

"If a vote were held today on building a permanent repository, would you vote for locating a repository at . . ."

Proposed Repository Site	Percentage of Nevada Respondents in Favor of Location
Hanford, Washington	4.2
Yucca Mountain, Nevada	24.3
Deaf Smith County, Texas	18.6
None of the above	44.0
Don't know	9.0

"Suppose instead your community were offered a large grant for improved public services like schools, parks, or hospitals to have the repository located at Yucca Mountain. Would you vote to locate the repository under these terms?"

Vote	Percentage of Nevada Respondents
Yes	33.5
No	58.7
Don't know	7.8

Table 7-11 Voting Behavior Model 1

Dependent Variable: Vote for Repository	Model 1 Coefficients (*t*-values)	Model 1a Coefficients (*t*-values)	Model 1b Coefficients (*t*-values)	Model 1c Coefficients (*t*-values)
Chi-square (χ^2)	230.23	234.81	263.13	272.31
Predicted as percentage of actual	.793	.783	.792	.799
Constant	***0.442	***−0.685	***−0.916	***−1.017
	(5.088)	(−3.428)	(−4.304)	(−4.760)
Perceived risk from HLNW repository	***−0.299			
	(−13.683)			
Predicted risk (from the the risk perception model)		***−0.186	***−0.174	***−0.171
		(−7.678)	(−7.056)	(−6.837)
Trust in federal government		***0.128	***0.125	***0.125
		(6.665)	(6.335)	(6.330)
Knowledge of HLNW		***0.270	***0.277	***0.281
		(4.686)	(4.734)	(4.768)
Economic benefits			***0.721	***0.699
			(4.741)	(4.553)
Prodevelopment view			0.161	0.165
			(1.451)	(1.480)
Lincoln				***0.454
				(2.978)
Nye				0.164
				(1.078)

Significance levels for *t*-values using two-tailed tests: ***$p \leq .01$, **$p \leq .05$, *$p \leq .10$.

the likelihood of voting for the location of the repository at Yucca Mountain. The significant chi-square value and the number of correctly predicted votes as a percentage of actual votes indicate that the model is fairly successful.

Model 1a adds variables that indicate the respondent's trust in the federal government to operate the repository safely and the respondent's knowledge of nuclear and repository issues to the equation. Using these variables to predict the risk variable presents a problem of simultaneity. To correct for this bias, we use the value for perceived risk predicted by the perceived risk model described above instead of the actual survey response to the 10-point rating scale. We followed this procedure for Model 1c and all subsequent voting models. Both the trust and knowledge variables have positive and

Table 7-12 Voting Behavior Model 2

Dependent Variable: Vote for Repository with Community Grant	Model 2 Coefficients (*t*-values)	Model 2a Coefficients (*t*-values)	Model 2b Coefficients (*t*-values)	Model 2c Coefficients (*t*-values)
Chi-square (χ^2)	152.70	145.26	171.88	182.53
Predicted as percentage of actual	.705	.703	.704	.716
Constant	***0.551 (6.421)	**0.404 (2.047)	0.126 (0.606)	0.002 (0.011)
Perceived risk from HLNW repository	***−0.169 (−11.867)			
Predicted risk (from the risk perception model)		***−0.197 (−8.517)	***−0.194 (−8.183)	***−0.187 (−7.850)
Trust in federal government		***0.064 (3.954)	***0.053 (2.899)	***0.052 (2.875)
Knowledge of HLNW		−0.029 (−0.516)	−0.027 (−0.482)	−0.023 (−0.401)
Economic benefits			***0.481 (2.929)	***0.394 (2.741)
Prodevelopment view			***0.402 (3.904)	***0.410 (3.964)
Lincoln				***0.447 (3.035)
Nye				0.229 (1.609)

Significance levels for *t*-values using two-tailed tests: ***$p \leq .01$, **$p \leq .05$, *$p \leq .10$.

significant influences on predicted voting behavior. Respondents who indicate trust in the federal government or exhibit a high level of knowledge about nuclear waste issues are more likely to vote for the repository than those who do not. The predicted risk value is negative and significant but has a smaller influence than the survey risk variable in Model 1.

Model 1b incorporates variables that indicate attitudes toward economic benefits and development. Not surprisingly, the variable that measures the respondent's expectations of the economic benefits resulting from the repository is positive and significant. Respondents with more optimistic expectations of economic benefits are more likely to vote for the repository. The variable that indicates whether or not the respondent has a prodevelopment view is positive but not statistically significant. As defined in Table 7-6,

these are respondents who think that there is no limit to growth for industrialized nations and that people have the right to change the environment to meet their needs. All previously introduced variables retain a significant and fairly constant influence.

Model 1c considers the respondent's proximity to Yucca Mountain in the prediction equation. Dummy variables were created for residents of Lincoln and Nye counties, the counties closest to the proposed repository site. County of residence exerts a positive influence on voting behavior for both counties, meaning that respondents who live in either county are more likely to vote for the repository than those who live elsewhere in Nevada. The variable is statistically significant for Lincoln County but not for Nye County.

With the dependent variable as the likelihood of voting for the location of the repository at Yucca Mountain if the respondent's community will receive a large grant to improve community services, Model 2 is estimated in Table 7-12. The structure of each variation in Model 2 is identical to those of Model 1 discussed above. The chi-square values and correct prediction percentages indicate that, when a large grant for improved public services is linked to the repository's location, all models provide fairly good predictions of the likelihood of an affirmative vote. The contributions of some individual variables, however, differ from their roles in the simpler voting question. In particular, knowledge drops out as a significant predictor while prodevelopment variable (*Prodevelopment View*) exerts a stronger and significant influence on voting behavior in Model 2. Respondents who have a prodevelopment outlook are 40 percent more likely to vote for a repository with a grant program than are those who do not.

Discussion

Overall, the survey results produce an unmistakably negative image of the HLNWR. Nevada and national respondents view the repository as a very undesirable facility due to the seriousness and unacceptability of the risks associated with it. Both samples rated the perceived risks of a HLNWR more seriously than the other six risks included in the survey. Clear majorities believe that repository risks are beyond the control of nearby residents who would dread living near it, that a repository accident would involve certain death to many people, and that a repository poses a serious risk for future generations. Somewhat surprisingly, concern for future generations was the most seriously perceived risk characteristic. A majority of respondents, often sizable, believes in the likelihood that the repository would release a large amount of radiation into the environment as a result of accidents, general deterioration, or human malevolence. Although they show

some recognition of economic benefits associated with the repository, respondents do not believe these outweigh the risks: in effect, the repository is perceived as a bad deal for local residents.

Both knowledge of nuclear wastes and trust in the federal government affect risk perceptions, with lower perceived risk existing among the more knowledgeable and the more trusting respondents. General attitudes toward nuclear power influence repository risk perceptions, with greater perceived seriousness among opponents and less seriousness among supporters. Consistent with previous research on other nuclear issues, women in both samples perceived the risks of the repository as substantially more serious than men did. None of the other background characteristics had significant effects in the Nevada sample, though race (nonwhites saw greater risks than whites did) and education did show some effect in the national sample.

Majorities of Nevadans believe that Nevada is neither the safest (63 percent) nor the best (62 percent) place for the repository. When asked to consider a hypothetical vote, less than a quarter would vote to site the repository at Yucca Mountain. A plurality, 44 percent, would vote not to locate the repository at any of the three finalist sites. Even when offered a community grant, a convincing majority of Nevadans would still vote against siting the repository at Yucca Mountain.

Conclusions

The data point to a disturbing policy conclusion: it will be extraordinarily difficult to site a HLNWR, not only in Nevada, but almost anywhere under the current institutional arrangements. Citizens of Nevada and the nation view the repository as imposing unacceptably high risks on themselves and on future generations. Even offers of compensation are insufficient to overcome the unacceptability of repository risks. The depth of concerns among Nevada respondents is especially revealing because it shows that the U.S. Department of Energy's (DOE) efforts to reduce concerns about the repository have generally failed. The failed efforts of DOE may, in part, be due to a mistrust of the federal government, found in our analysis to be a significant predictor of the perceived seriousness of repository risk. Whatever the cause, DOE's risk communication ineffectiveness underscores the importance, as pointed out by the National Research Council, of two-way communication about risks; risk information received from the public is as important as information transmitted to the public (National Research Council, 1989; Desvousges and Smith, 1988). In contrast, DOE's typical risk communication efforts have typically followed a "top-down" approach, where information is provided to the public along a one-way channel of communication.

There is little doubt that belief in the safety of the repository is a crucial

requisite of a successful siting program. Trust in the federal government's ability to manage the repository is crucial to producing such perceptions of safety. Given the widespread belief in the seriousness of repository risks (or belief in the absence of safety) and given the mistrust of those responsible for the repository, we can expect serious impediments in Nevada and elsewhere to the construction of a HLNWR.

Notes

1 Both samples are biased either in the same way or in very different ways. If biased in the same way, the bias is likely to be reflected in an overrepresentation of middle-class respondents (Dillman, 1978). While this would attenuate the validity of generalizing from the samples, the results would still be useful in understanding the segment of society most active in political matters. If, on the other hand, the bias is quite different, then that reinforces the contention that the populations from which the samples are drawn are homogeneous. Otherwise, one would have to argue the unlikely case that very similar results are due to very dissimilar samples.

2 General population surveys on risk perception have been conducted by Gould et al. (1988) in the states of Connecticut and Arizona. In those studies, nuclear power was perceived to be less risky than predicted from the pyschometric evidence. But, since respondents were not queried about nuclear wastes, it is difficult to extrapolate the findings to predictions about perceived repository risks.

3 Thirty-five percent of national respondents and 32 percent of Nevada respondents fall into the moderate dread category. Nine percent of national respondents and 8 percent of Nevada respondents are in the high dread category. It should be noted that use of these two categories as two separate dichotomous variables yields results analogous to treating high, medium, and low dread as a single, ordinal variable.

4 Forty percent of national respondents and 33 percent of Nevada respondents fall into the moderate likelihood category. Sixteen percent of national respondents and 22 percent of Nevada respondents are in the high likelihood category.

5 This relationship only holds at the mean values of the independent variables (Maddala, 1983).

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