DOE/CH/CRE-6-1999

LIFE-CYCLE COST AND RISK ANALYSIS OF ALTERNATIVE CONFIGURATIONS FOR SHIPPING LOW-LEVEL RADIOACTIVE WASTE TO THE NEVADA TEST SITE

December 1999

Prepared for the Center for Risk Excellence
U.S. Department of Energy, Chicago Operations Office

In Consultation with the U.S. Department of Energy's
Nevada Operations Office,
National Transportation Program,
Low-Level Waste/Mixed Low-Level Waste Center for Excellence,
Center for Acquisition and Business Excellence

Pacific Northwest National Laboratory
Richland, Washington

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December 15, 1999

Dr. Al Young
Center for Risk Excellence
U.S. Department of Energy
Chicago Operations Office
9800 South Cass Ave.
Argonne, IL 60439

Dear Dr. Young

SUBJECT: TRANSMITTAL OF *LIFE-CYCLE COST AND RISK ANALYSIS OF ALTERNATIVE CONFIGURATIONS FOR SHIPPING LOW-LEVEL RADIOACTIVE WASTE TO THE NEVADA TEST SITE*

Enclosed please find the Final Report; *Life-Cycle Cost And Risk Analysis Of Alternative Configurations For Shipping Low-Level Radioactive Waste To The Nevada Test Site.* As you know, the report reflects the contributions of a multi-laboratory team who began work over year ago under the direction of Mr. Peter Siebach of your staff. The technical assessments and document preparation were performed by myself, Dr. Bruce Biwer of Argonne National Laboratory, and Mr. Steve Ross of Battelle-Albuquerque.

In addition to the multi-laboratory team that performed the analysis and prepared the attached report, a number of others contributed guidance, technical and administrative support, and comments on draft manuscripts, including

- Mr. E. Frank DiSanza, DOE-Nevada Operations Office
- Mr. Steven Hamp, DOE-Albuquerque, National Transportation Program
- Mr. Ken Small, DOE-Nevada, Center of Excellence for Low-Level and Mixed Low-Level Waste
- Mr. Bruce Church, Desert Research Institute
- Mr. Michael Giblin, DOE-Nevada Operations Office
- Ms. Kathleen Grassmeier, DOE-Nevada Operations Office
- Ms. Ruth Weiner, Sandia National Laboratory
- Mr. Ed Parsons, Federal Energy Technology Center.
- Mr. Bill Andrews, Pacific Northwest National Laboratory

On behalf of myself and the team, I would like to thank you personally for the opportunity to develop this report and work closely with Mr. Siebach, the DOE-Nevada staff, and their

902 Battelle Boulevard • P.O. Box 999 • Richland, WA 99352

Telephone (509) 372-4239 ■ Email phil.daling@pnl.gov ■ Fax (509) 372-4995

stakeholders. We believe the report will provide a valuable resource to support transportation planning in Nevada and at potential LLW generator sites. We look forward to continuing to work closely with the Center for Risk Excellence.

Sincerely,

Philip M. Daling
Staff Engineer
Pacific Northwest National Laboratory

Encl:

cc (w/o encl.): P. Siebach, EPG
M. Williams, AL
A. Kapoor, AL
S. Hamp, AL
G. Duggan, ID
K. Grassmeier, NV
M. Giblin, NV
K. Small, NV
E. Parsons, FETC
C. Crawford, FETC
M. Letourneau, EM-20
T. Mustin, EM-20
J. Rhoderick, EM-20
H. Belencan, EM-20
N. Akgunduz, Fernald
W. Dixon. Yucca Mountain Project Office
J. Booth, Yucca Mountain Project Office
B. Biwer, ANL
R. Weiner, SNL/NM
W. Andrews, PNNL
P. Daling, PNNL
S. Ross, PNNL
F. Dilger, Clark County
D. Bechtel, Clark County
G. Swartz, State of Nevada
E. Dixon, UNLV
J. Williams
L. Bradshaw, Nye County
B. Church, DRI
J. Sharp

EXECUTIVE SUMMARY

The Nevada Test Site (NTS) is a major receiver of low-level radioactive waste (LLW) for disposal. Currently, all LLW received at NTS is shipped by truck. The trucks use highway routes to NTS that pass through the Las Vegas Valley and over Hoover Dam, which is a concern of local stakeholder groups in the State of Nevada. Rail service offers the opportunity to reduce transportation risks and costs, according to *the Waste Management Programmatic Environmental Impact Statement* (*WM-PEIS*). However, NTS and some DOE LLW generator sites are not served with direct rail service so intermodal transport is under consideration. Intermodal transport involves transport via two modes, in this case truck and rail, from the generator sites to NTS. LLW shipping containers would be transferred between trucks and railcars at intermodal transfer points near the LLW generator sites, NTS, or both. An Environmental Assessment (EA) *for Intermodal Transportation of Low-Level Radioactive Waste to the Nevada Test Site* (referred to as the *NTS Intermodal EA*) has been prepared to determine whether there are environmental impacts to alterations to the current truck routing or use of intermodal facilities within the State of Nevada. However, an analysis of the potential impacts outside the State of Nevada are not addressed in the *NTS Intermodal EA*. This study examines the rest of the transportation network between LLW generator sites and the NTS and evaluates the costs, risks, and feasibility of integrating intermodal shipments into the LLW transportation system.

This study evaluates alternative transportation system configurations for NTS approved and potential generators based on complex-wide LLW load information. Technical judgments relative to the availability of DOE LLW generators to ship from their sites by rail were developed. Public and worker risk and life-cycle cost components are quantified. The study identifies and evaluates alternative scenarios that increase the use of rail (intermodal where needed) to transport LLW from generator sites to NTS.

Two LLW disposal options and four transportation system configurations are considered in this study. These options are consistent with the LLW options being considered in the development of the *WM-PEIS* Record of Decision (ROD). The first LLW disposal option is a "high waste volume" case in which NTS is the primary disposal site for DOE LLW that will be shipped offsite (most of the LLW will be disposed onsite at four other DOE generator sites). The second disposal option is one in which the LLW to be disposed offsite will be about equally split between NTS and the Hanford Site in the State of Washington. This option is referred to here as the "low waste volume" case. The four shipping configurations evaluated here are:

- 100% truck transport using existing routes (base case),
- 100% truck transport using routes that avoid Las Vegas and Hoover Dam,
- intermodal transport from large generator sites using a candidate intermodal transfer facility in Barstow, California, and
- intermodal transport using a candidate intermodal transfer facility in Caliente, Nevada.

There are a total of 23 LLW generator sites that are projected to ship waste to NTS for disposal. Of these 23 sites, the physical capabilities of nine generator sites representing over 93% of the LLW volume to be shipped to NTS for disposal were examined. The other 14 sites are smaller-volume generators that were assumed to ship waste to NTS by truck. It was determined that, of these nine large-volume generators, five currently have direct rail access and four would require truck transport to an offsite railhead. For these four sites, intermodal transport would be used at both the origin and destination in order to use rail service. The other five generator sites could load LLW directly on to railcars onsite and ship by rail to the intermodal transfer facility near NTS.

> ***"Life-cycle"***
> *This study estimates "life-cycle" costs and risks of transporting LLW to NTS. This means that the risk and cost estimates developed here are accumulated or summed over an assumed 70-yr operating period for the LLW generators and NTS LLW disposal facilities. This involves projecting out to 70 years the LLW volume estimates from each generator and assumes waste treatment, transportation, and disposal technologies remain constant over this time frame. Obviously, technologies will change over this time frame, resulting in more efficient LLW management practices. Other technological changes over the next 70 years could also affect the results and conclusions presented here, such as development of safer vehicles, new materials, and development and construction of safer highway and rail systems. It is also assumed that regulatory requirements are for all practical purposes constant over this time frame, or at least that regulatory change does not result in substantial changes in costs, efficiencies, or operational risks. Finally, decisions over the next 70 years could affect the results in this study, such as decision to dispose LLW onsite.*

It should be noted that not all of the LLW generators considered here are approved generators for disposal at NTS. Those sites not currently on the approved generator list will need to undergo the approval process prior to their first shipment. The rail capability assessment addressed rail and intermodal physical capabilities and does not consider local opposition or political issues. Furthermore, although the DOE LLW generator sites in the "truck" category were assumed in this study to ship only by truck, they are also capable of shipping by rail, either via direct rail service or intermodal service. However, since these sites are small-quantity generators, the top nine LLW generators will effectively demonstrate the trends in impacts for switching over to rail transport.

The cost and risk analyses in this report were performed using existing DOE methods and data to the extent possible. The HIGHWAY and INTERLINE computer codes were used to develop route-specific information for shipments between DOE LLW generators and NTS, including shipping distances and population density data. The RADTRAN 4 computer code was used to calculate the risks to the public and workers from routine (incident-free) transport and accidents during shipments of LLW to NTS. Commonly used fatality rates for general freight service (fatality risk per mile traveled) were used to calculate the nonradiological risks of accidents (physical risks) and routine vehicular emissions.

Transportation cost information was extracted from a number of sources, including the *WM-PEIS*, to calculate the life-cycle costs of the various shipping configurations and waste loading cases examined in this study. The life-cycle cost estimates presented in this study include carrier charges, procurement and replacement costs for reusable LLW shipping containers, and first-order estimates of intermodal transfer costs. Not included are potential costs for improving rural highways in Nevada, upgrading emergency response capabilities along the routes, and capital costs for intermodal transfer facilities. The intent of these calculations is to identify the tradeoffs that exist between the various "risk" measures quantified in this study relative to increasing the use of rail to transport LLW to NTS as well as avoiding the Las Vegas Valley and Hoover Dam.

Table ES-1 summarizes the quantitative results of this study. The table includes total shipping distances, five health and safety risk measures, and total life-cycle costs for the four shipping configurations investigated. The key observations made about the results are:

- The life-cycle costs for the intermodal configurations are significantly lower than the all-truck configurations. The increased costs for intermodal transfers and the truck segment from the intermodal facility to NTS are more than offset by the lower costs for rail shipping from LLW generators to the intermodal facility, relative to the all-truck configurations.

Table ES-1. Summary of Transportation Impacts for the High Waste Volume Case [(a)]

Impact Measure	70-yr Life-Cycle Cost and Risk Estimates			
	1A (Intermodal at Barstow, CA)[(b)]	1B (Intermodal at Caliente, NV)[(b)]	2 (100% truck on routes that avoid Las Vegas)	3 (100% truck on routes that travel through Las Vegas)
Cost ($millions)	130	140	230	210
Shipping Distance (million mi)	26	28	52	45
Radiological Routine – Workers (Fatalities)	0.095	0.11	0.29	0.27
Radiological Routine – Public (Fatalities)	0.087	0.098	0.42	0.38
Radiological Accident Risks (Fatalities)	8.0E-06	1.2E-05	1.9E-05	1.9E-05
Nonradiological Accident Risks (Fatalities)	1.2	1.3	1.8	1.5
Nonradiological Routine Emissions (Fatalities)	0.13	0.16	0.21	0.28

Note: Results are given in abbreviated scientific notation; e.g., 8.0E-06 = 8.0×10^{-6} = 0.0000080.

(a) Includes costs and risks of truck and rail transport plus intermodal transfer operations, where applicable.

(b) For intermodal configurations, the top nine LLW generators by volume are assumed to ship by rail. Smaller-quantity LLW generators are assumed to ship by truck on routes that avoid Las Vegas.

- The life-cycle cost for the all-truck option that avoids Las Vegas is slightly higher than the cost for the all-truck option that travels through Las Vegas. This is due to the longer shipping distances that will become necessary to avoid Las Vegas. This cost difference is on the order of 10% of the total life-cycle costs, which is smaller than the uncertainties in the cost estimates.

- Total life-cycle costs were lower for the intermodal configuration in which the Barstow facility is assumed than for the configuration in which Caliente is the intermodal transfer point. This is a small cost difference that is within the uncertainties of the cost estimates. A lower life-cycle cost, however, is real because total shipping distance calculated for the Barstow configuration is shorter than that for Caliente.

- Radiological incident-free (or routine) risks were shown to be highest in the all-truck options and lowest in the intermodal options.

Risk Value Clarification

Risk values greater than 1.0 represent the number of fatalities projected to occur over the 70-yr life cycle of the LLW transportation and disposal operations. They may be rounded to the nearest whole number. Risk values less than 1.0 (i.e., fractional fatality) may be restated as the probability that at least one fatality occurs over the 70-yr life cycle by taking the inverse of the fractional fatality. In other words, if the risk estimate is 0.1 fatalities, there is a 1 in 10 chance (i.e., 1.0 divided by 0.1) of at least one fatality occurring in the 70-yr period.

- Nonradiological accident risks are higher than the other risk measures examined in this study. The nonradiological accident risks are higher in the all-truck options than in the intermodal options.

- Of the four main shipping configurations analyzed in this study, the intermodal configurations represent the lowest health and safety risks. Overall, the intermodal configuration in which intermodal transfers are performed at Barstow, CA, has the lowest risk, the Caliente intermodal configuration is second lowest, the all-truck option on routes that travel through Las Vegas is the third lowest, and the highest-risk option is the all-truck configuration that travels on routes that avoid Las Vegas.

- It can be seen by comparing the two all-truck options (Configurations 2 and 3 in Table ES-1) that routing around Las Vegas results in higher radiological routine risks than using routes that travel through Las Vegas. This is consistent with the trend in total shipping distance. Based on this observation, the increase in shipping distance associated with routing around Las Vegas more than offsets the potential radiological risk reductions associated with shifting the routes to less densely populated areas of Nevada. Thus, the radiological routine dose risks are lower if the routes through Las Vegas and Hoover Dam are used.

- Similar to the radiological routine risk trends, the increase in shipping distance required to route around Las Vegas has a greater influence on the nonradiological accident risk rankings than the more favorable accident rates on interstate and primary state highways in Nevada. Longer shipping distances are required to avoid Las Vegas and Hoover Dam. This increases the nonradiological risks, which are approximately linear with respect to shipping distance. (Note: they are not exactly a linear function because the type of highway and type of population zone influence the accident rates.) The more direct routes through Las Vegas are on well-maintained interstate and primary highways that have generally lower accident rates than the rural highways required to avoid Las Vegas. However, on a DOE complex basis, it was shown that the nonradiological accident and routine radiological dose risks are lower if the LLW truck shipments use the more direct routes.

Types of Health and Safety Risk

Several different types of health and safety risk are quantified in this study. Brief descriptions of these risk types are as follows:

- *<u>Incident-free radiological risk</u> is the risk associated with LLW shipments that reach their destination without experiencing an accident or loss of radioactive cargo. The risk in this case arises from the low levels of radiation that penetrate through the walls of the LLW shipping containers exposing persons nearby to an external radiation dose. Federal regulations specify the maximum external radiation dose rate permitted to penetrate through the walls of the LLW shipping containers.*

- *<u>Radiological accident risk</u> refers to potential releases of radioactive material that could be caused by a traffic accident that results in failure of the LLW packaging system. This type of risk is calculated by multiplying the frequency of an accident by its consequences. Consequences are represented by the radiation dose from inhalation, ingestion, and external exposure to the radioactive material that escapes from the shipping container.*

- *<u>Nonradiological accident risks</u> represent the risks of physical injury or death from vehicular accidents involving the LLW shipments. An example would be motorist in a vehicle that collides with an LLW shipment. These risks are independent of the LLW cargo being transported.*

- *<u>Nonradiological incident-free risks</u> are the risks associated with human exposure to vehicular emissions. These risks are independent of the LLW cargo being transported.*

- A number of comparisons of the risk estimates developed in this study for transporting LLW to NTS were made to risks commonly encountered in everyday life. It was demonstrated through these comparisons that the LLW transportation risks are small in relation to other, more commonly encountered risks, including natural background radiation doses. Furthermore, the analytical models and data used to calculate the transportation risks were shown to be conservative (i.e., tend to overpredict the risks), providing further indication that the risks of transporting LLW to NTS are small. Examples of important conservative elements of the risk analysis are summarized in Section 5.3.

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ACKNOWLEDGMENTS

The authors would like to express their appreciation to several individuals for their assistance in preparing and improving this report. We wish to thank Mr. Peter Siebach, DOE Center for Risk Excellence, for his valuable assistance and support throughout this project. We also wish to thank Mr. E. Frank Di Sanza, Mr. Michael Giblin, and Ms. Kathleen Grassmeier of DOE's Nevada Operations Office for their guidance and encouragement of this study. In addition, we wish to express our appreciation to Mr. Steve Hamp of DOE's National Transportation Program for his guidance and thoughtful reviews of draft versions of this report. Other reviewers that provided valuable comments and suggestions instrumental in improving this report include Mr. Robert Rea and Mr. Thomas Enyeart (SAIC-Las Vegas), Ms. Ruth Weiner (Sandia National Laboratory), Mr. James Williams (Nye County, Nevada), Mr. Russell DiBartolo (Clark County, Nevada), and Ms. Ginger Swartz (Nye County, Nevada). Finally, we wish to express our appreciation to Mr. Gary Smith, MACTEC, for providing the waste volumes used in this study, Mr. Mark John, Idaho National Engineering and Environmental Laboratory, for his transportation logistics support, and Mr. Ronald Pope, Oak Ridge National Laboratory, for providing the historical transportation cost information from the ETAS database.

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GLOSSARY

ANL-E	Argonne National Laboratory - East
ANL-W	Argonne National Laboratory - West
BCL	Battelle Columbus Laboratory
BNL	Brookhaven National Laboratory
CEQ	Council for Environmental Quality
CFR	U.S. Code of Federal Regulations
CPQT	Consolidated PBS Quantity Tables (database)
CRE	Center for Risk Excellence (DOE)
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
GE Val	General Electric Vallecitos Nuclear Center
GJPO	Grand Junction Projects Office
HRCQ	Highway-Route Controlled Quantity (of radioactive materials)
INEEL	Idaho National Engineering and Environmental Laboratory
ITRI	Inhalation Toxicology Research Institute
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkley National Laboratory
LCF	Latent Cancer Fatality
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
NTP	National Transportation Program (DOE)
NTS	Nevada Test Site
ORR	Oak Ridge Reservation
PGDP	Paducah Gaseous Diffusion Plant
PNNL	Pacific Northwest National Laboratory
PORT	Portsmouth Gaseous Diffusion Plant
PPPL	Princeton Plasma Physics Laboratory
RFETS	Rocky Flats Environmental Technology Site
SNL	Sandia National Laboratory
SPRU	Separations Process Research Unit
SRS	Savannah River Site

Units Conversions

1 mile (mi.)	=	1.609 km
1 Sievert (Sv)	=	100 rem
1 Curie (Ci)	=	3.7E+10 Becquerels (Bq)
1 lb.	=	0.454 kg
1 ft	=	0.3048 m
1 ft^3	=	0.028 m^3

Scientific Notation

9.4E-02 = 9.4×10^{-2} = 0.094

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1.0 INTRODUCTION

Regionalized options for disposal of low-level radioactive waste (LLW) are the preferred alternatives identified in *the Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*WM PEIS*; DOE 1997). The regional disposal alternatives consolidate LLW disposal operations at a few DOE sites. A total of six LLW disposal options are currently being considered, each of which combines onsite disposal at certain sites with disposal of offsite-generated LLW at one or more regional facilities. One of the facilities under consideration for disposal of onsite- and offsite-generated LLW is the Nevada Test Site (NTS).

Two modal options were considered in the analysis of LLW transportation impacts in the PEIS: 100% truck and 100% rail. It was recognized that all sites are capable of shipping by truck but less than half of the sites have onsite rail capabilities. The 100% rail option was assumed in the PEIS for calculational purposes. In general, it was determined that the 100% rail option would result in lower health and safety impacts than the 100% truck option. It is unlikely that DOE sites that generate small volumes of LLW would consider constructing direct rail service to their LLW facilities because of the costs involved. Therefore, a more likely scenario will involve a mix of truck and rail service. In addition, NTS lacks direct rail access to its LLW disposal facilities.

Intermodal service to the NTS is being studied as part of DOE's ongoing efforts to responsibly manage its risks. The draft *Intermodal Transportation of Low-Level Radioactive Waste to the Nevada Test Site – Draft Environmental Assessment* (DOE 1998a), referred to here as the *NTS Intermodal EA*, was issued for review in 1998. Intermodal transport is done in three general steps. Intermodal shipments consist of a combination of truck and rail service. For generator sites that currently have direct rail access, the LLW would be loaded onto railcars and transported by general freight rail service from the generator sites to an intermodal transfer facility near NTS. Dedicated train service in which the LLW containers are the only cargo aboard the train was not evaluated in this study. At the intermodal facility, the rail shipping container would be offloaded from the railcar and placed on a truck. Trucks would transport the LLW cargo to disposal areas on NTS. For LLW generators without rail access, intermodal transfers would occur at the origin and destination of the shipments. The LLW would first be loaded onto trucks at the generator sites and moved to a nearby railhead or intermodal transfer facility where the LLW containers would be loaded onto railcars. For this type of service, truck trailers carrying LLW may be transported on rail flatcars to simplify the loading and unloading processes. The rest of the shipment would proceed as described above for sites with direct rail access. Using these concepts, increasing the use of rail to transport LLW from generator and treatment sites to NTS for disposal is technically feasible for all DOE LLW generator sites.

The purpose of the report is to develop a credible basis for DOE-Nevada, authorized (and prospective) LLW shipping sites, stakeholders, and carriers to manage, understand, and discuss risks and costs associated with transportation of LLW to NTS. The report will:

- Investigate alternative transportation system configurations including truck and intermodal (mix of truck and rail) options.
- Assess life-cycle (70 year) human health risks and costs.
- Assess DOE systems-wide (generator site to NTS) human health risks and costs
- Dovetail with truck and intermodal alternatives identified in the *NTS Intermodal EA*.

- Address both cargo (i.e., radiological) and vehicle (i.e., non-radiological) related risk.

- Document cost trends among alternatives based on historical DOE transportation costs. Both capital and operating costs will be considered.

- Enable site-specific and national comparisons of cost vs. risk tradeoffs among truck and intermodal alternatives.

- Enable comparison of risk impacts by state for all alternatives

- Flag areas where more precise assessment could uncover opportunities for enhanced transportation safety and efficiency.

- Demonstrate to any DOE site that may receive waste or materials from other sites the framework and process for a thorough transportation risk assessment. It will apply concepts identified in the *Resource Handbook on DOE Transportation Risk Assessment* (Chen et al. 1999).

Limitations to the report include:

- The disposal configurations identified in this report should not be construed as policy. Policy will be determined when the DOE issues a Record of Decision (ROD) for LLW based on the *WM-PEIS*. The report is based on a today's understanding of waste loads (i.e., volumes and characteristics) and prospective generating sites (being considered in *the WM PEIS* ROD process) that could ship to NTS. The configurations were not crafted or altered by the authors of this report. It is recognized that waste volume loads and sites approved for disposal at NTS have been dynamic and are expected to remain dynamic until (and to a lesser extent after) the *WM PEIS* ROD is issued.

- This report does not attempt to anticipate new LLW transportation options that may result from Yucca Mountain high-level waste (HLW) decisions. However, data contained in this report may be useful to DOE management responsible for and stakeholders interested in cumulative transportation impacts associated with Yucca Mountain and HLW decisions.

- Assumptions concerning highway and rail routes are made that are representative (but not entirely reflective) of actual routes chosen by carriers. Assumptions are also made concerning locations of intermodal facilities near generator sites. They were made for purposes of assessment and are in no way binding on sites or carriers. Variations in routes and intermodal sites are expected; however, they are not expected to significantly impact the comparisons among alternatives.

- While the *NTS Intermodal EA* contains three potential intermodal sites, this report considers only two. For the purposes of this assessment, the Yermo, California, alternative is considered sufficiently reflective of the Barstow, California, alternative so the Yermo alternative was not analyzed.

- All LLW generating sites are assumed to ship waste to NTS via uniform volume "Sea-Land" containers. Additionally, all containers were assumed to be completely filled (if sufficient waste exists) to 75% by volume of the maximum cargo capacity of each shipping container. In reality, many different containers of varying capacity meet Department of Transportation requirements and could be used. Likewise, the fill rate of the assumed Sea-Land container could be constrained by weight and packaging (so the entire volume of the container may not be filled). If other assumptions concerning container volume or fill rate are made, impacts from this report can be scaled to the new volume. For example, if containers are assumed to be only 50% filled by volume, vehicle-related impacts could be multiplied by 1.5 (i.e., 75% divided by 50%). More shipments would be needed to transport the same volume of LLW, leading to higher transportation costs, higher nonradiological impacts, etc. Additional shipping containers may also be needed.

- Additional modeling assumptions have been made and are identified later in this report. Consistent assumptions tend to influence the *magnitude* of the impacts reported, rather than *trends* in impacts among alternatives. Therefore, more confidence should be placed in the trends among impacts than magnitude of impacts.

- Only state-specific accident statistics were used. Route-specific road segment accident statistics were insufficient to base an analysis upon.

- The report focuses on transportation -- it does not consider disposal cost. It also does not consider how transfer of hazard (i.e., LLW) from generator sites to NTS translates to transfer of mortgage (e.g., risk or cost).

Several interrelated tasks were performed to fulfill the purposes of this study. These tasks are listed below and brief descriptions are provided.

- **Rail/Intermodal Capability Assessment**: The capabilities of various DOE LLW generator sites to ship LLW to the NTS via rail or truck/rail intermodal service was investigated via telephone contacts with site representatives. Additional information was obtained from various published sources. This information was used to demonstrate whether it is feasible for waste generators to ship by rail and was also used in the evaluation of the costs and risks of rail/intermodal shipping configurations.

- **Transportation Cost Analysis**: This task calculated life-cycle (70 yr) transportation costs for various options for shipping LLW to NTS. Basic cost data were extracted from several sources and used to estimate the total life-cycle costs of transporting LLW to NTS.

- **Transportation Risk Analysis**: Life-cycle transportation risks were calculated using existing DOE methodologies, including the RADTRAN 4, HIGHWAY, and INTERLINE computer codes. These methods were used to calculate routine radiological doses to the public and workers involved in the transport of LLW to NTS, radiological accident risks, nonradiological accident risks, and risks from exposure to vehicle emissions. The cost and risk information was then integrated to identify tradeoffs among the shipping configuration options evaluated in this study.

- **DOE and Motor Carrier Routing Evaluations**: Information from a number of sources was collected and summarized to describe the evaluations performed by DOE and motor carriers relative to the transportation of LLW.

The results of the risk and cost analyses of each alternative LLW transportation configuration were combined with the evaluation of major stakeholder issues and the routing/risk analysis comparisons to develop insights that could help DOE to effectively manage LLW transportation system risks.

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2.0 LLW WASTE DISPOSAL OPTIONS AND SHIPPING DATA

This chapter provides supporting data for estimating the risks and costs associated with the increased use of rail to ship LLW to NTS disposal areas. Information in this chapter includes descriptions of the alternative shipping configurations examined in this study and site-by-site LLW generator waste loads.

2.1 DESCRIPTION OF ALTERNATIVE SHIPPING CONFIGURATIONS

Four alternative LLW transportation system configurations were constructed to examine the impacts on costs and risks of increasing the percentage of rail shipments to NTS. Two LLW volume projections to be shipped to NTS were also evaluated. The waste loads were taken from ongoing supplement analyses being conducted in support of the *WM-PEIS* Record of Decision (ROD) for LLW. In the first case, referred to here as the "high waste volume" case, all LLW shipped offsite is disposed at NTS. Four other sites dispose of their own LLW onsite, including Hanford, INEEL, Los Alamos, and SRS. This option maximizes the volume of LLW shipped to NTS. In the second case, referred to as the "low waste volume" case, both Hanford and NTS are used for offsite disposal of LLW, and INEEL, LANL, and SRS dispose of their LLW onsite (LANL also ships about 20% of its LLW to NTS). The volume of offsite waste shipped to NTS and Hanford is about equal. This option was selected for use in this study as it provides DOE with flexibility by maintaining two regional LLW disposal sites.

The four alternative transportation system configurations examined in this study were constructed to illustrate the potential differences in risks, costs, and operational efficiencies for increased use of rail service to NTS. The configuration options are labeled similarly to the alternatives analyzed in the *NTS Intermodal EA*. The four configurations are illustrated in Figures 2.1 and 2.2 and are described below.

Configuration 1A - Intermodal Service Via Barstow, California

This configuration is one of two analyzed in this study that avoids the Las Vegas Valley and Hoover Dam areas to the extent possible by encouraging the use of rail shipments to NTS (see Figure 2.3). Existing rail lines would be used to transport the wastes from LLW generator sites to Barstow, CA. At Barstow, the waste containers, which may be truck trailers loaded onto rail flatcars, would be transferred from railcars to trucks, and transported to NTS via I-15, CA 127, NV 373, and US 95. The intermodal facility at Barstow would be used to transfer the loaded shipping containers onto trucks for transit to NTS disposal areas. Generator sites without rail service currently would need to use trucks to ship to an intermodal transfer facility near their site to use this intermodal option. This configuration was constructed to examine the costs and risks of increasing the use of rail service for LLW shipments to NTS. It would involve establishing intermodal transfer capabilities[1] at generator sites currently without rail service as well as intermodal transfer capabilities at Barstow, CA. This alternative explores the costs and benefits of long-distance rail shipments for LLW and avoidance of truck shipments through the Las Vegas Valley and Hoover Dam areas to the extent practicable. Small quantity generator sites, where it would not be cost-effective to invest in direct or intermodal rail service, were assumed to ship via highway routes that avoid Las Vegas and Hoover Dam.

[1] DOE and its contractors are not anticipated to invest in new facilities or equipment to establish intermodal service. This is assumed to be a business decision on the part of the private sector.

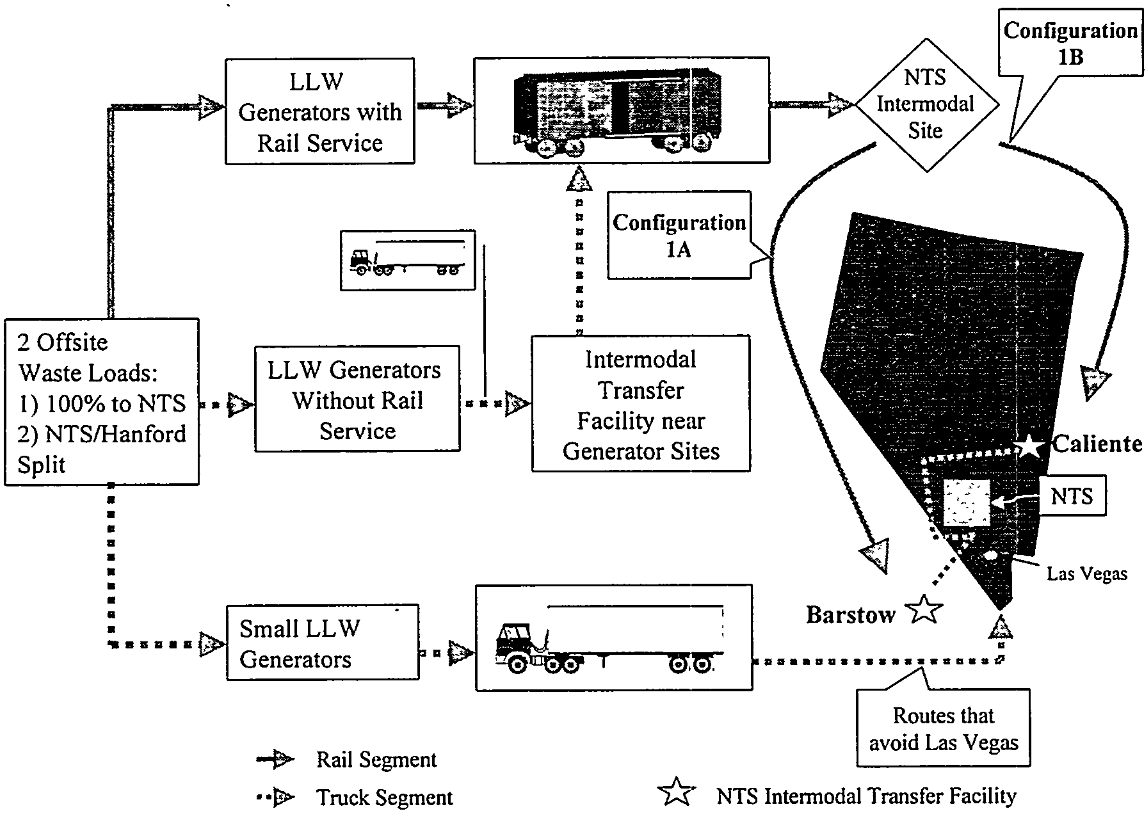


Figure 2.1. Illustration of Rail/Intermodal Shipping Configurations 1A and 1B

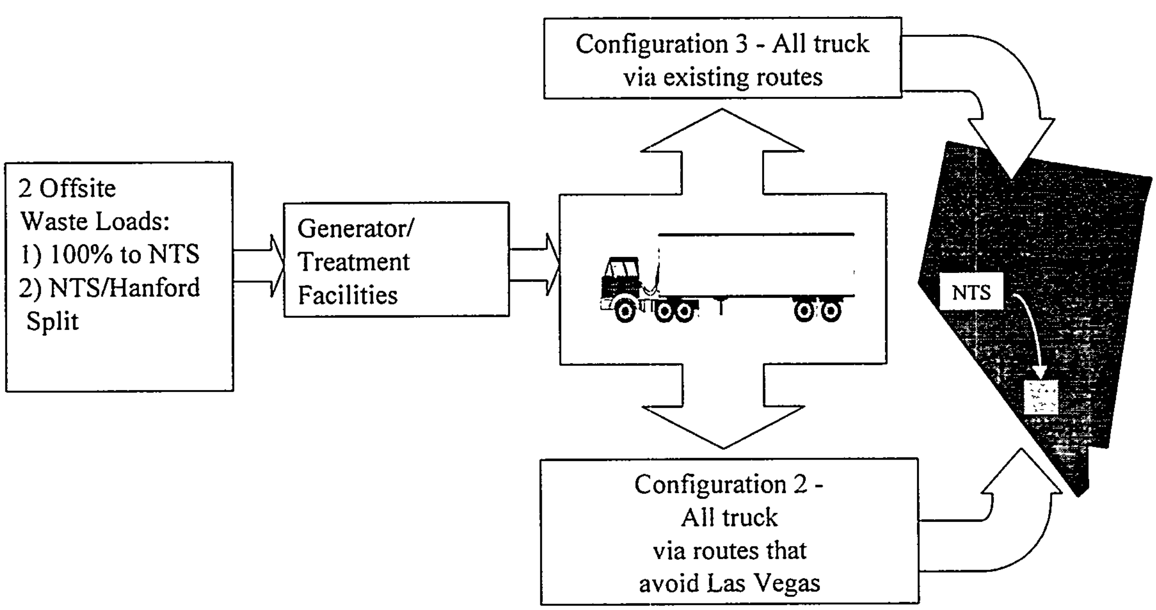


Figure 2.2. Illustration of All-Truck Shipping Configurations 2 and 3

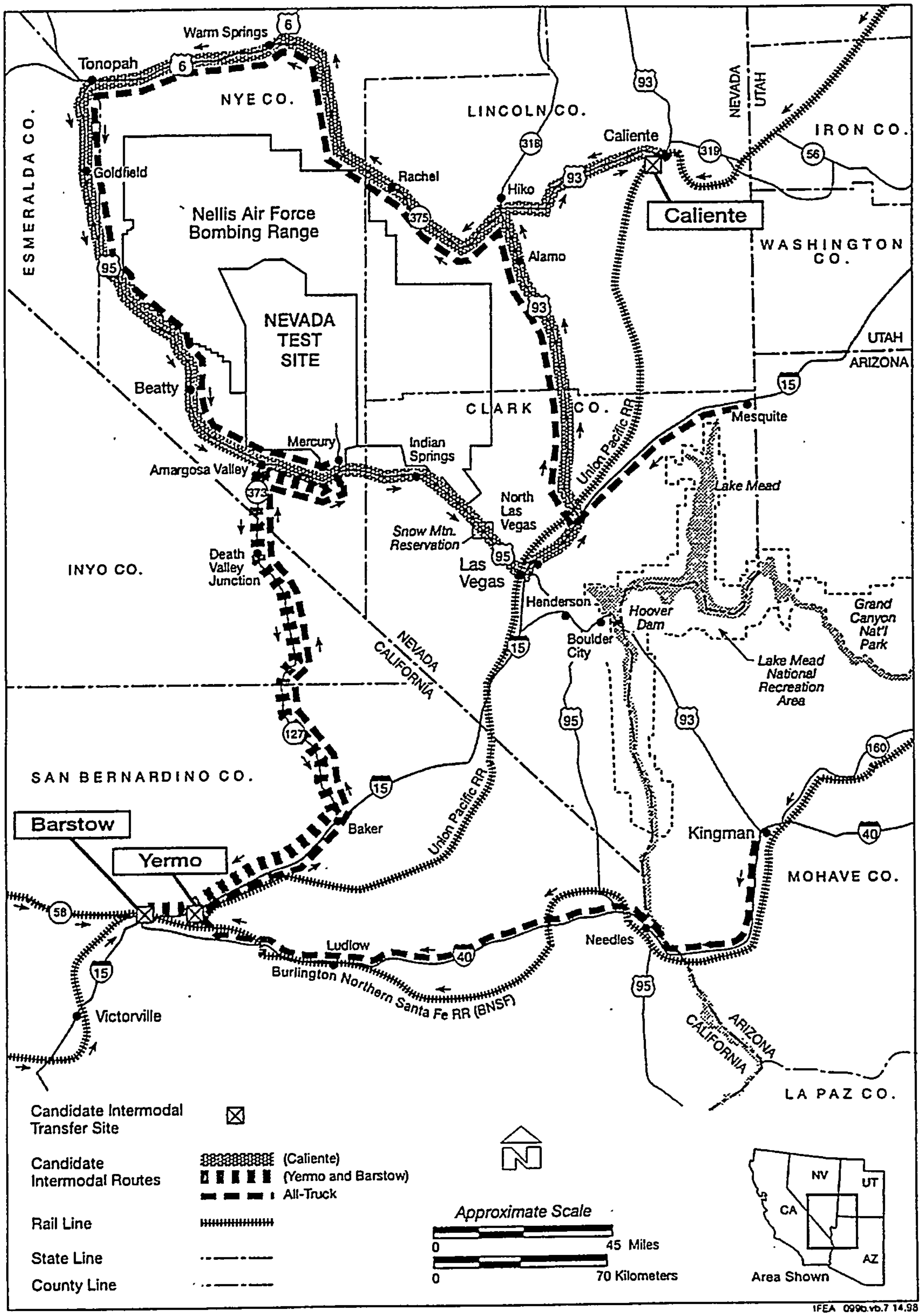


Figure 2.3. Intermodal Routes and Highway Routes that Avoid Las Vegas Enroute to NTS

Configuration 1B - Intermodal Service Via Caliente, Nevada

This configuration is similar to Configuration 1A in that it avoids the Las Vegas Valley and Hoover Dam areas to the extent possible by encouraging the use of rail shipments to NTS. Existing rail lines would be used to transport the wastes from LLW generator sites to Caliente, Nevada. At Caliente, the waste containers would be removed from railcars, loaded onto trucks, and transported to NTS via US 93, NV 375, US 6, and US 95. An intermodal facility at Caliente would be used to transfer the loaded shipping containers onto trucks for transit to NTS disposal areas. The facility would also be used to load empty containers onto railcars for further use. A different route (i.e., via US 95, I-15, and US 93 that traverses the Las Vegas Valley) could be followed for empty return shipments to reduce the distance and transit time and allow the opportunity to use maintenance and service facilities in Las Vegas. As with Configuration 1A, generator sites without rail service currently would need to invest in direct rail access or intermodal transfer capabilities to use the intermodal option at NTS. This configuration would involve establishing intermodal transfer capabilities at generator sites currently without rail service, would take advantage of lower risks for rail shipments, and would avoid truck shipments through the Las Vegas Valley and Hoover Dam areas. Small quantity generator sites, where it would not be cost-effective to invest in direct or intermodal rail service, would ship via highway routes that avoid Las Vegas and Hoover Dam. No distinction is made here between the Caliente In-town and South sites for the potential intermodal transfers that were considered in *the NTS Intermodal EA.*

Configuration 2 - 100% Truck Via Routes that Avoid Las Vegas

This configuration combines *NTS Intermodal EA* Alternatives 2A and 2B. In this configuration, all LLW shipments to NTS would be by truck over more circuitous routes that avoid the Las Vegas Valley and Hoover Dam (see Figure 2.3). Truck shipments that currently use the US 93 route that enters Nevada from the southeast would deviate at Kingman, Arizona, continuing on Interstate 40 (I-40) until it intersects with Interstate 15 in Barstow, California. At Barstow, the truck would take: I-15 northeast to Baker, California; California 127 north; and then Nevada 373 and US 95 to NTS. Shipments that currently enter Nevada from the east on I-15 would deviate from the current routes at the intersection with US 93. The shipments would take US 93 north to the intersection of Nevada 375, follow Nevada 375 northwest to US 6, travel west to US 95 at Tonopah, NV, and then take US 95 south to NTS. This configuration was constructed to compare the impacts of alternative highway routes to NTS. It would not involve the costs to upgrade NTS and LLW generator sites to rail or intermodal service, and would involve longer transit times and highway distances. However, this would avoid the highly populated Las Vegas Valley and recreation facilities at Hoover Dam.

Configuration 3 - 100% Truck Via Existing Routes

This configuration represents the No-Action Alternative in the *NTS Intermodal EA*. It assumes LLW transportation to NTS would continue via legal-weight truck across Hoover Dam and through metropolitan Las Vegas (see Figure 2.4). The highway routes would enter Nevada on Interstate 15 (I-15) or U.S. Highway 93 (US 93) and travel through Las Vegas and on to NTS. The US 93 route, which is used by more than 80% of the shipments, also travels over Hoover Dam. The remaining 20% of the shipments enter Nevada from the east or west on I-15. This configuration provides a basis for comparing the risk and cost impacts of alternative highway and rail configurations that avoid the

Planned Las Vegas Beltway

A beltway is currently being constructed around the urban center of Las Vegas. The initial beltway facility is planned to be completed by 2003. It is unknown if use of the beltway by LLW shipments would alleviate the concerns of Las Vegas residents about shipping radioactive material through the city on I-15 and US 95. The beltway also gives rise to two potentially more-optimum intermodal transfer facilities, one southwest and one northeast of the city center. Further analyses are necessary to evaluate these potential intermodal alternatives.

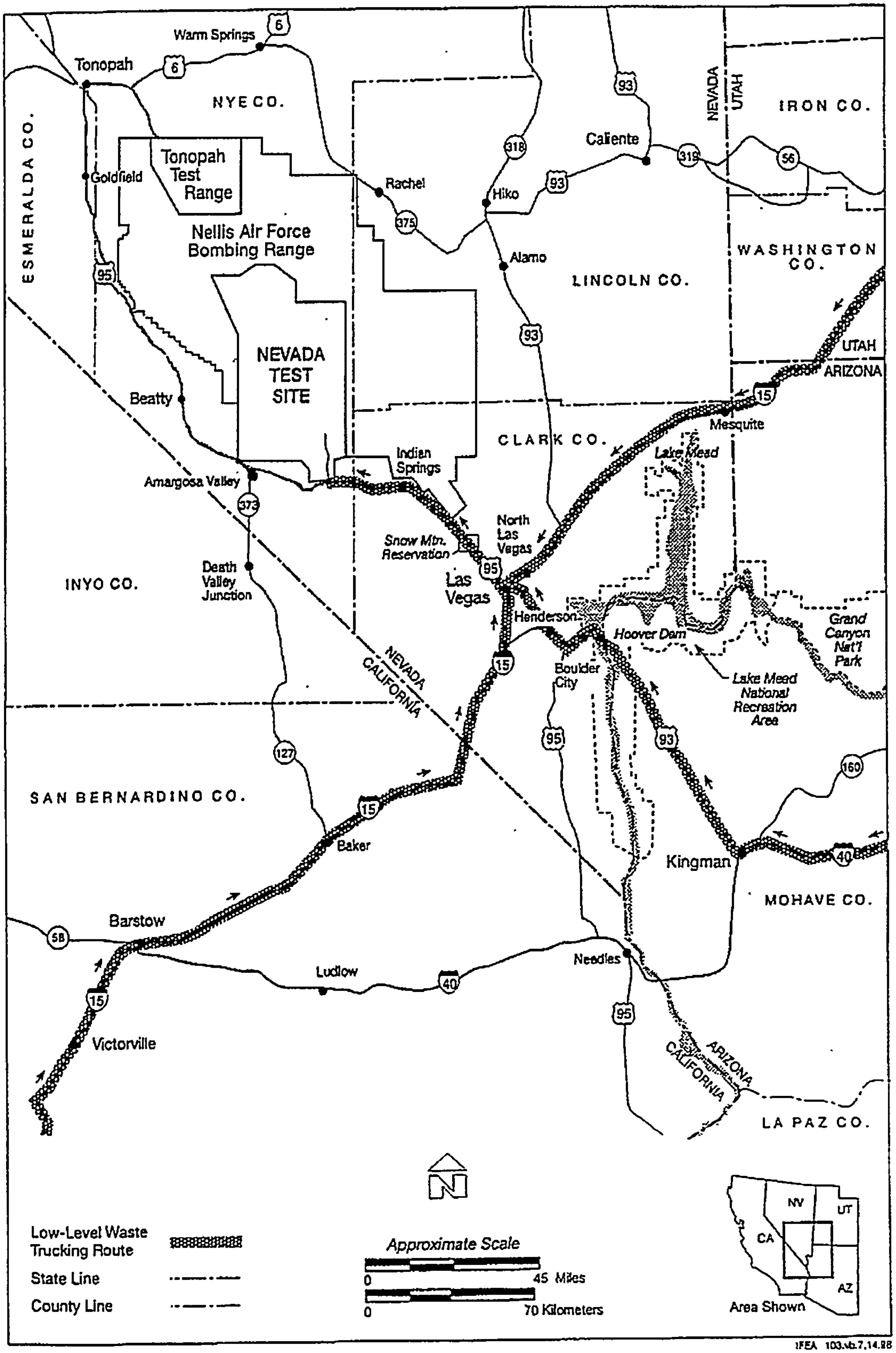


Figure 2.4. Current Highway Transport Routes to NTS

Las Vegas Valley. Changes in costs and risks estimates for the other configurations will be measured against this alternative

2.2 WASTE VOLUMES AND SHIPPING DATA

Two NTS disposal cases were examined in this study: 1) high waste volume case, and 2) low waste volume case. Waste volumes and shipping data were obtained from the Consolidated PBS Quantity Tables (CPQT) database, which is being used in the supplement analyses being conducted to support the *WM-PEIS* ROD. The CPQT data is an improved and evolved version of the database used in preparation of *Accelerating Cleanup - Paths to Closure* (DOE 1998b). The data used here is a snapshot of the CPQT data provided in late FY 1998. The CPQT data was characterized as becoming more stable as it has evolved and the data provided by the sites has become more and more consistent from year to year. The CPQT database is being placed under formal change control and this will improve its future stability.

2.2.1 High Waste Volume Case

In the high waste volume case, NTS is the primary disposal site for offsite LLW. A small quantity of offsite LLW is also disposed at Hanford but the bulk is disposed at NTS. Figure 2.5, generated using waste volume data from the CPQT database, illustrates the life-cycle LLW volumes to be disposed onsite (i.e., disposed at the generator site) and at offsite LLW disposal facilities. The waste volumes include those projected to be generated from Waste Management (WM) and Environmental Restoration (ER) activities at DOE sites. Note that there are five other LLW disposal sites, including Hanford, INEEL, LANL, SRS, and a commercial disposal site. The four DOE sites will continue to dispose of LLW onsite. The LANL and INEEL will continue onsite disposal until the projected capacity is reached and then will ship the remaining LLW to NTS for disposal. The commercial disposal site will dispose of certain LLW streams from ANL-E, LLNL, LBL, and SRS and certain ER LLW streams from BNL, ETEC, LANL, LBNL, and Pantex.

As shown in Figure 2.5, NTS is projected to receive about 740,000 m^3 (26 million ft^3) of LLW over the 70-yr life-cycle from offsite generators. This is the upper bound LLW volume to be shipped to NTS considered in this study. This does not include about 215,000 m^3 of LLW projected to be generated onsite at NTS, predominantly from ER activities.

Table 2.1 provides the waste loads to be transported to NTS from each generator site under the high waste volume case. As with the data in Figure 2.5, the site-by-site waste volume data were extracted from the September version of the CPQT database. The data provides the current projected life-cycle LLW volumes from both DOE-EM Waste Management operations as well as waste volumes projected to result from Environmental Restoration activities at DOE sites. The data was provided by the LLW generator site. It should be noted that waste volume projections over a 70-yr period have substantial uncertainties. However, the uncertainty in the waste volume projections does not affect the comparisons between shipping configurations as the uncertainties apply equally to all alternatives.

As shown in Table 2.1, over 93% of the total LLW volume destined for disposal at NTS under the high waste volume case is generated at nine sites (shaded area of Table 2.1). These nine sites are the most likely candidates for intermodal transport and, if significant cost and risk reductions are anticipated to result from increased use of rail service, the bulk of the savings will be derived from these sites. The other sites shown in Table 2.1 represent relatively small quantities of LLW and thus less significant cost and risk reductions from increased use of rail service. It was assumed that these sites would continue to ship by truck.

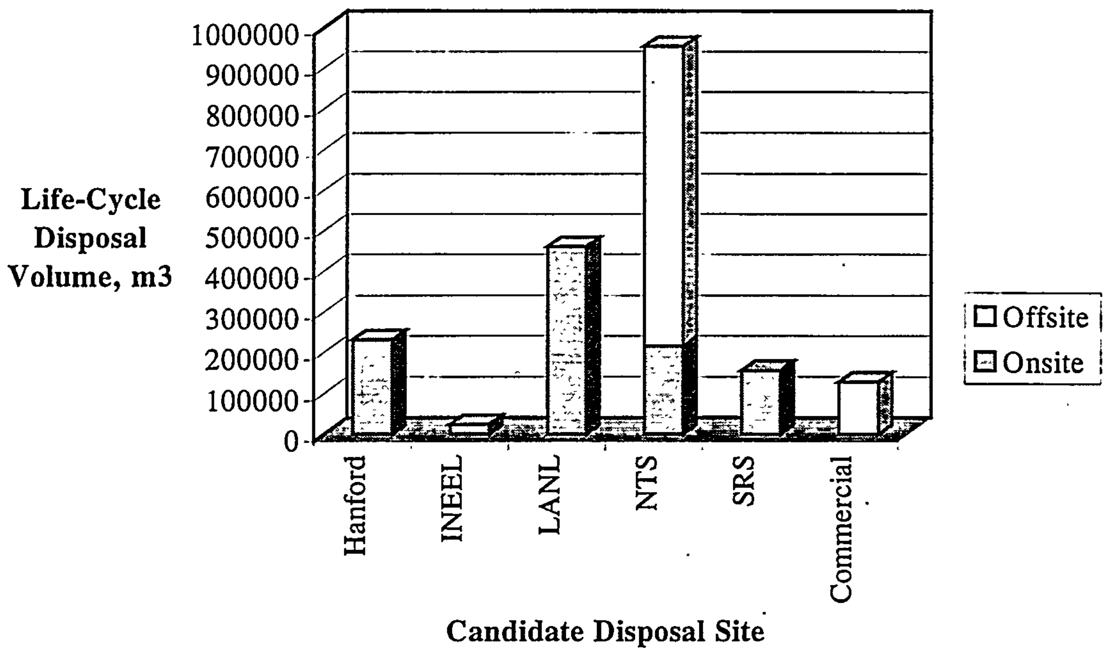


Figure 2.5. Life-Cycle LLW Disposal Volumes for the High Waste Volume Case

Staff of the DOE National Transportation Program (NTP) were requested to perform a detailed sort of the CPQT data to determine if the annual waste flows to NTS were within the analyzed boundaries of the *NTS Site-wide EIS.* Figures 2.6 and 2.7 present annual waste flows to NTS for the near-term (through 2010) and life-cycle (through 2070), respectively. As shown in Figure 2.6 (near-term), the largest annual flow occurs in the year 2001 and amounts to just over 40,000 m^3 (1,410,000 ft^3) of LLW per year. This is well below the upper bound LLW annual receipt rate analyzed in the *NTS Site-Wide EIS*, Expanded Use Alternative.

The numbers of shipments from the various waste generators to the NTS for the high waste volume case are shown in Table 2.2. The numbers of shipments were calculated by dividing the total inventory projected to be shipped by an assumed LLW shipment capacity. Each LLW shipment was assumed to consist of packaged LLW (e.g., 55-gal drums or standard boxes) within an external steel box shipping container, similar to the 20-ft Sea-Land container assumed in the *NTS Intermodal EA*. One container would be transported per truck shipment and three per rail shipment. It was assumed that each container would be loaded to 75% of its maximum cargo capacity or approximately 26.7 m^3 (940 ft^3) per truck shipment and 80 m^3 (2800 ft^3) per rail shipment. The shipment capacities were not adjusted to account for packaging efficiencies or weight limitations. Since this assumption was applied to all shipping configurations, it does not affect the trends in cost or risk impacts between the all-truck and rail/intermodal options.

2.2.2 Low Waste Volume Case

In this case, NTS and Hanford are the sites for disposal of LLW generated elsewhere. The volumes of waste shipped to NTS are about the same as the waste volume shipped to Hanford from offsite LLW generators (exclusive of large volumes of contaminated soil and debris that will be generated by

Table 2.1. Life-Cycle LLW Volumes to be Transported to NTS under the High Waste Volume Case[(a)]

LLW Generator Site[(b)]	Life-Cycle Waste Volume, m³			Percentage of Total	Cumulative Percentage
	Waste Management	Environmental Restoration	TOTAL		
ORR	242,160	20,267	262,427	35.52%	35.52%
LANL	102,022	0	102,022	13.81%	49.33%
Fernald	0	83,591	83,591	11.31%	60.64%
RFETS	20,215	44,817	65,032	8.80%	69.44%
Mound		64,177	64,177	8.69%	78.13%
LLNL	37,216	0	37,216	5.04%	83.17%
BNL	17,213	18,421	35,634	4.82%	87.99%
INEEL	24,860	0	24,860	3.36%	91.35%
ANL-E	13,217	778	13,995	1.89%	93.25%
WVDP	11,297	0	11,297	1.53%	94.78%
BCL	0	9,192	9,192	1.24%	96.02%
SPRU	0	8,220	8,220	1.11%	97.13%
Sandia	3,684	1,387	5,071	0.69%	97.82%
PGDP	4,379	0	4,379	0.59%	98.41%
ETEC	0	3,401	3,401	0.46%	98.87%
ITRI	2,313	0	2,313	0.31%	99.19%
PORT	2,031	0	2,031	0.27%	99.46%
PPPL	1,960	0	1,960	0.27%	99.73%
Pantex	1,403	0	1,403	0.19%	99.92%
LBL	434	0	434	0.06%	99.97%
Ames	118	0	118	0.02%	99.99%
GJPO	0	55	55	0.01%	100.00%
GE Val	0	21	21	0.00%	100.00%
TOTAL	~ 480,000	~ 250,000	~740,000	NA	NA

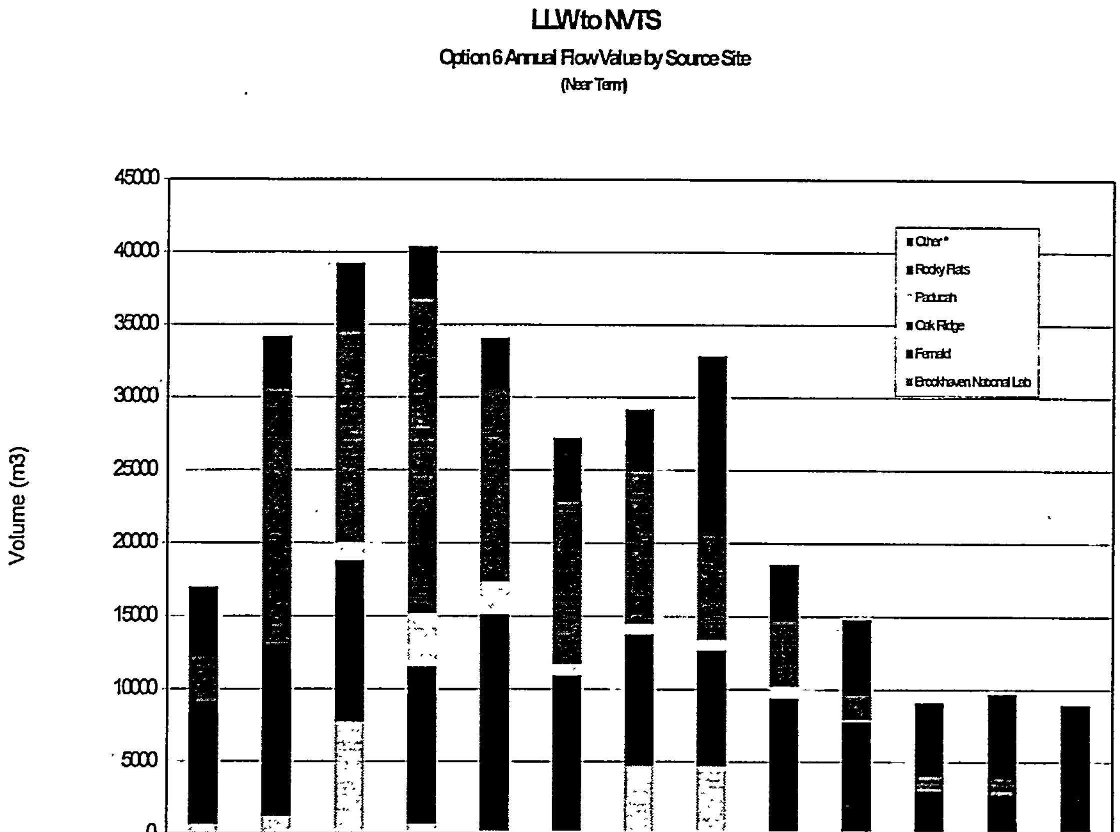
NOTE: Table contains excess significant figures that were retained for calculation purposes.

(a) Shaded region of table indicates most likely candidate LLW generator sites for rail/intermodal service. Waste volumes do not include LLW generated and disposed onsite at NTS.

(b) See glossary for definitions of acronyms used in this table.

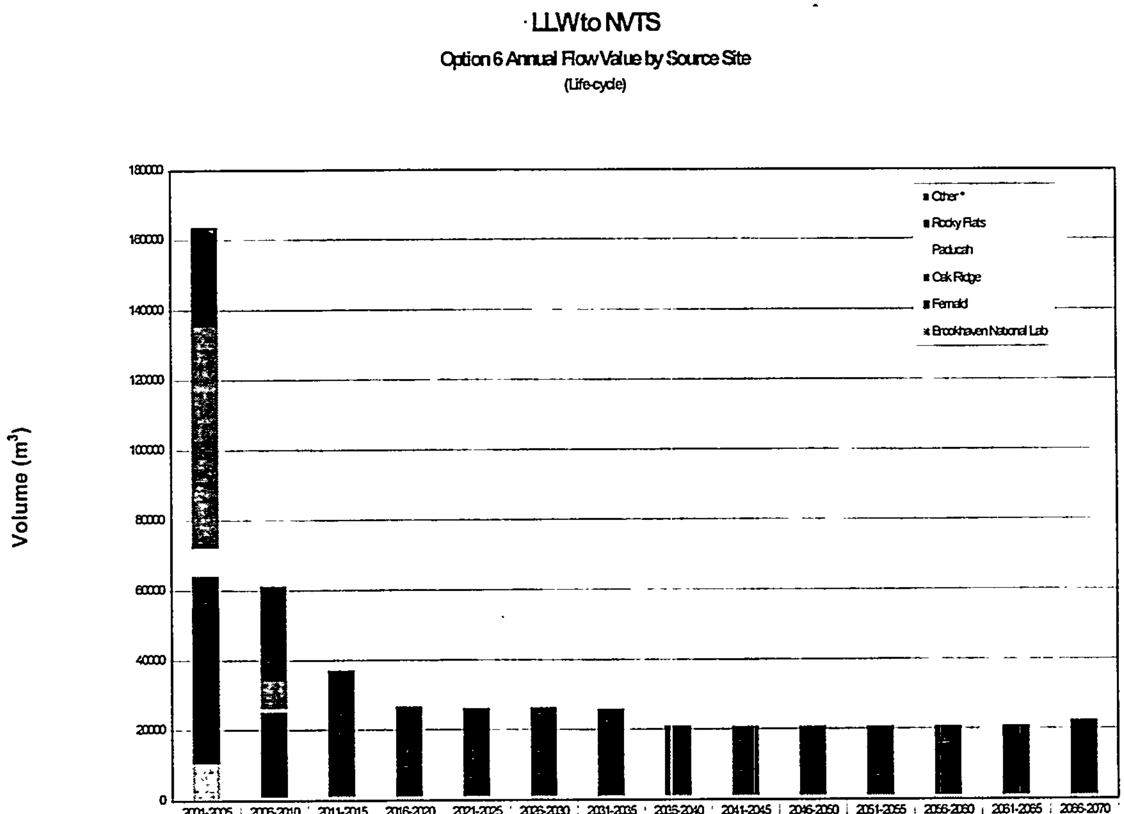
ER activities at Hanford and disposed onsite). Some LLW generators that ship to NTS in the high waste volume case will dispose of their waste at Hanford rather than NTS. Another key difference between this case and the high waste volume case is that some of the sites will dispose of certain categories of LLW onsite rather than shipping it to an offsite disposal facility.

Figure 2.8 illustrates the LLW volumes to be disposed onsite (i.e., at the LLW generator sites) and at offsite disposal facilities over the next 70 years. As with the high waste volume case, this data was developed using the August 1998 version of the CPQT database. Table 2.3 presents a summary of the LLW projected to be shipped to NTS for disposal from offsite LLW generators. Note that the offsite waste volume disposed at NTS is about one-third of the waste volume disposed at NTS in the high waste volume case. Several of the LLW generators that ship to NTS in the high waste volume case ship their waste to NTS in this case but some ship elsewhere.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Other*	4830.8	3706.38	4761.76	3672.71	3703.85	4350.01	4287.86	12391.31	3910.06	5246.720345	5190.770345	5892.194465	6882.944465
Rocky Flats	2945.2	17387.7	14449.7	21528.4	13005.6	11111.7	10358.5	7053.1	4364.5	1620.3	926.6	1059.6	0
Paducah	0	0	1200	3600	2226	780	750	732	816	84	0	0	0
Oak Ridge	848.41	1796.01	2689.9	1992.9	1263.1	1041.5	2441.4	2200.8	2105.3	3103.8	2169.6	1887.6	1887.6
Fernald	7695	10060.5	8324	8906	13661	9677	6606.5	5748	7101	4533	640	640	0
Brookhaven National Lab	684	1233	7798	704	236	235	4735	4735	235	236	235	235	235

Figure 2.6. Near-Term Annual LLW Flow to NTS for the High Waste Volume Case (numbers contain excess significant figures)



	2001-2005	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051-2055	2056-2060	2061-2065	2066-2070
Other*	28405.75	27122.68952	28685.32232	20286.77232	19876.92232	19991.87232	19540.92232	14591.6	14511.05	14507.7	14511.05	14507.7	14511.05	14518.6
Rocky Flats	63067.3	7981	0	0	0	0	0	0	0	0	0	0	0	0
Paducah	8088	900	0	0	0	0	0	0	0	0	0	0	0	0
Oak Ridge	8839.7	11153.9	7221.67	5365	5212	5192	5162	5162	5162	5162	5153	5132	5132	6759.79
Fernald	44597.5	12914	0	0	0	0	0	0	0	0	0	0	0	0
Brookhaven National Lab	10644	1175	1175	1175	1175	1175	1175	1175	1175	1175	1175	1175	1175	1175

Figure 2.7. Life-Cycle LLW Flow to NTS for the High Waste Volume Case (numbers contain excess significant figures)

Table 2.2. Numbers of Truck and Rail Shipments of LLW Destined for NTS Disposal Facilities – High Waste Volume Case (70-yr life-cycle)[a]

LLW Generator	Configurations 1A and 1B (Rail/Intermodal)		Configurations 2 and 3 (All Truck)	
	Truck or Rail	Number of Shipments	Truck or Rail	Number of Shipments
ORR	Rail	3,283	Truck	9,848
LANL	Rail	1,277	Truck	3,829
Fernald	Rail	1,046	Truck	3,137
RFETS	Rail	814	Truck	2,441
Mound	Rail	803	Truck	2,409
LLNL	Rail	466	Truck	1,397
BNL	Rail	446	Truck	1,338
INEEL	Rail	311	Truck	933
ANL-E	Rail	176	Truck	526
WVDP	Truck	424	Truck	424
BCL	Truck	345	Truck	345
SPRU	Truck	309	Truck	309
Sandia-NM	Truck	191	Truck	191
PGDP	Truck	165	Truck	165
ETEC	Truck	128	Truck	128
ITRI	Truck	87	Truck	87
PORT	Truck	77	Truck	77
PPPL	Truck	74	Truck	74
Pantex	Truck	53	Truck	53
LBL	Truck	17	Truck	17
Ames	Truck	5	Truck	5
GJPO	Truck	3	Truck	3
GE Val	Truck	1	Truck	1

(a) The table provides the number of long-haul shipments and does not provide information on the number of truck shipments between LLW generators and intermodal transfer facilities nor the number of truck shipments between Nevada intermodal facilities and NTS.

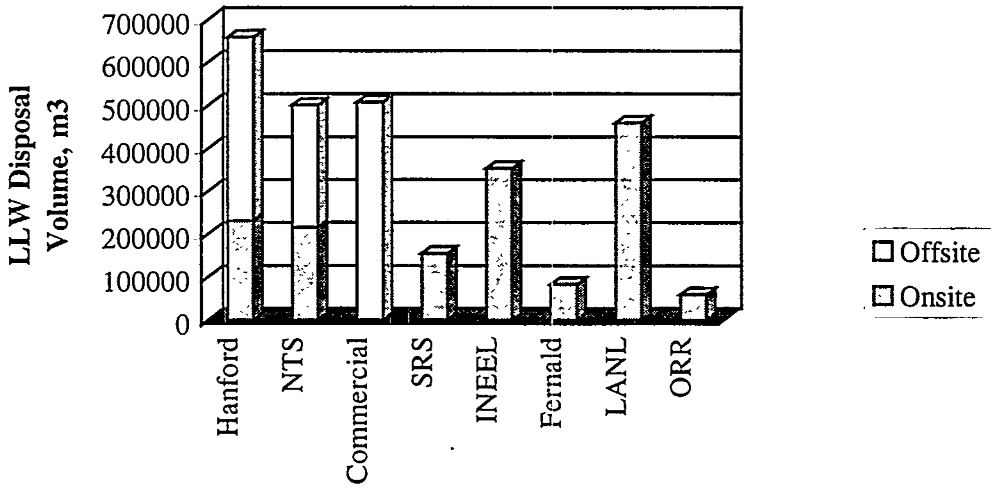


Figure 2.8. Life-Cycle LLW Disposal Volumes for the Low Waste Volume Case

Table 2.3. LLW Volume and Number of LLW Shipments[a] to NTS – Low Waste Volume Case[b]

LLW Generator	Waste Volume, m^3	Configuration 1A and 1B		Configuration 2 and 3	
		Truck or Rail	Number of Shipments	Truck or Rail	Number of Shipments
LANL	101,022	Rail	1,264	Truck	3,791
Fernald	83,591	Rail	1,045	Truck	3,131
RFETS	65,032	Rail	814	Truck	2,441
Mound	64,177	Rail	803	Truck	2,409
LLNL	37,216	Rail	466	Truck	1,397
Sandia	5,071	Truck	191	Truck	191
PGDP	4,379	Truck	165	Truck	165
ETEC	2,760	Truck	104	Truck	104
ITRI	2,313	Truck	87	Truck	87
PORT	2,031	Truck	77	Truck	77
Pantex	1,403	Truck	53	Truck	53
TOTAL	~369,000				

(a) The table provides the number of long-haul shipments and does not provide information on the number of truck shipments between LLW generators and intermodal transfer facilities nor the number of truck shipments between Nevada intermodal facilities and NTS.

(b) Shaded region of table indicates most likely candidate LLW generator sites for rail/intermodal service. Waste volumes do not include LLW generated and disposed onsite at NTS.

3.0 CAPABILITIES OF LLW GENERATORS TO SHIP BY RAIL TO NTS

Rail/intermodal access data for the LLW generators was collected via telephone contacts with the cognizant DOE Traffic Managers and is described in this chapter for nine sites. It is anticipated that not all sites will be candidates for rail/intermodal service. Some sites generate only small volumes of LLW and it would not be cost-effective to undertake projects to change over to rail or intermodal service. In addition, rail carriers are most interested in moving large volumes and would have high unit costs for small quantity generator sites. Thus, a cutoff was established below which changes to rail/intermodal capability were not investigated. The cutoff was established based on selecting the LLW generators that will ship over 90% of the LLW volume to be transported to NTS. These sites are the Oak Ridge Reservation (ORR), Los Alamos National Laboratory (LANL), Fernald, Rocky Flats Environmental Technology Site (RFETS), Mound, Lawrence Livermore National Laboratory (LLNL), Brookhaven National Laboratory (BNL), Idaho National Engineering and Environmental Laboratory (INEEL), and Argonne National Laboratory – East (ANL-E). For the small quantity LLW generator sites, a separate investigation will be conducted to explore the possibility they could ship LLW by truck to the nearest large quantity generator site and there it would be transferred onto railcars for shipment to NTS. The results of this assessment will be provided in the final report.

An informal phone survey of the traffic managers for these nine sites revealed that four of the nine sites surveyed do not have the capability to directly ship LLW offsite by rail (LANL, RFETS, ANL-E, and LLNL). The cost to upgrade three of the four sites without the capability to directly ship LLW by rail ranges from $500,000 to $10,000,000 based on a rule-of-thumb construction cost of $1,000,000 per rail mile. However, there is much uncertainty relative to the feasibility of obtaining access to construct a rail spur. The fourth site (Los Alamos National Laboratory) would require hauling the LLW approximately 40 miles by truck to the nearest rail access. Consequently, intermodal shipping was assumed for these sites.

The following sections summarize the results of the telephone surveys for each of the nine sites surveyed including the rail line serving the site and the site crane capacity.

3.1 OAK RIDGE RESERVATION

See Figure 3.1 for a map of the Oak Ridge Reservation (ORR).

K-25 Site

The K-25 site has the capability to ship LLW offsite by rail. Norfolk-Southern Railway Co. through Blair, TN, serves the K-25 facility. The facility performs internal switching within the plant area, taking delivery of cars from Southern Railway at the north end of the plant at an interchange yard located approximately 5 miles south of Blair. The facility's maximum crane capacity is 75 tons.

Y-12 Plant

The Y-12 Plant has the capability to ship LLW offsite by rail. The Y-12 Plant trackage connects at Oak Ridge, TN (DuPont Siding) with the CSX Railroad Company for this area. The Y-12 plant performs on-site internal switching arrangements. Trackage is available to receive 20 rail cars at one time. The facility crane capacity is 75 tons.

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DOE-OAK RIDGE INSTALLATIONS

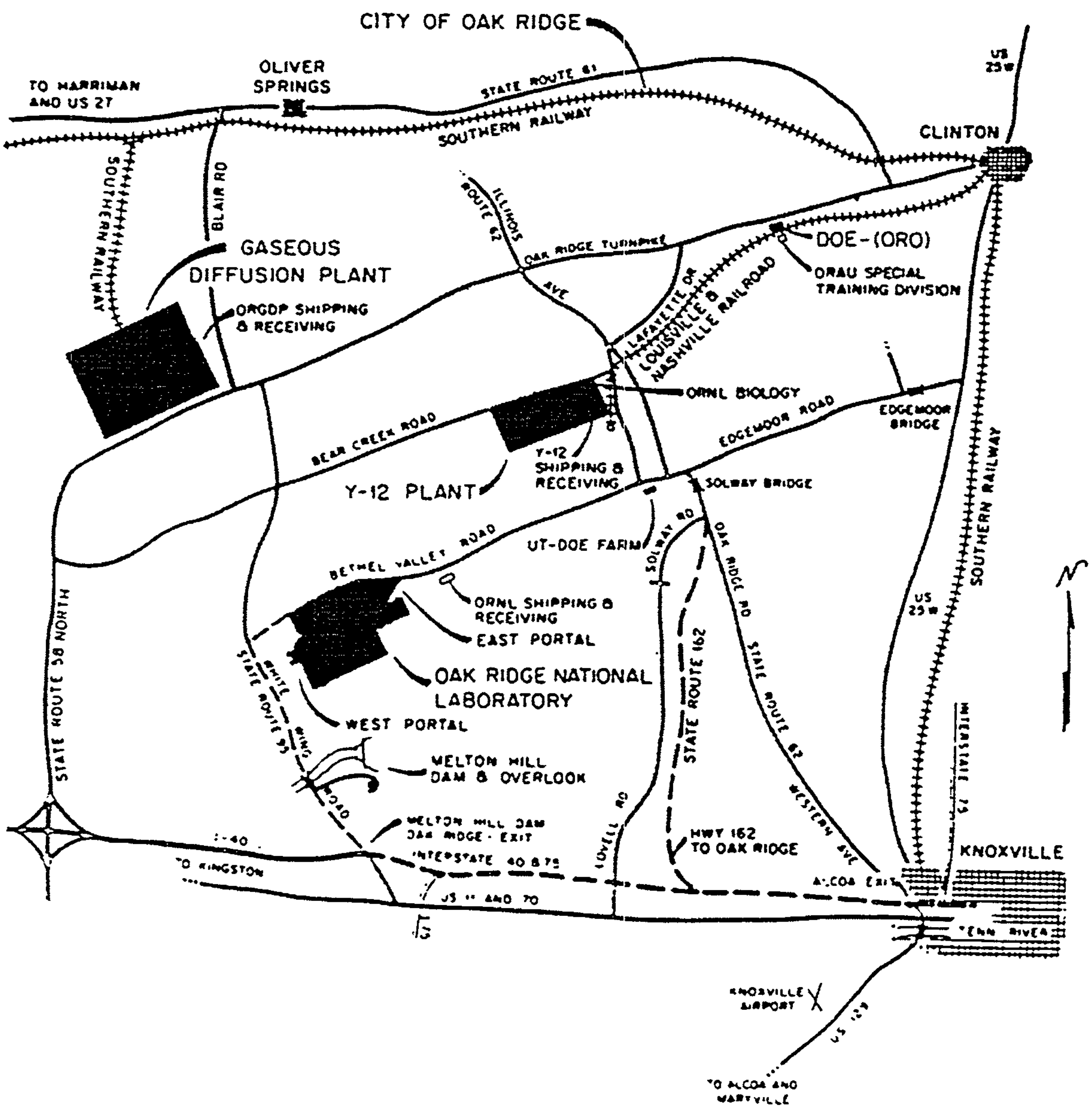


Figure 3.1. Map of Oak Ridge Reservation

3.2 LOS ALAMOS NATIONAL LABORATORY

There is no rail service to Los Alamos, NM. The nearest rail siding with unloading facilities is Lamy, NM, approximately 40 miles to the east. Rail and intermodal service is also available in Albuquerque, NM, approximately 100 miles to the south. The BNSF Railroad serves both. Facility crane capacity is 10 tons. A map of LANL is shown in Figure 3.2.

3.3 FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION (FERMCO)

The Fernald site has the ability to ship LLW offsite by rail. The Fernald site trackage connects at Shandon, Ohio, with the CSX System. The Fernald site performs internal switching and trackage is available to receive 30 rail cars. The mobile crane capacity is 33 tons. A map of Fernald is shown in Figure 3.3.

3.4 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

The Rocky Flats site does not currently have the capability to ship LLW offsite by rail. The installation of approximately 0.5 miles of rail track would be required to enable the shipment of LLW offsite by rail. The Union Pacific (UP) is the only line serving Rocky Flats, that also performs internal switching. There is a paved area for off-loading with a crane with a capacity of 25 tons. Intermodal service is available in Denver, approximately 20 miles from RFETS. A map of Rocky Flats is shown in Figure 3.4.

3.5 EG&G MOUND APPLIED TECHNOLOGIES, INC.

The Mound facility has the ability to ship LLW waste offsite by rail. Trackage connects at Miamisburg, OH, with Conrail, which performs internal switching. The facility crane capacity is 35 tons. A map of the Mound Site is shown in Figure 3.5.

3.6 LAWRENCE LIVERMORE NATIONAL LABORATORY

No rail sidings are available at the Lawrence Livermore National Laboratory. In Livermore, CA, the Public Team Tracks of Union Pacific Railroad are available. They are approximately four miles from the facility. Site 300 uses the Public Team Tracks of Union Pacific Railroad, in Tracy, CA, approximately 13 miles from Site 300. Facility Riggers with a 20-ton crane and other lifting equipment (fork-lifts, cherry-pickers) are available. A map of LLNL is shown in Figure 3.6.

3.7 BROOKHAVEN NATIONAL LABORATORY

The capability to ship LLW directly offsite by rail exists at Brookhaven. The Brookhaven site trackage connects at Yaphank with the Long Island Railroad. Trackage is available to receive 20 rail cars at one time. Side and end ramps are available. The facility crane capacity is 65 tons. A map of BNL is shown in Figure 3.7.

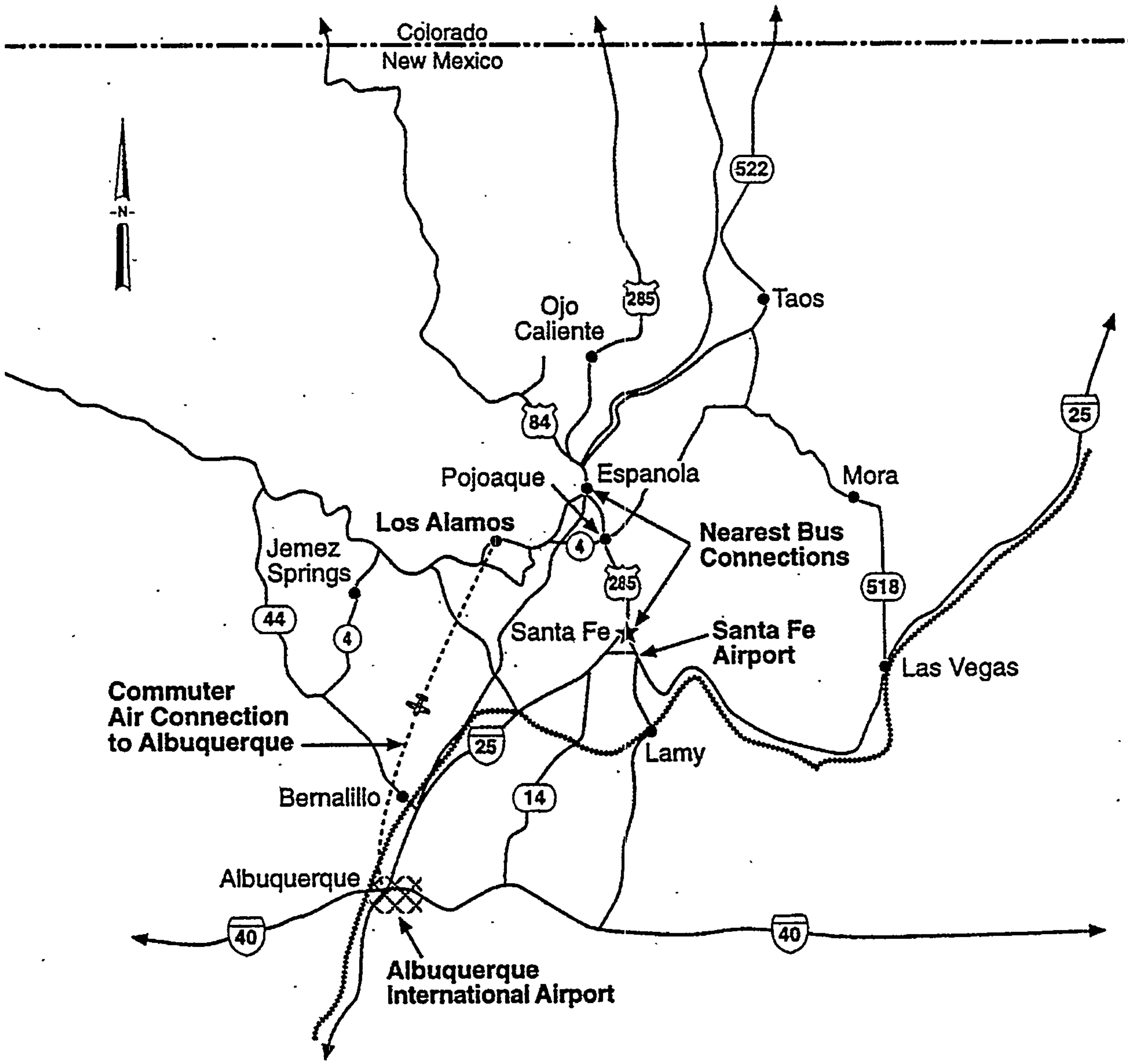


Figure 3.2. Map of Los Alamos National Laboratory Transportation Routes

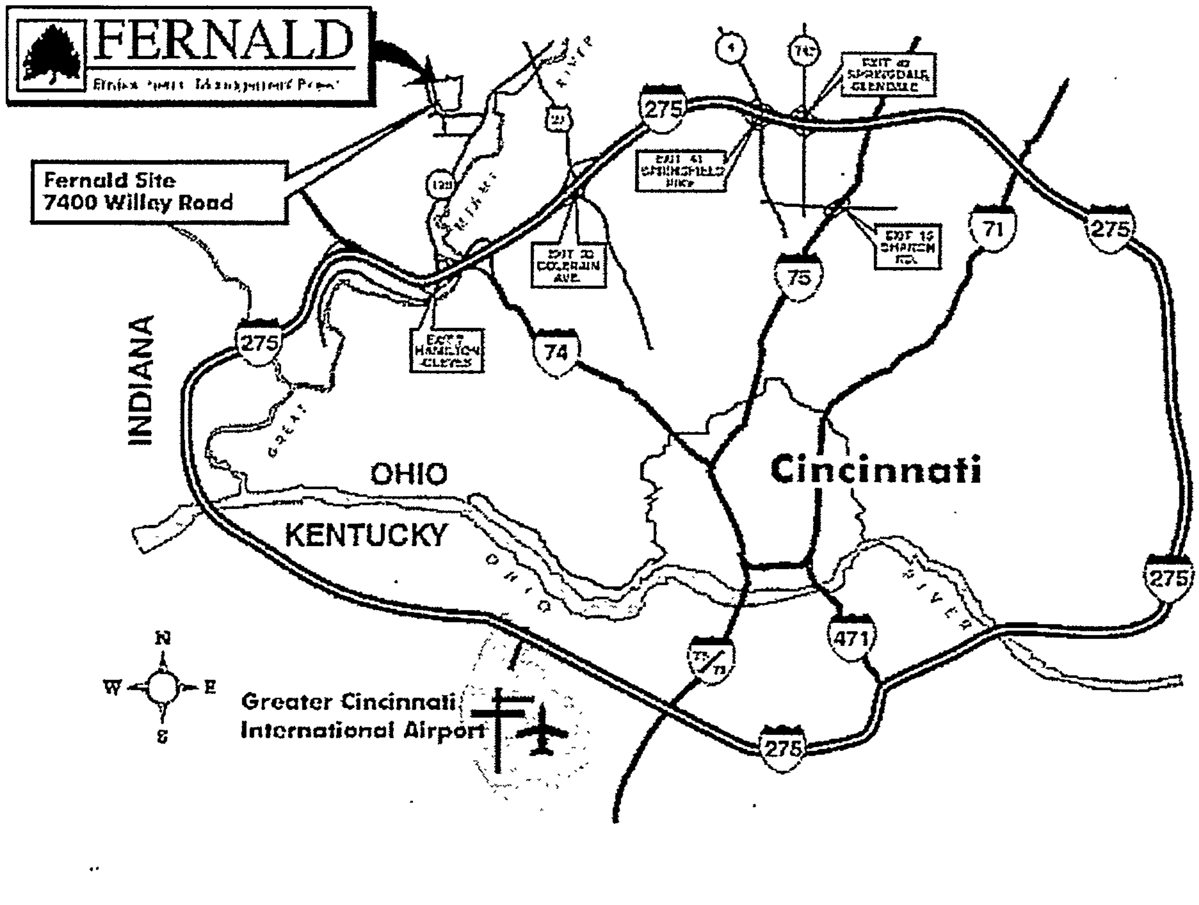


Figure 3.3. Map of FEMP Region

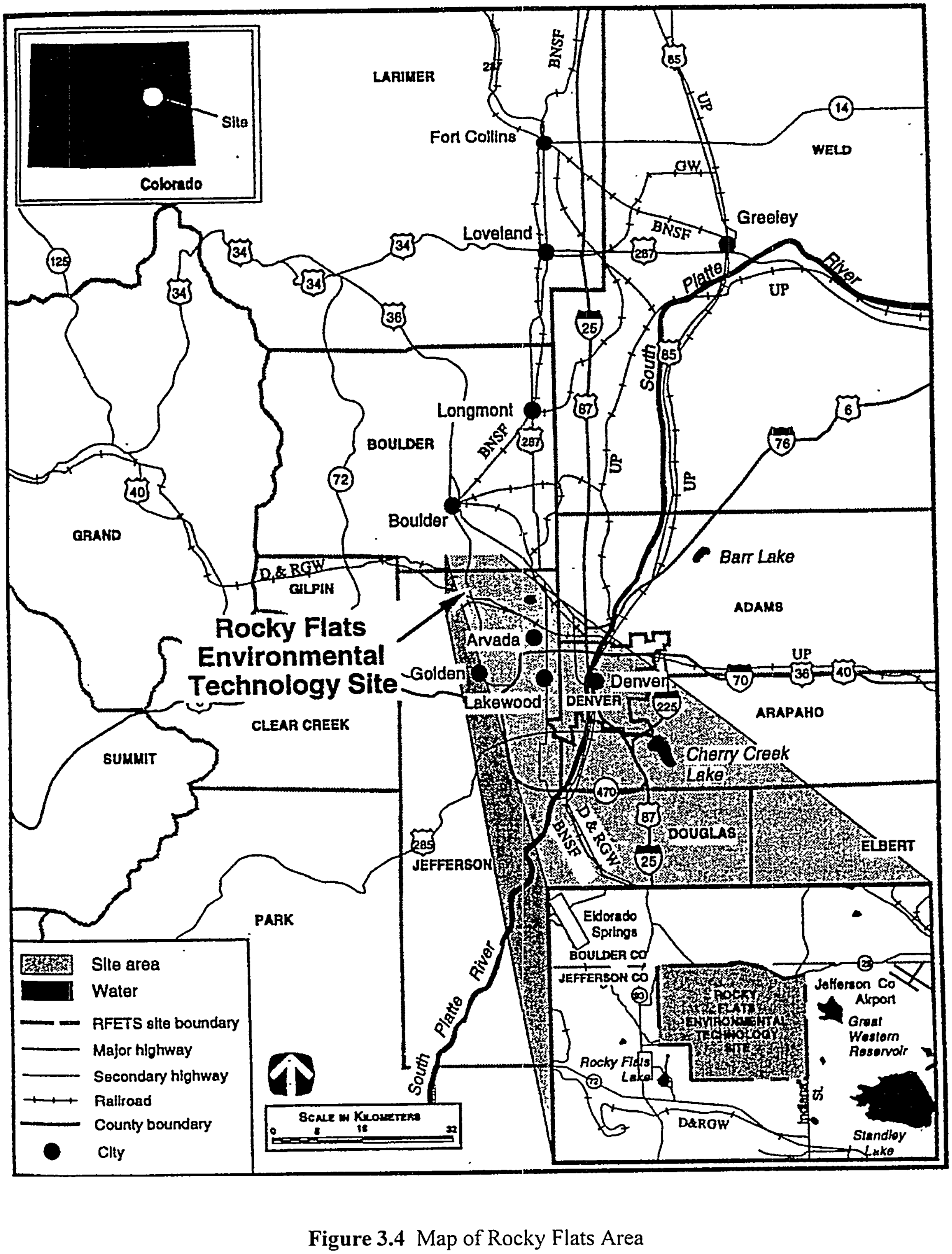


Figure 3.4 Map of Rocky Flats Area

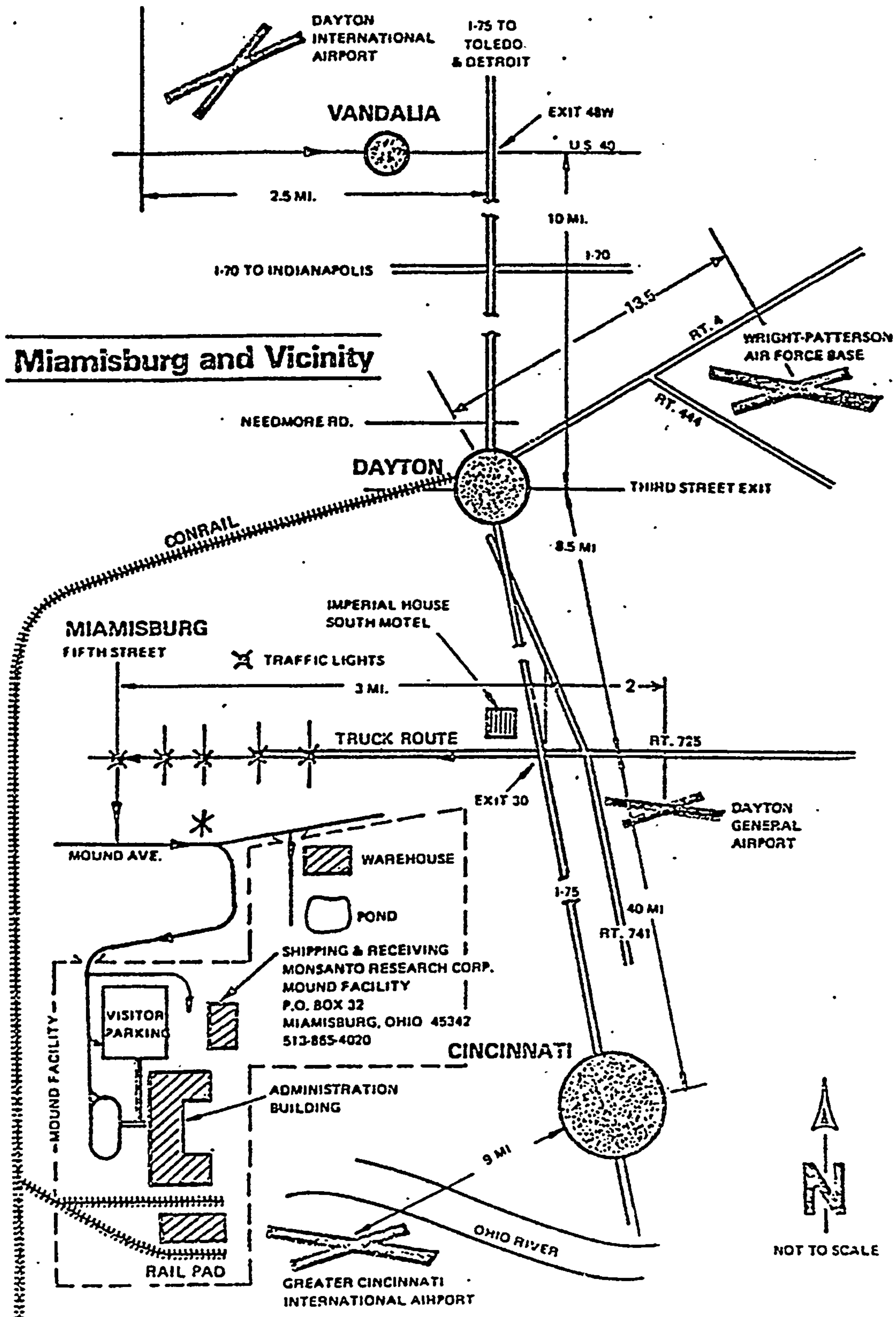


Figure 3.5. Map of Mound Area

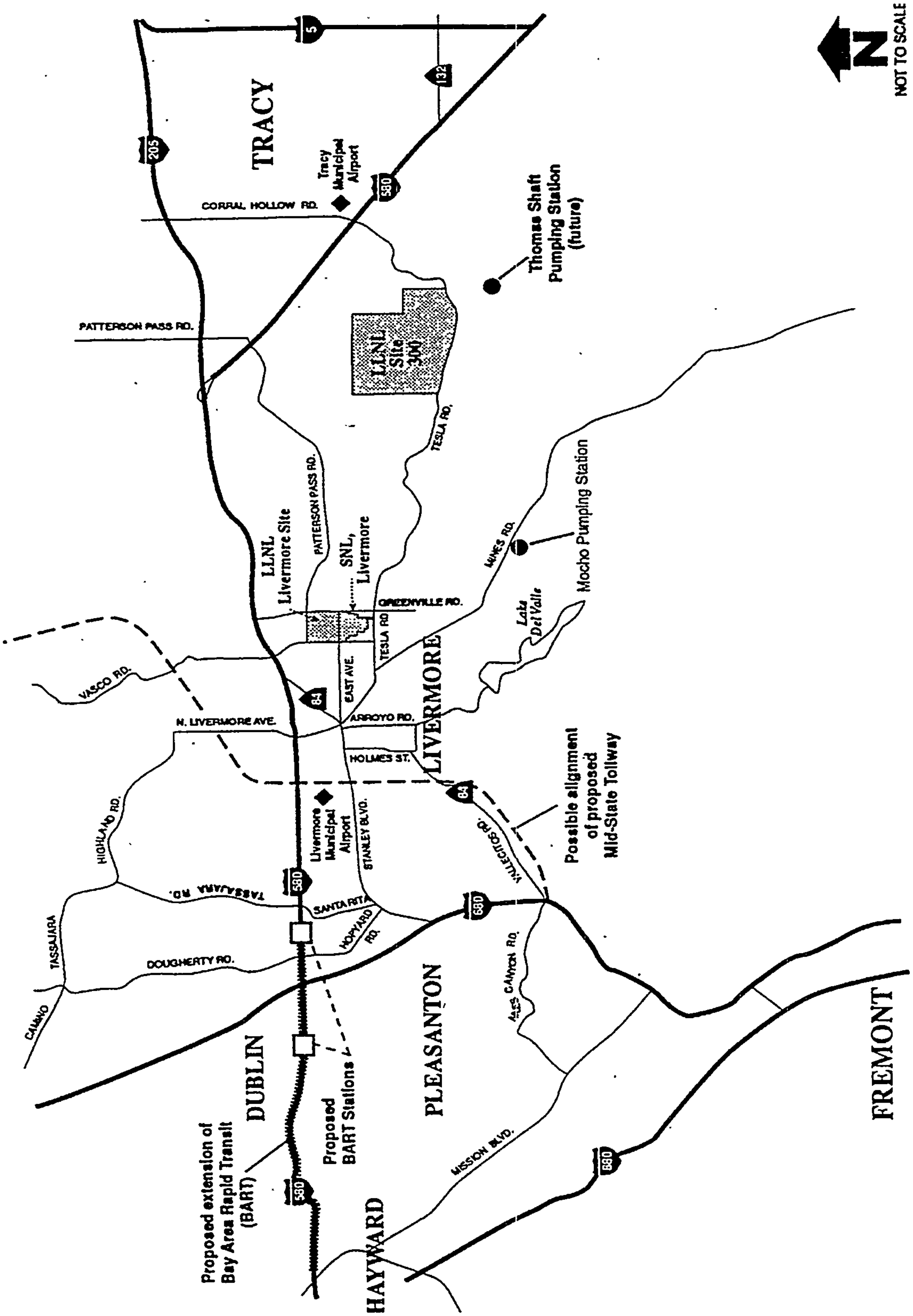
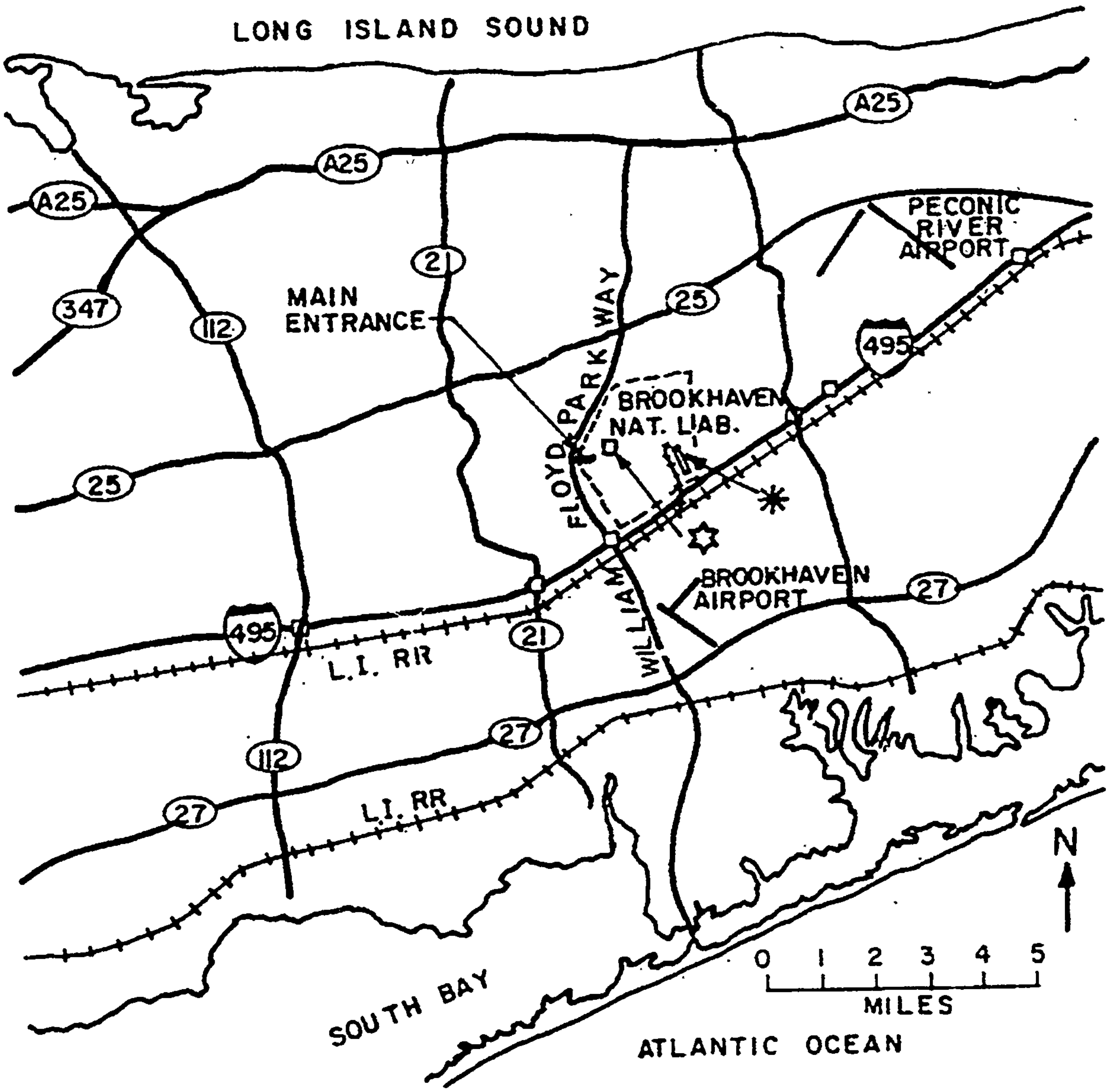


Figure 3.6. Map of LLNL Area



BROOKHAVEN NATIONAL LABORATORY

Figure 3.7. Map of BNL Area

3.8 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

INEEL has the capability to directly ship LLW by rail. INEEL site trackage connects with the Union Pacific Railroad at the Scoville, ID siding, approximately 3 miles from the Central Facility Area (CFA). The contractor or government performs internal switching. End ramp unloading is available in addition to routine flat and boxcars. The facility has a stationary gantry crane with a capacity of 160 tons and a mobile hydraulic crane with a capacity of 75 tons. A map of INEEL is shown in Figure 3.8.

3.9 ARGONNE NATIONAL LABORATORY – EAST

ANL-E does not currently have direct rail service although a rail spur does connect to the site. The opinion of those contacted indicated that intermodal service is more likely to be used in the future than direct rail service. The site is located approximately 10 miles from a railyard where trucks could deliver LLW to a rail shipper. Truck shipping facilities are provided with a 50-ton crane. A map of ANL-E is provided in Figure 3.9.

3.10 SUMMARY OF RAIL ACCESS INFORMATION

The following sites of the top nine LLW generators have direct rail service available for LLW shipments to NTS:

- Oak Ridge
- Fernald
- Mound
- INEEL
- Brookhaven

Of the top nine LLW generators, the following sites would require intermodal transfers near the origin facilities to ship LLW by rail. The distance from the generator sites to the nearest rail access point is also provided.

- Los Alamos: 40 miles to Lamy, NM, or about 100 miles to Albuquerque, NM
- Rocky Flats: Install about 0.5 miles of track to link to existing rail line
- LLNL: 13 miles to Tracy, CA
- ANL-E: approximately 10 miles to nearest railyard

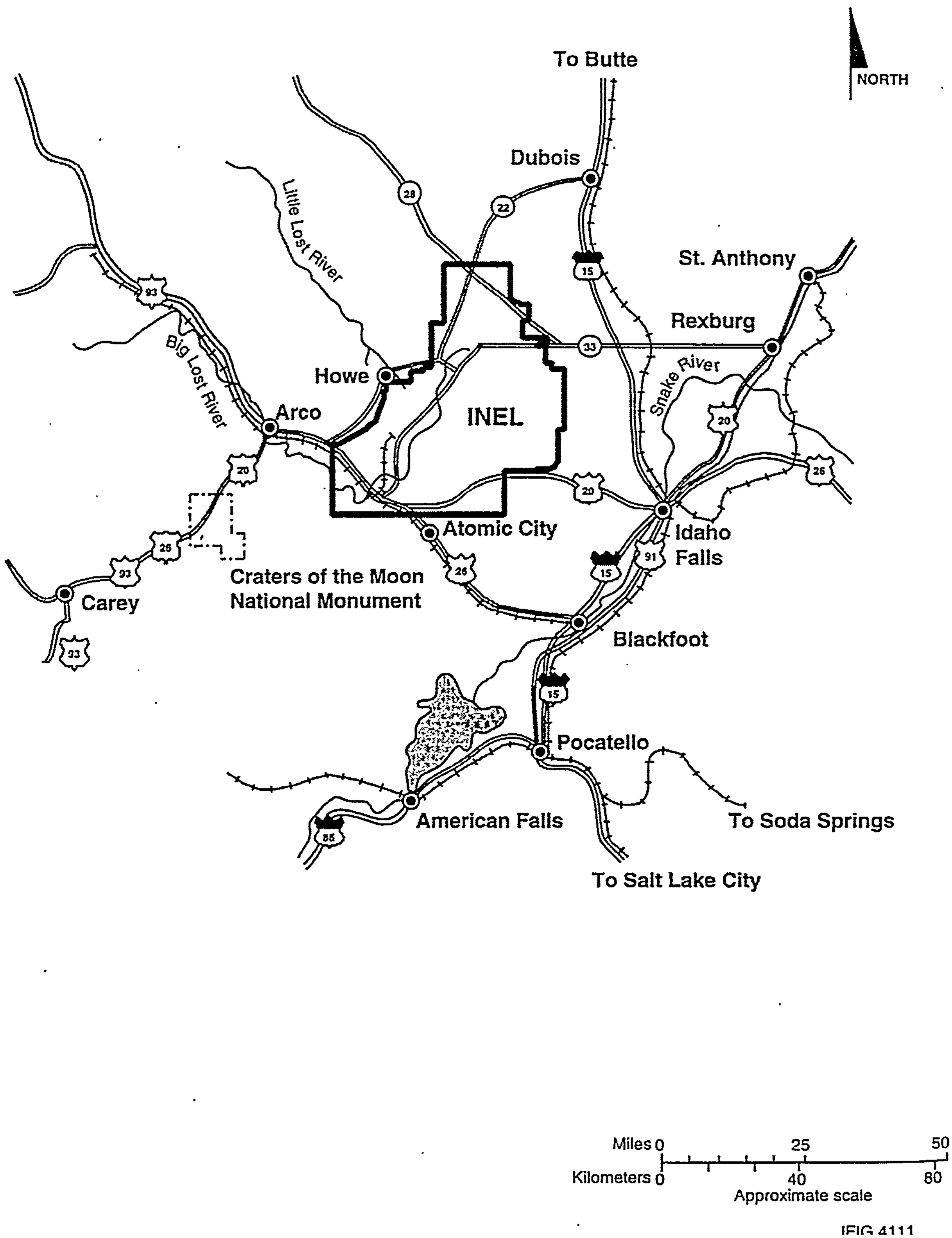


Figure 3.8. Map of INEEL Transportation Routes

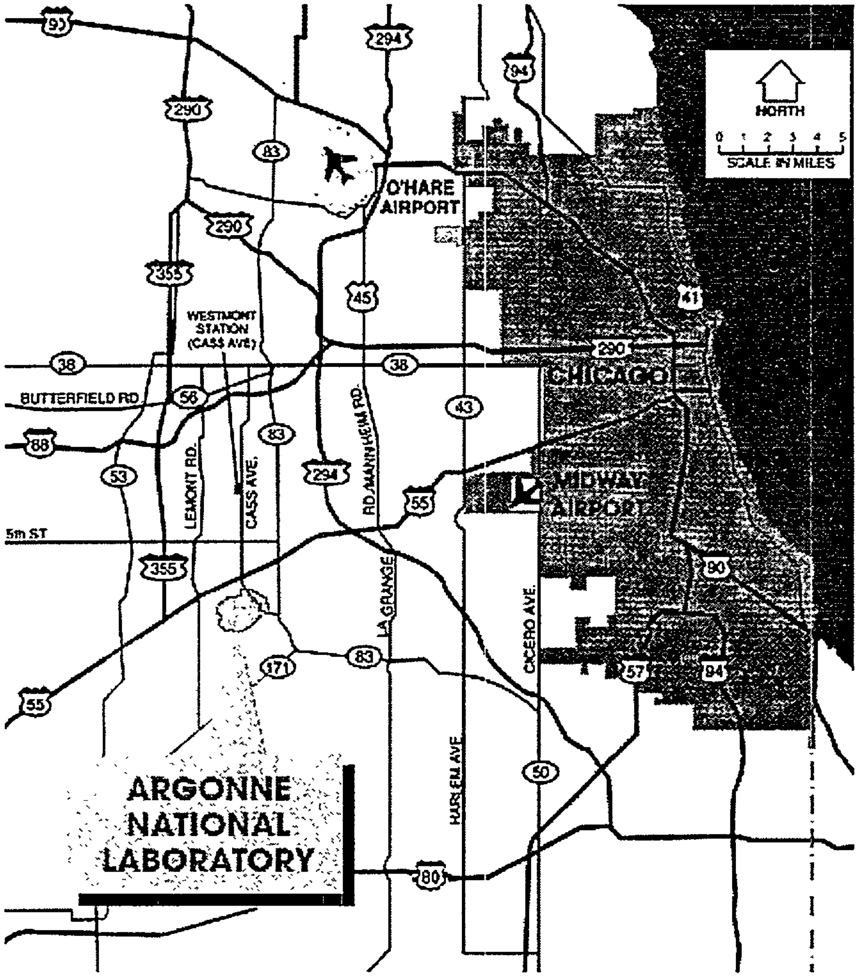


Figure 3.9. Map of ANL-E Transportation Routes

4.0 TRANSPORTATION COST ANALYSIS

This chapter presents basic unit transportation cost data that will be used in the cost analysis of the truck and intermodal shipping configurations. Cost data from published sources and historical cost data on DOE shipments are extracted and summarized in this chapter, along with recommendations on their use and applicability.

For this assessment, it was assumed that the costs to upgrade or modify potential intermodal transfer facilities to accept and handle LLW shipments would be borne by private industry. This is consistent with the *NTS Intermodal EA*. Since the shipments are speculative, based on generator LLW volume projections, negotiations between DOE and private industry have not yet occurred. However, based on the potential business represented by DOE's LLW shipments, it does not seem unreasonable that private industry would invest in such a business venture.

4.1 TRUCK AND RAIL CARRIER CHARGES

This section presents and compares truck and rail carrier cost information from three recent sources, including the *NTS Intermodal EA*, *WM-PEIS*, and historical data from and DOE's Enterprise Transportation Analysis System (ETAS) database. This data is summarized in Sections 4.1.1, 4.1.2, and 4.1.3, respectively. The rationale for selection of the basic carrier cost information used in the cost estimates in this study is presented in Section 4.1.3.

4.1.1 Transportation Cost Data from the *NTS Intermodal EA*

The *NTS Intermodal EA* provided transportation cost information that was obtained from carriers and LLW generators. The data includes truck and intermodal transportation costs for shipments of 20-ft containers from 11 LLW generators to NTS. This data is summarized in Table 4.1.

There are some important caveats that accompany the cost data. The data was obtained from commercial carrier companies and LLW generators so it represents reasonable estimates of true costs. However, actual costs will not be known until contracts are negotiated with carriers. The estimated costs are for transportation of LLW in 20-ft cargo containers; transportation in smaller or larger shipping containers would have different unit costs. One container would be shipped in each truck shipment and rail shipments could handle three containers per railcar. Shipment capacities are approximately 26.65 m^3 (940 ft^3) of LLW per truck shipment and 79.95 m^3 (2820 ft^3) of LLW per rail shipment. One final caveat is that the cost estimates are based on reasonable throughput rates. Unit costs for high throughput rates may be lower than those presented and higher for low throughput rates. The uncertainty associated with this variable introduces uncertainty in the cost estimates because actual rates cannot be determined until contracts are negotiated.

The cost estimates included in the table are costs to be paid to carriers for over-the-road or rail transport only and do not include purchase or lease costs for the 20-ft cargo containers. Costs for demurrage of the carriers vehicles and driver detention while awaiting completion of loading and unloading activities were considered in the cost. In the *NTS Intermodal EA*, it was assumed that the freight containers would be disposable. Therefore, the costs for empty return shipments were not estimated.

Table 4.1. Truck and Intermodal Transportation Costs for LLW Shipments to NTS (DOE-NVO 1998)

Origin	Shipping Dist. Using Existing Routes (mi.)	Truck Cost ($) per 20-ft Container	Incremental Distance to Avoid Las Vegas Valley (mi.)	Shipping Distance to Avoid Las Vegas Valley (mi.)	Adjusted Truck Cost ($) per 20-ft Container	Rail Cost ($) per 20-ft Container[a]
Aberdeen, MD	2542	5084	294	2896	5672	4200
Canoga Park, CA	383	1210	10	393	1242	
Fernald, OH	2012	4124	294	2306	4727	3200
Ashtabula, OH (RMI)	2207	4414	294	2501	5002	4200[b]
Miamisburg, OH	2044	4088	294	2338	4676	3350
San Diego, CA	400	1104	10	410	1132	
Kansas City, MO	1419	2838	294	1713	3426	2800
Livermore, CA	593	1601	10	603	1624	
Amarillo, TX	930	2000	234	1164	2386	2200[c]
Golden, CO	809	1780	294	1103	2261	2100
Albuquerque, NM	645	1710	234	879	2224	

(a) Costs are for one-way transport of 20-ft containers shipped via the Caliente, NV, intermodal transfer facility, except where indicated otherwise.
(b) Includes cost of returning reusable containers to origin facility.
(c) Assumes shipment via the Barstow, CA, intermodal facility. Costs for shipping via the Barstow facility for shipments from Golden, CO, and Kansas City, MO, are slightly higher than the costs for using the Caliente, NV, intermodal transfer facility.

The data is presented in Table 4.1 for shipments from 11 LLW generator sites. The system configuration described in Chapter 2 includes 23 potential LLW generator sites. To extend the data to include these additional 12 generators, the cost data in Table 4.1 was plotted and a line through the data points was developed using linear-regression techniques. The trend line was also extrapolated to longer shipping distances than those given in Table 4.1. This plot is shown in Figure 4.1. Note that the trend lines for truck and intermodal shipment costs cross at a one-way shipping distance of about 1000 miles. Truck shipping costs are lower for shipping distances less than about 1000 miles and rail is more cost-effective for shipping distances greater than 1000 miles.

Note that the rail cost estimate for shipments from Ashtabula, OH (RMI) to NTS includes the costs of returning the empty container to the origin facility. The other rail cost estimates are for one-way shipment of the loaded container only. Thus, it is necessary to adjust the cost estimates in Table 4.1 to include the costs of the empty return shipment. This was done by multiplying the costs for the other generators by a factor that represents the ratio of the round-trip costs from Ashtabula, OH, to the one-way costs for shipments from Fernald, OH. Based on this adjustment, the round-trip rail costs are estimated to increase by about 30% to account for the empty return shipments.

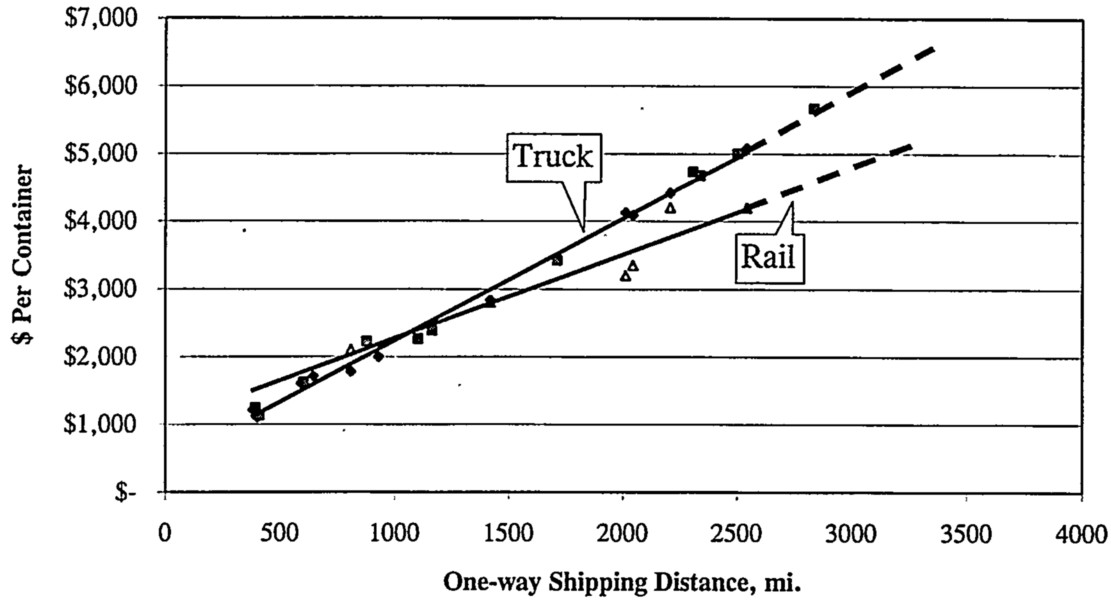


Figure 4.1. Plot of Truck and Rail Transportation Costs as a Function of Shipping Distance

4.1.2 Transportation Cost Data from the *WM-PEIS*

Transportation costs for various waste types were estimated in the *WM-PEIS.* Feizollahi, Shropshire, and Burton (1995) developed the supporting transportation cost data that was used in the *WM-PEIS.* The costs are for general freight rail service. No cost estimates were provided for dedicated train shipments (i.e., rail shipments in which LLW would be the only cargo aboard the train). Even though dedicated trains may offer some potential advantages (e.g., higher average speed, reduced stop time, reduced worker exposure), dedicated train shipments were not assumed in this analysis because there is little recent cost information for shipping hazardous cargo via dedicated train.

Feizollahi, Shropshire, and Burton (1995) followed a similar process to that used in the *NTS Intermodal EA* for developing the cost estimates; i.e., by obtaining estimates from various carriers and transportation hardware providers. A methodology was developed in which transportation costs are the sum of fixed and variable components. For LLW, the fixed component of the costs was $880 per shipment. The variable costs, referred to as the cost per loaded mile (CPLM), are as follows:

- Less than 30 miles: $ 5.94/mile
- 30 - 200 miles: $ 4.98/mile
- More than 200 miles: $ 4.00/mile

To estimate the costs for a single shipment of LLW, one needs to multiply the shipping distance between the generator site and NTS by the appropriate CPLM and then add the fixed cost component. This has been done in Table 4.2 for the same generator sites that were shown in Table 4.1. This has also been done for rail shipment costs using a fixed cost of $750/container and the following variable costs:

Table 4.2. Transportation Costs Derived from *WM-PEIS* for NTS LLW Generators

	Truck, per container			Rail, per container		
	Distance, mi.[a]	Cost per Shipment	Unit Cost, per mile	Distance, mi.[b]	Cost per Shipment	Unit Cost, per mile
Aberdeen, MD	2542	$ 11,048.00	$ 4.35	2542	$ 4,817.20	$ 1.90
Canoga Park, CA	383	$ 2,412.00	$ 6.30	383	$ 1,638.56	$ 4.28
Fernald, OH	2012	$ 8,928.00	$ 4.44	2391	$ 4,575.60	$ 1.91
Ashtabula, OH (RMI)	2207	$ 9,708.00	$ 4.40	2391	$ 4,575.60	$ 1.91
Miamisburg, OH	2044	$ 9,056.00	$ 4.43	2386	$ 4,567.60	$ 1.91
San Diego, CA	400	$ 2,480.00	$ 6.20	400	$ 1,678.00	$ 4.20
Kansas City, MO	1419	$ 6,556.00	$ 4.62	1670	$ 3,939.70	$ 2.36
Livermore, CA	593	$ 3,252.00	$ 5.48	1370	$ 3,928.40	$ 2.87
Amarillo, TX	930	$ 4,600.00	$ 4.95	1376	$ 3,942.32	$ 2.87
Golden, CO	809	$ 4,116.00	$ 5.09	987	$ 3,039.84	$ 3.08
Albuquerque, NM	645	$ 3,460.00	$ 5.36	1065	$ 3,220.80	$ 3.02

(a) Truck shipping distances were taken from the *NTS Intermodal EA*.
(b) Rail shipping distances were taken from the *WM-PEIS* where available and were assumed the same as truck shipping distances given in the *NTS Intermodal EA* where not available.

- 500 to 1,000 miles: $ 2.32/mile
- 1,000 to 2,000 miles: $ 1.91/mile
- More than 2,000 miles: $ 1.60/mile

4.1.3 DOE Historical Shipment Cost Data

A third source of transportation cost data is described in this section. The following information was provided to the authors of this report by staff representing DOE's National Transportation Program (NTP).

The Enterprise Transportation Analysis System (ETAS) is being designed to provide the DOE NTP with data about all DOE hazardous materials shipments and with analytical tools that can be used to project future shipping trends and costs for DOE.

ETAS is evolving from an earlier system called the Shipment Mobility Accountability Collection (SMAC) system. SMAC was originally developed to provide a database of all DOE shipping activities. SMAC has been used to gather data about DOE shipping activities since the late 1980s. For years, members of the SMAC staff have manually developed reports about DOE shipping activities using this data. Reports have been produced to satisfy two circumstances (a) standard data reports to DOE HQ, DOE operations offices, and DOE contractors, and (b) special data reports developed upon user requests.

ETAS development began from the solid foundation provided by evolving from the SMAC system. This base provides much of the necessary infrastructure, database, interface to data sources, etc. that is required for a system like ETAS to function. The two primary goals for ETAS are to provide users with easier access to the DOE hazardous shipment data and to provide tools that will allow users to easily project shipping costs and activity. For more information on ETAS, readers are encouraged to contact the DOE NTP.

ETAS staff searched the ETAS database for fiscal years 1997 and 1998 for cost information on LLW shipments. The search resulted in almost 1000 shipments over the 2-yr period, about half of which included relevant transportation cost data. The ETAS database also provided information on each shipment's mode of transport (motor carrier, rail, or private motor carrier), cargo weight, origin, destination, carrier, and date of shipment. ETAS staff then implemented the TRAGIS system to determine the most likely routes and projected one-way shipping distances. The distances determined using TRAGIS are not significantly different than those determined using HIGHWAY and INTERLINE in Chapter 5. The cost, distance, and cargo weight data was then manipulated to calculate the unit cost for each shipment ($/ton-mile) or shipping campaign. The unit cost data is summarized in Table 4.3.

The transportation cost data for the truck shipments listed in Table 4.3 was averaged to obtain a unit cost of about $0.37/ton-mi. (based on the mean cost column). This average unit cost was applied to the shipping distances for the origin-destination pairs in the *NTS Intermodal EA* to calculate the cost per shipment from each LLW generator. A total cargo weight of 40,000 lbs (20 tons) was assumed in the calculations. The results are shown in Table 4.4.

The truck transportation costs from all three sources of cost information were compared to each other. Rail costs are not included in this comparison because the rail cost data from ETAS was insufficient (i.e., only one data point) to support calculation of the relationship between costs and shipping distance. Note that the truck costs from ETAS are consistently higher than those from the *WM-PEIS* and *NTS Intermodal EA*. The differences are related to the different bases (e.g., container capacities, disposable vs. reusable shipping containers) between the studies and the ages of the data.

4.1.4 Rational for Selection of Carrier Costs Used in This Study

The truck and rail cost data in Tables 4.1, 4.2, and 4.4 was plotted as a function of one-way shipping distance in Figure 4.2. As can be seen, the unit cost ($/container-mile) estimates derived using the ETAS data are significantly higher than those derived using the *WM-PEIS*, which in turn are significantly higher than those given in the *NTS Intermodal EA*. Truck transportation costs derived from the *WM-PEIS* are about a factor of two higher than those given in the *NTS Intermodal EA*. Rail costs are about 10 to 40% higher in the *WM-PEIS* than the *NTS Intermodal EA*. Part of the difference comes from different packaging assumptions. The WM-PEIS rates are based on truck shipment in 48-ft long truck trailers carrying up to 44,000 lb of LLW per shipment whereas 20-ft containers were used in the *NTS Intermodal EA*. Three 20-ft containers were assumed in the *NTS Intermodal EA* to be transported by rail and two 40-ft containers were assumed to be transported per railcar in the *WM-PEIS*. The differences in weight between the *NTS Intermodal EA* and *WM-PEIS* shipment configurations explain at least part of the difference. Another potential difference is the fixed costs given in the *WM-PEIS*. The fixed costs generally represent the costs for demurrage of vehicles and detention of drivers during loading and unloading activities. In addition, the *WM-PEIS* fixed cost components are stated to include the costs of procuring and maintaining the shipping containers, tractors, and railroad cars used to perform the shipments. The final difference is related to whether or not the costs for empty return shipments are included in the cost estimates. In the *NTS Intermodal EA*, shipping containers were assumed to be disposed along with the LLW, so there are no costs associated with empty return shipments. Reuse of the shipping containers was assumed in the *WM-PEIS*, so the costs of empty return shipments are included in Table 4.2.

Table 4.3. Cost Data for Consignments from FY 1997 and FY 1998

Origin	Destination	Mode[a] [Number of Shipments]	Route distance (mi)	Transportation Cost						
				Actual Cost from ETAS[b]	Projected Cost Rate using TRAGIS					
				($)	($/ton-mi)			($/mi)		
				Range	Min	Mean	Max	Min	Mean	Max
ANL	Hanford, WA	M [23]	1981	1855 - 4226	0.10	0.39	0.68	1.04	1.61	2.23
Bettis Atomic, ID	Puget Sound Naval Shipyard	M [1]	773	2362	7.64	7.64	7.64	3.06	3.06	3.06
Bettis Atomic, PA	SRS	M	608/[25]	2371 - 3159	0.18	0.24	0.30[d]	3.97	4.59	5.20
BMI, OH	Envirocare	M [8]	1794	3348[c]	0.08	0.11	0.14	1.87	1.87	1.87
BMI, OH	Hanford, WA	M [1]	2318	4044	0.31	0.31	0.31	1.74	1.74	1.74
B&W Ohio	Envirocare	M [6]	1739	2389-2400	0.08	0.13	0.17	1.37	1.375	1.38
B&W Ohio	NTS	M [33]	2036	2400 - 3200	0.07	0.13	0.19	1.18	1.38	1.57
DynCorp of Colorado	NTS	M [37]	814	1562 - 3363	0.10	2.51	4.92	1.92	3.03	4.13
Fermi Nat Acc., IL	Hanford, WA	M	1960/[2]	3775 - 3885	0.09	0.09	0.09	1.93	1.96	1.98
FluorDaniel, Fernald	Envirocare	M	1718/[2]	1718	0.16	0.17	0.18	2.80	2.80	2.80
FluorDaniel, Fernald	NTS	M [11], E[2]	2013	2013 - 2875	0.07	.085	0.10	1.39	1.72	2.05
Princeton, Plasma Phy, NJ	Hanford, WA	M [2]	2774	2774	0.19	0.25	0.31	2.11	2.11	2.11
RMI Titanium, OH	NTS	M [4]	2268	2268	0.08	0.095	0.11	1.39	1.39	1.39
West Valley, NY	Envirocare	M [3]	1995	1995	0.26	0.29	0.31	3.51	3.51	3.51
B&W Ohio	Envirocare	R [308]	1998	6375 - 6566	0.03	0.035	0.04[e]	3.19	3.24	3.29

a M=motor, E=private motor, R=rail.
b Costs in ETAS are assembled from individual sites using ATMS, electronic transfers, manual inputs of freight bills, or waste manifests.
c One cost shown was $348, while all others were $3348. It is suspected that this is a data entry error. **Data for that shipment not included here.**
d One consignment showed only 423 pounds, which results in very high cost per ton-mile value of $19.45. **Data for that shipment not included here.**
e One consignment has an anomalous data entry for cost. **Data for this consignment (number 225) not included here.** In addition, one consignment was for a partial railcar load of only 6566 pounds, which led to an single, exceptionally high cost per ton-mile value of $1.00. **Data for that shipment not included here.**

Table 4.4. Highway Transportation Costs from ETAS

LLW Generator	Shipping Distance, mi	Costs, $/shipment (20-ton cargo capacity)
Aberdeen, MD	2,542	18,811
Canoga Park, CA	383	2,834
Fernald, OH	2,012	14,889
Ashtabula, OH (RMI)	2,207	16,332
Miamisburg, OH	2,044	15,126
San Diego, CA	400	2,960
Kansas City, MO	1,419	10,501
Livermore, CA	593	4,388
Amarillo, TX	930	6,882
Golden, CO	809	5,987
Albuquerque, NM	645	4,773

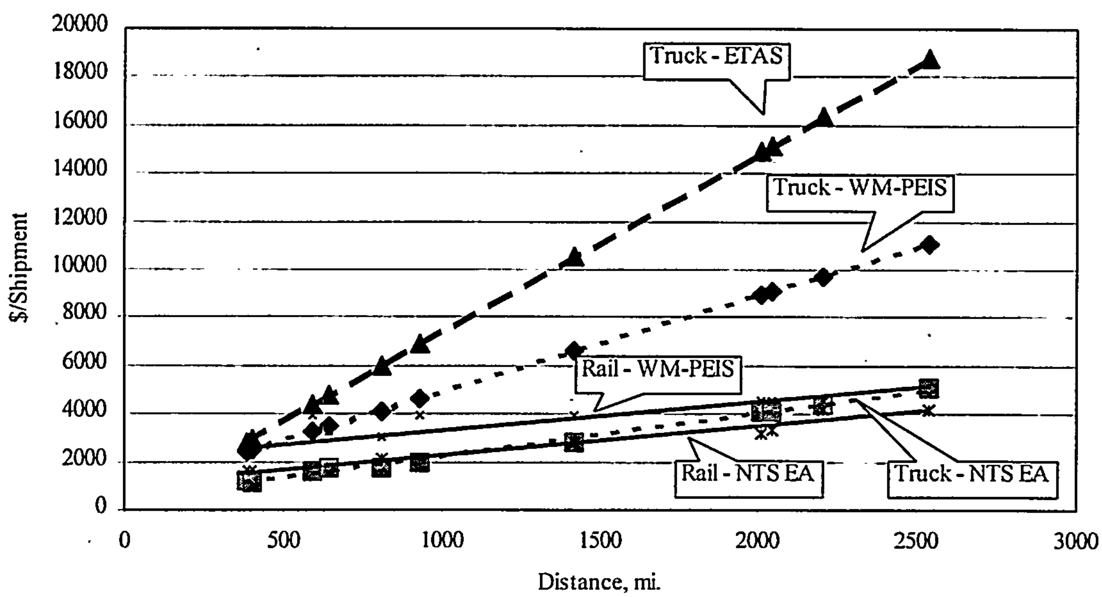


Figure 4.2. Comparison of Transportation Cost Data from Three Sources

The cost data from the *WM-PEIS* will be used in this study for the following reasons. First, the *WM-PEIS* data is internally consistent and provides a consistent basis for comparison of truck, rail, and intermodal alternatives. The cost data in the *NTS Intermodal EA* was not used because it is based on a fundamentally different assumption than is used here; i.e., the assumption that the shipping containers will be disposed of along with the LLW. The historical data from ETAS was not used directly, although it also is internally consistent. It is also more recent and may reflect actual current costs. However, the cost data for rail shipping was insufficient to develop unit costs as a function of distance. Thus, there was no comparable data set to compare truck, rail, and intermodal shipping costs. Since the basic purpose of this study is to illustrate trends that develop among alternative shipping configurations, the *WM-PEIS* cost data is believed to be sufficient.

4.2 SHIPPING CONTAINER PROCUREMENT COSTS

The total life-cycle shipping costs for the alternatives examined here include the costs for procurement of the required number of shipping containers to allow each site to ship its LLW to NTS. It was assumed here that shipping containers will be reused whereas the *NTS Intermodal EA* assumed the shipping containers would be disposed along with each shipment of LLW. Reusable shipping containers were assumed here because it is the current practice for most LLW shipments. There does not appear to be a need to include an outer packaging to meet long-term LLW disposal performance requirements, as all LLW was assumed to be pre-packaged in metal drums and boxes prior to being loading into shipping containers. It is recognized that some LLW types and forms will be shipped in different packaging systems due to differing shielding, long-term performance, and other requirements. However, until detailed characterization of the LLW has been performed, the volumes, types, and origins of LLW streams that will require a different packaging concept are difficult to accurately project.

The required number of shipping containers at each LLW generator site was calculated by first determining the approximate transit time to travel between the generator facility and destination. The shipping distances presented in Chapter 5 were divided by the average in-transit speeds for truck (assumed here to be 40 mi/hr over the entire trip) and rail shipments (assumed to be 10 mi/hr) to determine the round-trip travel time. Total trip time also includes the handling time (also referred to as turnaround time) at the origin and destination facilities, assumed to be 24 hours of clock time at each end. This includes the time it takes to unload the shipping containers as well as any required decontamination, monitoring, inspection, and maintenance. For intermodal shipments, an additional 8 hours of clock time was added at the shipment origin to ship the LLW by truck from the generator facility to the railhead. In addition, 24 hours of clock time was added at the intermodal facility to transfer the containers from the rail cars to truck and an additional 6 hours was added to ship the LLW by truck from the intermodal facility to NTS. Total round-trip transit times were calculated for each LLW generator by combining these estimates where appropriate.

The number of shipping containers required to transport the prescribed volume of LLW to NTS each year was calculated by dividing the number of container-hrs/yr required by the average availability of each shipping container. A total availability of 2000 hrs/yr per container was used in this calculation. The container-hrs per year required is the product of the average number of shipments per year from each generator (total life-cycle waste volume divided by 70 years) and the round-trip transit time calculated above. Then, it was assumed that the shipping containers would be replaced every 10 years so a total of seven procurement cycles will be included in the life-cycle cost estimates (i.e., initial procurement plus six replacement cycles). Thus, the total number of containers required over the 70-year life cycle is the number of shipping containers required annually multiplied by seven total procurement cycles. The total life-cycle container cost is the product of the number of containers required over the 70-year life-cycle and the unit cost of a shipping container. According to Feizollahi, Shropshire, and Burton (1995), the cost of a Sea-Land type container is about $3,500.

4.3 INTERMODAL TRANSFER COSTS

The costs for intermodal transfers of LLW shipping containers were difficult to obtain, primarily because there is little recent experience with this type of shipment. As a result, first-order cost estimates were developed here to include in the total life-cycle costs for Configurations 1A and 1B.

Intermodal transfer operations were broken down into trucking and handling activities to develop the cost estimates. The trucking portions of the intermodal transfers were costed using the basic carrier charges presented in Sections 4.1 to 4.3. The transfer portion was costed using the following assumptions:

- Heavy-lift equipment costs were estimated at $500 per transfer. This includes the costs at the railhead nearest to the LLW generator to lease a heavy-lift forklift or crane to lift the shipping containers off a truck trailer and set it down on a railcar. The reverse operation occurs at the intermodal transfer facility near NTS, and the costs are assumed to be the same.

- The costs for salaries, benefits, etc. for equipment operators at the intermodal facilities were also included. It was assumed that a total of 5 man-hours is required for each transfer, including heavy-equipment operators, railyard personnel, riggers, and any necessary support staff. The transfer operation is relatively simple, so this estimate is believed to be reasonable. Personnel costs were estimated assuming a unit cost of $50.00 per hour.

The unit transfer costs were then estimated to be $850/transfer. To account for uncertainties, the unit transfer cost was rounded to $1,000/transfer.

> ***Other Potential Cost Elements***
>
> *Some potential cost elements were not quantified in this assessment because they are too speculative to develop reasonable estimates. These include the costs for improvements to rural highways in Nevada that would be used under the shipping configurations that avoid Las Vegas and Hoover Dam as well as upgrades to emergency response capabilities along the rural highways. The cost estimates also do not include the costs to construct intermodal transfer facilities. Consistent with* the NTS Intermodal EA, *it was assumed that private interests would construct the necessary rail trackage, container-handling systems, and support facilities required. A first-order estimate of intermodal transfer costs is included in this analysis. More detailed cost estimates are needed to accurately characterize the rates a private company would charge for this service. Finally, handling and disposal costs at NTS were not included because they would be the same for all of the shipping configurations. Since all of the LLW shipments arrive at NTS by truck, handling costs are independent of the shipping configurations analyzed here. In reality, less efficient packaging than that assumed here would lead to higher handling costs. However, this would not be a discriminator among the shipping configuration alternatives as it would apply equally to all the alternatives. Similarly, disposal costs are a function of the type and volume of waste to be disposed and would apply equally to all of the shipping configuration alternatives.*

4.4 RESULTS OF TRANSPORTATION COST ANALYSIS

The results of applying the unit transportation costs to the DOE complex LLW transportation configurations are presented in this section. The basic carrier costs used here are those presented in Section 4.2 from the *WM-PEIS*.

4.4.1 High Waste Volume Case

Table 4.5 presents the total life-cycle shipping cost results for the high waste volume case

Table 4.5. Total Life-Cycle Shipping Costs ($M) for Each Alternative – High Waste Volume

Alternative	Highway Carrier	Rail Carrier	Intermodal Transfers		Container Costs	Total
			Carrier	Transfer		
1A	17	37	48	26	1.2	130
1B	17	36	62	26	1.2	140
2	230	0	0	0	1.1	230
3	210	0	0	0	1.0	210

considered in this study. The total shipping costs for the all-truck configurations include highway carrier costs and the costs for procurement of the required number of shipping containers. For the intermodal shipping configurations, the costs include those for direct truck shipments from small-quantity LLW generators as well as rail carrier costs and intermodal transfer costs at the origin and destination of the rail shipments.

As shown in Table 4.5, the costs for the intermodal alternatives (1A and 1B) are significantly lower than for the all-truck shipping configurations (2 and 3). The costs for the intermodal transfers are more than offset by the generally lower costs for rail shipping, resulting in lower overall costs for the intermodal alternatives. In comparing the all-truck options, the option of shipping through Las Vegas was slightly lower than the option of shipping around Las Vegas, although the small difference is within the uncertainties of the costs estimates. This difference is real, however, given the generally longer shipping distances that result from avoiding Las Vegas, but the magnitude of the difference shown in the table is uncertain. Similarly, of the two intermodal configurations (1A and 1B), lower life-cycle costs were estimated for the intermodal configuration in which the Barstow facility is assumed. The main difference is in the costs to transport LLW from the intermodal facility to NTS. Barstow is closer to NTS than Caliente, resulting in lower costs to transport LLW by truck from Barstow. This difference more than offsets the smaller rail carrier costs for the Caliente option. Caliente is a shorter shipment than Barstow for the LLW transported from LLW generators in the eastern and southern United States.

The table illustrates that the costs for procurement and replacement of shipping containers are insignificant relative to the shipping and transfer costs. Therefore, although more shipping containers are required to complete the required shipments in the intermodal alternatives, the increased costs are much smaller than the other cost elements. Shipping container requirements are higher in the intermodal alternatives than the all-truck alternatives because rail shipments travel at slower average speeds and thus have substantially longer transit times than truck shipments.

4.4.2 Low Waste Volume Case

The total life-cycle shipping costs for the low waste volume case are shown in Table 4.6. Note that the total costs shown in Table 4.6 are about one-third of the costs for the high waste volume case, similar to the ratio of waste volumes.

The general cost trends in Table 4.6 are similar to those in Table 4.5, including:

- The life-cycle costs for the intermodal configurations are significantly lower than the all-truck configurations.

Table 4.6. Total Life-Cycle Shipping Costs ($M) for Each Alternative – Low Waste Volume

Alternative	Highway Carrier	Rail Carrier	Intermodal Transfers		Container Costs	Total
			Carrier	Transfer		
1A	3.5	15	19	10	0.54	48
1B	3.5	15	24	10	0.56	53
2	95	0	0	0	0.47	95
3	82	0	0	0	0.47	83

- The life-cycle costs for the all-truck option that avoids Las Vegas are slightly higher than the costs for the all-truck option that travels through Las Vegas.

- Lower life-cycle costs were estimated for the intermodal configuration in which the Barstow facility is assumed than for the configuration in which Caliente is the intermodal transfer point.

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5.0 TRANSPORTATION RISK ANALYSIS

The objective of this chapter is to present estimates of the radiological and physical (i.e., nonradiological) risks[1] for the different transportation system configurations and waste loads investigated in this study. The scope of the transportation risk assessment includes radiological routine and accident risks as well as the physical hazards (i.e., fatalities) projected to occur from traffic accidents involving the LLW shipments that are independent of the cargo being transported. Health effects from routine vehicular emissions are also quantified. Radiological and physical risks to workers at intermodal transfer facilities are also estimated in this chapter. The total life cycle (70-year) radiological and nonradiological risks as well as state-by-state risks are presented for each alternative. Table 5.1 summarizes the types of risks assessed in this study and their associated pathways and sources.

"Risk" is a difficult term to define to everyone's satisfaction. The dictionary defines risk as "the possibility of loss or injury." However, risk may also mean the possible occurrence of a "desired" event, such as winning the Lottery. In these contexts, the engineering definition of risk was derived; i.e., risk is the product of the likelihood of an event and its consequences. This is the definition of risk used in this report.

Two categories of radiological risk are evaluated in this study, incident-free (or routine) risk and accident risk. These two types of risk are calculated using different methods. The vast majority of LLW shipments to NTS are expected to reach their destination without experiencing an accident or incident or releasing any LLW cargo. The "incident-free" risks from these normal, routine shipments arise from the low levels of radiation that are emitted externally from the shipping container. Although Federal regulations in 10 CFR 71 and 49 CFR 173 impose constraints on radioactive material shipments, some radiation penetrates the shipping container and exposes nearby persons to low levels of radiation. The Federal regulations also impose maximum allowable limits on external radiation; e.g., radiation levels must be less than or equal to 10 mrem/hr at 2 m from the edge of the transport vehicle. Actual radiation levels emitted from most LLW shipments to NTS will usually be a fraction (a few percent) of the regulatory maximum levels and are often low enough to be undetectable. However, a fraction of the shipments will emit dose rates near or at regulatory limits. Regulations also limit the maximum allowable dose rate in occupied areas of the transport vehicle, such as the truck cab.

The general equation for calculating external (including incident-free) radiological dose to an individual is to combine two terms, the dose rate (or radiation field strength) and the length of time a person is exposed as follows:

$$\textit{Individual Radiation Dose}\,(mrem) = \textit{Dose Rate}\,(mrem\,/\,hr) \times \textit{Exposure Duration}\,(hr)$$

The dose rate is a function of the source strength, amount of shielding between the source and receptor, and the distance from the source. Because radiation dose rates decrease with distance from the source, the farther away a person is from the shipping container, the lower the dose rate. Shielding, such as the steel walls of the waste packages (e.g., 55-gal. drums) and shipping containers, also reduces the radiation dose rate.

The transportation risk analysis methodology used here calculates incident-free doses to populations exposed to the passing shipments of LLW by recognizing that the external dose rate from the package is the source of radiation, and treating this external dose rate mathematically like the radiation source. Therefore, the dose and risk from incident-free transportation depend only on the external dose rate, and

[1] In this report, the terms "risk" and "impact" may be used interchangeably.

Table 5.1. Types and Sources of Health Risks Assessed in this Study

Endpoint	Exposure Period	Receptor	Pathway	Source
Latent cancer fatalities from radiological sources	70-yr LLW disposal life-cycle	Public	Direct Radiation exposures from routine transport Inhalation and direct radiation exposures from accidents during transport	Cargo (radioactive material in LLW)
		Intermodal facility workers	Direct radiation exposures from routine handling operations	Cargo (external radiation field emitted from LLW shipping containers)
		Truck/rail crewmembers	Direct radiation exposures from routine transport	Cargo (external radiation field emitted from LLW shipping containers)
Latent fatalities from non-radiation sources	70-yr LLW disposal life-cycle	Public	Inhalation of carcinogenic chemicals	Routine vehicle emissions (diesel fuel combustion products, fugitive dust, tire particles)
Trauma (physical) fatalities	70-yr LLW disposal life-cycle	Public	Physical hazards	Traffic accidents in transit
		Intermodal facility workers	Physical hazards	Industrial accidents during handling operations

not on the nature of the radioactive material being transported. The general formula for calculating population doses (sometimes referred to as "collective doses") is:

$$Population\ Dose\ (person - mrem) = Dose\ Rate\ (mrem\ /\ hr) \times Exposure\ Duration\ (hr) \times No.\ Exposed\ Persons$$

Mathematical models are used to calculate and track the dose rate at various distances from the shipping container, the number and locations of persons in the affected population group (e.g., bystanders at truck stops, persons residing near the highway or rail line), and the length of time they are exposed. The calculated population doses, in units of person-rem, are then multiplied by a risk factor that estimates the number of latent cancer fatalities (LCFs) that are projected to occur in the exposed population. A detailed discussion of these models may be found in Neuhauser and Kanipe (1995).

In terms of the definition of risk; i.e., probability times consequence, the probability that there will be some amount of incident-free radiological risk is essentially 1.0. This is because the probability that the LLW shipment reaches its destination without incident is essentially 1.0, as opposed to accidents in which the probability is orders of magnitude less than 1.0 (on the order of 1 serious accident per hundred million miles traveled). The consequence term is the projected dose in the exposed population. Since the probability term is 1.0, incident-free LCF risk is taken to be the consequence (dose) multiplied by an LCF risk factor.

Radiation Terms

Dose *refers to the amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed person receives. All are expressed in units of rem (or Sievert in the Standard International unit system). The dose equivalent takes into account the difference in tissue damage caused by different types of radiation (e.g., alpha, gamma, and neutron). The effective dose equivalent (EDE) takes into account the different absorption by, and damage to, different tissues (e.g., thyroid, lung). The committed or total effective dose equivalent (CEDE or TEDE) is the EDE for the 50-yr period after the radioactive material is ingested or inhaled.*

Collective or population dose *is the sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-Sievert).*

External dose or exposure *is the portion of the dose equivalent received from radiation sources outside the body (e.g., "external sources" such as the LLW shipping container).*

Internal dose or exposure *is the portion of the dose equivalent received from radioactive material taken into the body via inhalation, ingestion, or absorption through the skin. There are no internal doses unless radioactive material is released into the environment, such as following a severe transportation accident that results in failure of the LLW packages and shipping container.*

Rem *is a unit used in radiation protection to measure the amount of damage to human tissue from a dose of radiation. Millirem (mrem) is one-thousandth of a rem. An average American receives 0.360 rem (360 mrem) of radiation each year from natural and man-made sources (National Research Council 1990).*

Accident risks are calculated using different mathematical models than those used to calculate incident-free risks. The risk in this case results from potential exposures to radioactive material that could be released from the LLW shipping container if it is subjected to severe enough accident conditions to cause a breach or opening in the packaging system (shipping container plus internal waste containers) that confine the cargo. This is a different concept than incident-free risks, in which no cargo is released from the shipping container.

In terms of the risk of transportation accidents, risk is the product of the likelihood (or frequency) of an accident during transport and the consequences of that accident. In other words, if the frequency of an accident is estimated to be once per hundred years (10^{-2} per yr) and its consequence is ten fatalities, the risk of this accident is 10^{-2} per yr times 10 fatalities 10^{-1} fatalities per yr. Since there is a spectrum of possible accidents that could occur, ranging from minor fender-benders with no or only minor consequences to severe accidents that could result in serious injuries and deaths, accident scenarios causing similar damage are grouped together using binning techniques to simplify the mathematics. These groups or bins are called "accident severity categories" and the grouping used in this analysis is presented in Section 5.1.1.2. Total risk is the sum of the risks of each severity category. Risk is then calculated as the frequency of each severity category times the consequences of an accident in that category, and then summed over all the accident severity categories.

Two mathematical terms are combined to estimate the likelihood of a transportation accident. These are the overall mode-specific accident rate (e.g., the rate of accidents experienced by heavy-combination trucks, such as those used for LLW shipments to NTS, or the rate experienced by rail shipments), and the conditional probability that an accident will produce conditions encompassed by each severity category. For example, if 9 out of 10 accidents are minor and do not threaten the cargo, the conditional probability of a severity category that results in no release from the packaging is 0.9. Similar conditional probabilities are developed for each severity category.

> ***Latent Cancer Fatalities***
>
> *Radiological incident-free and accident risks are expressed in this study as latent cancer fatalities (LCFs). An LCF is a death from cancer resulting from exposure to ionizing radiation. Such a death would occur years after the exposure – hence the term "latent." According to the International Commission on Radiological Protection (ICRP), a 1 rem dose has an estimated 0.0005 chance (1 chance in 2000) of causing a fatal cancer.*

The second general term in the risk equation is the consequence of a release of radioactive material. Accident consequences are a function of the amount of radioactive material released as a result of a given accident. The conditions the shipping containers and waste packages are exposed to in an accident, as well as the container and material responses to these conditions, determine the amount of material released. Radionuclide-specific "release fractions" are developed to describe the quantity of each radionuclide released to the environment. The release fractions are multiplied by the initial inventory of radioactive materials in the shipment to determine the amount of radioactive material that escapes from the damaged shipping container. Release fractions may be developed for gaseous (e.g., tritium and krypton), semi-volatile (e.g., cesium), and particulate radionuclides (e.g., plutonium). One would expect a higher release fraction for a gas than for a semi-volatile material and higher release fraction for semi-volatiles than for particles. In other words, an accident of a given severity may release 100% of the gaseous radionuclides, 50% of the semi-volatile radionuclides, and 1% of the particulates. A more severe accident may release 100% of the gases, semi-volatiles, and particulates. In this manner, the severity categories and release fractions are related to each other. The release fractions are also modified by the fraction of the released material that is of dispersable-sized particles and the fraction that is of respirable size. The dispersible fraction determines the quantity of the released material that is small enough to be dispersed in the air after release (large particles are too heavy to be dispersed). The respirable fraction determines the quantity of released materials that is small enough to be inhaled into the lungs (large particles are filtered by the human respiratory system and do not reach the lungs). These quantities are then input to the atmospheric dispersion, pathway, and internal/external dose models to calculate the consequences of the release.

The models developed to calculate the consequences of radioactive material releases assume the released material is dispersed into the environment, which models the dilution of the released "plume" of radioactive material as the distance from the release point increases. The released plume travels in the direction the prevailing wind takes it and spreads out vertically and horizontally after it escapes from the shipping container. The concentration of radioactive material in the plume decreases with distance from the source due to this spreading effect. Radioactive material may also be deposited on the ground or in water bodies as particles fall out of the plume.

The next process in calculating consequences from a release of radioactive material is to model the potential human exposure pathways for the released material. In most cases, the most important exposure pathway is inhalation of radioactive material by people who might be within the passing plume. Inhalation leads to an "internal" dose: the dose to the individual is from radioactive material that is taken internally into the body. Ingestion is a second internal dose pathway. The ingestion dose results from persons consuming food products and drinking water that may contain released material. A third internal exposure pathway is resuspension. In this pathway, persons can inhale radioactive material that has been deposited on the ground and then becomes airborne again (resuspended). Two additional external exposure pathways — radiation from airborne material ("cloudshine") and from material deposited on the ground ("groundshine") — can also result in an external radiation dose. The contributions of groundshine and cloudshine to the total dose are usually very small.

The accident consequence model tracks the concentration of radioactive material in the plume and on the ground as a function of the distance from the release point. The population model is then superimposed on the population density map of the route to estimate the number of persons in the plume, the atmospheric and ground concentrations of radioactive material they would be exposed to at those locations, and the amount of time they would be exposed. This information is combined with radionuclide-specific dose conversion factors that determine the radiological doses to persons exposed to the released material. For example, for inhalation doses, the model determines the concentration of radioactive materials in the plume at various distances from the accident in Ci per m^3 of air. An average breathing rate is then used to determine the amount of each radionuclide inhaled. A detailed description of these calculations is contained in Neuhauser and Kanipe (1995). The dose conversion factors (in units of rem per Ci inhaled) are then applied to calculate the dose that would result from inhalation of that quantity. Ingestion is a more complicated pathway to evaluate but the concept is the same; i.e., dose conversion factors (in units of rem per Ci ingested) specific for ingestion are used to calculate the dose from ingestion of contaminated food and water. For external exposure pathways, the dose conversion factors relate the gamma radiation emissions from radioactive material in the airborne cloud to the dose. Accident risks are then calculated by combining the accident frequency and consequence terms for each severity category and then summing over the severity categories.

Calculation of both incident-free and transportation accident risks is usually done on a per-shipment basis, which may then be summed over the number of shipments per year and number of years per shipping campaign to calculate the total incident-free and accident risks of a shipping campaign. For example, a single shipment of LLW may be modeled, resulting in an incident-free and accident dose risk, both of which are expressed in units of person-rem/shipment. The term "dose risk" is used for accident models (rather than just "dose" as the units imply) because the probabilities are involved in the calculations. The per-shipment dose and risk estimates are multiplied by the number of shipments in an average year to result in average annual risk estimates (person-rem/yr). Or, they may be multiplied by the total number of shipments over an entire shipping campaign to calculate the total life-cycle dose and dose risk in person-rem. The population doses and dose risks (person-rem) may be multiplied by an appropriate risk factor (LCF per person-rem) to predict the number of LCFs in the exposed population. Even though the units of accident risk and incident-free risk may be the same, it is suggested that they not be added together because of the differences in the bases and calculation methods (i.e., probabilistic basis for accident risks versus pure consequence-based incident-free risks).

Existing DOE transportation risk analysis computer models are used in this study to develop the necessary input data (i.e., the HIGHWAY and INTERLINE routing codes) and calculate life-cycle transportation risks (i.e., RADTRAN). The methods and data used in the risk analysis are generally consistent with the *NTS Intermodal EA* and the *WM-PEIS*. In some areas, there are differences in the data used to quantify LLW transportation risks. However, these differences may affect the magnitude of the calculated risks but should not affect the comparisons among alternatives.

5.1 METHODOLOGY DESCRIPTION

This section presents a brief overview of the methods used to calculate transportation impacts. The RADTRAN 4 computer code (Neuhauser and Kanipe 1992) was used to calculate the routine (or incident-free) radiological doses and accident risks of the in-transit segments between LLW generator sites and NTS. The HIGHWAY (Johnson et al. 1993a) and INTERLINE (Johnson et al. 1993b) computer codes were implemented to develop the routing data (e.g., shipping distances and population distributions along the routes) that is used by the RADTRAN 4 code. Published unit risk factors (risk per unit distance traveled) are used to estimate the physical impacts of accidents during the in-transit segments. A unit risk factor approach is also used to estimate the impacts of nonradiological routine (i.e., chemical pollutant) emissions. Hand calculations were employed to estimate the routine radiological doses and physical accident risks to workers at the intermodal transfer facilities. A unit factor approach (impacts per unit handled) was used to quantify these impacts.

5.1.1 In-Transit Radiological Impact Methodology

The radiological incident-free doses and accident risks associated with truck and rail transport of LLW to NTS were calculated using the RADTRAN 4 computer code (Neuhauser and Kanipe 1992). The following sections present descriptions of RADTRAN 4 and the HIGHWAY (Johnson et al. 1993a) and INTERLINE (Johnson et al. 1993b) routing models. For additional information, readers are referred to the computer codes' user's manuals.

RADTRAN 4 is used to estimate radiological risks to populations. The code was developed in the 1970s and has been extensively reviewed, updated, and used for transportation risk assessments. Population risks are the primary means of comparing the LLW transportation system configurations and waste load options investigated in this study.

The RADTRAN 4 computer code is organized into eight sets of models listed below:

- Material model
- Transportation model
- Population distribution models
- Material models: isotopic compositions and properties
- Accident severity and package behavior models
- Meteorological dispersion model
- Health effects model
- Economic model.

The code uses these models to calculate the potential population doses from normal (routine or incident-free) transportation and to calculate the risk to the population from user-defined accident scenarios. The economic model is not used in this study.

Risks Not Quantified in this Study

This study does not quantify the risks to workers of LLW package handling at NTS or long-term risks to the public and workers of LLW disposal at NTS. These risks are independent of the four shipping configurations constructed for this analysis (Configurations 1A, 1B, 2, and 3). All LLW shipments are received at NTS by truck. Consequently, handling risks are identical for all four shipping configurations. Long-term disposal risks are also independent of the shipping configurations used to transport the LLW to the disposal site.

5.1.1.1 Population Exposures from Routine (Incident-Free) Transport

The RADTRAN 4 incident-free models calculate external radiation doses to people on or near the transportation routes from exposure to the low-levels of radiation emitted from the loaded shipping containers. RADTRAN 4 calculates incident-free doses to the following population groups:

- **Persons along the route (referred to as "off-link population")**. RADTRAN 4 calculates population doses to persons living or working within 0.8 km (0.5) mi on each side of a transportation route. The population densities developed by the routing codes are distributed in this model within this 0.8-km-wide band.

- **Persons sharing the route ("on-link population").** Population doses to persons in vehicles sharing the transportation route, both traveling in the same and opposite directions, are calculated by RADTRAN 4.

- **Persons at stops.** RADTRAN 4 calculates population doses to persons who may be exposed to a shipment while it is at a stop. For truck shipments, stops may be made for refueling, vehicle inspections, food, or rest. For rail shipments, stops may be made for classification or train makeup purposes.

- **Crew members.** RADTRAN 4 calculates incident-free doses to truck and rail crew members.

The total public doses from incident-free transportation are the sum of the doses to the off-link population, on-link population, and persons at stops.

Incident-free doses calculated by RADTRAN 4 are generally based on extrapolating the dose rate emitted from the package as a function of distance from a point source. The public and worker doses are dependent upon parameters such as population density, shipping distance, exposure distance, exposure duration, stop times, traffic density, and the Transportation Index (TI) of the package or packages. The TI is defined as the highest package dose rate in millirem per hour at a distance of 1 m from the external surface of the package. The values used for this parameter and others are presented in Table 5.2. Dose consequences are also dependent on the longest dimension of the package, as indicated in the material model description, which determines whether the package is modeled as a point source or line source for close-proximity exposures. The package size and other important parameters used in the RADTRAN 4 analysis of incident-free transport of LLW to NTS are also presented in the table.

RADTRAN 4 calculations are performed for each origin-destination pair (i.e., LLW generator and NTS). For each pair, HIGHWAY or INTERLINE is implemented to develop route characteristics, including distances traveled in rural, suburban, and urban population zones and their corresponding population

General Equations for Calculating Risks

The following are generalized equations for calculating transportation risks.

Incident-Free Radiological Doses

$$Population\ Dose\ (person-mrem) = Dose\ Rate\ (mrem/hr) \times Exposure\ Duration\ (hr) \times No.\ Exposed\ Persons$$

Population "doses" are then multiplied by ICRP "dose to risk" conversion factor.

Radiological Accident Risks

$$Risk = \sum_{SevCat} Frequency_{SevCat} \times Consequence_{SevCat}$$

$$Frequency_{SevCat} = Accident\ Rate \times Conditional\ Probability_{SevCat}$$

$$Consequence_{SevCat} = External\ Dose_{SevCat} + Inhalation\ Dose_{SevCat} + Ingestion\ Dose_{SevCat}$$
$$+ Resuspension\ Dose_{SevCat} + Groundshine\ Dose_{SevCat}$$

Nonradiological Accident Risks

$$Risk = Fatality\ Rate\ per\ km \times Total\ Distance\ Traveled$$

Nonradiological Risks Due to Routine Vehicular Emissions

$$Risk = Emission\ Risk\ Per\ km\ in\ Urban\ Region \times Total\ Distance\ Traveled\ in\ Urban\ Regions$$

Table 5.2. RADTRAN 4 Input Parameters Used in the Analysis of Incident-Free Radiological Exposures

Input Parameter	Parameter Value	
	Truck	**Rail**
Package Data		
Transport Index (mrem/h at 1 m)	1	1
Package Size (m)[a]	6.1	18.3
Shipment/Route Data		
No. of crew	2	5
Distance from source to crew (m)	4.3	152
Average vehicular speed (km/h)		
Rural	88	64
Suburban	40	40
Urban	24	24
Stop time (h/km)	0.011[b]	0.033
No. of people exposed while stopped	25[c]	100
No. of people per vehicle sharing route	2	3
Population densities (persons/km^2)		
Rural	Route-specific	Route-specific
Suburban		
Urban		
One-way traffic count (vehicles/h)		
Rural	470	1
Suburban	780	5
Urban	2,800	5

(a) Package size for truck crew exposures is 3 m.
(b) Set to zero for intermodal truck shipments from Barstow and Caliente to NTS.
(c) Set to 2 for truck shipments from LLW generators to intermodal transfer facilities and from intermodal facilities to NTS.

densities. For intermodal shipments from the major generators, up to three shipment segments are analyzed: 1) a truck segment from the LLW generator to an intermodal transfer facility; 2) a rail segment from the intermodal facility near the generator site to an intermodal facility near NTS, and 3) a truck segment from the intermodal facility to NTS. The total incident-free doses for an intermodal shipment are the sum of the doses calculated for the three segments. For LLW generators with rail service, the total incident-free doses include only a rail segment and the final truck segment. Only a single segment is needed to model truck shipments. The HIGHWAY routing model is manipulated until it provides the data for the exact route desired (i.e., through or around Las Vegas and Hoover Dam; see Figures 2.3 and 2.4). The shipping distances and population densities used in this analysis are presented in Table 5.3. The actual routes assumed to be taken by the shipments are presented in Appendix A. An example RADTRAN 4 output file is presented in Appendix B.

Table 5.3. Route Parameters Used in the RADTRAN 4 Calculations

Configuration 1A - Rail Shipments to Barstow and Truck Shipments from Barstow to NTS

LLW Shipper	One-way Distance, km	Travel Fraction, %			Population Density, persons/km^2		
		Rural	Suburban	Urban	Rural	Suburban	Urban
ORR	3759	88.8	10.4	0.9	6.1	339.4	2170.0
LANL	1231	95.6	4	0.4	2.8	272.2	2098.3
Fernald	3763	90.1	8.7	1.2	5.3	352.7	2261.1
RFETS	2045	91.8	6.7	1.5	3.3	417.7	2205.1
Mound	3947	87.4	10.9	1.7	6	362.3	2237.9
LLNL	645	73.3	19.7	7.0	9.1	353.0	2273.1
BNL	4953	75.7	19.4	4.8	6.9	375.7	2573
INEEL	2051	83.7	12.2	4.1	5.7	337.6	2373.6
ANL-E	3268	93.1	6.2	0.7	4.5	329.6	2155.7
Route Data for Truck Shipment from Barstow to NTS							
NTS	320	99.5	0.1	0.4	1.8	759.6	2615.8

Configuration 1B - Rail Shipments to Caliente andTruck Shipments from Caliente to NTS

LLW Shipper	One-way Distance, km	Travel Fraction, %			Population Density, persons/km^2		
		Rural	Suburban	Urban	Rural	Suburban	Urban
ORR	3683	90.9	7.5	1.6	6.6	394.7	2178.7
LANL	2066	91.6	7.2	1.2	3.1	410.7	2202.8
Fernald	3483	89.4	9.0	1.7	5.4	394.2	2269.3
RFETS	1249	95.4	4.4	0.3	2.6	330.7	2191.3
Mound	3614	82.9	13.3	3.8	6.2	410.2	2546.3
LLNL	1747	89.8	7.1	3.1	2.9	399.0	2446.5
BNL	4578	72.5	21.7	5.7	7.4	388.4	2566.8
INEEL	885	90.8	7.4	1.7	4	401.3	2022.2
ANL-E	2953	91.6	7.2	1.2	4.5	372.0	2164.6
Route Data for Truck Shipment from Caliente to NTS							
NTS	484	99.8	0.2	0	1.2	89.8	0
Note: A highway node for Caliente does not exist in the HIGHWAY database. The nearest highway node to Caliente, located at Panaca, NV, was used in the analysis. Panaca is about 66 km farther from NTS than Caliente. The shipping distances in the table and in the analysis were adjusted to reflect this difference.							

Configuration 2 - Truck Shipments That Avoid Las Vegas

LLW Shipper	One-way Distance, km	Travel Fraction, %			Population Density, persons/km²		
		Rural	Suburban	Urban	Rural	Suburban	Urban
ORR	3641	89.9	8.9	1.2	5.9	328.5	2139.9
LANL	1569	94.7	4.7	0.5	3.4	395.4	2174.8
Fernald	3627	88.7	9.9	1.4	6.2	327.6	2372.4
RFETS	1799	95.2	4.5	0.3	2.1	309.9	1878.3
Mound	3664	88.0	10.2	1.8	6.3	355.0	2336.7
LLNL	916	96.5	2.7	0.8	4.1	246.1	2156.6
BNL	4761	84.4	13.5	2.1	6.9	326.5	2494.9
INEEL	1427	97.0	2.7	0.3	2.2	335.5	1820.7
ANL-E	3382	92.9	6.5	0.6	3.8	306.4	2176.9
WVDP	4240	86.7	11.9	1.4	5.9	309.8	2229.1
BCL	3752	87.8	10.5	1.7	6.4	343.0	2347.0
SPRU	4681	83.5	14.9	1.5	6.9	298.3	2227.5
Sandia	1430	94.9	4.2	0.9	2.9	424.4	2128.4
PGDP	3228	91.2	7.7	1.1	5.1	348.3	2145.3
ETEC	550	76.4	9.2	14.4	2.2	553.2	3031.4
ITRI	1430	94.9	4.2	0.9	2.9	424.4	2128.4
PORT	3802	88.3	10.0	1.7	6.3	349.7	2286.2
PPPL	4553	81.8	16.0	2.2	7.9	314.1	2335.3
Pantex	1900	94.7	4.2	1.1	3.0	443.2	2166.5
LBNL	981	92.5	4.7	2.8	4.3	382.2	2845.3
Ames	2922	93.8	5.5	0.7	3.3	304.1	2121.3
GJPO	1400	97.7	2.2	0.2	1.5	343.9	1764.7
GE Val	930	95.6	3.1	1.3	4.2	292.9	2117.5

Configuration 3 - Truck Shipments Through Las Vegas

LLW Shipper	One-way Distance, km	Travel Fraction, %			Population Density, persons/km²		
		Rural	Suburban	Urban	Rural	Suburban	Urban
ORR	3252	87.8	10.5	1.8	6.5	343.9	2213.6
LANL	1179	90.6	7.5	1.9	4.1	443.2	2341.5
Fernald	3237	86.4	11.6	2.0	6.9	341.6	2387.9
RFETS	1318	91.5	7.6	0.8	2.5	391.1	2103.3
Mound	3274	85.8	11.9	2.4	7.0	367.4	2355.8
LLNL	948	94.3	4.6	1.1	4.3	335.7	2240.1
BNL	4280	82.1	15.5	2.4	7.8	338.4	2486.1
INEEL	1141	84.1	13.3	2.6	4.0	486.7	2101.6
ANL-E	2901	90.9	8.2	0.9	4.3	341.1	2209.3
WVDP	3759	84.3	14.0	1.7	6.7	325.3	2237.6
BCL	3363	85.5	12.1	2.3	7.2	355.3	2364.1
SPRU	4199	81.0	17.1	1.8	7.8	309.9	2234.6
Sandia	1041	90.3	7.1	2.6	3.5	476.0	2291.1
PGDP	2838	89.0	9.3	1.7	5.7	367.1	2230.1

LLW Shipper	One-way Distance, km	Travel Fraction, %			Population Density, persons/km^2		
		Rural	Suburban	Urban	Rural	Suburban	Urban
ETEC	582	73.9	11.9	14.1	2.6	525.2	3009.5
ITRI	1041	90.3	7.1	2.6	3.5	476.0	2291.1
PORT	3413	86.1	11.5	2.3	6.9	362.2	2313.5
PPPL	4166	79.4	17.8	2.8	8.7	321.5	2348.3
Pantex	1511	91.5	6.2	2.3	3.4	481.0	2276.6
LBNL	1014	90.5	6.5	3.0	4.5	402.5	2805.2
Ames	2441	91.6	7.4	1.0	3.9	350.2	2166.7
GJPO	919	93.7	5.4	0.8	1.8	495.0	2163.9
GE Val	962	93.4	5.0	1.5	4.4	355.8	2184.6

5.1.1.2 Radiological Accident Risks

Accident risk assessment is performed by RADTRAN 4 by combining the frequencies and consequences of accidents to produce a "risk" value (see Section 5.0). RADTRAN 4 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (e.g., "fender benders") to those with low frequencies and high consequences (accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Accident analysis in RADTRAN 4 is performed using accident severity and package release models. The user can define up to 20 severity categories for three population densities (urban, suburban, and rural). In general, higher-numbered accident severity categories result in more severe potential damage to the container and are less probable than lower-numbered severity categories. Severity categories are related to scenarios, including fire, puncture, crush, and immersion environments created in vehicular accidents. For this study, the eight severity categories defined in NUREG-0170 (NRC 1977) were adopted. Severity Category I represents minor accidents in which the packaging system (drum or box within a Sea-Land container) retains confinement of the LLW cargo (i.e., no release). Higher severity categories represent more severe accident conditions with correspondingly higher releases (and higher consequences) and lower frequencies. In the highest severity categories, the release fractions are set to 1.0 (i.e., 100% of the radioactive material is released from the packaging system).

The frequency of each specific accident scenario is calculated by multiplying together the overall rate of all accidents and the probability that the specific accident scenario occurs. In RADTRAN 4, each severity category has a conditional probability assigned to it; i.e., the probability given an accident that it will be of the specified severity. The accident scenarios are further defined by allowing the user to input release fractions and aerosol and respirable fractions for each severity category. These fractions are also a function of the physical-chemical properties of the materials being transported.

The input parameters used in this analysis are shown in Table 5.4. The radiological inventories per shipment of LLW, taken from the *NTS Intermodal EA*, are shown in Table 5.5. These inventories were developed in the *NTS Intermodal EA* based on waste characterization data from the *NTS Site-wide EIS* and are representative of the actual LLW shipped to NTS in the past. Radionuclide inventories are generator-specific and are anticipated to change over time. Radionuclide decay will reduce the inventories of short-lived radionuclides. The inventories will also change, some increasing and some decreasing, when generators revise waste management practices or complete waste management and environmental restoration projects and begin new ones. At any rate, since these inventories were used

Table 5.4. RADTRAN 4 Input Parameters for Radiological Accident Analysis[(a)]

Parameter	Truck			Rail		
	Rural	Suburban	Urban	Rural	Suburban	Urban
Accident Rate	State-specific (Saricks and Tompkins 1999)			State-specific (Saricks and Tompkins 1999)		
Fractional Occurrence by Severity Category (conditional probability given an accident occurs)						
I	0.55			0.50		
II	0.36			0.30		
III	0.07			0.18		
IV	0.016			0.018		
V	0.0028			0.0018		
VI	0.0011			1.3E-04		
VII	8.5E-05			6.0E-05		
VIII	1.5E-05			1.0E-05		
Fractional Occurrence by Population Zone (conditional probability given an accident occurs of the specified severity category)						
I	0.10	0.10	0.80	0.10	0.10	0.80
II	0.10	0.10	0.80	0.10	0.10	0.80
III	0.30	0.40	0.30	0.30	0.40	0.30
IV	0.30	0.40	0.30	0.30	0.40	0.30
V	0.50	0.30	0.30	0.50	0.30	0.30
VI	0.70	0.20	0.10	0.70	0.20	0.10
VII	0.80	0.10	0.10	0.80	0.10	0.10
VIII	0.90	0.05	0.05	0.90	0.05	0.05
Release Fraction (fraction released from shipping container by severity category)						
I	0			0		
II	0.01			0.01		
III	0.1			0.1		
IV	1			1		
V	1			1		
VI	1			1		
VII	1			1		
VIII	1			1		
Aerosol Fraction[(b)]	0.006			0.006		
Respirable Fraction[(b)]	0.01			0.01		

(a) Data taken from NUREG-0170 (NRC 1977) except where indicated otherwise.
(b) Source: *NTS Intermodal EA*.

consistently across the alternative shipping configurations, this parameter will not affect the comparisons of radiological accident risk among the alternatives.

For accidents that result in a release of radioactive material, RADTRAN 4 assumes the material is dispersed into the environment according to standard Gaussian diffusion models. The code allows the user to choose two different methods for modeling the atmospheric transport of radionuclides after a potential accident. The user can either input Pasquill atmospheric-stability category data or averaged time-integrated concentrations. In this analysis, the dispersion of radionuclides after a potential accident is modeled assuming Pasquill Stability Class D and wind speed of 4 m/sec (i.e., neutral conditions).

As was described in Section 5.0, RADTRAN 4 calculates the population dose from the released radioactive material for four exposure pathways. These are:

Table 5.5. Radionuclide Inventories per Container Shipped (1 container per truck and 3 per railcar)

Radio-nuclide	Inventory, Ci per container	Radio-nuclide	Inventory, Ci per container	Radio-nuclide	Inventory, Ci per container
Ba-137m	2.86E-04	Mn-54	5.54E-03	Tc-99	1.23E-04
Bi-212	1.19E-06	Pa-234m	2.95E-06	Th-228	1.59E-09
C-14	1.48E-04	Pb-212	9.95E-07	Th-231	2.87E-05
Co-58	5.12E-03	Po-212	2.57E-08	Th-232	2.41E-08
Co-60	5.17E-03	Po-216	3.98E-10	Th-234	1.47E-02
Cs-134	5.73E-03	Ra-224	9.95E-08	U-235	1.14E-04
Cs-137	7.53E-03	Ra-228	5.95E-08	U-238	1.50E-01
H-3	1.00E-03	Sr-90	1.39E-04	Y-90	3.47E-03

Note: Results are given in abbreviated scientific notation. For example, 5.54E-03 = 5.54×10^{-3} = 0.00554.

- External exposure to the passing cloud of radioactive material (cloudshine)
- External exposure to contaminated soil deposited on the ground by the passing plume (groundshine)
- Internal exposure from inhalation of airborne radioactive contaminants (inhalation and resuspension),
- Internal exposure from ingestion of contaminated food (ingestion).

Standard radionuclide uptake and dosimetry models are incorporated in RADTRAN 4. Dose conversion factors were taken from DOE (1988a and 1988b). The computer code combines the accident consequences and frequencies of each severity category, sums over the severity categories, and then integrates over all the shipments. Accident risk impacts are provided in the form of a population dose (person-rem over the entire shipping campaign), which is then converted to health risk using health effects conversion factors. The conversion factors were taken from the International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991) and amount to 4.0E-04 latent cancer fatalities (LCF) per person-rem for workers and 5.0E-04 LCF/person-rem for the general public.

5.1.2 Radiological Exposures to Workers at Intermodal Transfer Facilities

Workers at intermodal transfer facilities will be exposed to the external radiation fields surrounding the LLW shipping containers. Hand calculations were performed to quantify these doses. The hand-calculations combine a population dose estimate per unit handled (person-rem per container) for transferring LLW containers from trucks to railcars and vice versa and the total number of handling cycles. The population dose per unit handled was based on the *NTS Intermodal EA* where an estimate of about 1.7E-04 person-rem per container was developed. This was calculated using a TI value of 0.5 mrem/hr. Since the TI used in this analysis is 1.0 mrem/hr (see Table 5.2), the unit collective dose used in the *NTS Intermodal EA* was doubled to 3.4E-04 person-rem per container handled (0.00034 person-rem or 0.34 person-millirem per container) for this analysis. This unit dose factor is multiplied by the total number of container handlings at intermodal facilities, including intermodal transfers that occur near the LLW generator and near NTS. The resulting population dose was next converted to LCFs using the risk factor for workers given above. For this assessment, shipping container transfer operations are assumed to be the same at all intermodal transfer facilities.

5.1.3 Physical (Nonradiological) Routine Risks

Nonradiological routine impacts consist of fatalities from pollutants emitted from the vehicles. This category of impacts is not related to the radiological characteristics of the cargo. Hand calculations were performed using unit risk factors (fatalities per km of travel) to derive estimates of the nonradiological impacts. The nonradiological impacts were calculated by multiplying the unit risk factors by the total shipping distances for all of the shipments in each shipping option. Nonradiological unit risk factors for incident-free transport were taken from Rao et al. (1982) and amount to 1.0E-07 latent cancers per km traveled in urban areas for truck shipments and 1.3E-07 latent cancers/railcar-km for rail shipments.

5.1.4 Physical (Nonradiological) Accident Risks in Transit

This section describes the analyses performed to assess nonradiological impacts of vehicular accidents involving the LLW shipments to NTS.

The nonradiological impacts associated with the transportation of LLW are assumed to be comparable to the impacts associated with general transportation activities in the United States. To calculate nonradiological impacts or fatalities, fatality rates for the specific transport modes (i.e., fatalities per km or fatalities per mi.) are multiplied by the shipment distance. Fatality rates and shipping distances (provided by INTERLINE and HIGHWAY) are developed for three population density regions (rural, suburban, and urban) to account for differences in risk that arise during transport in highly populated areas relative to suburban and rural areas. The fatalities are due to vehicular impacts with solid objects, rollovers, or collisions and are not related to the radioactive nature of the cargo being transported. The fatality rates used in the analysis were developed using state-specific accident data (Saricks and Tompkins 1999). A single combined fatality rate was used to encompass either truck or rail crew members and the public.

5.1.5 Physical (Nonradiological) Accident Risks to Workers at Intermodal Transfer Facilities

Workers at intermodal transfer facilities will be exposed to the general physical hazards associated with material handling that are not related to the radioactive nature of the cargo. A unit risk factor approach is used here to estimate these impacts. The unit risk factor was derived from Bureau of Labor Statistics (BLS) accident data representative of material handling industries. Fatality rate data from 1996 was reviewed to identify industry classifications that are representative of intermodal transfer activities. Three were identified, including "trucking and warehousing," "material-moving equipment operator," and "laborers except construction." Of these three industry categories, the highest fatality rate was for "trucking and warehousing," operations, which amounted to 20.8 fatalities per 100,000 workers in 1996. This was rounded down to 20 fatalities/100,000 workers to account for the lower fatality rate operations (e.g., laborers that perform hands-on operations as opposed to equipment operators). This was converted to a fatality rate per person-hr (using 2000 person-hr/yr) to calculate a fatality rate of 1E-07 fatalities per person-hr for intermodal transfer operations. The unit risk factor for intermodal transfer operations was estimated by multiplying this fatality rate by the per-container exposure durations given in the *NTS Intermodal EA* that amounted to about 0.5 person-hr per container. The unit risk factor was calculated to be 5E-08 fatalities per container handled. The total life-cycle risk of intermodal transfer operations was calculated by multiplying this fatality rate by the total number of containers processed at intermodal transfer facilities near the LLW generator sites and near NTS.

5.2 COMPARISONS OF INPUT PARAMETERS WITH OTHER STUDIES

This section compares the assumptions and parameters used in the determination of transportation risks in this study with other recent LLW transportation risk assessments. A summary and comparison of input data with the other risk assessments (*NTS Intermodal EA* [DOE 1998], *NTS Site-Wide EIS* [DOE 1996], and *WM-PEIS* [DOE 1997]) are given in Tables 5.6 and 5.7.

Table 5.6. Radiological Incident-Free Input Parameters

	This Study		*NTS Intermodal EA*		*NTS Site-wide EIS*[(a)]		*WM PEIS*	
	Truck	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Package Data								
Transport Index (mrem/h at 1 m)	1	1	0.5	NA[(b)]	0.05	NA	1	1
Package Size (m)[(c)]	6.1	18.3	6.1	NA	6.4	NA	12	16
Shipment/Route Data								
No. of crew	2	5	2	NA	2	NA	2	5
Distance from source to crew (m)	4.3	152	4.3	NA	3	NA	3	152
Average vehicular speed (km/h) Rural Suburban Urban	 88 40 24	 64 40 24	 88 40 24	NA	 88 40 24	NA	 88 40 24	 64 40 24
Stop time (h/km)	0.011[(d)]	0.033	0[(e)]	NA	NA	NA	0.011	0.033
No. of people exposed while stopped	25[(f)]	100	2[(g)]	NA	25	NA	25	100
No. people per vehicle sharing route	2	3	2	NA	2	NA	2	3
Population densities (persons/km^2) Rural Suburban Urban	Route-specific	Route-specific	 6 719 3,861	NA	Route-specific	NA	 6 719 3,861	 6 719 3,861
One-way traffic count (vehicles/h) Rural Suburban Urban	 470 780 2,800	 1 5 5	 470 780 2,800	NA	Route-specific	NA	 470 780 2,800	 1 5 5

[a] Note that the *NTS Site-wide EIS* did not use RADTRAN. Thus, direct comparison of parameters with the other studies may not necessarily be valid.
[b] NA - Not Applicable.
[c] Package size for crew exposure is 3 m except for the *NTS Site-wide EIS*.
[d] Set to zero for intermodal shipments from Barstow and Caliente.
[e] Based on trip duration less than 8 h.
[f] Set to 2 for intermodal shipments.
[g] One stop assumed for vehicle inspection when crossing the NV state line.

Table 5.7. Accident and Nonradiological Input Parameters

Parameter	This Study	*NTS Intermodal EA*	*NTS Site-wide EIS*	*WM PEIS*
Total Inventory and Shipments	738,848 m^3 for high case, approximately 27,725 truck shipments	Assumed same number of truck shipments *as NTS Site-wide EIS*, 25,084 (10-yr Period) or 9,457 railcars using truck to railcar ratio from *WM PEIS*	1 million m^3, includes Hanford, SRS, and NTS 36,672 truck shipments (10 yr. period)	LLW Centralized 2 Altern. 1.5 million m^3, includes Hanford, SRS, and NTS 257,000 truck shipments (stored + 20 yr. generation period)
Accident Parameters				
Radionuclide Inventory	1 container profile, profile from EA to be used	1 container profile, See Table 5.5 of this report.	1 profile derived from site-specific data	Site-specific
Accident Rates	Saricks & Tompkins (1999)	Route-specific	Nevada-specific	Saricks & Kvitek (1994)
Conditional Probabilities	NUREG-0170	NUREG-0170	NUREG-0170	NUREG-0170
Release/ Aerosol/ Respirable Fractions	NUREG-0170/ *DOE Release Fraction Handbook* (DOE 1994)	NUREG-0170/ *DOE Release Fraction Handbook* (DOE 1994)	Modified NUREG-0170/ *DOE Release Fraction Handbook* (DOE 1994)	NUREG-0170/ RADTRAN suggestions
Nonradiological Input				
Emission Fatalities	Latent fatalities from diesel exhaust and fugitive dust emissions, Rao et al. (1982)	Latent cancer fatalities from diesel exhaust, derived from EPA's *Motor Vehicle-Related Air Toxics Study* (1993)	Latent fatalities from Rao et al. (1982) and latent cancer fatalities derived from EPA (1993)	Latent fatalities from diesel exhaust and fugitive dust emissions, Rao et al. (1982)
Accident Fatalities	Saricks & Tompkins (1999)	Nevada-specific	Nevada-specific	Saricks & Kvitek (1994)

The intent of this section is to place the input assumptions and parameters in perspective with other studies, so the reader is aware of the most significant differences among the various studies that analyzed the risk of LLW transportation. For the most part, the differences affect only the magnitudes of the calculated risk values. The differences do not affect the comparisons between alternative shipping configurations, which are the predominant interests in this study, but would affect the absolute magnitudes of the calculated risks. As an illustration, assume that the radiation dose rate (the input parameter is the Transport Index or TI) is approximately 10 mrem/hr rather than 1.0. The calculated radiological incident-free doses are approximately linear with respect to the TI. As a result, the calculated impacts would be 10 times higher for the case where the TI was set to 10 than it would be for a TI of 1.0. However, as long as the TI value used is consistently applied to all alternatives, the differences between alternatives would still be valid.

Finally, it should be noted that the LLW volume projections assumed in this study include a number of LLW generators that are currently not on the NTS disposal facility's approved generator list. For the purposes of this study, it was assumed that all potential DOE LLW generators are capable of obtaining approval to dispose of their LLW at NTS.

5.2.1 Shipment Volumes and Configurations

Truck shipments are assumed to consist of one 20-ft container (cargo capacity = 26.65 m^3 of LLW per shipment). Rail shipments are considered to be one railcar with three 20-ft containers (79.95 m^3/shipment). Risks are estimated for two waste load projections, high and low cases, covering a 70-year period. Both cases consider Waste Management (WM) and Environmental Restoration (ER) wastes. For the high case, with NTS as the primary offsite LLW disposal site, current projections of waste to be disposed of at NTS are about 740,000 m^3 from 23 sites. On an average or levelized annual basis, this is equivalent to receiving about 10,600 m^3 (370,000 ft^3) of LLW per year for 70 years. This is well below the annual LLW volumes projected to be disposed at NTS in the *NTS Site-wide EIS.*

The *WM-PEIS* Centralized 2 Alternative, where all LLW is disposed of at NTS, had approximately 257,000 truck shipments (approximately 1.5 million m^3) of waste being disposed at NTS. This figure includes shipments from sites such as Hanford and SRS. Current inventories in storage plus a 20-year generation period were assumed. Only WM waste was considered in the *WM-PEIS.*

The major differences between the *WM-PEIS* and the other studies in the number of shipments are the 20-yr generation period, changing waste volume estimates, and the assumption of shipments being weight limited. Waste characterization estimates for LLW in the *WM-PEIS* included both volume and weight estimates. Shipments were found in many cases to be weight limited (legal weight truck shipments must be 80,000 lb or less, truck and cargo combined). Thus, the *WM-PEIS* used a 44,000-lb truck weight limit (120,000-lb railcar limit) for the LLW cargo. The *NTS Site-wide EIS* assumed 12 4-ft x 4-ft x 7-ft boxes per LLW truck shipment (approximately 38 m^3 or less). This study and the *NTS Intermodal EA* assume a standard 20-ft shipping container (approximately 26.7 m^3) for all LLW shipments.

5.2.2 Shipment Routes

Different alternatives were analyzed for each of the two waste load options. The alternatives analyzed in this study match those analyzed in the *NTS Intermodal EA*. For the configurations with rail/intermodal shipping in this study, only the 9 sites with the largest volumes of waste (> 93% of the total) would ship by rail (ORR, LANL, Fernald, RFETS, Mound, LLNL, BNL, INEEL, and ANL-E). The remaining sites were assumed to always ship by truck because their waste volumes are less likely to justify use of the larger railcar shipment volumes. This is a departure from the *NTS Intermodal EA* where all sites were assumed to ship by rail in the rail/intermodal configurations.

Shipment routes were determined in this study using the HIGHWAY (Johnson et al. 1993a) and INTERLINE codes (Johnson et al. 1993b) for truck and rail shipments, respectively. The *NTS Intermodal EA* does not evaluate national transportation risk, but it states that over 80% of the LLW shipments that enter Nevada currently do so via US 93 at Hoover Dam in legal-weight trucks. This percentage is based on the past volumes shipped by approved generator sites. Using the sites and waste volumes identified for this study, approximately 73% of the shipments in the high waste volume case would be routed over Hoover Dam using the representative truck routes determined with HIGHWAY.

5.2.3 Radiological Risks

Incident-Free Transportation

Collective population incident-free risks were estimated in this study using RADTRAN and the general input parameters shown in Table 5.6. The values for these parameters, with the exception of the transport index, stop parameters, and population densities, were the same as those values used in the *NTS Intermodal EA*. Stop parameters more appropriate for national transportation scenarios, as found in the *WM PEIS*, were used. Route-specific population densities were used in this study. No credit for shielding of the exposed collective populations (crew and general public) was taken. The *NTS Site-wide EIS* used attenuation factors ranging from 0.0001 to 0.01.

Transportation Accident Risks

References for the various accident input parameters can be found in Table 5.7. State-specific accident rates from Saricks and Tompkins (1999), an update of Saricks and Kvitek (1994) that is commonly used in other studies, were used here (see Section 5.2.4). The accident rates used in this study for travel in Nevada are the primary (non-interstate) highway accident rates in the State of Nevada (Saricks and Tompkins 1999). As used in all previous studies, the accident category scheme and associated conditional accident probabilities suggested in NUREG-0170 (NRC 1977) were input into RADTRAN for calculating collective population risks. As in the *NTS Intermodal EA*, accident release fractions were taken from NUREG-0170, and the associated aerosolized and respirable fractions were based on recommendations in the DOE handbook on release and respirable fractions (DOE 1994). The radionuclide inventory per shipping container available for release was taken from the *NTS Intermodal EA*.

5.2.4 Nonradiological Risks

Accident fatalities were assessed using the fatality rates in Saricks and Tompkins (1999).

The most recent truck and rail accident and fatality rate statistics (Saricks and Tompkins 1999) were used in this report. These rates update the values in an earlier report (Saricks and Kvitek 1994) that were used in the *WM PEIS*. As discussed in Saricks and Tompkins (1999), the truck accident statistics are similar for the two reports although they are not directly comparable. Accident reporting criteria for highway accidents, and therefore the statistical basis, had changed between the years investigated by the first study (1986–1988) and the years investigated by the second study (1994–1996). Reporting criteria for rail incidents/accidents remained consistent between the two studies.

The use of the new truck fatality rates results in a reduction of approximately a factor of one-half in the vehicle-related accident impacts for alternatives on a national scale. This reduction is attributed in part to the availability of more effective safety equipment and the completion of the U.S. interstate system (Saricks and Tompkins 1999). On the other hand, the national average rail fatality rate increased by more than a factor of 3, from 2.35E-08 to 7.82E-08 fatalities/railcar-km (Saricks and Kvitek [1994] and Saricks and Tompkins [1999], respectively). These fatality rates include all fatalities occurring at grade-crossings, along rights-of-way, and in railyards. However, the *WM PEIS* used a rail fatality rate as stated in Saricks and Kvitek (1994) that was consistent with the truck fatality rate which excludes most fatalities occurring in rail yards. Such an approach is misleading because these fatalities occur primarily during marshalling of the train versus loading of the cars, that is, a necessary function for shipment by general rail that does not have a truck counterpart. Such a rate is not given in Saricks and Tompkins (1999). Thus, the new applicable national average rail fatality rate, 7.82E-08 fatalities/railcar-km, is approximately 100 times larger than the 6.5E-10 fatalities/railcar-km used in the *WM PEIS*. This increase in rates does not have as a pronounced effect on the rail fatality impacts estimated in this study because state-specific fatality rates were used (Saricks and Tompkins 1999). The use of state-specific fatality rates lowers the impacts because the high national average is driven by a number of eastern states, most of which are not involved in the rail routes analyzed. State-specific rail accident fatality rates were not available in Saricks and Kvitek (1994). In summary, for vehicle-related accident fatalities, the truck rates used in this report are approximately a factor of one-half lower, and the rail rates are approximately a factor of 30 higher than the rates used in the *WM PEIS*.

Fatalities from vehicle emissions were assessed in this study using the latent fatality risk factors in Rao et al. (1982). These risks factors are for latent cancer fatalities in urban areas resulting from emissions of diesel exhaust, fugitive dust, and tire and brake particulates. The emission risk factor in the *NTS Intermodal EA* is only for latent cancer fatality from just diesel exhaust. As a result, such estimates for a given shipment will be at least 100 to 1,000 times lower than when using Rao et al.'s factor, which is only valid for urban zones but accounts for all emissions and health effects. The *NTS Site-wide EIS* used both sets of emission risk factors.

5.3 RESULTS OF TRANSPORTATION IMPACT ANALYSES

This section presents the results of the transportation risk analyses of the shipping configurations and waste load options examined in this study. Detailed results are presented in Appendices B and C.

5.3.1 Shipping Mileage

Figure 5.1 is a comparison of the truck, rail, and total mileage traveled by LLW shipments destined for NTS for the high waste loading option. In Configuration 1A (intermodal transfer at Barstow), the total distance traveled is about 40 million km (25 million mi) if the direct truck shipments from small generator sites travel through Las Vegas and about 41 million km (26 million mi) if the direct truck shipments travel on routes that avoid Las Vegas. For Configuration 1B (intermodal at Caliente), the total distances traveled are about 45 million km (28 million mi) and 44 million km (27 million mi), for direct truck routes that travel around or through Las Vegas, respectively. Rail shipping distances shown in the figure were calculated on a per-railcar basis. In Configuration 2, truck carriers are encouraged to operate on routes that avoid Hoover Dam and the Las Vegas Valley. In this configuration, the total distance traveled by loaded LLW shipments was calculated to be about 84 million km (52 million mi). In Configuration 3, in which past carrier routing options were assumed, the total highway distance traveled is about 73 million km (45 million mi.).

In the two all-truck configurations, the one in which the Las Vegas and Hoover Dam areas are avoided represents about 15% more miles traveled on a DOE complex-wide basis than the configuration in which travel over Hoover Dam and through the Las Vegas Valley is assumed. If intermodal transfers at Barstow are assumed, the total distances traveled are reduced to about 56% of the total distance traveled assuming present all-truck shipping practices. The total mileage is reduced to about 60% of the all-truck

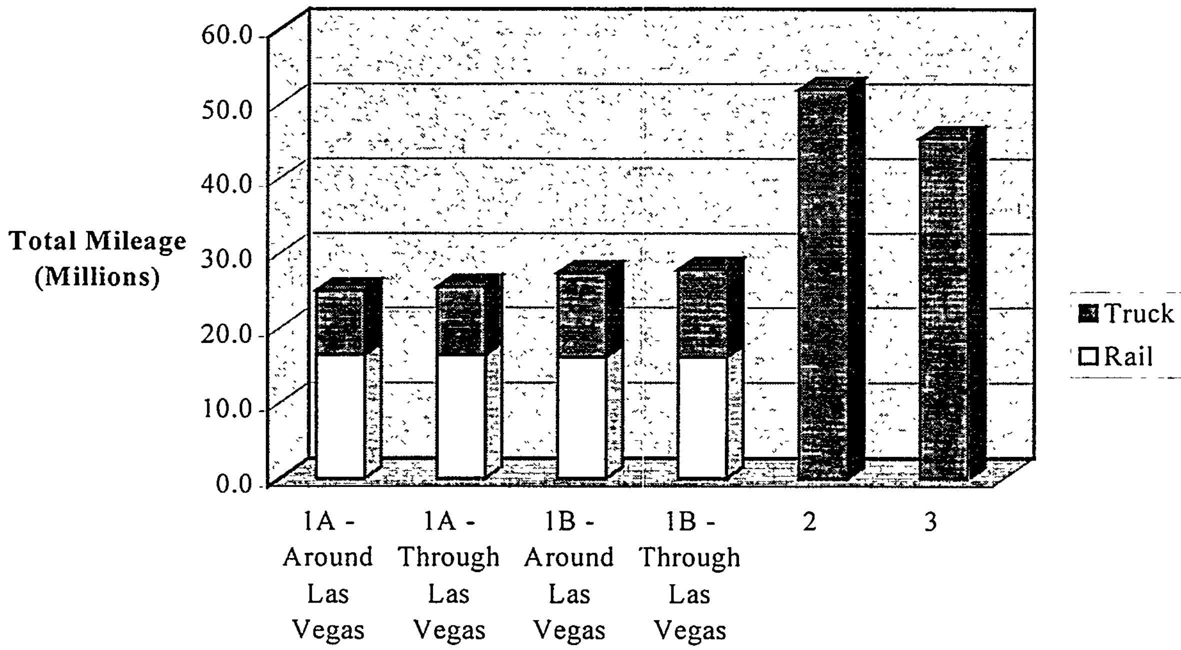

Figure 5.1. Truck and Rail Shipping Mileage Totals for all Configurations – High Waste Volume Option

(Configuration 3) shipping distances if intermodal transfers occur at Caliente. The overall difference between Options 1A and 1B is less than 10% in favor of the Barstow intermodal option. The shorter rail shipping distances between LLW generators and Caliente are more than offset by the substantially longer truck shipping distance between Caliente and NTS (about 300 mi from Caliente to NTS versus about 200 mi from Barstow).

Figure 5.2 presents the same information for the low waste loading option. There is about a factor of 3 difference in shipping mileage between the high and low waste loading cases. The percentage differences between the various configurations are consistent with the percentage differences presented above for the high waste loading option. The differences between the configurations are approximately the same because about 94% of the LLW is transported by rail under both waste loading options.

Average Daily Traffic Volumes

Average daily traffic volumes were calculated based on a 70-yr life-cycle and assuming LLW is received at NTS 365 days/yr. The average daily traffic volumes for the all-truck configurations (2 and 3) amount to slightly over 1 vehicle per day. Assuming less-efficient packaging systems are used for some shipments, it is estimated that as many as 2 to 3 truck shipments of LLW may be received at NTS per day. Assuming the peak annual receipt rate is twice the average annual rate, as many as 6 shipments of LLW may be received per day in peak years and substantially less than that in off-peak years. This is an extremely small truck traffic increment above current truck traffic volumes on Nevada's major highways, including Interstate 15 and US 95 through Las Vegas. It is a larger increase, but still a small fraction of the average daily traffic volume on highway routes that avoid Las Vegas, such as US 6, CA 127, and NV 375 (see the NTS Intermodal EA *for average daily traffic volume data).*

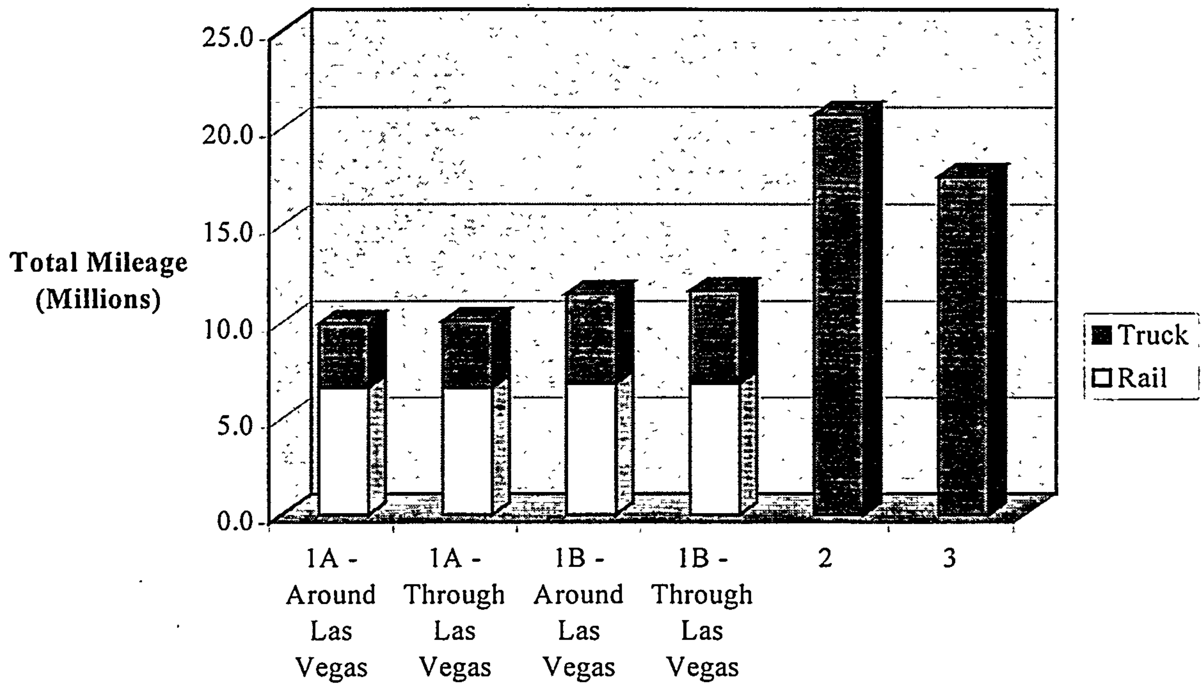

Figure 5.2. Truck and Rail Shipping Mileage Totals for all Configurations – Low Waste Volume Option

5.3.2 Transportation Risks by LLW Generator Site

Tables 5.8 through 5.17 illustrate the differences in human health risk projections that result from the various shipping configurations examined in this study. Table 5.8 presents the human health risk results for Configuration 1A (intermodal at Barstow) for the high waste loading option, and Table 5.9 presents the same information for the low waste loading option. The results for Configuration 1B (intermodal at Caliente) are presented in Tables 5.10 and 5.11 for the high and low waste loading options, respectively. For all four of these tables, it was assumed that the direct truck shipments from small-quantity LLW generators would be routed around Las Vegas. Table 5.12 presents the results for Configuration 1B assuming the direct truck shipments travel through Las Vegas. The effect on transportation risks of assuming that the direct truck shipments travel through Las Vegas as they do presently is demonstrated by comparing Table 5.10 with Table 5.12. Table 5.13 presents the health risks of Configuration 2 in which all of the LLW in the high waste loading option is transported by truck on routes that avoid Las Vegas. The same information is presented in Table 5.14 for the low waste loading option. Tables 5.15 and 5.16 present the results for Configuration 3, all truck shipments through Las Vegas, for the high and low waste loading options, respectively.

The total life-cycle transportation risk assessment results for both waste-loading cases are presented in Table 5.17. The life-cycle risks for the high waste loading option are shown in Figure 5.3. As shown in the figure, nonradiological accident risks are the highest of the five risk measures examined in this study (note that radiological accident risks are not shown in Figure 5.3 due to their small values relative to the other risks shown in the figure). The life-cycle risks are highest in the all-truck options and lowest for the intermodal options.

Table 5.8. Results of Transportation Impact Analysis for Configuration 1A (Rail/Intermodal Through Barstow, Trucks Avoid Las Vegas, High Waste Volume)[(a)]

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
Rail to Barstow					
ORR	2.3E-02	2.3E-02	1.9E-07	4.4E-01	2.8E-02
LANL	5.2E-03	3.5E-03	3.9E-08	4.9E-02	1.5E-03
Fernald	7.3E-03	7.8E-03	1.2E-06	1.3E-01	1.2E-02
RFETS	4.1E-03	4.5E-03	7.9E-08	4.3E-02	6.6E-03
Mound	5.8E-03	7.1E-03	9.4E-07	1.1E-01	1.4E-02
LLNL	1.6E-03	2.2E-03	6.1E-08	2.1E-02	5.5E-03
BNL	3.7E-03	9.1E-03	1.2E-06	1.1E-01	2.8E-02
INEEL	1.6E-03	2.4E-03	7.2E-08	2.7E-02	6.8E-03
ANL-E	1.1E-03	9.6E-04	1.9E-07	1.8E-02	1.0E-03
Subtotal	**5.3E-02**	**6.0E-02**	**4.9E-06**	**9.5E-01**	**1.0E-01**
Truck from Barstow to NTS					
Subtotal	**2.6E-02**	**3.6E-03**	**4.9E-07**	**1.5E-01**	**5.8E-03**
Direct Truck					
WVDP	6.5E-03	9.3E-03	9.2E-07	4.1E-02	5.0E-03
BCL	4.7E-03	6.7E-03	4.8E-07	2.7E-02	4.5E-03
SPRU	5.4E-03	7.5E-03	7.3E-07	3.5E-02	4.4E-03
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.1E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	3.2E-04	5.2E-04	9.2E-09	1.2E-03	2.0E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
PPPL	1.3E-03	1.8E-03	1.3E-07	7.1E-03	1.5E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
LBL	5.8E-05	8.9E-05	1.5E-09	2.6E-04	9.4E-05
Ames	4.9E-05	7.3E-05	5.5E-09	3.8E-04	1.9E-05
GJPO	1.3E-05	2.0E-05	1.0E-10	1.2E-04	1.4E-06
GE Val	3.1E-06	4.7E-06	7.3E-11	1.5E-05	2.4E-06
Subtotal	**2.3E-02**	**3.3E-02**	**2.5E-06**	**1.4E-01**	**2.1E-02**
Intermodal Transfer					
Subtotal	**4.6E-03**	**Not Evaluated**	**Not Evaluated**	**1.7E-03**	**Not Evaluated**
TOTAL	**1.1E-01**	**9.7E-02**	**8.0E-06**	**1.2E+00**	**1.3E-01**

Note: 2.3E-02 = 2.3×10^{-2} = 0.023

(a) Includes impacts of intermodal transfers in addition to in-transit impacts.

Explanation of Risk Values

The risk values shown in this and the following tables represent the integrated (or accumulated) risk to the affected population groups over 70 years. Risk values greater than 1.0 can be interpreted as that many fatalities over the 70-year life cycle (for example, 1.2 fatalities are projected to occur; this may be rounded to 1). Risk values less than 1.0 may be restated as a probability of fatality over the 70-year life cycle. The probability of a fatality is the inverse of the risk value. In other words, if the risk estimate is 0.1 fatalities, then there is a 1 in 10 chance (i.e., 1.0 divided by 0.1) of at least one fatality occurring in the 70-year period.

Table 5.9. Results of Transportation Impact Analysis for Configuration 1A (Rail/Intermodal Through Barstow, Trucks Avoid Las Vegas, Low Waste Volume)[(a)]

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
Rail to Barstow					
LANL	5.1E-03	3.4E-03	3.8E-08	4.8E-02	1.5E-03
Fernald	7.0E-03	8.6E-03	1.4E-06	1.3E-01	1.6E-02
RFETS	4.1E-03	4.5E-03	7.9E-08	4.3E-02	6.7E-03
Mound	5.8E-03	7.1E-03	9.4E-07	1.1E-01	1.4E-02
LLNL	1.6E-03	2.2E-03	6.1E-08	2.1E-02	5.5E-03
Subtotal	**2.4E-02**	**2.6E-02**	**2.5E-06**	**3.5E-01**	**4.3E-02**
Truck from Barstow to NTS					
Subtotal	**1.3E-02**	**1.8E-03**	**2.5E-07**	**7.8E-02**	**3.0E-03**
Direct Truck					
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.1E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	2.6E-04	4.2E-04	7.5E-09	9.5E-04	1.7E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
Subtotal	**4.8E-03**	**7.1E-03**	**2.6E-07**	**2.9E-02**	**4.8E-03**
Intermodal Transfer					
Subtotal	**3.0E-03**	**Not Evaluated**	**Not Evaluated**	**1.1E-03**	**Not Evaluated**
TOTAL	**4.4E-02**	**3.5E-02**	**3.0E-06**	**4.6E-01**	**5.1E-02**

(a) Includes impacts of intermodal transfers in addition to in-transit impacts.

Table 5.10. Results of Transportation Impact Analysis for Configuration 1B (Rail/Intermodal Through Caliente, Trucks Avoid Las Vegas, High Waste Volume)[(a)]

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
Rail to Caliente					
ORR	2.3E-02	2.7E-02	4.2E-06	3.3E-01	4.9E-02
LANL	6.4E-03	6.7E-03	1.4E-07	7.8E-02	8.4E-03
Fernald	7.0E-03	8.6E-03	1.4E-06	1.0E-01	1.6E-02
RFETS	3.3E-03	2.4E-03	3.6E-08	3.8E-02	6.8E-04
Mound	5.5E-03	1.1E-02	1.6E-06	8.4E-02	2.9E-02
LLNL	2.2E-03	2.9E-03	5.3E-08	2.7E-02	6.5E-03
BNL	3.5E-03	9.6E-03	1.5E-06	9.8E-02	3.0E-02
INEEL	1.1E-03	1.1E-03	2.2E-08	1.2E-02	1.2E-03
ANL-E	1.1E-03	1.1E-03	3.1E-07	1.6E-02	1.6E-03
Subtotal	**5.3E-02**	**7.0E-02**	**9.3E-06**	**7.8E-01**	**1.4E-01**
Truck from Caliente to NTS					
Subtotal	**3.9E-02**	**4.7E-03**	**5.9E-08**	**4.1E-01**	**0.0E+00**
Direct Truck					
WVDP	6.5E-03	9.3E-03	9.2E-07	4.1E-02	5.0E-03
BCL	4.7E-03	6.7E-03	4.8E-07	2.7E-02	4.5E-03
SPRU	5.4E-03	7.5E-03	7.3E-07	3.5E-02	4.4E-03
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.1E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	3.2E-04	5.2E-04	9.2E-09	1.2E-03	2.0E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
PPPL	1.3E-03	1.8E-03	1.3E-07	7.1E-03	1.5E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
LBL	5.8E-05	8.9E-05	1.5E-09	2.6E-04	9.4E-05
Ames	4.9E-05	7.3E-05	5.5E-09	3.8E-04	1.9E-05
GJPO	1.3E-05	2.0E-05	1.0E-10	1.2E-04	1.4E-06
GE Val	3.1E-06	4.7E-06	7.3E-11	1.5E-05	2.4E-06
Subtotal	**2.3E-02**	**3.3E-02**	**2.5E-06**	**1.4E-01**	**2.1E-02**
Intermodal Transfer					
Subtotal	**4.6E-03**	**Not Evaluated**	**Not Evaluated**	**1.7E-03**	**Not Evaluated**
TOTAL	**1.2E-01**	**1.1E-01**	**1.2E-05**	**1.3E+00**	**1.6E-01**

(a) Includes impacts of intermodal transfers in addition to in-transit impacts.

Table 5.11. Results of Transportation Impact Analysis for Configuration 1B (Rail/Intermodal Through Caliente, Trucks Avoid Las Vegas, Low Waste Volume)[(a)]

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
Rail to Caliente					
LANL	6.3E-03	6.7E-03	1.3E-07	7.7E-02	8.4E-03
Fernald	7.0E-03	8.6E-03	1.4E-06	1.0E-01	1.6E-02
RFETS	3.3E-03	2.5E-03	3.6E-08	3.8E-02	6.9E-04
Mound	5.5E-03	1.1E-02	1.7E-06	8.4E-02	2.9E-02
LLNL	2.2E-03	2.9E-03	5.3E-08	2.7E-02	6.5E-03
Subtotal	**2.4E-02**	**3.1E-02**	**3.3E-06**	**3.3E-01**	**6.0E-02**
Truck from Caliente to NTS					
Subtotal	**2.0E-02**	**2.4E-03**	**3.0E-08**	**7.8E-02**	**3.0E-03**
Direct Truck					
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.1E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	2.6E-04	4.2E-04	7.5E-09	9.5E-04	1.7E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
Subtotal	**4.8E-03**	**7.1E-03**	**2.6E-07**	**2.9E-02**	**4.8E-03**
Intermodal Transfer					
Subtotal	**3.0E-03**	**Not Evaluated**	**Not Evaluated**	**1.1E-03**	**Not Evaluated**
TOTAL	**5.2E-02**	**4.1E-02**	**3.6E-06**	**4.4E-01**	**6.8E-02**

(a) Includes impacts of intermodal transfers in addition to in-transit impacts.

Table 5.12. Results of Transportation Impact Analysis for Configuration 1B (Rail/Intermodal Through Caliente, Trucks Through Las Vegas, High Waste Volume)[(a)]

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
Rail to Caliente					
ORR	2.3E-02	2.7E-02	4.2E-06	3.3E-01	4.9E-02
LANL	6.4E-03	6.7E-03	1.4E-07	7.8E-02	8.4E-03
Fernald	7.0E-03	8.6E-03	1.4E-06	1.0E-01	1.6E-02
RFETS	3.3E-03	2.4E-03	3.6E-08	3.8E-02	6.8E-04
Mound	5.5E-03	1.1E-02	1.6E-06	8.4E-02	2.9E-02
LLNL	2.2E-03	2.9E-03	5.3E-08	2.7E-02	6.5E-03
BNL	3.5E-03	9.6E-03	1.5E-06	9.8E-02	3.0E-02
INEEL	1.1E-03	1.1E-03	2.2E-08	1.2E-02	1.2E-03
ANL-E	1.1E-03	1.1E-03	3.1E-07	1.6E-02	1.6E-03
Subtotal	**5.3E-02**	**7.0E-02**	**9.3E-06**	**7.8E-01**	**1.4E-01**
Truck from Caliente to NTS					
Subtotal	**3.9E-02**	**4.7E-03**	**5.9E-08**	**1.5E-01**	**5.8E-03**
Direct Truck					
WVDP	6.0E-03	8.3E-03	9.2E-07	1.6E-02	2.8E-03
BCL	4.3E-03	6.2E-03	4.8E-07	1.2E-02	2.7E-03
SPRU	5.0E-03	6.9E-03	7.4E-07	1.4E-02	2.4E-03
Sandia-NM	7.1E-04	1.1E-03	9.0E-09	1.9E-03	5.1E-04
PGDP	1.7E-03	2.4E-03	1.2E-07	5.4E-03	8.1E-04
ETEC	3.5E-04	5.5E-04	1.0E-08	5.1E-04	1.1E-03
ITRI	3.2E-04	4.8E-04	4.1E-09	8.7E-04	2.3E-04
PORT	9.7E-04	1.4E-03	1.0E-07	2.8E-03	6.2E-04
PPPL	1.2E-03	1.7E-03	1.3E-07	3.3E-03	8.6E-04
Pantex	2.8E-04	4.2E-04	6.7E-09	8.3E-04	1.8E-04
LBL	4.5E-03	6.7E-03	1.1E-07	1.2E-04	5.2E-05
Ames	4.2E-05	6.2E-05	5.6E-09	1.4E-04	1.2E-05
GJPO	9.2E-06	1.4E-05	1.5E-10	2.9E-05	2.3E-06
GE Val	3.3E-06	4.9E-06	8.0E-11	6.7E-06	1.5E-06
Subtotal	**2.5E-02**	**3.6E-02**	**2.6E-06**	**5.8E-02**	**1.2E-02**
Intermodal Transfer					
Subtotal	**4.6E-03**	**Not Evaluated**	**Not Evaluated**	**1.7E-03**	**Not Evaluated**
TOTAL	**1.2E-01**	**1.1E-01**	**1.2E-05**	**9.9E-01**	**1.6E-01**

(a) Includes impacts of intermodal transfers in addition to in-transit impacts.

Table 5.13. Results of Transportation Impact Analysis for Configuration 2 (100% Truck, Avoid Las Vegas, High Waste Volume)

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
ORR	1.3E-01	1.8E-01	4.1E-06	7.3E-01	8.5E-02
LANL	2.0E-02	3.0E-02	2.6E-07	1.2E-01	6.5E-03
Fernald	4.0E-02	5.9E-02	4.2E-06	2.4E-01	3.2E-02
RFETS	1.4E-02	2.1E-02	3.4E-07	1.2E-01	2.7E-03
Mound	3.2E-02	4.6E-02	3.3E-06	1.9E-01	3.1E-02
LLNL	4.2E-03	6.3E-03	9.7E-08	2.0E-02	2.1E-03
BNL	2.4E-02	3.4E-02	3.3E-06	1.5E-01	2.6E-02
INEEL	4.3E-03	6.5E-03	8.4E-08	3.2E-02	6.9E-04
ANL-E	6.0E-03	8.8E-03	8.8E-07	4.4E-02	2.1E-03
WVDP	6.5E-03	9.3E-03	9.2E-07	4.1E-02	5.0E-03
BCL	4.7E-03	6.7E-03	4.8E-07	2.7E-02	4.5E-03
SPRU	5.4E-03	7.5E-03	7.3E-07	3.4E-02	4.4E-03
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.2E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	3.2E-04	5.2E-04	9.2E-09	1.2E-03	2.0E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
PPPL	1.3E-03	1.8E-03	1.3E-07	7.1E-03	1.5E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
LBL	5.8E-05	8.9E-05	1.5E-09	2.6E-04	9.4E-05
Ames	4.9E-05	7.3E-05	5.5E-09	3.8E-04	2.0E-05
GJPO	1.3E-05	2.0E-05	1.0E-10	1.2E-04	1.4E-06
GE Val	3.1E-06	4.7E-06	7.3E-11	1.4E-05	2.3E-06
TOTAL	**2.9E-01**	**4.3E-01**	**1.9E-05**	**1.8E+00**	**2.1E-01**

Table 5.14. Results of Transportation Impact Analysis for Configuration 2 (100% Truck, Avoid Las Vegas, Low Waste Volume)

LLW Generator	Radiological Impacts, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
LANL	2.0E-02	2.9E-02	2.6E-07	1.1E-01	6.5E-03
Fernald	4.0E-02	5.9E-02	4.2E-06	2.4E-01	3.2E-02
RFETS	1.4E-02	2.1E-02	3.4E-07	1.2E-01	2.7E-03
Mound	3.2E-02	4.6E-02	3.3E-06	1.9E-01	3.1E-02
LLNL	4.2E-03	6.3E-03	9.7E-08	2.0E-02	2.1E-03
Sandia-NM	9.0E-04	1.4E-03	1.2E-08	5.1E-03	5.0E-04
PGDP	1.8E-03	2.7E-03	1.2E-07	1.2E-02	1.2E-03
ETEC	2.6E-04	4.2E-04	7.5E-09	9.5E-04	1.7E-03
ITRI	4.1E-04	6.2E-04	5.6E-09	2.3E-03	2.3E-04
PORT	1.1E-03	1.5E-03	1.0E-07	6.2E-03	1.0E-03
Pantex	3.3E-04	5.1E-04	7.6E-09	2.0E-03	2.2E-04
TOTAL	**1.2E-01**	**1.7E-01**	**8.5E-06**	**7.1E-01**	**7.9E-02**

Table 5.15. Results of Transportation Risk Analysis for Configuration 3 (100% Truck, Through Las Vegas, High Waste Volume)

LLW Generator	Radiological Risks, Fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
ORR	1.2E-01	1.7E-01	3.9E-06	6.6E-01	1.1E-01
LANL	1.6E-02	2.3E-02	1.9E-07	8.9E-02	1.7E-02
Fernald	3.7E-02	5.3E-02	4.2E-06	2.2E-01	4.0E-02
RFETS	1.1E-02	1.6E-02	3.8E-07	6.9E-02	5.3E-03
Mound	2.9E-02	4.2E-02	3.2E-06	1.7E-01	3.8E-02
LLNL	4.4E-03	6.7E-03	1.1E-07	1.8E-02	2.9E-03
BNL	2.2E-02	3.1E-02	3.3E-06	1.2E-01	2.8E-02
INEEL	4.0E-03	5.7E-03	1.5E-07	2.0E-02	5.5E-03
ANL-E	5.3E-03	7.7E-03	8.9E-07	3.3E-02	2.7E-03
WVDP	6.0E-03	8.3E-03	9.2E-07	3.2E-02	5.5E-03
BCL	4.3E-03	6.2E-03	4.8E-07	2.4E-02	5.4E-03
SPRU	5.0E-03	6.9E-03	7.4E-07	2.8E-02	4.8E-03
Sandia-NM	7.1E-04	1.1E-03	9.0E-09	3.8E-03	1.0E-03
PGDP	1.7E-03	2.4E-03	1.2E-07	1.1E-02	1.6E-03
ETEC	3.5E-04	5.5E-04	1.0E-08	1.0E-03	2.1E-03
ITRI	3.2E-04	4.8E-04	4.1E-09	1.7E-03	4.7E-04
PORT	9.7E-04	1.4E-03	1.0E-07	5.7E-03	1.2E-03
PPPL	1.2E-03	1.7E-03	1.3E-07	6.6E-03	1.7E-03
Pantex	2.8E-04	4.2E-04	6.7E-09	1.7E-03	3.7E-04
LBL	6.2E-05	9.3E-05	1.6E-09	2.4E-04	1.0E-04
Ames	4.2E-05	6.2E-05	5.6E-09	2.8E-04	2.5E-05
GJPO	9.2E-06	1.4E-05	1.5E-10	5.7E-05	4.6E-06
GE Val	3.3E-06	4.9E-06	8.0E-11	1.3E-05	3.0E-06
TOTAL	**2.7E-01**	**3.9E-01**	**1.9E-05**	**1.5E+00**	**2.8E-01**

Table 5.16. Results of Transportation Impact Analysis for Configuration 3 (100% Truck, Through Las Vegas, Low Waste Volume)

LLW Generator	Radiological Impacts,fatalities			Nonradiological Fatalities	
	Incident-Free Exposures		Accident Risk		
	Crew	Public		Accidents	Emissions
LANL	1.6E-02	2.3E-02	1.9E-07	8.8E-02	1.7E-02
Fernald	3.7E-02	5.3E-02	4.2E-06	1.1E-01	2.0E-02
RFETS	1.1E-02	1.6E-02	3.8E-07	6.9E-02	5.3E-03
Mound	2.9E-02	4.2E-02	3.2E-06	1.7E-01	3.8E-02
LLNL	4.4E-03	6.7E-03	1.1E-07	1.8E-02	2.9E-03
Sandia-NM	7.1E-04	1.1E-03	9.0E-09	3.8E-03	1.0E-03
PGDP	1.7E-03	2.4E-03	1.2E-07	1.1E-02	1.6E-03
ETEC	2.8E-04	4.5E-04	8.2E-09	8.3E-04	1.7E-03
ITRI	3.2E-04	4.8E-04	4.1E-09	1.7E-03	4.7E-04
PORT	9.7E-04	1.4E-03	1.0E-07	5.7E-03	1.2E-03
Pantex	2.8E-04	4.2E-04	6.7E-09	1.7E-03	3.7E-04
TOTAL	**1.0E-01**	**1.5E-01**	**8.4E-06**	**4.8E-01**	**8.9E-02**

Table 5.17. Summary of Life-Cycle Risks for Each Configuration[(a)]

Impact Measure	1A (Intermodal at Barstow, CA)[(b)]	1B (Intermodal at Caliente, NV)[(b)]	2 (100% truck on routes that avoid Las Vegas)	3 (100% truck on routes that travel through Las Vegas)
High Waste Volume Case				
Shipping Distance (mi.)	2.6E+07	2.8E+07	5.2E+07	4.5E+07
Radiological Routine – Workers (Fatalities)	1.1E-01	1.2E-01	2.9E-01	2.7E-01
Radiological Routine – Public (Fatalities)	9.7E-02	1.1E-01	4.3E-01	3.9E-01
Radiological Accident Risks (Fatalities)	8.0E-06	1.2E-05	1.9E-05	1.9E-05
Nonradiological Accident Risks (Fatalities)	1.2E+00	1.3E+00	1.8E+00	1.5E+00
Nonradiological Routine Emissions (Fatalities)	1.3E-01	1.6E-01	2.1E-01	2.8E-01
Low Waste Volume Case				
Shipping Distance (mi.)	1.0E+07	1.2E+07	2.1E+07	1.7E+07
Radiological Routine – Workers (Fatalities)	3.7E-02	4.4E-02	1.2E-01	1.0E-01
Radiological Routine – Crew (Fatalities)	3.0E-02	3.6E-02	1.7E-01	1.5E-01
Radiological Accident Risks (Fatalities)	3.0E-06	3.6E-06	8.5E-06	8.4E-06
Nonradiological Accident Risks (Fatalities)	4.6E-01	4.4E-01	7.1E-01	4.8E-01
Nonradiological Routine Emissions (Fatalities)	5.1E-02	6.8E-02	7.9E-02	8.9E-02

(a) Includes risks from truck and rail transport of LLW as well as intermodal transfer operations.
(b) Transport from small LLW generator sites is by truck via routes that avoid Las Vegas.

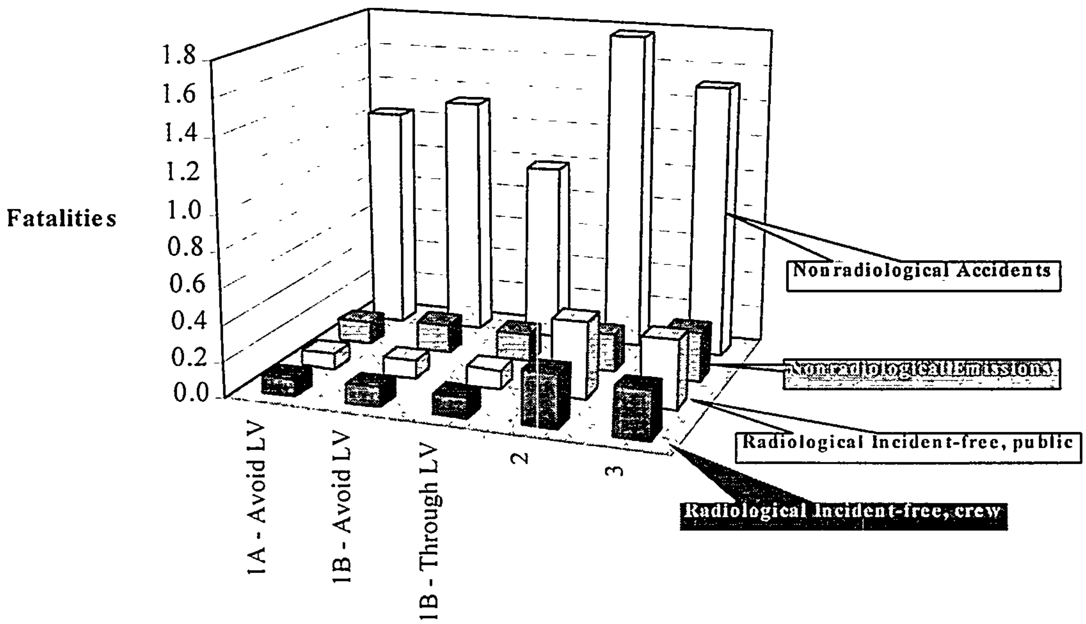

Figure 5.3. Plot of Total Transportation Risks for the High Waste Loading Option (Radiological Accident Risks Not Plotted)

The options in which routes avoid the Las Vegas Valley and Hoover Dam appear to result in higher public and worker risks than options that use routes through Las Vegas, in part because the total shipping distances are higher for the options that avoid Las Vegas. The option with the highest total shipping distance results in the highest nonradiological accident risks, which are approximately linear with shipping distance for any particular transport mode. Radiological routine risks, on the other hand, are affected by shipping distance as well as other parameters, specifically population density. One would think that the options that avoid Las Vegas would result in lower radiological routine risks because they divert the shipments away from densely populated areas of Nevada to rural highways. However, as the results in Table 5.17 indicate, on a DOE complex basis, the effects of the longer shipping distances associated with the options that avoid Las Vegas offset the reductions associated with diverting the shipments away from highly populated Las Vegas. Moreover, the Las Vegas

Risk Perspective – Maximum Individual Doses

The RADTRAN 4 results include an estimate of the maximum individual dose from incident-free transport. The estimate is based on a person that is located 30m from the transport link exposed to a shipment passing by at 24 km/hr (15 mph). The package dose rate in this example was conservatively set to 10 mrem/hr at 1 m from the package surface. Based on these assumptions, the maximum individual dose was calculated to be 5.6E-07 rem per shipment. Assuming this person is exposed to every truck shipment in the high waste volume configuration, the accumulated dose over 70 years (27,725 truck shipments) would be about 20 mrem. This is small relative to the annual radiation dose from natural and man-made sources of about 300 mrem/yr or 21,000 mrem over a 70-yr period. This is also a small fraction of the Nuclear Regulatory Commission's (NRC's) annual dose limit for members of the public 100 mrem/yr (see 10 CFR 20.1301). The dose to this maximum individual is equivalent to the dose from about 3 to 4 chest X-rays. Clearly, this maximum individual dose accumulated over 70 years represents an insignificant risk to this hypothetical individual.

Risk Perspective
Incident-free Population Dose

The incident-free population risks from transporting LLW to NTS can be compared to the risks of exposure to natural background radiation. Natural background doses were calculated using the population densities and shipping distances calculated by HIGHWAY for the route from Boulder City, NV, to NTS (i.e., through Las Vegas). The calculation also used the RADTRAN 4 assumption that the exposed population includes all persons within 800 m on either side of a truck shipment. The total exposed population was assumed to be uniformly distributed in this 1.6-km-wide band over the entire length of the trip from Boulder City to NTS. Using these assumptions, the total exposed population would be about 81,000 people in this corridor. Using this value of the exposed population and assuming natural background dose rates are on the order of 360 mrem/yr, the total population dose from natural background is about 29,000 person-rem/yr. This converts to about 15 Latent Cancer Fatalities (LCFs) per year. However, if the actual population of Nevada was used, the total population dose would be about 150,000 person-rem or, in terms of fatalities, about 75 LCFs per year from natural background. The estimated incident-free dose risks from LLW transport to NTS are all less than 1 cancer fatality (see Tables 5.19 to 5.22) in 70 years. This demonstrates that the incident-free dose risks from transporting LLW to NTS are a small fraction of the risks from background radiation. To further put this in perspective, there were about 3,000 deaths from all forms of cancer from all causes in Nevada in 1995 (National Center for Health Statistics 1997).

Valley, although densely populated, is only a small fraction of the any of the routes and thus does not greatly influence the total risk over the entire route.

The configurations that avoid Las Vegas divert shipments from well-maintained interstate and primary state highways to less well-maintained rural highways. The interstates and primary highways are also better designed and constructed to handle heavy truck traffic (roadbeds, shoulders, etc.) than rural highways. This is part of the reason why DOT highway routing guidelines direct carriers to use interstate highways in most instances. In addition, the routes that travel through Las Vegas are shorter and more direct than the routes that avoid Las Vegas. One would expect nonradiological fatalities to be lowest for alternatives that make the most extensive use of interstate highways and result in lower total shipping distances. This is borne out by the results presented in the previous tables.

Another observation is that the trend discussed above in which the risks are most favorable for options that travel through Las Vegas is not applicable to nonradiological routine emissions. This is because the routes that avoid Las Vegas have higher proportions of the trips in rural and suburban areas than routes that travel through Las Vegas. The nonradiological routine risk factor is 0 in rural and suburban population zones (see Section 5.1.3). As a result, the effects of shifting LLW shipments to routes that avoid Las Vegas tend to result in lower nonradiological routine risks than shipping through Las Vegas. The decrease in travel through high population density regions more than offsets the risk increase that results from longer shipping distances as most of the mileage increase is in rural areas of Nevada where nonradiological routine emission risks are assumed to be 0.

Figure 5.3 illustrates the comparison between shipping by truck around (Configuration 2 – see Tables 5.13 and 5.14) versus through Las Vegas (Configuration 3 – see Tables 5.15 and 5.16). It also illustrates the differences in the intermodal options when shipments from small LLW generator sites are routed around versus through Las Vegas (compare Tables 5.10 and 5.12). For both comparisons, the total life-cycle risks are higher for the options that avoid Las Vegas. The total risks in this figure include the in-transit segments of the shipments as well as the nonradiological accident risks and radiological dose risks to workers at the intermodal transfer facilities. It should be noted that the intermodal transfer risks are small relative to the in-transit risks. The intermodal transfer risks amount to about 4% of the total worker radiological doses and less than 1% of the nonradiological fatality estimates for the intermodal configurations.

The radiological doses to the truck crews and public in Figure 5.3 are about 10% lower for Configuration 3 relative to Configuration 2 whereas the nonradiological accident risks are about 15% lower for Configuration 2. Numerically, nonradiological accident risks are significantly higher than the radiological dose risks. This means that the absolute differences in the calculated risks are more significant for nonradiological accident risks than are the absolute differences in radiological dose risks, even though the percentage changes are about the same. For example, the absolute difference in nonradiological accident risks between Configurations 2 and 3 amounts to about 0.3 fatalities where the difference between public radiological risks amounts to about 0.05 fatalities.

The intermodal configurations examined in this study are projected to result in smaller radiological and nonradiological risks to workers (i.e., truck and rail crews) and to the public than the all-truck configurations. The main drivers for these differences are smaller total shipping distances (resulting from rail shipments having a higher capacity than truck shipments) and lower accident rates and unit risk factors for rail shipments than for truck shipments. The risks from intermodal transfer activities are small relative to the in-transit risks, so they can be ignored when making these comparisons.

Tables 5.8 through 5.17 report total public radiological risk for incident-free transportation. "Public risk" is the sum of off-link risk (the risk to people living and working within a half-mile of the route), on-link risk (the risk to occupants of vehicles sharing the route with the radioactive cargo), and stop risk (the risk to people at stops where the vehicle is stopped). The stop risk is always one to two orders of magnitude larger than off-link and on-link risks for truck transportation, so that the total public risks are usually just a reflection of the stop risk (see Table 5.18 and Figure 5.4). For intermodal transportation, which is primarily rail, the stop risk is the same order of magnitude as the off-link risk.

For truck transportation, the radiological risk to residents along the route (off-link risk) is about 1 to 4% of the total public risk, and is a slightly higher fraction for the routes through Las Vegas than for a route that avoids Las Vegas. For example, for the ORR-to-NTS route, the off-link risk is about 2.9% of the total public risk for the route through Las Vegas and about 2.2% of the total public risk for the route that avoids Las Vegas. For the RFETS-to-NTS route, off-link risks are about 1.8% of the total public risk for the route that travels through Las Vegas and about 0.8% of the total public risk on the route that avoids Las Vegas.

For rail transportation, the stop risks are smaller fraction of the incident-free public risks than for truck transportation, because there are far fewer people near the cargo at the stops. The off-link risks for rail transport are about half of the total public rail risk, compared to the 1 to 4 % of the total for truck transport. This illustrates that increasing the use of rail causes the dominant incident-free public risks to shift from the population at truck stops to an approximate equal split between the population surrounding rail stops and the population within a half-mile of the rail lines.

In general, the life-cycle incident-free public risks from rail transportation are smaller than for truck transportation, as shown in the tables. However, the off-link doses, which are a concern to local stakeholder groups in Nevada and in corridor states, are actually lower on a DOE complex basis for truck shipments than for rail. Referring to Table 5.18, the total life-cycle off-link doses are 55 and 68 person-rem for Intermodal Configurations 1A and 1B, respectively. For Configurations 2 and 3 (100% truck shipments), the off-link risks are 17 and 21 person-rem, respectively. Thus, there is about a factor of 3 to 4 difference in favor of truck shipments when only off-link doses or risks are considered. However, this difference is overwhelmed by the large difference in stop doses, which favor rail shipments.

Table 5.18. Detailed Truck and Rail Incident-Free Doses for Major LLW Generators

LLW Generator	Crew Dose (person-rem)	Public Dose (person-rem)			
		Off-link	On-link	Stops	Total
Configuration 1A: Intermodal at Barstow [a]					
ORR	7.1E+01	1.9E+01	3.5E+00	1.9E+01	4.1E+01
LANL	1.8E+01	9.1E-01	1.1E+00	3.3E+00	5.3E+00
FEMP	2.3E+01	6.6E+00	1.1E+00	6.4E+00	1.4E+01
RFETS	1.4E+01	3.1E+00	7.5E-01	4.1E+00	7.9E+00
Mound	1.8E+01	7.1E+00	9.1E-01	5.2E+00	1.3E+01
LLNL	5.9E+00	2.2E+00	4.2E-01	1.3E+00	3.9E+00
BNL	1.1E+01	1.3E+01	6.9E-01	3.5E+00	1.8E+01
INEEL	5.2E+00	2.8E+00	3.2E-01	1.3E+00	4.4E+00
ANL-E	3.6E+00	5.9E-01	1.7E-01	9.2E-01	1.7E+00
Subtotal	1.7E+02	5.5E+01	9.0E+00	4.5E+01	1.1E+02
Small Generators	5.7E+01	1.9E+00	7.8E+00	5.6E+01	6.5E+01
Grand Total	**2.3E+02**	**5.7E+01**	**1.7E+01**	**1.0E+02**	**1.7E+02**
Configuration 1B: Intermodal at Caliente [a]					
ORR	8.3E+01	2.3E+01	4.4E+00	2.2E+01	5.0E+01
LANL	2.6E+01	4.3E+00	1.6E+00	6.4E+00	1.2E+01
FEMP	2.6E+01	7.8E+00	1.4E+00	6.8E+00	1.6E+01
RFETS	1.5E+01	5.6E-01	9.2E-01	2.6E+00	4.1E+00
Mound	2.0E+01	1.4E+01	1.2E+00	5.6E+00	2.0E+01
LLNL	9.1E+00	2.7E+00	5.7E-01	2.1E+00	5.3E+00
BNL	1.2E+01	1.4E+01	8.3E-01	3.5E+00	1.9E+01
INEEL	5.3E+00	5.3E-01	3.6E-01	1.1E+00	1.9E+00
ANL-E	4.1E+00	8.0E-01	2.2E-01	9.8E-01	2.0E+00
Subtotal	2.0E+02	6.8E+01	1.2E+01	5.1E+01	1.3E+02
Small Generators	5.7E+01	1.9E+00	7.8E+00	5.6E+01	6.5E+01
Grand Total	**2.6E+02**	**7.0E+01**	**1.9E+01**	**1.1E+02**	**2.0E+02**
Configuration 2: Truck Shipments to NTS - Avoid Las Vegas (Truck Risks Only)					
ORR	3.1E+02	7.8E+00	4.0E+01	3.2E+02	3.6E+02
LANL	4.9E+01	7.2E-01	5.5E+00	5.3E+01	5.9E+01
FEMP	1.0E+02	3.0E+00	1.3E+01	1.0E+02	1.2E+02
RFETS	3.6E+01	3.3E-01	3.8E+00	3.9E+01	4.3E+01
Mound	7.9E+01	2.7E+00	1.1E+01	7.8E+01	9.2E+01
LLNL	1.0E+01	1.3E-01	1.2E+00	1.1E+01	1.3E+01
BNL	6.0E+01	2.4E+00	8.7E+00	5.6E+01	6.7E+01
INEEL	1.1E+01	7.5E-02	1.1E+00	1.2E+01	1.3E+01
ANL-E	1.5E+01	2.3E-01	1.7E+00	1.6E+01	1.8E+01
Subtotal	6.8E+02	1.7E+01	8.6E+01	6.8E+02	7.8E+02
Small Generators	5.7E+01	1.9E+00	7.8E+00	5.6E+01	6.5E+01
Grand Total	**7.3E+02**	**1.9E+01**	**9.4E+01**	**7.4E+02**	**8.5E+02**
Configuration 3: Truck Shipments to NTS - Through Las Vegas (Truck Risks Only)					
ORR	2.9E+02	9.5E+00	4.0E+01	2.8E+02	3.3E+02
LANL	4.0E+01	1.4E+00	5.6E+00	4.0E+01	4.7E+01
FEMP	9.3E+01	3.5E+00	1.3E+01	9.0E+01	1.1E+02
RFETS	2.8E+01	5.7E-01	3.3E+00	2.8E+01	3.2E+01

LLW Generator	Crew Dose (person-rem)	Public Dose (person-rem)			
		Off-link	On-link	Stops	Total
Mound	7.3E+01	3.1E+00	1.1E+01	7.0E+01	8.4E+01
LLNL	1.1E+01	2.2E-01	1.4E+00	1.2E+01	1.3E+01
BNL	5.5E+01	2.5E+00	8.4E+00	5.0E+01	6.1E+01
INEEL	1.0E+01	4.8E-01	1.6E+00	9.4E+00	1.1E+01
ANL-E	1.3E+01	2.8E-01	1.6E+00	1.3E+01	1.5E+01
Subotal	6.1E+02	2.1E+01	8.7E+01	6.0E+02	7.0E+02
Small Generators	5.2E+01	2.1E+00	7.7E+00	4.9E+01	5.9E+01
Grand Total	**6.7E+02**	**2.4E+01**	**9.4E+01**	**6.4E+02**	**7.6E+02**

(a) These results include the in-transit doses for rail transport from LLW generators to the specified intermodal transfer facility, including stops for marshalling and inspection, in addition to the in-transit doses for a truck shipment from the intermodal facility to NTS. Small generators were assumed to ship by truck via routes that avoid Las Vegas and Hoover Dam.

From a DOE-complex perspective, when only the off-link incident-free risk is considered, the risks on truck routes that travel through Las Vegas (Configuration 3) are about 1.3 times higher (i.e., 30% higher) than the risks on truck routes that avoid Las Vegas (Configuration 2). This increase is within the uncertainty in the results and thus there is essentially no difference between the two truck routes on Complex-wide basis. For the major generators, the off-link risks were about 1.1 (BNL to NTS) to about 6 (INEEL to NTS) times higher for Configuration 3 than Configuration 2. For all but INEEL, the difference was less than a factor of 2. The large difference calculated for INEEL was due the fact that the route taken to avoid Las Vegas was determined by HIGHWAY to be 97% rural and the route taken through Las Vegas was determined to be only 84% rural (see Table 5.3). Even though the route that avoids Las Vegas is about 25% longer (887 versus 719 mi), the affected population (including persons on-link, off-link, and at stops) is about one-sixth of that along the route through Las Vegas. The rural travel fractions for the other major generators also follow this trend (i.e., generally higher rural travel fractions and longer shipping distances for Configuration 2), but are much less pronounced than the differences between the INEEL to NTS truck routes.

5.3.3 Transportation Risks by State

The risk estimates developed in this study were sorted by state to provide an understanding of the level of risks to be borne by each state along the transportation corridors between LLW generators and NTS. The state-by-state risk estimates for the high waste loading case are presented in Tables 5.19 to 5.22 for Configurations 1A, 1B, 2, and 3, respectively.

Figures 5.5 and 5.6 were plotted to illustrate the effect on state-level impacts of the various configurations. Since the shipments converge on the State of Nevada, the impacts of the shipping configurations are most likely to appear in Nevada and adjoining states Arizona, California, and Utah. Thus, Figures 5.5 and 5.6 focus on the impacts in these four states. Also, since public risks are often the most controversial, the figures focus on public routine radiological doses and public nonradiological accident risks.

Figures 5.5 and 5.6 illustrate trends in state-level risks. By comparing the all-truck configurations (2 and 3) in Figure 5.5, one can see that the public radiological risks for Configuration 2 (100% truck on routes that avoid Las Vegas) are slightly lower than Configuration 3 in Nevada, Arizona, and Utah. These risks

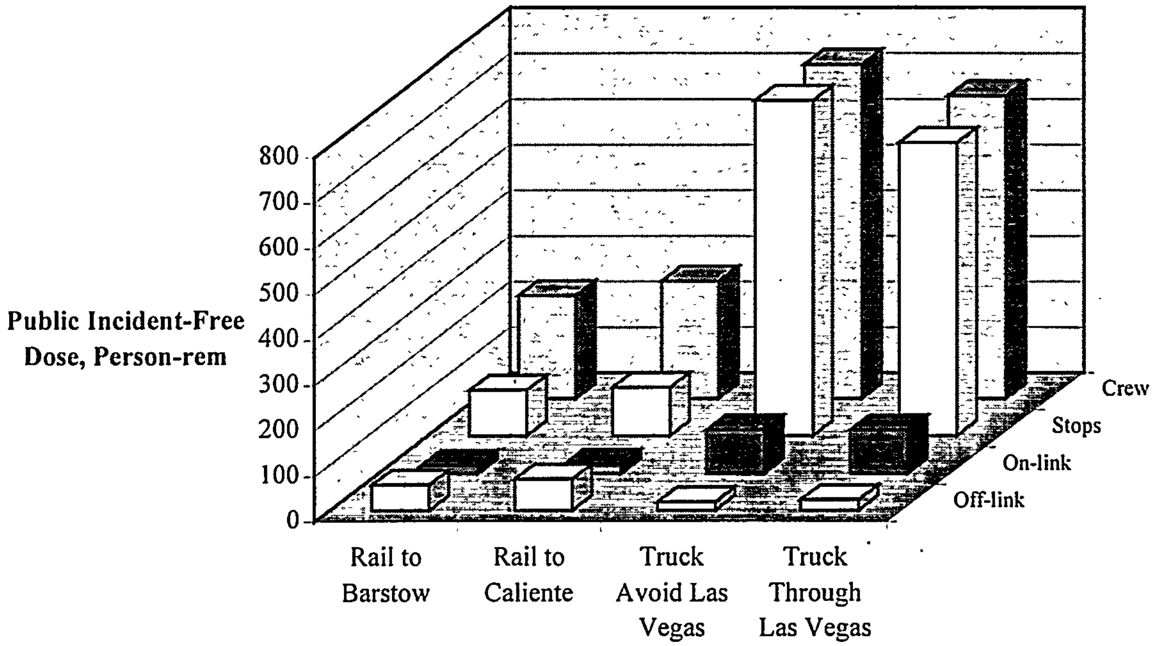

Figure 5.4. Components of Incident-Free Routine Radiological Public Risks For Each LLW Shipping Configuration

are significantly higher in California for Configuration 2 (avoid Las Vegas) than Configuration 3. The main reason for this is that many shipments that now enter the State of Nevada from the south (i.e., via Hoover Dam in Configuration 3), will be diverted to the west in Configuration 2 on Interstate 40 and enter Nevada on Highway 127 near Death Valley Junction (see Figure 2.3). This substantially increases the number of miles traveled in California relative to the current highway routing scheme. This illustrates one form of redistributing risks. However, this observation is valid only for the routing options that are evaluated here. Further analysis would be necessary to explore all potential highway routing alternatives for avoiding Las Vegas and Hoover Dam. In addition, even though the risks are significantly higher in California, the state-level risk estimates are small. The difference in California between Configurations 2 and 3 represents an incremental 100 person-rem, or a probability of about one chance in 20 of an excess latent cancer fatality, over 70 years. On an annual basis, the difference represents about 1 person-rem/yr or less than one chance in 1000 per year of an excess latent cancer fatality.

In general, Figure 5.5 demonstrates that the rail/intermodal shipping configurations (1A and 1B) result in lower routine radiological impacts to the public in all four states relative to the all-truck configurations (2 and 3). Also, note that Configuration 1A, where an intermodal transfer facility at Barstow is assumed, has higher public radiological risks in California and Arizona than Configuration 1B (intermodal at Caliente) and lower risks in Utah and Nevada. This is primarily because a large fraction of the route used for the truck segments from the Barstow intermodal facility to NTS travels through California whereas the Caliente to NTS intermodal segment is entirely in Nevada. Also, direct truck shipments that use the southern route (Interstate 40) would also be diverted from entering Nevada at Hoover Dam, resulting in additional truck mileage in California.

Table 5.19. Total Risk[a] By State: Configuration 1A (Intermodal at Barstow) – High Waste Volume, Avoid Las Vegas

State	Radiological Fatalities			Nonradiological Fatalities	
	Incident-Free Transport		Accident Risk		
	Crew	Public		Accidents	Emissions
AL	9.9E-04	1.5E-03	5.4E-08	3.6E-02	2.3E-03
AZ	7.8E-03	7.6E-03	6.5E-08	1.2E-01	8.1E-03
AR	8.6E-04	8.4E-04	1.2E-07	4.0E-02	8.2E-04
CA	3.8E-02	2.4E-02	8.3E-07	3.0E-01	2.0E-02
CO	3.8E-03	4.5E-03	1.8E-07	1.9E-02	6.0E-03
GA	1.7E-05	8.8E-06	5.4E-10	4.6E-04	0.0E+00
ID	2.8E-04	2.6E-04	8.3E-09	2.4E-03	3.1E-04
IL	2.2E-03	3.8E-03	1.9E-06	4.1E-02	8.4E-03
IN	3.4E-03	3.7E-03	6.1E-07	4.0E-02	6.7E-03
IA	1.3E-03	1.8E-03	4.0E-08	7.4E-03	1.8E-04
KS	2.3E-03	1.8E-03	4.0E-07	2.2E-02	5.1E-03
KY	8.7E-05	1.2E-04	5.8E-09	5.2E-04	1.8E-04
MS	2.0E-04	1.9E-04	4.5E-08	1.4E-02	0.0E+00
MO	5.2E-03	5.3E-03	4.5E-07	6.5E-02	7.9E-03
NE	2.4E-03	2.2E-03	4.9E-07	1.2E-02	1.4E-03
NV	8.8E-03	4.0E-03	1.1E-08	8.6E-02	7.0E-04
NJ	1.0E-05	1.3E-05	2.7E-09	3.8E-05	0.0E+00
NM	8.7E-03	6.7E-03	2.4E-08	7.8E-02	2.5E-03
NY	1.8E-03	4.9E-03	6.0E-07	5.8E-02	1.3E-02
OH	3.7E-03	6.8E-03	1.9E-07	2.6E-02	1.3E-02
OK	4.2E-03	4.9E-03	3.6E-07	1.2E-01	5.5E-03
PA	5.1E-04	8.1E-04	2.9E-08	4.1E-03	1.3E-03
TN	3.4E-03	5.6E-03	2.0E-07	3.9E-02	1.2E-02
TX	3.0E-03	3.3E-03	2.6E-07	1.0E-01	2.0E-03
UT	2.5E-03	2.2E-03	1.7E-09	1.5E-02	2.3E-06
WV	9.5E-06	1.3E-05	5.9E-11	5.6E-05	1.4E-06
TOTAL	**1.1E-01**	**9.7E-02**	**8.0E-06**	**1.2E+00**	**1.3E-01**

(a) Includes risk from in-transit segments and intermodal transfers.

Table 5.20. Total Risk[a] By State: Configuration 1B (Intermodal at Caliente) – High Waste Volume, Avoid Las Vegas

State	Radiological Fatalities			Nonradiological Fatalities	
	Incident-Free Transport		Accident Risk		
	Crew	Public		Accidents	Emissions'
AZ	2.5E-03	3.5E-03	1.3E-08	1.2E-02	5.4E-04
CA	2.6E-03	4.4E-03	1.0E-07	1.9E-02	7.9E-03
CO	4.7E-03	6.2E-03	2.8E-07	4.7E-02	8.8E-03
ID	2.8E-04	2.6E-04	8.3E-09	2.4E-03	3.1E-04
IL	3.1E-03	8.9E-03	3.4E-06	7.9E-02	2.9E-02
IN	2.8E-03	4.8E-03	1.2E-06	7.6E-02	1.1E-02
IA	2.2E-03	3.7E-03	1.5E-06	2.5E-02	6.1E-03
KS	1.4E-03	1.7E-03	4.3E-07	2.4E-02	2.2E-03
KY	1.3E-03	2.6E-03	1.3E-07	3.2E-02	8.8E-03
MO	3.6E-03	6.7E-03	6.0E-07	5.3E-02	1.7E-02
NE	5.9E-03	5.8E-03	2.5E-06	6.8E-02	5.3E-03
NJ	4.7E-02	3.4E-02	1.5E-09	3.8E-05	4.8E-05
NV	5.1E-02	1.3E-05	6.3E-08	4.4E-01	1.1E-03
NM	3.7E-03	3.7E-03	1.6E-08	1.9E-02	2.6E-03
NY	1.8E-03	4.9E-03	6.8E-07	5.8E-02	1.3E-02
OH	3.8E-03	7.3E-03	3.8E-07	3.0E-02	1.9E-02
OK	1.8E-03	1.8E-03	9.3E-08	1.0E-02	1.3E-03
PA	5.1E-04	8.1E-04	6.0E-08	4.1E-03	1.5E-03
TN	2.8E-03	2.0E-03	3.8E-08	1.5E-02	1.4E-04
TX	6.7E-04	1.0E-03	8.5E-08	5.1E-03	6.0E-04
UT	8.0E-03	1.0E-02	3.2E-07	3.0E-01	2.3E-02
WV	9.5E-06	1.3E-05	3.3E-10	5.6E-05	5.5E-05
WY	4.6E-03	3.3E-03	5.1E-08	1.9E-02	3.7E-03
TOTAL	**1.2E-01**	**1.1E-01**	**1.2E-05**	**1.3E+00**	**1.6E-01**

(a) Includes risk from in-transit segments and intermodal transfers.

Table 5.21. Total Risk[(a)] by State: Configuration 2 (100% Truck Avoid Las Vegas)

State	Radiological Fatalities			Nonradiological Fatalities	
	Incident-Free Transport		Accident Risk		
	Crew	Public		Accidents	Emissions
AZ	4.0E-02	6.0E-02	2.7E-07	2.3E-01	1.1E-02
AK	1.7E-02	2.3E-02	4.3E-07	5.6E-02	2.2E-03
CA	3.6E-02	5.5E-02	9.1E-07	1.6E-01	1.1E-02
CO	1.1E-02	1.5E-02	7.3E-07	6.8E-02	3.8E-03
ID	1.4E-03	2.1E-03	6.9E-08	3.2E-03	5.4E-04
IL	8.4E-03	1.2E-02	3.5E-06	3.7E-02	6.1E-03
IN	8.5E-03	1.1E-02	2.1E-06	2.8E-02	8.9E-03
IA	4.5E-03	6.3E-03	1.2E-06	2.4E-02	3.4E-04
KY	8.6E-05	1.2E-04	7.9E-09	5.2E-04	1.8E-04
MO	1.2E-02	1.6E-02	2.0E-06	7.2E-02	2.1E-02
NE	5.0E-03	7.6E-03	1.7E-06	4.1E-02	5.0E-03
NV	1.8E-02	2.9E-02	3.2E-08	2.0E-01	1.5E-04
NJ	9.6E-04	1.3E-03	1.3E-07	3.6E-03	5.9E-03
NM	3.9E-02	5.8E-02	2.9E-07	2.7E-01	4.4E-02
NY	2.2E-03	2.8E-03	2.7E-07	1.3E-02	1.1E-02
OH	5.5E-03	6.7E-03	4.5E-07	8.9E-03	8.5E-03
OK	3.2E-02	4.5E-02	2.1E-06	2.3E-01	1.8E-02
OR	5.6E-04	8.7E-04	5.6E-09	4.1E-03	0.0E+00
PA	2.9E-03	3.9E-03	2.3E-07	2.1E-02	1.0E-03
TN	2.4E-02	3.3E-02	5.9E-07	1.2E-01	3.5E-02
TX	1.6E-02	2.3E-02	2.0E-06	1.2E-01	1.4E-02
UT	9.6E-03	1.4E-02	9.9E-08	7.0E-02	2.3E-03
WV	9.5E-06	1.3E-05	3.3E-10	5.6E-05	5.5E-05
TOTALS	**2.9E-01**	**4.3E-01**	**1.9E-05**	**1.8E+00**	**2.1E-01**

(a) Includes risk from in-transit segments between LLW generators and NTS. There are no intermodal transfers or rail shipments in this configuration.

Table 5.22. Total Risk[(a)] by State: Configuration 3 (100% Truck Through Las Vegas)

State	Radiological Fatalities			Nonradiological Fatalities	
	Incident-Free Transport		Accident Risk		
	Crew	Public		Accidents	Emissions
AZ	4.1E-02	6.2E-02	2.8E-07	2.4E-01	1.1E-02
AK	1.7E-02	2.3E-02	4.3E-07	5.6E-02	2.2E-03
CA	3.9E-03	5.9E-03	1.0E-07	1.6E-02	4.2E-03
CO	1.1E-02	1.5E-02	7.3E-07	6.8E-02	3.8E-03
ID	6.7E-04	9.8E-04	3.3E-08	1.5E-03	1.8E-04
IL	8.4E-03	1.2E-02	3.5E-06	3.7E-02	6.1E-03
IN	8.5E-03	1.1E-02	2.1E-06	2.8E-02	8.9E-03
IA	4.5E-03	6.3E-03	1.2E-06	2.4E-02	3.4E-04
KY	8.6E-05	1.2E-04	7.9E-09	5.2E-04	1.8E-04
MO	1.2E-02	1.6E-02	2.0E-06	7.2E-02	2.1E-02
NE	5.0E-03	7.6E-03	1.7E-06	4.1E-02	5.0E-03
NV	2.0E-02	3.0E-02	5.9E-07	6.4E-02	7.0E-02
NJ	9.6E-04	1.3E-03	1.3E-07	3.6E-03	5.9E-03
NM	3.9E-02	5.8E-02	2.9E-07	2.7E-01	4.4E-02
NY	2.2E-03	2.8E-03	2.7E-07	1.3E-02	1.1E-02
OH	5.5E-03	6.7E-03	4.5E-07	8.9E-03	8.5E-03
OK	3.2E-02	4.5E-02	2.1E-06	2.3E-01	1.8E-02
PA	2.9E-03	3.9E-03	2.3E-07	2.1E-02	1.0E-03
TN	2.4E-02	3.3E-02	5.9E-07	1.2E-01	3.5E-02
TX	1.6E-02	2.3E-02	2.0E-06	1.2E-01	1.4E-02
UT	1.2E-02	1.8E-02	1.9E-07	8.5E-02	6.6E-03
WV	9.5E-06	1.3E-05	3.3E-10	5.6E-05	5.5E-05
TOTALS	**2.7E-01**	**3.9E-01**	**1.9E-05**	**1.5E+00**	**2.8E-01**

(a) Includes risk from in-transit segments between LLW generators and NTS. There are no intermodal transfers or rail shipments in this configuration.

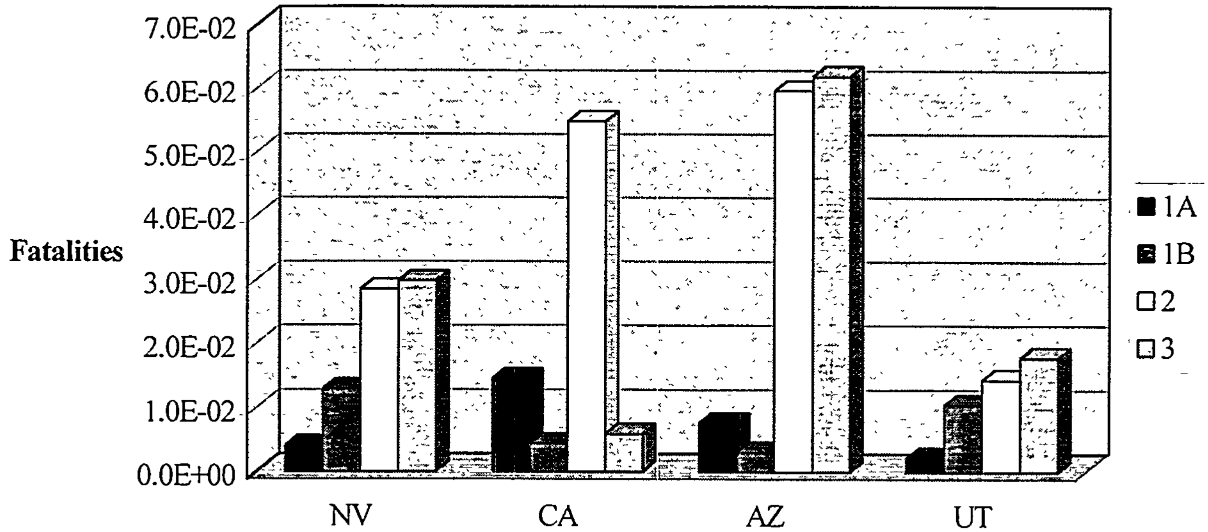

Figure 5.5. Illustration of State-Level Public Radiological Routine Risks

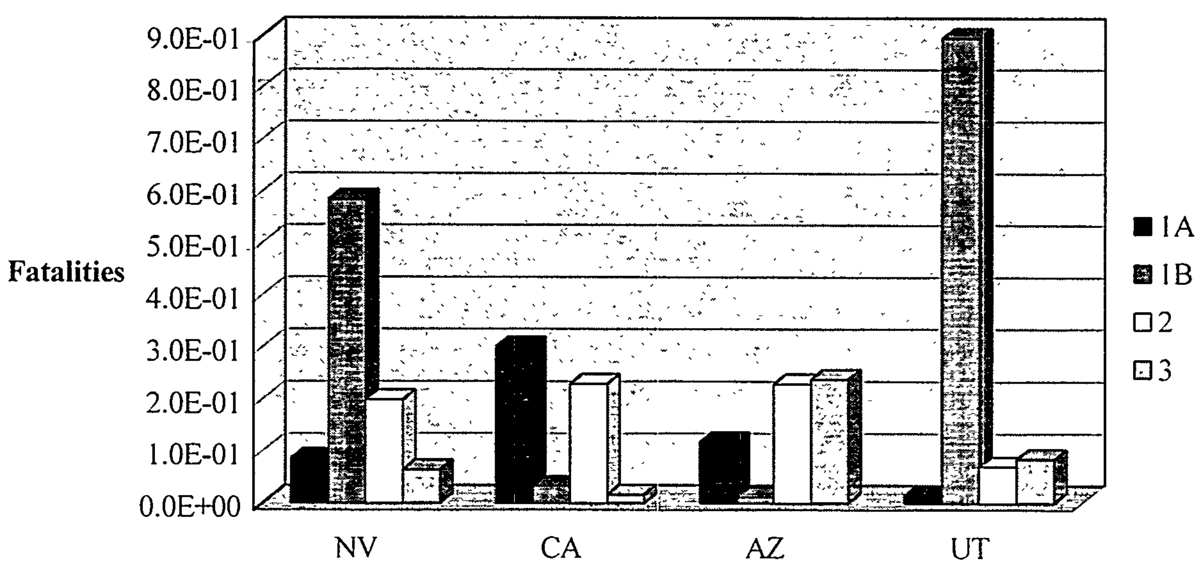

Figure 5.6. Illustration of State-Level Nonradiological Accident Risks

> *Risk Perspective*
> *Nonradiological (Physical) Accident Risks*
>
> *Several comparisons with actual motor vehicle and truck transport accident risk measures were developed to put the nonradiological (physical) accident risk projections in Tables 5.19 to 5.22 in perspective. The State of Nevada will be used as an example. The highest projected nonradiological fatality estimate from NTS LLW shipments by truck is for Configuration 2, truck shipments that avoid Las Vegas. The projection was 0.2 fatalities over 70 years, or an average of about 0.003 deaths per year. This can be compared to about 350 deaths per year (1996 and 1997 data) from all motor-vehicle traffic accidents in Nevada (National Safety Council 1998). For accidents involving heavy combination-trucks, there were 10 to 12 deaths per year (1995 and 1996 data) on interstate highways, primary highways, and other roads and highways in Nevada (Saricks and Tompkins 1999). Based on these comparisons, at the state-level, no significant increases in nonradiological accident risks are projected to result from the truck traffic represented by LLW shipments to NTS for any of the shipping configuration alternatives.*

Figure 5.6 illustrates the distribution of nonradiological accident risks in Nevada and its bordering states for each LLW shipping configuration. In comparing Configuration 2 to Configuration 3, one can see that the nonradiological accident risks in Configuration 2 are higher in Nevada and California and slightly lower in Utah and Arizona relative to Configuration 3. This redistribution effect arises from the increased truck shipping distances in Nevada and California in Configuration 2 that are required to avoid Las Vegas and Hoover Dam. Nonradiological accident rates are also higher on the less-traveled rural highways in Nevada and California than they are on the interstate highway system and US 95 used in Configuration 3.

In Configuration 1A (Barstow intermodal facility), substantially higher nonradiological accident risks are projected in California and Arizona than in the all-truck configurations. The risks, however, are lower in Nevada and Utah relative to Configurations 2 and 3. The higher risks in California and Arizona result from the both the rail and direct truck shipment mileages increasing in these two states. This is because: 1) the destination for the rail shipments is the Barstow, CA, intermodal facility, 2) direct truck shipments using the southern route across the country are diverted from Hoover Dam and Las Vegas to the route that enters Nevada near Death Valley Junction, and 3) the intermodal truck segments travel over California highways to NTS (see Figure 2.3). The risks are lower in Nevada because truck shipments are diverted from US 93 and US 95 in Nevada to the highway routes in Arizona and California.

Configuration 1B results in higher nonradiological accident risks in Nevada than all other configurations. The nonradiological accident risks in Nevada for Configuration 1B are higher than they would be if the present highway route through Las Vegas is used (Configuration 3). This is due to the increased truck shipping distances required to avoid Las Vegas and the relatively long highway segment in Nevada that would be used to move LLW from the Caliente intermodal facility to NTS. Nonradiological accident risks in Utah are also higher for Configuration 1B than the others because of the rail shipments that travel through Utah on the way to Caliente, NV, that would otherwise enter the state from the south. The nonradiological accident risks in California and Arizona in Configuration 1B are lower than in Configuration 1A because the rail shipments and subsequent intermodal truck shipments would not pass through these two states.

An additional observation about the state-level risk results is that the selection of the intermodal facility redistributes risks from one state to another at distances even farther than the states next to Nevada. It was observed that the risks in the State of Colorado are significantly higher when Caliente is the transfer point than they are when the intermodal transfer facility is located in Barstow. This is because shipments from southern and eastern LLW generators tend to stay farther north when they are destined for Caliente than they do when the shipments are destined for Barstow. Since there are few routing options for rail shipments and a limited set of routing options for highway shipments that avoid Las Vegas, many of the shipments had to be redirected northward rather than entering Nevada from the south. This resulted in increased travel through Colorado, as can be seen by comparing Tables 5.19 and 5.20.

This study demonstrates that the shipping configuration where an intermodal facility is located at Barstow, CA (Configuration 1A), is slightly favored over the intermodal facility at Caliente, NV, in terms of the total life-cycle radiological fatalities. The *NTS Intermodal EA* results indicate that Caliente is the preferred location for the intermodal facility. The most significant difference between these two studies is the assumption in the *NTS Intermodal EA* that the trucks receive a state inspection at the California/Nevada border. This assumption adds to the incident-free radiological risks of the Barstow intermodal configuration that is not included in the Caliente configuration, since the truck route from Caliente to NTS is entirely within Nevada. Given that there are over 27,000 shipments of LLW to NTS in the high waste volume case, this could be sufficient to drive the results in this study in favor of the Caliente intermodal configuration. There are also likely to be slight differences in highway and rail routes used in the two studies, particularly the selection of southern or northern interstate highways used to deliver the LLW to Nevada and the selection of rail routes.

Another inconsistency between the options favored in this study versus the *NTS Intermodal EA* is that the nonradiological accident risks in this study are lower in Configuration 3 (all truck through Las Vegas) than in Configuration 1A (intermodal at Barstow). The main difference in the two studies that leads to these conflicting results is the truck accident (fatality) rates used. The *NTS Intermodal EA* used accident rate data specific to the highway segments under analysis. This study used state-specific accident rates that are a level of detail less sophisticated than the route segment-specific data. Sections of the highway route between Barstow and NTS that avoid Las Vegas appear to have significantly higher fatality rates than the state-specific fatality rates used here. In any event, the difference in nonradiological accident risks between Configurations 1A and 3 is less than the level of uncertainty in the results.

Analytical Conservatisms

The analytical methods and input parameters used to develop the risk analysis results tend to overpredict or develop conservative estimates of the actual risks of LLW transport. Some of the key sources of conservatism are described below:

- *The RADTRAN 4 population distribution model used for incident-free risk calculations assumes a uniform population density out to 0.8 km (0.5) mi on both sides of the transport link (see Box on page 5.31).*
- *Shipment dose rates were selected to be high relative to the average dose rate emitted from DOE LLW shipments.*
- *Accidental releases were assumed to be dispersed in the atmosphere under neutral conditions with low wind speed. Such conditions are unlikely to coincide with an accident, yet no credit is taken for the low likelihood of these conditions.*
- *The conversion from radiation dose to latent cancer fatalities is conservative, although there is much controversy surrounding the theoretical basis for radiation-induced health effects.*
- *Stop frequency and duration (stop dose is a major component of incident-free truck doses and lesser component of rail doses) are high for long-distance truck shipments that use a two-person driving team.*
- *Average truck and rail speeds are very low relative to actual experience. This results in longer exposure times than would actually occur.*

In general, the assumptions made in the analytical models and selection of conservative input data lead the authors to believe the predicted risks will be higher than the actual risks of transporting LLW to NTS.

6.0 HIGHWAY ROUTING CONSIDERATIONS FOR DOE LLW SHIPMENTS TO NTS

This chapter describes highway routing considerations applicable to DOE LLW shipments to NTS. Routing considerations addressed here include those considered in DOE's transportation planning process as well as highway routing requirements applicable to motor carriers. Note that there are no corresponding routing requirements for rail shipments of LLW or other radioactive materials. This chapter also provides some background information and insights on the highway routing requirements for LLW shipments versus requirements for Highway-Route Controlled Quantities (HRCQ) of radioactive materials, the most visible of which are commercial spent nuclear fuel (SNF) and high-level radioactive waste (HLW) shipments.

6.1 ROUTING CONSIDERATIONS IN DOE'S TRANSPORTATION PLANNING PROCESS

Two routing-related components of DOE's planning process provide assurance that its transportation activities will be conducted in an environmentally protective manner. They include the environmental analysis required by the National Environmental Policy Act (NEPA) and motor carrier assessments conducted by the DOE's National Transportation Program. Although this report is not part of any NEPA study, traditionally, DOE has applied recommended NEPA analytical methods in most of its transportation planning. Along with motor carrier assessments, this approach has led to DOE's excellent overall record in the transportation of radioactive materials.

6.1.1 National Environmental Policy Act

The statutory basis requiring federal agencies to undertake risk assessment in decision making with regard to the transportation of radioactive materials is found in NEPA (see 42 CFR 4321). The cornerstone of NEPA is Section 102(2)(C), which requires that, to the fullest extent possible, all agencies of the Federal Government include in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the environment, a detailed statement by the responsible official on (1) the environmental impact of the proposed action, (2) any adverse environmental effects which cannot be avoided should the proposal be implemented, (3) alternatives to the proposed action, (4) the relationship between the local short-term uses of man's environment and the maintenance and enhancement of the long-term productivity, and (5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. An agency is required to prepare an EIS whenever a proposed action qualifies as a "major federal action significantly affecting the quality of the human environment." ["Major," as used above in NEPA, reinforces but does not have a meaning independent of "significantly" (see 40 CFR 1508.18).]

The procedures that DOE uses to comply with Section 102(2) of NEPA and the Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508) are provided in DOE Implementing Procedures (10 CFR 1021). Those procedures are intended to supplement and be used in conjunction with the CEQ regulations. DOE internal requirements and responsibilities for implementing NEPA, the CEQ regulations, and the DOE NEPA Implementing Procedures are established in DOE Order 451.1A. However, no specific federal requirements for conducting transportation risk assessments exist.

Guidance concerning the preparation of transportation risk assessments for DOE NEPA activities is contained in Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, commonly called the "Green Book." The following is taken from the Green Book (DOE 1993):

Transportation Impacts

When transport of waste or materials of a hazardous or radioactive nature is a necessary part of a proposed action or analyzed alternative, or, more generally, when transport is in any respect a major factor (e.g., transportation of construction materials for a proposed major dam), the environmental impacts of such transport should be analyzed, even when DOE is not responsible for the transportation. Transportation impacts include those from transport to a site, on-site, and from a site, when such activities are reasonably construed as part of the proposed action or analyzed alternative. If not otherwise analyzed, include any necessary loading or unloading activities in the transportation impact analysis.

As with the choice of alternatives, apply a sliding scale approach to the transportation analysis. The nature of the proposed action and analyzed alternative determines whether to describe the transportation impacts qualitatively or to analyze them quantitatively, and what types of potential transportation accidents to consider (see subsection 6.4).

Recommendations

- *Analyze all transportation links that are reasonably foreseeable parts of the proposed action or analyzed alternative, such as overload transport, port transfer, and marine transport. If the action contains links that traverse the global commons (e.g., the oceans or outer space), then impacts from such transport should be included in the NEPA analysis; state that the global commons analysis is provided pursuant to Executive Order 12114.*

- *Do not rely on statements that transportation would be conducted in accordance with all applicable regulations or requirements of the U.S. Department of Energy, The Department of Transportation, the Environmental Protection Agency, the Nuclear Regulatory Commission, or State authorities.*

- *Evaluate both routine (i.e., incident-free) transport and accidents. (Accidents are discussed in subsection 6.4.) Give special emphasis to public or worker health impacts from exposure to chemicals or radiation.*

- *Be sure to use defensible estimation methods for assessing the radiological impacts of transportation (such as the most current version of RADTRAN).*

- *Estimate the annual and total impact of all DOE and non-DOE transportation associated with the use of specific routes (if known) over the term of the proposed action or analyzed alternative, including, for chemical and radiological exposure, the impact on a maximally exposed individual. The impacts of the proposed action related to transportation must be totaled over the duration of the project (e.g., 48 trips per year for 5 years). (Note: This total is not the cumulative impact of transportation impacts from the proposed action and other transportation activities over the same time period in the same area.)*

- *In determining the cumulative impact from transportation activities, use available data to estimate, for example, the number of radioactive materials packages that were shipped over a given transportation system over a given period of time.*

Although the Green Book guidance provides a general overview of what a DOE NEPA transportation assessment should include, specific recommendations are not provided concerning specific end-points, methodologies, and input parameters.

More detailed guidance is provided in the *Framework for Assessing the Effects of Radioactive Materials Transportation in Department of Energy Documents* (DOE 1995a), subsequently referred to as the "Framework." The Framework discusses inclusion of packing and loading/unloading activities if the primary activity addressed by the EA or EIS is transportation. Such activities must be included if they are part of the proposed action. The analysis should consider the number of workers involved, protective equipment employed, and the sequence of events followed during packing or loading/unloading (i.e., time-motion studies), including movement of the material within the facility.

As recommended in the Framework, analysis of transportation activities should cover the shipment mode (e.g., truck or rail), the number of shipments, the number of crew members per shipment, origin and destination site (route definition), stops required along the route, and any necessary intermodal transfers. Incident-free transportation impacts to consider include radiological dose and resultant health effects to the general public and workers (crew and others at stops). Impacts to the public include persons alongside the route (pedestrians or persons living or working on the sides of the route), sharing the route (persons traveling on the same route), and at stops (e.g., rest areas or refueling areas). In addition, impacts to a maximally exposed individual (MEI) along the route (e.g., a person living next to the transport route) should be determined.

The Framework suggests that the focus on radiological effects from accident conditions should be the bounding accident (the most severe reasonably foreseeable accident). Such an accident could be traffic-related, or due to acts of terrorism or sabotage. Results should be presented for the collectively exposed population and the MEI. Nonradiological effects, such as health effects due to vehicle emissions (e.g., fugitive dust and engine emissions) and hazards from vehicle accidents (e.g., fatalities), should also be addressed.

A draft guidance document, the *EM NEPA Technical Guidance Handbook* (DOE 1997a), was written to help streamline the DOE NEPA process and has been made available for comment. In the section on transportation assessment, the Framework is referenced and provides the basis for the transportation analysis. For impact assessment, HIGHWAY (Johnson et al. 1993a) and INTERLINE (Johnson et al. 1993b) are recommended as the routing models to use, and RADTRAN 4 (Neuhauser and Kanipe 1992) and RISKIND (Yuan et al. 1995) are recommended as the radiological models to use. Emphasis is also placed on analyzing the effects on traffic and roads (e.g., increased noise, traffic volume) in the immediate vicinity of the origin and destination sites. These latter effects need only be assessed if significant changes in traffic or traffic patterns result from the proposed action(s), and to the degree that they impact the environment.

Early in the history of NEPA document preparation, transportation impacts were addressed on an aggregate route basis using generic, national-average data (such as population distributions and accident rates). Today, a trend has developed toward more route-specific evaluations and the calculational tools used in NEPA documents have been improved to provide this capability. However, for LLW shipments, the routes analyzed in NEPA documents may not be the exact routes used by motor carriers. The carrier may select the exact route used by an LLW shipment after considering such items as trip duration, highway construction delays and hazards, inclement weather, availability of services, and traffic congestion. In fact, carriers may use different routes between two points based on current conditions and may even deviate from a planned route based on changes to these conditions. The point is that NEPA documents are somewhat "theoretical" with regard to transportation routing considerations. They attempt to develop bounding estimates of transportation impacts to allow decision-makers to compare alternatives. In this manner, the environmental impacts that form the basis for a Record of Decision are intended to be bounding, regardless of the actual route used by the shipments.

6.1.2 Motor Carrier Evaluation Program (MCEP)

DOE's National Transportation Program reports the following on its website:

> *The U.S. Department of Energy (DOE)'s Motor Carrier Evaluation Program (MCEP) provides DOE and its contractors with a process to assure that only the most highly qualified motor carriers are utilized to transport DOE materials, including hazardous materials (particularly radioactive), hazardous substances, and hazardous and mixed wastes. The MCEP uses the United States Department of Transportation's (DOT) motor carrier safety fitness rating and SafetyNet reports as a basis. The MCEP outlines criteria and guides the transportation manager through an objective process of evaluating a carrier's overall management and operations (i.e., vehicle maintenance programs, drivers qualifications, safety programs, financial stability, emergency response, insurance coverage, freight damage claim procedures and other general data). During Fiscal Year 1994, DOE sites nationwide made 23,937 hazardous material shipments including 5,946 that were radioactive materials.*
>
> *Since the inception of the MCEP in the spring of 1990, over sixty commercial motor carriers transporting various commodities for the DOE have voluntarily participated in the program. The MCEP has provided DOE and its contractors with sufficient information to more effectively transport its hazardous commodities across the nation's highways in a safe and regulatory compliant manner. This program has helped DOE to maintain its excellent safety record in the transportation of all commodities, especially hazardous and radioactive materials, substances and wastes, during the 1990's.*
>
> *The MCEP also responds to public concerns surrounding the transportation of hazardous materials, particularly radioactive materials and wastes, by the DOE and its contractors. Representatives of other Federal agencies, state and local governments, Indian tribes, the news media and the public in general have often expressed concern about the safety and capabilities of the motor carriers who transport hazardous materials for the DOE. Much of the concern regarding the qualifications for the motor carriers is centered around the question of the capability of the carrier to effectively transport hazardous materials including radioactive materials, such as spent fuel and low level waste.*
>
> *As a prudent shipper of hazardous materials, the DOE believes it must take additional precautions to ensure that only the most qualified carriers are utilized for these types of commodities. The DOE views DOT safety requirements as the minimum standard for a motor carrier. The MCEP evaluates the carrier beyond this minimum standard. Through the MCEP the DOE extends its philosophy regarding safety, especially with regards to hazardous and radioactive materials, beyond the site boundaries to cover movement from origin to final destination.*
>
> *The Motor Carrier Evaluation Program is currently developing a workshop to effectively train the local DOE and contractor traffic managers to perform evaluations of their regional and local*

carriers. The goal of DOE is to utilize only motor carriers that have been successfully evaluated through the TMD Motor Carrier Evaluation Program. DOE continues to refine the MCEP selection criteria and methodology needed to identify quality motor carriers.

The Motor Carrier Evaluation Program has proven itself as an effective "tool" to assist DOE Headquarters and the DOE Operations Offices in their goal of safe and cost effective transportation of hazardous materials over the nation's highways in support of its mission.

6.2 MOTOR CARRIER REQUIREMENTS

Title 49 of the Code of Federal Regulations (CFR) 397.101 states:

"... a carrier or any person operating a motor vehicle that contains a Class 7 (radioactive) material, as defined in 49 CFR 172.403, for which placarding is required under 49 CFR part 172 shall:

1. Ensure that the motor vehicle is operated on routes that minimize radiological risk.
2. Consider available information on accident rates, transit time, population density and activities, and the time of day and the day of the week during which transportation will occur to determine the level of radiological risk; ..."

While the Department of Transportation (DOT) has prepared *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity (HRCQ) Shipments of Radioactive Materials*, no such guidance exists for non-HRCQs. Telephone discussions with DOT Research and Special Programs Administration staff confirm that carriers are expected to use their professional judgment in considering "available information on accident rates, transit time, population density and activities, and the time of day and the day of the week during which transportation will occur to determine the level of radiological risk." However, no formal methods or level of rigor are prescribed by DOT, and enforcement of the requirement for non-HRCQ shipments is not a current DOT priority.

A discussion of the origin of the DOT regulations for HRCQ shipments of Class 7 radioactive material may shed light on risk requirements and the motor carrier's approach in addressing these requirements. It begins with understanding packaging. Properly designed, fabricated, and prepared packaging systems are the primary means of ensuring the safe transport of radioactive materials. Packaging systems provide containment of the radioactive materials (i.e., barrier to airborne and waterborne releases to the environment), shielding (barrier to penetrating radiation), and prevention of nuclear criticality. The second key element of transportation safety addressed in DOT regulations is vehicle safety. Vehicle safety includes such items as inspections of the condition of tractors and trailers, braking systems, shipping papers, and drivers. Another element of vehicle safety is shipment placarding. The third key element of transportation safety addressed in DOT regulations is highway routing.

The regulations allow radioactive materials to be shipped in different types of packaging systems, depending on the total radiological hazard of the material being shipped. Most DOE LLW shipments are well below the limits allowable for Type A packaging (for definition of Type A, see 49 CFR 173 Subpart I). The IAEA has determined that the consequences of accidental releases involving Type A quantities or less of radioactive material would be "acceptable, within the principles of radiological protection." Based on this determination, failure of a package containing DOE LLW waste would not produce a catastrophic health consequence. Conversely, severe transportation accidents involving HRCQs of radioactive material, which are 3000 greater than the Type A packaging limits, could potentially result in serious consequences. For this reason, HRCQs of radioactive material must be shipped in accident-resistant Type B packaging systems (see 49 CFR 173, Subpart I) and special routing considerations are applicable.

The U.S. DOT considered the overall hazards presented by shipments of Type A quantities of radioactive materials and decided not to impose the requirements for a formal routing evaluation and other restrictions that are applicable to shipments of HRCQs of radioactive material. To manage transportation of DOE LLW according to the requirements for shipping HRCQs of radioactive material would not be necessary or prudent based on the radiological hazard of the shipment. DOT HRCQ requirements do not apply to radioactive materials unless the Type A limits are exceeded by a factor of 3000. DOE LLW shipments typically contain a fraction of the Type A package limits and are thus approximately 4 orders of magnitude ($1/10{,}000^{th}$) less hazardous than a typical HRCQ shipment. Management per DOT non-HRCQ requirements and NEPA guidelines (discussed in Section 6.1.1) should be assumed to be fully protective.

7.0 DISCUSSION OF RESULTS

This chapter discusses the results of the technical analyses (rail or intermodal capabilities at generator sites, costs, risks, stakeholder issues, and carrier routing/risk evaluation process) and develops insights about the results, including the observed most favorable alternatives. Based on these insights, observations that could help DOE to safely and efficiently manage the risks of LLW transportation to NTS were developed. Discussions about the results from this study are presented in this chapter as a list of questions and answers.

Is it feasible for DOE to encourage LLW generators to ship their waste to NTS by rail?

Based on the survey of DOE Traffic Managers at major LLW generator sites performed in this study, it is technically feasible for all DOE LLW generators to ship by rail. Five of the nine major LLW generator sites surveyed indicated they had direct rail service to their sites. For the other four, it was determined to be feasible, although not necessarily cost-effective, to implement intermodal transportation at the LLW generator site in order to ship the waste to NTS by rail. The cost-effectiveness of intermodal transport at the generator sites is a function of the waste volume to be transported, shipping distance, the costs of necessary upgrades, and the actual rates negotiated with truck and rail carrier companies. However, at no site was it determined that rail service is not feasible, either directly or via an intermodal concept. Similarly, it is feasible for NTS, which is not provided with direct rail access, to receive waste shipped from generator sites by rail via an intermodal transport concept.

Would DOE transportation system life-cycle costs favor the increased use of rail service to transport LLW to NTS?

Seventy-year life-cycle transportation costs were developed in this study to examine the effects on costs of options that involve use of rail service to ship LLW to NTS. Cost elements included truck and rail carrier costs, intermodal transfer costs, and shipping container procurement costs. With regard to intermodal transportation options, the following general conclusions were derived from the life-cycle cost analysis presented in Chapter 4.

- The life-cycle costs for the intermodal configurations are significantly lower than the all-truck configurations. The increased costs for intermodal transfers and the truck segment from the intermodal facility to NTS is more than offset by the lower costs for rail shipping from LLW generators to the intermodal facility, relative to the all-truck configurations.

- Lower life-cycle costs were estimated for the intermodal configuration in which the Barstow facility is assumed than for the configuration in which Caliente is the intermodal transfer point. This is a small cost difference that is most likely within the uncertainties of the cost estimates. A lower life-cycle cost, however, is real because of the shorter distance between Barstow and NTS relative to the distance between Caliente and NTS. This leads to lower truck transport costs for the Barstow to NTS segment. Rail transport costs to the Barstow facility are higher than Caliente because of longer rail shipping distances to Barstow. However, the lower rail shipping costs to Caliente are more than offset by the higher truck shipping costs for the Caliente to NTS segment. Thus, the Barstow intermodal site is more cost-effective, although the overall differences are relatively small.

Would there be a significant risk reduction associated with the increased use of rail service to transport LLW to NTS?

Five risk measures were calculated in Chapter 5 of this study of options for DOE's LLW transportation system to NTS. These included radiological routine doses to the public and workers, public radiological accident risks, public nonradiological (physical) accident risks, and public routine exposures to hazardous emissions. The results indicate that a tradeoff exists between routine radiological dose risks and nonradiological (physical) accident risks. Nonradiological accident risks are the highest of the five risk measures examined in this study. The nonradiological accident risks are lowest in the intermodal options and highest for the option in which all LLW is transported by truck via routes that travel through Las Vegas. Radiological routine doses, however, were shown to be highest in the all-truck options and lowest in the intermodal options. Several competing effects are illustrated here:

- The nonradiological (i.e., physical) accident risks calculated for the intermodal configurations are dominated by the rail shipment impacts.

- Traveling on routes that avoid Las Vegas, which is done in Configurations 1A and 1B (i.e., the intermodal configurations) as well as Configuration 2 (100% by truck on routes that avoid Las Vegas), reduces radiological routine doses because the shipments would not travel through the densely populated Las Vegas Valley. The intermodal truck segments and direct truck shipments from LLW generators would be diverted to predominantly rural areas of Nevada (Caliente intermodal facility) and California (Barstow intermodal facility) versus traveling through Las Vegas and over Hoover Dam. Although this increases transit times and shipping distances, lower routine doses are calculated because there are fewer people along the rural highways in Nevada than in the Las Vegas Valley.

Therefore, a tradeoff exists between increasing the use of rail shipping to NTS (results in lower radiological dose risks to the public and truck crews, and health effects from routine emissions) and traveling through Las Vegas (results in lower nonradiological accident risks). Although there are no significant health risks for any of the shipping configurations studied here and nonradiological risks are higher than radiological risks, DOT still requires carriers to select routes that minimize radiological risk.

From a DOE-complex perspective, would there be a significant risk reduction associated with transportation configuration alternatives that avoid the Las Vegas Valley and Hoover Dam?

Similar to the answer given above, a tradeoff exists between nonradiological accident risks and routine radiological dose risks. The all-truck option that avoids Las Vegas was shown to have higher nonradiological accident risks than the all-truck option that travels through Las Vegas on historically used highways. The converse is true for radiological routine dose risks, which are highest for the all-truck configuration that travels through Las Vegas. Again, the sources of this tradeoff are the higher accident rates and longer shipping distances on the highway routes that avoid Las Vegas versus the larger populations exposed to low radiation dose rates emitted from the shipments that travel through Las Vegas.

From a DOE-complex perspective, would there be a cost penalty associated with transportation configuration alternatives that avoid the Las Vegas Valley and Hoover Dam?

The life-cycle cost analysis results indicated that life-cycle costs for the all-truck option that avoids Las Vegas is slightly higher than the costs for the all-truck option that travels through Las Vegas. This is due to the longer shipping distances that will become necessary to avoid the routes through Las Vegas. It should be noted that this cost difference is on the order of 10% of the total life-cycle costs, which is smaller than the uncertainties in the cost estimates. However, since both all-truck configurations were costed using equivalent bases, some difference in cost is expected with the lowest-cost option being the option that travels through Las Vegas.

Overall, the three main observations about transportation costs are given below:

- The life-cycle costs for the intermodal configurations are significantly lower than the all-truck configurations.
- The life-cycle costs for the all-truck option that avoids Las Vegas are slightly higher than the costs for the all-truck option that travels through Las Vegas.
- Life-cycle costs were lower for the intermodal configuration in which the Barstow facility is assumed than for the configuration in which Caliente is the intermodal transfer point.

Based on these observations, transportation costs favor the intermodal options and there are slightly higher costs for using highway routes that avoid Las Vegas.

Would routing/risk assessments performed by carriers to comply with Department of Transportation highway routing regulations reach the same conclusions as risk assessments performed in support of NEPA documents?

Chapter 6 of this study compared and contrasted the routing evaluations performed by DOE in support of NEPA documentation and the DOT's routing requirements for LLW shipments as they are implemented by carriers (see 49 CFR 397.101). Basically, it was determined that DOE NEPA documents include transportation risk assessments, including route characterizations, where offsite transport is a part of the proposed action. However, DOE is not required to compare routes, so a "representative" route is typically selected and used as the basis for the impact calculations. This representative route is in no way binding on the carriers for LLW shipments. Carriers are responsible for selecting the actual routes they will use for LLW shipments. Because LLW shipments are far less hazardous than shipments of spent nuclear fuel and high-level waste (examples of highway route controlled quantity [HRCQ] shipments), no formal method exists for selecting highway routes for LLW shipments. Telephone discussions with DOT Research and Special Programs Administration staff confirm that carriers are expected to use their professional judgment in considering the non-HRCQ routing requirements to operate on routes that minimize radiological risk and consider available information on accident rates, transit time, population density and activities, and the time of day and the day of the week during which transportation will occur to determine the level of radiological risk (49 CFR 397.101). However, no formal methods or level of rigor are prescribed by DOT, and enforcement of the requirement for non-HRCQ shipments is not a current DOT priority.

Which stakeholder issues generally encourage and which issues discourage increased use of rail scenarios? Are these conclusions consistent with the cost and risk analyses performed in this study?

The key stakeholder issue affecting LLW shipments in Nevada is the expressed desire by certain groups to avoid transporting LLW through the Las Vegas Valley and Hoover Dam areas. The possibility of an accident in a densely populated area, as well as the possible effects on tourism and property values, appear to be the drivers for this concern. This desire is not necessarily shared by all stakeholders, particularly those in the rural counties of Nevada, as their perception is that the risks are being transferred from the urban areas to less-represented rural areas. The rural counties point out the generally poor condition of the rural highways, potential lack of timely emergency response to an accident, and effects on property values as their main concerns. Both parties are concerned with the potential precedents that could be set by the LLW shipments for the future shipments of spent nuclear fuel and high-level waste to the proposed repository at Yucca Mountain and with the potential effects of radiation on residents of Nevada near the routes.

The results of the cost and risk evaluations in this study may be used to support either party's position on avoiding Las Vegas. The life-cycle costs generally favor the rail/intermodal shipping configurations (i.e., 1A and 1B). However, the all-truck configuration that avoids Las Vegas (Configuration 2) is more costly than the all-truck configuration that assumes travel through Las Vegas. The health risk assessment indicated that a tradeoff exists between nonradiological accident risk (higher for the configurations that avoid Las Vegas than the all-truck option that travels though Las Vegas) and radiological dose risk (highest in the configurations that travel though Las Vegas). The intermodal shipping configuration options and the all-truck option that avoids Las Vegas, however, transfer some risk from the highly populated Las Vegas Valley to the less populated rural counties. However, it should be noted that comparing the radiological and nonradiological risks on the same basis requires careful consideration. Nonradiological risks are based on statistically sound empirical data whereas radiological risks are projections that are driven in part by conservative assumptions and data. Although the consensus is that the radiological risk assessment methods used here are bounding and adequate for their intended purpose, empirical data needed to validate the radiation dose and health effects projections is lacking.

For the shipments from LLW generators that were projected to be shipped using rail or intermodal service, rail routes were selected that did not pass through Las Vegas. For example, the rail route from LANL to NTS was routed to the north through Pueblo, Colorado Springs, and eventually Denver, CO, before turning west, even though a more direct route to the west could be used. The more direct westerly route was considered and dismissed because it would travel through the Las Vegas Valley. The route distance in this case was 230 miles longer than the more direct route that would travel through Las Vegas. For the INEEL to Barstow rail shipments, the shipping distance increased by over 400 miles compared to the direct route that would travel through Las Vegas. The INEEL to NTS shipments had to be routed through Reno, NV, and Sacramento, Stockton, and Fresno, CA (although this route avoided the Salt Lake City area as well as Las Vegas). Consequently, from a DOE complex perspective, the Nevada stakeholder desire to avoid Las Vegas and Hoover Dam affects other states and locales as well as Nevada citizens.

What are the uncertainties that could influence the results of this analysis?

Uncertainties are important factors to consider when developing conclusions based on the results of this evaluation. The shipping configurations and technical analyses were planned such that differences among alternatives could be observed. The intent was to treat each alternative on an equivalent basis so the differences would be highlighted and the reasons for the differences could be explored and verified. It could be said in some cases that the quantitative differences among alternatives are smaller than the uncertainties in the results, and thus the comparisons are not valid. However, by treating the alternatives on an equivalent basis, the differences that have arisen are "real," although they may be small.

Some of the major sources of uncertainty are described below:

- **Waste volume estimates:** The waste volume estimates used here are the best available. However, projections over a 70-year time frame are highly uncertain. Data such as these are constantly changing to reflect current technologies and regulatory requirements. As it is, DOE's waste volume data is becoming more and more stable, and should improve as time passes. However, at this time, the LLW generation projections for Environmental Restoration wastes are order-of-magnitude estimates, at best, particularly at the sites where large volumes are projected. This uncertainty has little effect on the comparisons among shipping configuration alternatives as the same waste volumes were used in the calculations for all the alternatives. It could affect the absolute magnitude of the results and the magnitude of the differences among alternatives but would have no effect on which alternative is most favorable.

- **Shipping containers:** To simplify the analysis, all LLW was assumed to be packaged in 55-gallon drums or boxes and then overpacked in a Seal-Land container for shipment to NTS. This is one source of uncertainty, as this concept is not yet certified for LLW transport. In reality, a number of different packaging systems will be used to transport LLW, including heavily-shielded shipping containers that are much less efficient. This would increase the number of shipments to NTS but would increase the number of shipments in each alternative by the same amount. However, it is not apparent that this uncertainty would affect the quantitative results of each alternative by the same amount. For example, if most of the less-efficient packaging systems are used at a large generator site, more rail shipments would be required in the intermodal alternatives, perhaps skewing the results of the comparisons with the all-truck alternatives. There is no reason to believe this would occur, although there are general differences in waste characteristics among sites (e.g., Fernald's LLW is generally contaminated with uranium whereas another site's LLW may be contaminated by fission products).

- **Highway and rail routing evaluations**: The best available highway and rail routing information was used to project the routes between LLW generators and NTS. However, as discussed in Chapter 6, actual routes cannot be determined until the time the shipment occurs and may even change after a shipment has departed from the generator's facility (e.g., for severe weather conditions, traffic obstructions, enroute repairs, etc.). The routing evaluations for all alternatives attempted to find the shortest and/or fastest route between the LLW generator and NTS. Shorter or faster routes than those used here may exist. Longer and slower routes than those used here may ultimately be used. Different routes would result in smaller (or larger) impacts. However, the route projections should affect each alternative equally so the comparisons among alternatives should not be affected. This uncertainty could affect the determination of the most favorable alternative.

What are the uncertainties that could influence the results of this analysis? (Continued)

- **Road conditions**: The conditions of the highways on which the shipments are operated could affect accident rates and thus the comparisons among the alternatives. However, the best available data was used for both truck and rail accidents, including state-specific fatality rates and Nevada secondary highway fatality rates, so the differences are judged to be valid. Local conditions in some areas may be more hazardous than conditions in other areas. An analysis at a lower level of resolution (e.g., using mile-by-mile fatality rates versus state-level statistics) may yield a different result. Although mile-by-mile data could be obtained from each corridor state, it would be difficult and costly to perform a DOE complex-wide risk analysis on a mile-by-mile basis. Such an analysis may demonstrate that local risks are higher in some areas than others. Since the state-level statistics used here include the high accident rate areas in the data, DOE complex-wide (aggregate) risks should not be significantly different. Differences may appear in the state-level risk estimates shown in Section 5.3.3. As discussed in that section, differences in results were detected between this study and the *NTS Intermodal EA* that result from the use of higher accident rates on specific road segments than are reflected in the state-level statistics. However, the differences in risks illustrated in this study are within the level of uncertainty of the analysis, regardless of the data set used to calculate nonradiological accident risks.

- **Transportation costs**: The transportation costs are based on the best available data and are applied equally to all alternatives. However, actual costs are negotiated with carriers and so the cost estimates used here are uncertain, particularly when considering a 70-yr life-cycle. Even so, the comparisons among alternatives should be valid, even though the quantitative results of each alternative may be higher or lower. One aspect of the costs may affect the comparisons, and that is the relative difference between truck and rail carrier charges. However, reasonable attempts are made in the source documents for the transportation costs to obtain comparable data from both truck and rail carriers. Therefore, the relative differences in cost between truck and rail shipments are judged to provide an adequate basis for comparison.

- **Transportation risk modeling**: The uncertainties in the transportation risks models and input parameter values are, in general, larger than the differences among the alternatives. For example, the radiation dose rates used in the calculations may be high or low, depending on the radiological characteristics of the LLW being transported. Shipments may move at different speeds, depending on the local road conditions, traffic congestion, construction, etc. However, every attempt was made to evaluate each shipping configuration on an equivalent basis so the comparisons would be valid and differences between alternative would be real, although the absolute magnitudes of the risks may be higher or lower than those given in this report.

- **Intermodal facility costs**: The costs developed in this study for intermodal transfers are first-order approximations and highly uncertain. It was assumed that carriers would provide intermodal transfer service at or near the shipper's site and near NTS. No significant construction costs were included in the estimates. Should DOE or the carriers have to construct intermodal transfer facilities, the cost estimates for Configurations 1A and 1B would most likely increase. Other costs were difficult to characterize, such as the costs to provide radiation protection training, security, emergency response training, and other administrative costs that may be necessary to handle LLW shipments. These cost elements were included in the personnel cost estimates that form the basis for the intermodal transfer costs presented in Chapter 4, or at least in rounding of the basic cost estimates to a higher value to account for uncertainties. Consequently, the uncertainties in the intermodal facility cost and risk estimates could affect the observation that the intermodal shipping configurations (1A and 1B) have lower costs than the all-truck configurations (2 and 3).

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APPENDIX A

ROUTE DESCRIPTIONS

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APPENDIX A ROUTE DESCRIPTIONS

This appendix presents the route description information from the HIGHWAY and INTERLINE output files. It is organized as follows:

1. Truck Routes from LLW generators to NTS – Through Las Vegas
2. Truck Routes from LLW generators to NTS – Avoid Las Vegas
3. Truck Routes from intermodal facilities to NTS
4. Rail Routes from LLW generators to Barstow
5. Rail Routes from LLW generators to Caliente

The format for the truck route information is as follows:

Segment Length, miles	Highway Designation	City	Intersection	State	Cumulative distance, miles	Time to travel segment	Date	Clock time

The following is an example or a truck route output file to help the reader follow the tables in this appendix.

```
 0.0            AMES LAB                 IA      .0      0:00     1/30  @   8:47
 3.0    LOCAL   AMES SW      U30  LOCL   IA     3.0      0:09     1/30  @   8:56
 4.0     U30    AMES E       I35  X111   IA     7.0      0:13     1/30  @   9:01
25.0     I35    DES MOINES N I235 I35    IA    32.0      0:36     1/30  @   9:24
```

The format for the rail route information is as follows:

Rail Carrier	Rail "Node" designator	City	State	Cumulative Distance

```
IHB        4170     -LA GRANGE     IL       1051.
- - - - - - - - - - - - - - - - - - - - - - - - - TRANSFER
BNSF       4170     -LA GRANGE     IL       1051.
BNSF       4190     -AURORA        IL       1076.
```

TRUCK ROUTES FROM LLW GENERATORS TO NTS - THROUGH LAS VEGAS

From: AMES LAB IA Leaving : 1/30/99 at 8:47 CST
to : MERCURY NV Arriving: 1/31/99 at 10:40 PST

Routing through:

.0			AMES LAB				IA	.0	0:00	1/30 @ 8:47
3.0	LOCAL		AMES	SW	U30	LOCL	IA	3.0	0:09	1/30 @ 8:56
4.0	U30		AMES	E	I35	X111	IA	7.0	0:13	1/30 @ 9:01
25.0	I35		DES MOINES	N	I235	I35	IA	32.0	0:36	1/30 @ 9:24
14.0	I35	I80	DES MOINES	W	I235	I35	IA	46.0	0:51	1/30 @ 9:39
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	165.0	2:41	1/30 @ 11:28
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	168.0	2:44	1/30 @ 11:31
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	522.0	8:44	1/30 @ 16:31
186.0	I76		ARVADA	S	I70	I76	CO	708.0	12:08	1/30 @ 19:55
502.0	I70		COVE FORT	W	I15	I70	UT	1210.0	21:53	1/31 @ 5:39
242.0	I15		LAS VEGAS				NV	1452.0	26:09	1/31 @ 8:55
1.0	U95		LAS VEGAS	W	U95	U95B	NV	1453.0	26:10	1/31 @ 8:56
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	1460.0	26:19	1/31 @ 9:06
51.0	U95		MERCURY	S	U95	LOCL	NV	1511.0	27:45	1/31 @ 10:31
6.0	LOCAL		MERCURY				NV	1517.0	27:54	1/31 @ 10:40

From: ARGONNE NATL L IL Leaving : 1/30/99 at 8:34 CST
to : MERCURY NV Arriving: 1/31/99 at 15:43 PST

Routing through:

.0			ARGONNE NATL L				IL	.0	0:00	1/30 @ 8:34
1.0	LOCAL		DARIEN	S	I55	X273	IL	1.0	0:03	1/30 @ 8:37
4.0	I55		LEMONT	NW	I355	I55	IL	5.0	0:07	1/30 @ 8:41
8.0	I355$		DOWNERS GROVE	W	I355	U34	IL	13.0	0:16	1/30 @ 8:50
1.0	U34		LISLE		U34	S53	IL	14.0	0:18	1/30 @ 8:52
1.0	S53		LISLE	N	I88	S53	IL	15.0	0:20	1/30 @ 8:53
86.0	I88 $	TEWT$	ROCK FALLS	SE	I88	X44	IL	101.0	1:53	1/30 @ 10:27
44.0	I88		RAPIDS CITY	S	I80	I88	IL	145.0	2:41	1/30 @ 11:15
173.0	I80		DES MOINES	N	I235	I35	IA	318.0	5:53	1/30 @ 14:26
14.0	I35	I80	DES MOINES	W	I235	I35	IA	332.0	6:08	1/30 @ 14:41
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	451.0	7:58	1/30 @ 16:31
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	454.0	8:01	1/30 @ 16:34
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	808.0	14:30	1/30 @ 22:04
186.0	I76		ARVADA	S	I70	I76	CO	994.0	17:25	1/31 @ 0:58
502.0	I70		COVE FORT	W	I15	I70	UT	1496.0	27:39	1/31 @ 11:12
242.0	I15		LAS VEGAS				NV	1738.0	31:55	1/31 @ 14:28
1.0	U95		LAS VEGAS	W	U95	U95B	NV	1739.0	31:56	1/31 @ 14:29
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	1746.0	32:06	1/31 @ 14:39
51.0	U95		MERCURY	S	U95	LOCL	NV	1797.0	33:01	1/31 @ 15:34
6.0	LOCAL		MERCURY				NV	1803.0	33:10	1/31 @ 15:43

From: BROOKHAVEN LAB NY Leaving : 1/30/99 at 8:32 EST
to : MERCURY NV Arriving: 2/01/99 at 10:10 PST

Routing through:

.0			BROOKHAVEN LAB				NY	.0	0:00	1/30 @ 8:32
1.0	LOCAL		YAPHANK	NE	C46	LOCL	NY	1.0	0:02	1/30 @ 8:34
2.0	C46		UPTON	SW	I495	X68	NY	3.0	0:04	1/30 @ 8:36
49.0	I495		LITTLE NECK	S	I495	X30	NY	52.0	0:58	1/30 @ 9:30
4.0	TCIP		BAYSIDE	NW	I295	TCIP	NY	56.0	1:03	1/30 @ 9:34
3.0	I295#		LOCUST POINT		I295	I695	NY	59.0	1:06	1/30 @ 9:38
1.0	I295		BRONX	SE	I678	I95	NY	60.0	1:07	1/30 @ 9:39
1.0	I95	I278	BRONX	E	I278	I95	NY	61.0	1:09	1/30 @ 9:40
7.0	I95		G W BRIDGE	E	I95	X1A	NY	68.0	1:20	1/30 @ 9:51
1.0	I95 #		FT LEE	NE	TPAL	I95	NJ	69.0	1:26	1/30 @ 9:57
4.0	I95		BOGOTA	SE	I80	I95	NJ	73.0	1:30	1/30 @ 10:02
64.0	I80		PAHAQUARRY	S	I80	X1	NJ	137.0	2:40	1/30 @ 11:11
2.0	I80 #		E STROUDSBURG	E	I80	X52	PA	139.0	2:43	1/30 @ 11:14
330.0	I80		NORTH JACKSON	NE	I76	I80	OH	469.0	9:43	1/30 @ 18:14
74.0	I80 $		ELYRIA	NW	I80	I90	OH	543.0	11:04	1/30 @ 19:35
281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	824.0	16:27	1/31 @ 1:58
1.0	I80		LAKE STATION	NE	I80	I94	IN	825.0	16:28	1/31 @ 1:59
19.0	I80	I94	LANSING	W	I294	I94	IL	844.0	16:49	1/31 @ 2:20
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	849.0	16:54	1/31 @ 2:25
326.0	I80		DES MOINES	N	I235	I35	IA	1175.0	23:22	1/31 @ 8:53
14.0	I35	I80	DES MOINES	W	I235	I35	IA	1189.0	23:37	1/31 @ 9:08
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	1308.0	25:27	1/31 @ 10:58
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	1311.0	25:30	1/31 @ 11:01
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1665.0	32:00	1/31 @ 16:31
186.0	I76		ARVADA	S	I70	I76	CO	1851.0	34:54	1/31 @ 19:25
502.0	I70		COVE FORT	W	I15	I70	UT	2353.0	44:39	2/01 @ 5:09
242.0	I15		LAS VEGAS				NV	2595.0	48:54	2/01 @ 8:25
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2596.0	48:56	2/01 @ 8:26
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2603.0	49:35	2/01 @ 9:05
51.0	U95		MERCURY	S	U95	LOCL	NV	2654.0	50:31	2/01 @ 10:01
6.0	LOCAL		MERCURY				NV	2660.0	50:40	2/01 @ 10:10

From: COLUMBUS NE I670 I71 OH Leaving : 1/30/99 at 8:36 EST
to : MERCURY NV Arriving: 1/31/99 at 21:40 PST

Routing through:

.0			COLUMBUS	NE	I670	I71	OH	.0	0:00	1/30 @ 8:36
4.0	I670		COLUMBUS	W	I670	I70	OH	4.0	0:04	1/30 @ 8:40
169.0	I70		INDIANAPOLIS	NE	I65	I70	IN	173.0	3:03	1/30 @ 11:39
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	175.0	3:06	1/30 @ 11:41
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	313.0	6:01	1/30 @ 15:37
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	319.0	6:08	1/30 @ 15:43
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	396.0	7:32	1/30 @ 17:07

20.0	I55	I70	ST LOUIS		I55	I64	MO	416.0	7:54	1/30 @ 17:29
1.0	I55		ST LOUIS	S	I44	I55	MO	417.0	7:55	1/30 @ 17:31
290.0	I44		JOPLIN	SW	I44	X1	MO	707.0	12:57	1/30 @ 22:32
17.0	I44 $		MIAMI	E	I44	X313	OK	724.0	13:12	1/30 @ 22:47
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	796.0	14:49	1/31 @ 0:24
20 0	I44		OAKHURST	E	I44	X221	OK	816.0	15:09	1/31 @ 0:44
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	902.0	16:29	1/31 @ 2:04
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	907.0	16:34	1/31 @ 2:10
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	917.0	16:45	1/31 @ 2:20
1004.0	I40		KINGMAN	NW	I40	X48	AZ	1921.0	34:17	1/31 @ 18:52
83.0	U93		ALUNITE		U93	U95	NV	2004.0	36:26	1/31 @ 20:01
22.0	U93	U95	LAS VEGAS				NV	2026.0	36:51	1/31 @ 20:25
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2027.0	36:52	1/31 @ 20:26
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2034.0	37:01	1/31 @ 20:36
51.0	U95		MERCURY	S	U95	LOCL	NV	2085.0	37:57	1/31 @ 21:31
6.0	LOCAL		MERCURY				NV	2091.0	38:06	1/31 @ 21:40

From: CANOGA PARK S27 LOCL CA Leaving : 1/30/99 at 9:04 PST
to : MERCURY NV Arriving: 1/30/99 at 16:15 PST

Routing through:

.0			CANOGA PARK		S27	LOCL	CA	.0	0:00	1/30 @ 9:04
3.0	S27		WOODLAND HILLS		U101	S27	CA	3.0	0:04	1/30 @ 9:08
25.0	U101		LOS ANGELES		I10	I5	CA	28.0	0:31	1/30 @ 9:36
41.0	I10		ONTARIO	E	I10	I15	CA	69.0	1:16	1/30 @ 10:20
228.0	I15		LAS VEGAS				NV	297.0	5:56	1/30 @ 15:00
1.0	U95		LAS VEGAS	W	U95	U95B	NV	298.0	5:57	1/30 @ 15:01
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	305.0	6:06	1/30 @ 15:10
51.0	U95		MERCURY	S	U95	LOCL	NV	356.0	7:02	1/30 @ 16:06
6.0	LOCAL		MERCURY				NV	362.0	7:11	1/30 @ 16:15

From: FERNALD PLANT OH Leaving : 1/30/99 at 8:23 EST
to : MERCURY NV Arriving: 1/31/99 at 20:03 PST

Routing through:

.0			FERNALD PLANT				OH	.0	0:00	1/30 @ 8:23
7.0	S128		MIAMITOWN	S	I74	X7	OH	7.0	0:11	1/30 @ 8:34
2.0	I275	I74	HARRISON	SE	I275	I74	OH	9.0	0:13	1/30 @ 8:36
81.0	I74		INDIANAPOLIS	SE	I465	I74	IN	90.0	1:34	1/30 @ 9:57
14.0	I465	I74	INDIANAPOLIS	SW	I465	I70	IN	104.0	1:49	1/30 @ 10:12
131.0	I70		TEUTOPOLIS	NW	I57	I70	IL	235.0	4:06	1/30 @ 13:29
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	241.0	4:43	1/30 @ 14:06
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	318.0	6:07	1/30 @ 15:30
20.0	I55	I70	ST LOUIS		I55	I64	MO	338.0	6:29	1/30 @ 15:52
1.0	I55		ST LOUIS	S	I44	I55	MO	339.0	6:30	1/30 @ 15:53
290.0	I44		JOPLIN	SW	I44	X1	MO	629.0	11:32	1/30 @ 20:54
17.0	I44 $		MIAMI	E	I44	X313	OK	646.0	11:47	1/30 @ 21:10

72.0	I44 $ TWRT$	CATOOSA	S	I44	X241	OK	718.0	12:54	1/30 @ 22:16
20.0	I44	OAKHURST	E	I44	X221	OK	738.0	13:44	1/30 @ 23:06
86.0	I44 $ TTRT$	EDMOND	SE	I35	I44	OK	824.0	15:04	1/31 @ 0:27
5.0	I35 I44	OKLAHOMA CITY	NE	I35	I44	OK	829.0	15:10	1/31 @ 0:32
10.0	I44	OKLAHOMA CITY	W	I40	I44	OK	839.0	15:20	1/31 @ 0:43
1004.0	I40	KINGMAN	NW	I40	X48	AZ	1843.0	32:52	1/31 @ 17:14
83.0	U93	ALUNITE		U93	U95	NV	1926.0	34:31	1/31 @ 17:53
22.0	U93 U95	LAS VEGAS				NV	1948.0	34:56	1/31 @ 18:18
1.0	U95	LAS VEGAS	W	U95	U95B	NV	1949.0	34:57	1/31 @ 18:19
7.0	U95BU	LAS VEGAS	NW	U95	U95B	NV	1956.0	35:06	1/31 @ 18:28
51.0	U95	MERCURY	S	U95	LOCL	NV	2007.0	36:32	1/31 @ 19:54
6.0	LOCAL	MERCURY				NV	2013.0	36:41	1/31 @ 20:03

From: GE VALLECITOS CA Leaving : 1/30/99 at 9:05 PST
to : MERCURY NV Arriving: 1/30/99 at 21:33 PST

Routing through:

.0		GE VALLECITOS				CA	.0	0:00	1/30 @ 9:05
10.0	S84	LIVERMORE	NE	I580	S84	CA	10.0	0:14	1/30 @ 9:19
26.0	I580	VERNALIS	W	I5	I580	CA	36.0	0:42	1/30 @ 9:47
196.0	I5	STOCKDALE HWY	W	I5	LOCL	CA	232.0	4:46	1/30 @ 13:51
17.0	LOCAL	BAKERSFIELD	SW	S58	S99	CA	249.0	5:15	1/30 @ 14:20
61.0	S58	MOJAVE	N	S14	S58	CA	310.0	6:22	1/30 @ 15:27
1.0	S14 S58	MOJAVE		S14	S58	CA	311.0	6:23	1/30 @ 15:28
71.0	S58	BARSTOW	E	I15	S58	CA	382.0	7:59	1/30 @ 17:04
151.0	I15	LAS VEGAS				NV	533.0	11:13	1/30 @ 20:17
1.0	U95	LAS VEGAS	W	U95	U95B	NV	534.0	11:14	1/30 @ 20:19
7.0	U95BU	LAS VEGAS	NW	U95	U95B	NV	541.0	11:23	1/30 @ 20:28
51.0	U95	MERCURY	S	U95	LOCL	NV	592.0	12:19	1/30 @ 21:24
6.0	LOCAL	MERCURY				NV	598.0	12:28	1/30 @ 21:33

From: GRAND JCT U50 U6 CO Leaving : 1/30/99 at 8:48 MST
to : MERCURY NV Arriving: 1/30/99 at 18:10 PST

Routing through:

.0		GRAND JCT		U50	U6	CO	.0	0:00	1/30 @ 8:48
6.0	U50 U6	GRAND JCT	NW	I70	X26	CO	6.0	0:07	1/30 @ 8:55
258.0	I70	COVE FORT	W	I15	I70	UT	264.0	4:50	1/30 @ 13:39
242.0	I15	LAS VEGAS				NV	506.0	9:06	1/30 @ 16:54
1.0	U95	LAS VEGAS	W	U95	U95B	NV	507.0	9:07	1/30 @ 16:55
7.0	U95BU	LAS VEGAS	NW	U95	U95B	NV	514.0	9:17	1/30 @ 17:05
51.0	U95	MERCURY	S	U95	LOCL	NV	565.0	10:13	1/30 @ 18:01
6.0	LOCAL	MERCURY				NV	571.0	10:22	1/30 @ 18:10

From: ID NATL ENG LAB U20 LOCL ID Leaving : 1/30/99 at 8:33 MST
to : MERCURY NV Arriving: 1/30/99 at 20:05 PST

Routing through:

.0			ID NATL ENG LAB		U20	LOCL	ID	.0	0:00	1/30 @ 8:33
4.0	U20	U26	ATOMIC CITY	NW	U20	U26	ID	4.0	0:05	1/30 @ 8:38
36.0	U26		BLACKFOOT	NW	I15	X92	ID	40.0	0:48	1/30 @ 9:21
112.0	I15		TREMONTON	W	I15	I84	UT	152.0	2:31	1/30 @ 11:04
39.0	I15	I84	OGDEN	S	I15	I84	UT	191.0	3:09	1/30 @ 11:42
32.0	I15		SALT LAKE CITY	W	I15	I80	UT	223.0	3:43	1/30 @ 12:15
4.0	I15	I80	SALT LAKE CITY	S	I15	I80	UT	227.0	3:47	1/30 @ 12:20
417.0	I15		LAS VEGAS				NV	644.0	11:17	1/30 @ 18:50
1.0	U95		LAS VEGAS	W	U95	U95B	NV	645.0	11:18	1/30 @ 18:51
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	652.0	11:28	1/30 @ 19:00
51.0	U95		MERCURY	S	U95	LOCL	NV	703.0	12:23	1/30 @ 19:56
6.0	LOCAL		MERCURY				NV	709.0	12:32	1/30 @ 20:05

From: SANDIA NATL LBS NM Leaving : 1/30/99 at 8:38 MST
to : MERCURY NV Arriving: 1/30/99 at 19:23 PST

Routing through:

.0			SANDIA NATL LBS				NM	.0	0:00	1/30 @ 8:38
3.0	LOCAL		ALBUQUERQUE	E	I40	X165	NM	3.0	0:07	1/30 @ 8:45
474.0	I40		KINGMAN	NW	I40	X48	AZ	477.0	7:56	1/30 @ 16:34
83.0	U93		ALUNITE		U93	U95	NV	560.0	10:05	1/30 @ 17:43
22.0	U93	U95	LAS VEGAS				NV	582.0	10:30	1/30 @ 18:07
1.0	U95		LAS VEGAS	W	U95	U95B	NV	583.0	10:31	1/30 @ 18:08
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	590.0	10:41	1/30 @ 18:18
51.0	U95		MERCURY	S	U95	LOCL	NV	641.0	11:36	1/30 @ 19:14
6.0	LOCAL		MERCURY				NV	647.0	11:45	1/30 @ 19:23

From: KAPL-KNOLLS NY Leaving : 1/30/99 at 8:37 EST
to : MERCURY NV Arriving: 2/01/99 at 8:43 PST

Routing through:

.0			KAPL-KNOLLS				NY	.0	0:00	1/30 @ 8:37
4.0	LOCAL		SCHENECTADY	E	S146	S7	NY	4.0	0:08	1/30 @ 8:45
2.0	S7		SCHENECTADY	SE	I890	X7	NY	6.0	0:10	1/30 @ 8:47
2.0	I890		SCHENECTADY	NW	I890	X1	NY	8.0	0:12	1/30 @ 8:49
1.0	I890$		SCHENECTADY	NW	I890	I90	NY	9.0	0:13	1/30 @ 8:50
258.0	I90 $	TNYT$	BUFFALO	NE	I290	I90	NY	267.0	5:25	1/30 @ 14:02
9.0	I90	TNYT	LACKAWANNA	E	I90	X55	NY	276.0	5:35	1/30 @ 14:11
66.0	I90 $	TNYT$	RIPLEY	W	I90	X61	NY	342.0	6:47	1/30 @ 15:23
124.0	I90		CLEVELAND	S	I71	I90	OH	466.0	9:32	1/30 @ 18:08
9.0	I71		BROOK PARK	N	I480	I71	OH	475.0	9:42	1/30 @ 18:18
10.0	I480		N RIDGEVILLE	S	I480	I80	OH	485.0	9:53	1/30 @ 18:29
8.0	I80 $		ELYRIA	NW	I80	I90	OH	493.0	10:01	1/30 @ 18:38

281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	774.0	15:24	1/31 @	1:01
1.0	I80		LAKE STATION	NE	I80	I94	IN	775.0	15:26	1/31 @	1:02
19.0	I80	I94	LANSING	W	I294	I94	IL	794.0	15:46	1/31 @	1:23
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	799.0	15:52	1/31 @	1:28
326.0	I80		DES MOINES	N	I235	I35	IA	1125.0	21:50	1/31 @	7:26
14.0	I35	I80	DES MOINES	W	I235	I35	IA	1139.0	22:35	1/31 @	8:11
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	1258.0	24:25	1/31 @	10:01
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	1261.0	24:28	1/31 @	10:04
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1615.0	30:28	1/31 @	15:04
186.0	I76		ARVADA	S	I70	I76	CO	1801.0	33:52	1/31 @	18:28
502.0	I70		COVE FORT	W	I15	I70	UT	2303.0	43:36	2/01 @	4:12
242.0	I15		LAS VEGAS				NV	2545.0	47:52	2/01 @	7:28
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2546.0	47:53	2/01 @	7:29
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2553.0	48:03	2/01 @	7:38
51.0	U95		MERCURY	S	U95	LOCL	NV	2604.0	48:59	2/01 @	8:34
6.0	LOCAL		MERCURY				NV	2610.0	49:08	2/01 @	8:43

From: LOS ALAMOS NM Leaving : 1/30/99 at 8:22 MST
to : MERCURY NV Arriving: 1/30/99 at 21:07 PST

Routing through:

.0			LOS ALAMOS				NM	.0	0:00	1/30 @	8:22
6.0	LTRKR		BANDELIER N M	W	S4	LTRK	NM	6.0	0:10	1/30 @	8:33
1.0	S4		BANDELIER N M	N	S4	S502	NM	7.0	0:12	1/30 @	8:34
12.0	S502		POJOAQUE		U285	S502	NM	19.0	0:27	1/30 @	8:50
18.0	U285	U84	SANTA FE		U285	U84	NM	37.0	0:47	1/30 @	9:09
2.0	U84		SANTA FE	S	I25	X282	NM	39.0	0:50	1/30 @	9:12
56.0	I25		ALBUQUERQUE	E	I25	I40	NM	95.0	1:43	1/30 @	10:06
468.0	I40		KINGMAN	NW	I40	X48	AZ	563.0	9:56	1/30 @	18:18
83.0	U93		ALUNITE		U93	U95	NV	646.0	11:35	1/30 @	18:57
22.0	U93	U95	LAS VEGAS				NV	668.0	12:00	1/30 @	19:22
1.0	U95		LAS VEGAS	W	U95	U95B	NV	669.0	12:01	1/30 @	19:23
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	676.0	12:10	1/30 @	19:32
51.0	U95		MERCURY	S	U95	LOCL	NV	727.0	13:06	1/30 @	20:28
6.0	LOCAL		MERCURY				NV	733.0	13:45	1/30 @	21:07

From: L BERKELEY LAB CA Leaving : 2/02/99 at 9:07 PST
to : MERCURY NV Arriving: 2/02/99 at 22:10 PST

Routing through:

.0			L BERKELEY LAB				CA	.0	0:00	2/02 @	9:07
3.0	LOCAL		BERKELEY	W	I580	LOCL	CA	3.0	0:07	2/02 @	9:14
2.0	I580	I80	OAKLAND	NW	I580	I80	CA	5.0	0:09	2/02 @	9:16
1.0	I580		PIEDMONT	NW	I580	I980	CA	6.0	0:10	2/02 @	9:17
2.0	I980		OAKLAND		I880	I980	CA	8.0	0:13	2/02 @	9:19
11.0	I880		SAN LEANDRO		I238	I880	CA	19.0	0:25	2/02 @	9:31
2.0	I238		CASTRO VALLEY	W	I238	I580	CA	21.0	0:27	2/02 @	9:34

47.0	I580		VERNALIS	W	I5	I580	CA	68.0	1:18	2/02 @ 10:25
196.0	I5		STOCKDALE HWY	W	I5	LOCL	CA	264.0	5:22	2/02 @ 14:29
17.0	LOCAL		BAKERSFIELD	SW	S58	S99	CA	281.0	5:51	2/02 @ 14:58
61.0	S58		MOJAVE	N	S14	S58	CA	342.0	6:58	2/02 @ 16:04
1.0	S14	S58	MOJAVE		S14	S58	CA	343.0	6:59	2/02 @ 16:06
71.0	S58		BARSTOW	E	I15	S58	CA	414.0	8:35	2/02 @ 17:41
151.0	I15		LAS VEGAS				NV	565.0	11:48	2/02 @ 20:55
1 0	U95		LAS VEGAS	W	U95	U95B	NV	566.0	11:49	2/02 @ 20:56
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	573.0	11:59	2/02 @ 21:05
51.0	U95		MERCURY	S	U95	LOCL	NV	624.0	12:55	2/02 @ 22:01
6.0	LOCAL		MERCURY				NV	630.0	13:04	2/02 @ 22:10

From: L LIVERMORE LB CA Leaving : 1/30/99 at 9:03 PST
to : MERCURY NV Arriving: 1/30/99 at 21:20 PST

Routing through:

.0			L LIVERMORE LB				CA	.0	0:00	1/30 @ 9:03
3.0	LOCAL		ALTAMONT	SW	I580	LOCL	CA	3.0	0:05	1/30 @ 9:09
24.0	I580		VERNALIS	W	I5	I580	CA	27.0	0:31	1/30 @ 9:35
196.0	I5		STOCKDALE HWY	W	I5	LOCL	CA	223.0	4:05	1/30 @ 13:09
17.0	LOCAL		BAKERSFIELD	SW	S58	S99	CA	240.0	5:04	1/30 @ 14:08
61.0	S58		MOJAVE	N	S14	S58	CA	301.0	6:11	1/30 @ 15:14
1.0	S14	S58	MOJAVE		S14	S58	CA	302.0	6:12	1/30 @ 15:16
71.0	S58		BARSTOW	E	I15	S58	CA	373.0	7:48	1/30 @ 16:51
151.0	I15		LAS VEGAS				NV	524.0	11:02	1/30 @ 20:05
1.0	U95		LAS VEGAS	W	U95	U95B	NV	525.0	11:03	1/30 @ 20:06
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	532.0	11:12	1/30 @ 20:16
51.0	U95		MERCURY	S	U95	LOCL	NV	583.0	12:08	1/30 @ 21:11
6.0	LOCAL		MERCURY				NV	589.0	12:17	1/30 @ 21:20

From: MOUND FACILITY OH Leaving : 1/30/99 at 8:30 EST
to : MERCURY NV Arriving: 1/31/99 at 20:44 PST

Routing through:

.0			MOUND FACILITY				OH	.0	0:00	1/30 @ 8:30
1.0	LOCAL		MIAMISBURG		S725	LOCL	OH	1.0	0:02	1/30 @ 8:32
3.0	S725		MIAMISBURG	E	I75	X44	OH	4.0	0:06	1/30 @ 8:36
8.0	I75		DAYTON		I75	X52	OH	12.0	0:14	1/30 @ 8:44
31.0	U35		NEW WESTVILLE	NE	I70	X1	OH	43.0	0:56	1/30 @ 9:26
75.0	I70		INDIANAPOLIS	NE	I65	I70	IN	118.0	2:12	1/30 @ 10:42
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	120.0	2:14	1/30 @ 10:45
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	258.0	5:10	1/30 @ 14:40
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	264.0	5:17	1/30 @ 14:47
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	341.0	6:41	1/30 @ 16:11
20.0	I55	I70	ST LOUIS		I55	I64	MO	361.0	7:03	1/30 @ 16:33
1.0	I55		ST LOUIS	S	I44	I55	MO	362.0	7:04	1/30 @ 16:34
290.0	I44		JOPLIN	SW	I44	X1	MO	652.0	12:05	1/30 @ 21:35

17.0	I44 $		MIAMI	E	I44	X313	OK	669.0	12:21	1/30 @ 21:51
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	741.0	13:27	1/30 @ 22:57
20.0	I44		OAKHURST	E	I44	X221	OK	761.0	14:17	1/30 @ 23:47
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	847.0	15:38	1/31 @ 1:07
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	852.0	15:43	1/31 @ 1:13
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	862.0	15:54	1/31 @ 1:24
1004.0	I40		KINGMAN	NW	I40	X48	AZ	1866.0	33:26	1/31 @ 17:55
83.0	U93		ALUNITE		U93	U95	NV	1949.0	35:05	1/31 @ 18:34
22.0	U93	U95	LAS VEGAS				NV	1971.0	35:29	1/31 @ 18:58
1.0	U95		LAS VEGAS	W	U95	U95B	NV	1972.0	35:30	1/31 @ 18:59
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	1979.0	36:10	1/31 @ 19:39
51.0	U95		MERCURY	S	U95	LOCL	NV	2030.0	37:06	1/31 @ 20:35
6.0	LOCAL		MERCURY				NV	2036.0	37:15	1/31 @ 20:44

From: PADUCAH GDP KY Leaving : 1/30/99 at 8:38 CST
to : MERCURY NV Arriving: 1/31/99 at 15:21 PST

Routing through:

.0			PADUCAH GDP				KY	.0	0:00	1/30 @ 8:38
3.0	LOCAL		KEVIL	E	U60	LOCL	KY	3.0	0:06	1/30 @ 8:44
19.0	U60		WICKLIFFE		U51	U60	KY	22.0	0:29	1/30 @ 9:07
6.0	U51	U60	CAIRO	S	U51	U60	IL	28.0	0:36	1/30 @ 9:14
12.0	U60	U62	CHARLESTON	E	I57	X12	MO	40.0	0:50	1/30 @ 9:29
13.0	I57		SIKESTON	E	I55	I57	MO	53.0	1:02	1/30 @ 9:41
51.0	U60		POPLAR BLUFF	W	U160	U60	MO	104.0	2:04	1/30 @ 10:42
8.0	U60	U67	POPLAR BLUFF	NW	U60	U67	MO	112.0	2:12	1/30 @ 10:51
96.0	U60		WILLOW SPRINGS	SE	U60	U63	MO	208.0	4:08	1/30 @ 12:46
14.0	U60	U63	CABOOL	SE	U60	U63	MO	222.0	4:53	1/30 @ 13:31
29.0	U60		MANSFIELD	N	U60	S5	MO	251.0	5:24	1/30 @ 14:03
1.0	U60	S5	MANSFIELD	NW	U60	S5	MO	252.0	5:26	1/30 @ 14:04
38.0	U60		SPRINGFIELD	SE	U60	U65	MO	290.0	6:07	1/30 @ 14:45
9.0	U65		SPRINGFIELD	NE	I44	X82	MO	299.0	6:17	1/30 @ 14:55
82.0	I44		JOPLIN	SW	I44	X1	MO	381.0	7:34	1/30 @ 16:12
17.0	I44 $		MIAMI	E	I44	X313	OK	398.0	7:49	1/30 @ 16:28
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	470.0	8:56	1/30 @ 17:34
20.0	I44		OAKHURST	E	I44	X221	OK	490.0	9:46	1/30 @ 18:24
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	576.0	11:06	1/30 @ 19:44
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	581.0	11:12	1/30 @ 19:50
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	591.0	11:23	1/30 @ 20:01
1004.0	I40		KINGMAN	NW	I40	X48	AZ	1595.0	28:54	1/31 @ 12:32
83.0	U93		ALUNITE		U93	U95	NV	1678.0	30:33	1/31 @ 13:11
22.0	U93	U95	LAS VEGAS				NV	1700.0	30:58	1/31 @ 13:35
1.0	U95		LAS VEGAS	W	U95	U95B	NV	1701.0	30:59	1/31 @ 13:36
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	1708.0	31:38	1/31 @ 14:16
51.0	U95		MERCURY	S	U95	LOCL	NV	1759.0	32:34	1/31 @ 15:12
6.0	LOCAL		MERCURY				NV	1765.0	32:43	1/31 @ 15:21

From: PORTSMOUTH GDP OH Leaving : 1/30/99 at 8:43 EST
to : MERCURY NV Arriving: 1/31/99 at 22:09 PST

Routing through:

.0			PORTSMOUTH GDP				OH	.0	0:00	1/30 @ 8:43
3.0	U23		PIKETON	S	U23	S32	OH	3.0	0:03	1/30 @ 8:47
75.0	S32		MT CARMEL HGTS	E	I275	X63	OH	78.0	1:25	1/30 @ 10:08
21.0	I275		ERLANGER	N	I275	I71	KY	99.0	1:48	1/30 @ 10:31
12.0	I71	I75	WALTON	NW	I71	I75	KY	111.0	1:59	1/30 @ 10:42
76.0	I71		LOUISVILLE	E	I64	I71	KY	187.0	3:10	1/30 @ 11:53
181.0	I64		MT VERNON	SW	I57	I64	IL	368.0	6:49	1/30 @ 16:32
5.0	I57	I64	MT VERNON	NW	I57	I64	IL	373.0	6:54	1/30 @ 16:37
71.0	I64		EAST ST LOUIS	NE	I55	I64	IL	444.0	8:12	1/30 @ 17:55
3.0	I55	I70	ST LOUIS		I55	I64	MO	447.0	8:15	1/30 @ 17:58
1.0	I55		ST LOUIS	S	I44	I55	MO	448.0	8:16	1/30 @ 17:59
290.0	I44		JOPLIN	SW	I44	X1	MO	738.0	13:48	1/30 @ 23:30
17.0	I44 $		MIAMI	E	I44	X313	OK	755.0	14:03	1/30 @ 23:46
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	827.0	15:10	1/31 @ 0:53
20.0	I44		OAKHURST	E	I44	X221	OK	847.0	15:30	1/31 @ 1:13
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	933.0	16:50	1/31 @ 2:33
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	938.0	16:56	1/31 @ 2:38
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	948.0	17:06	1/31 @ 2:49
1004.0	I40		KINGMAN	NW	I40	X48	AZ	1952.0	34:38	1/31 @ 19:20
83.0	U93		ALUNITE		U93	U95	NV	2035.0	36:47	1/31 @ 20:29
22.0	U93	U95	LAS VEGAS				NV	2057.0	37:12	1/31 @ 20:54
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2058.0	37:13	1/31 @ 20:55
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2065.0	37:22	1/31 @ 21:04
51.0	U95		MERCURY	S	U95	LOCL	NV	2116.0	38:18	1/31 @ 22:00
6.0	LOCAL		MERCURY				NV	2122.0	38:27	1/31 @ 22:09

From: PANTEX PLANT F245 F683 TX Leaving : 1/30/99 at 8:45 CST
to : MERCURY NV Arriving: 1/30/99 at 23:33 PST

Routing through:

.0			PANTEX PLANT		F245	F683	TX	.0	0:00	1/30 @ 8:45
4.0	F683		PANTEX	S	U60	F683	TX	4.0	0:08	1/30 @ 8:53
7.0	U60		AMARILLO	E	U60	L335	TX	11.0	0:16	1/30 @ 9:01
2.0	L335		AMARILLO	E	I40	X75	TX	13.0	0:19	1/30 @ 9:04
756.0	I40		KINGMAN	NW	I40	X48	AZ	769.0	12:59	1/30 @ 20:44
83.0	U93		ALUNITE		U93	U95	NV	852.0	15:09	1/30 @ 21:53
22.0	U93	U95	LAS VEGAS				NV	874.0	15:33	1/30 @ 22:18
1.0	U95		LAS VEGAS	W	U95	U95B	NV	875.0	15:34	1/30 @ 22:19
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	882.0	15:44	1/30 @ 22:28
51.0	U95		MERCURY	S	U95	LOCL	NV	933.0	16:39	1/30 @ 23:24
6.0	LOCAL		MERCURY				NV	939.0	16:48	1/30 @ 23:33

From: PRINCTN PLASMA U1 LOCL NJ Leaving : 1/30/99 at 8:44 EST
to : MERCURY NV Arriving: 2/01/99 at 8:04 PST

Routing through:

.0			PRINCTN PLASMA		U1	LOCL	NJ	.0	0:00	1/30 @	8:44
12.0	U1		TRENTON		U1	S29	NJ	12.0	0:14	1/30 @	8:59
3.0	U1 #		MORRISVILLE	SW	U1	U13	PA	15.0	0:18	1/30 @	9:02
6.0	U13		BRISTOL	N	I276	X29	PA	21.0	0:25	1/30 @	9:09
31.0	I276$		VALLEY FORGE	SE	I276	I76	PA	52.0	0:58	1/30 @	9:43
84.0	I76 $		NEW CUMBERLND	S	I76	X18	PA	136.0	2:30	1/30 @	11:14
2.0	I83		HARRISBURG	SW	I83	X20	PA	138.0	2:32	1/30 @	11:16
2.0	S581		CAMP HILL	SW	U11	U15	PA	140.0	2:34	1/30 @	11:18
10.0	U11		CARLISLE	NE	I76	X16	PA	150.0	2:48	1/30 @	11:32
66.0	I76 $		BREEZEWOOD	SW	I70	I76	PA	216.0	4:00	1/30 @	12:44
71.0	I70 $	I76 $	DONEGAL		I70	X9	PA	287.0	5:47	1/30 @	14:31
.0	I70	XRAMP	DONEGAL	S	I70	S31	PA	287.0	5:47	1/30 @	14:31
17.0	S31		WYANO	S	I70	X24	PA	304.0	6:13	1/30 @	14:57
32.0	I70		LABORATORY	NE	I70	I79	PA	336.0	6:48	1/30 @	15:32
5.0	I70	I79	WASHINGTON	N	I70	I79	PA	341.0	6:53	1/30 @	15:37
157.0	I70		COLUMBUS	SE	I70	I71	OH	498.0	10:14	1/30 @	18:58
2.0	I70	I71	COLUMBUS	SW	I70	I71	OH	500.0	10:16	1/30 @	19:00
172.0	I70		INDIANAPOLIS	NE	I65	I70	IN	672.0	13:49	1/30 @	22:32
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	674.0	13:51	1/30 @	22:35
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	812.0	16:17	1/31 @	2:00
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	818.0	16:23	1/31 @	2:07
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	895.0	17:47	1/31 @	3:31
20.0	I55	I70	ST LOUIS		I55	I64	MO	915.0	18:39	1/31 @	4:23
1.0	I55		ST LOUIS	S	I44	I55	MO	916.0	18:41	1/31 @	4:24
290.0	I44		JOPLIN	SW	I44	X1	MO	1206.0	23:42	1/31 @	9:25
17.0	I44 $		MIAMI	E	I44	X313	OK	1223.0	23:58	1/31 @	9:41
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	1295.0	25:04	1/31 @	10:47
20.0	I44		OAKHURST	E	I44	X221	OK	1315.0	25:24	1/31 @	11:07
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	1401.0	26:44	1/31 @	12:28
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	1406.0	27:20	1/31 @	13:03
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	1416.0	27:31	1/31 @	13:14
1004.0	I40		KINGMAN	NW	I40	X48	AZ	2420.0	44:32	2/01 @	5:15
83.0	U93		ALUNITE		U93	U95	NV	2503.0	46:41	2/01 @	6:24
22.0	U93	U95	LAS VEGAS				NV	2525.0	47:06	2/01 @	6:49
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2526.0	47:07	2/01 @	6:50
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2533.0	47:17	2/01 @	6:59
51.0	U95		MERCURY	S	U95	LOCL	NV	2584.0	48:12	2/01 @	7:55
6.0	LOCAL		MERCURY				NV	2590.0	48:21	2/01 @	8:04

From: ROCKY FLATS CO Leaving : 1/30/99 at 8:26 MST
to : MERCURY NV Arriving: 1/30/99 at 23:01 PST

Routing through:

.0			ROCKY FLATS				CO	.0	0:00	1/30 @	8:26

5.0	LOCAL		ARVADA	NW	S72	LOCL	CO	5.0	0:09	1/30 @ 8:35
9.0	S72		WHEAT RIDGE	NW	I70	X266	CO	14.0	0:25	1/30 @ 8:51
498.0	I70		COVE FORT	W	I15	I70	UT	512.0	10:05	1/30 @ 18:30
242.0	I15		LAS VEGAS				NV	754.0	14:20	1/30 @ 21:46
1.0	U95		LAS VEGAS	W	U95	U95B	NV	755.0	14:22	1/30 @ 21:47
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	762.0	14:31	1/30 @ 21:57
51.0	U95		MERCURY	S	U95	LOCL	NV	813.0	15:27	1/30 @ 22:52
6.0	LOCAL		MERCURY				NV	819.0	15:36	1/30 @ 23:01

From: SANDIA NATL LBS NM Leaving : 1/30/99 at 8:38 MST
to : MERCURY NV Arriving: 1/30/99 at 19:23 PST

Routing through:

.0			SANDIA NATL LBS				NM	.0	0:00	1/30 @ 8:38
3.0	LOCAL		ALBUQUERQUE	E	I40	X165	NM	3.0	0:07	1/30 @ 8:45
474.0	I40		KINGMAN	NW	I40	X48	AZ	477.0	7:56	1/30 @ 16:34
83.0	U93		ALUNITE		U93	U95	NV	560.0	10:05	1/30 @ 17:43
22.0	U93	U95	LAS VEGAS				NV	582.0	10:30	1/30 @ 18:07
1.0	U95		LAS VEGAS	W	U95	U95B	NV	583.0	10:31	1/30 @ 18:08
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	590.0	10:41	1/30 @ 18:18
51.0	U95		MERCURY	S	U95	LOCL	NV	641.0	11:36	1/30 @ 19:14
6.0	LOCAL		MERCURY				NV	647.0	11:45	1/30 @ 19:23

From: WEST VALLEY RP NY Leaving : 1/30/99 at 8:34 EST
to : MERCURY NV Arriving: 2/01/99 at 3:20 PST

Routing through:

.0			WEST VALLEY RP				NY	.0	0:00	1/30 @ 8:34
2.0	C85		SPRINGVILLE	SW	U219	C85	NY	2.0	0:05	1/30 @ 8:39
3.0	U219		SPRINGVILLE	W	U219	S39	NY	5.0	0:08	1/30 @ 8:43
13.0	S39		COLLINS		U62	S39	NY	18.0	0:26	1/30 @ 9:00
2.0	U62		GOWANDA		U62	S39	NY	20.0	0:28	1/30 @ 9:03
18.0	S39		SHERIDAN	SW	U20	S39	NY	38.0	0:52	1/30 @ 9:27
2.0	U20		FREDONIA	NE	U20	S60	NY	40.0	0:55	1/30 @ 9:29
1.0	S60		DUNKIRK	SE	I90	X59	NY	41.0	0:57	1/30 @ 9:31
27.0	I90 $	TNYT$	RIPLEY	W	I90	X61	NY	68.0	1:26	1/30 @ 10:00
124.0	I90		CLEVELAND	S	I71	I90	OH	192.0	3:41	1/30 @ 12:15
9.0	I71		BROOK PARK	N	I480	I71	OH	201.0	3:51	1/30 @ 12:25
10.0	I480		N RIDGEVILLE	S	I480	I80	OH	211.0	4:32	1/30 @ 13:06
8.0	I80 $		ELYRIA	NW	I80	I90	OH	219.0	4:41	1/30 @ 13:15
281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	500.0	10:04	1/30 @ 19:38
1.0	I80		LAKE STATION	NE	I80	I94	IN	501.0	10:05	1/30 @ 19:39
19.0	I80	I94	LANSING	W	I294	I94	IL	520.0	10:26	1/30 @ 20:00
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	525.0	10:31	1/30 @ 20:05
326.0	I80		DES MOINES	N	I235	I35	IA	851.0	16:29	1/31 @ 2:03
14.0	I35	I80	DES MOINES	W	I235	I35	IA	865.0	16:44	1/31 @ 2:18

119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	984.0	19:04	1/31 @ 4:38
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	987.0	19:07	1/31 @ 4:41
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1341.0	25:07	1/31 @ 9:41
186.0	I76		ARVADA	S	I70	I76	CO	1527.0	28:31	1/31 @ 13:05
502.0	I70		COVE FORT	W	I15	I70	UT	2029.0	38:16	1/31 @ 22:49
242.0	I15		LAS VEGAS			.	NV	2271.0	42:31	2/01 @ 2:05
1.0	U95		LAS VEGAS	W	U95	U95B	NV	2272.0	42:33	2/01 @ 2:06
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	2279.0	42:42	2/01 @ 2:15
51.0	U95		MERCURY	S	U95	LOCL	NV	2330.0	43:38	2/01 @ 3:11
6.0	LOCAL		MERCURY				NV	2336.0	43:47	2/01 @ 3:20

From: Y-12 TN Leaving : 1/30/99 at 8:21 EST
to : MERCURY NV Arriving: 1/31/99 at 17:30 PST

Routing through:

.0			Y-12				TN	.0	0:00	1/30 @ 8:21
7.0	LOCAL		BEAR CREEK		S95	LOCL	TN	7.0	0:10	1/30 @ 8:30
2.0	S95		OAK RIDGE	SW	S58	S95	TN	9.0	0:13	1/30 @ 8:33
7.0	S58		KINGSTON	E	I40	X356	TN	16.0	0:21	1/30 @ 8:42
145.0	I40		NASHVILLE	E	I24	I40	TN	161.0	2:37	1/30 @ 9:58
2.0	I24	I40	NASHVILLE	SE	I24	I40	TN	163.0	2:39	1/30 @ 10:00
1.0	I40	I65	NASHVILLE	S	I40	I65	TN	164.0	2:41	1/30 @ 10:01
218.0	I40		WEST MEMPHIS	E	I40	I55	AR	382.0	6:36	1/30 @ 13:56
3.0	I40	I55	WEST MEMPHIS	N	I40	I55	AR	385.0	6:39	1/30 @ 13:59
455.0	I40		OKLAHOMA CITY	E	I35	I40	OK	840.0	14:43	1/30 @ 22:03
2.0	I35	I40	OKLAHOMA CITY	S	I235	I35	OK	842.0	14:45	1/30 @ 22:05
1009.0	I40		KINGMAN	NW	I40	X48	AZ	1851.0	32:22	1/31 @ 14:41
83.0	U93		ALUNITE		U93	U95	NV	1934.0	34:01	1/31 @ 15:20
22.0	U93	U95	LAS VEGAS				NV	1956.0	34:25	1/31 @ 15:45
1.0	U95		LAS VEGAS	W	U95	U95B	NV	1957.0	34:26	1/31 @ 15:46
7.0	U95BU		LAS VEGAS	NW	U95	U95B	NV	1964.0	34:36	1/31 @ 15:56
51.0	U95		MERCURY	S	U95	LOCL	NV	2015.0	35:32	1/31 @ 16:51
6.0	LOCAL		MERCURY				NV	2021.0	36:11	1/31 @ 17:30

TRUCK ROUTES FROM LLW GENERATORS TO NTS - AVOID LAS VEGAS

From: AMES LAB IA Leaving : 2/01/99 at 9:21 CST
to : MERCURY NV Arriving: 2/02/99 at 17:50 PST

Routing through:

.0			AMES LAB				IA	.0	0:00	2/01 @	9:21
3.0	LOCAL		AMES	SW	U30	LOCL	IA	3.0	0:09	2/01 @	9:30
4.0	U30		AMES	E	I35	X111	IA	7.0	0:13	2/01 @	9:35
25.0	I35		DES MOINES	N	I235	I35	IA	32.0	0:36	2/01 @	9:58
14.0	I35	I80	DES MOINES	W	I235	I35	IA	46.0	0:51	2/01 @	10:13
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	165.0	2:41	2/01 @	12:03
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	168.0	2:44	2/01 @	12:06
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	522.0	8:44	2/01 @	17:05
186.0	I76		ARVADA	S	I70	I76	CO	708.0	12:08	2/01 @	20:29
502.0	I70		COVE FORT	W	I15	I70	UT	1210.0	21:53	2/02 @	6:13
221.0	I15		GARNET		I15	X64	NV	1431.0	25:47	2/02 @	9:07
85.0	U93		HIKO	S	U93	S375	NV	1516.0	27:29	2/02 @	10:49
98.0	S375		WARM SPRINGS				NV	1614.0	29:56	2/02 @	13:17
50.0	U6		TONOPAH				NV	1664.0	30:56	2/02 @	14:17
146.0	U95		MERCURY	S	U95	LOCL	NV	1810.0	34:21	2/02 @	17:41
6.0	LOCAL		MERCURY				NV	1816.0	34:30	2/02 @	17:50

From: ARGONNE NATL L IL Leaving : 2/01/99 at 9:01 CST
to : MERCURY NV Arriving: 2/02/99 at 22:46 PST

Routing through:

.0			ARGONNE NATL L				IL	.0	0:00	2/01 @	9:01
1.0	LOCAL		DARIEN	S	I55	X273	IL	1.0	0:03	2/01 @	9:04
4.0	I55		LEMONT	NW	I355	I55	IL	5.0	0:07	2/01 @	9:08
8.0	I355$		DOWNERS GROVE	W	I355	U34	IL	13.0	0:16	2/01 @	9:17
1.0	U34		LISLE		U34	S53	IL	14.0	0:18	2/01 @	9:19
1.0	S53		LISLE	N	I88	S53	IL	15.0	0:20	2/01 @	9:20
86.0	I88 $	TEWT$	ROCK FALLS	SE	I88	X44	IL	101.0	1:53	2/01 @	10:54
44.0	I88		RAPIDS CITY	S	I80	I88	IL	145.0	2:41	2/01 @	11:42
173.0	I80		DES MOINES	N	I235	I35	IA	318.0	5:53	2/01 @	14:53
14.0	I35	I80	DES MOINES	W	I235	I35	IA	332.0	6:08	2/01 @	15:08
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	451.0	7:58	2/01 @	16:58
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	454.0	8:01	2/01 @	17:01
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	808.0	14:30	2/01 @	22:31
186.0	I76		ARVADA	S	I70	I76	CO	994.0	17:25	2/02 @	1:25
502.0	I70		COVE FORT	W	I15	I70	UT	1496.0	27:39	2/02 @	11:39
221.0	I15		GARNET		I15	X64	NV	1717.0	31:03	2/02 @	14:03
85.0	U93		HIKO	S	U93	S375	NV	1802.0	33:15	2/02 @	16:15
98.0	S375		WARM SPRINGS				NV	1900.0	35:13	2/02 @	18:13
50.0	U6		TONOPAH				NV	1950.0	36:43	2/02 @	19:43
146.0	U95		MERCURY	S	U95	LOCL	NV	2096.0	39:37	2/02 @	22:37

6.0	LOCAL		MERCURY				NV	2102.0	39:46	2/02 @ 22:46

From: COLUMBUS NE I670 I71 OH Leaving : 2/01/99 at 9:08 EST
to : MERCURY NV Arriving: 2/03/99 at 2:57 PST

Routing through:

.0			COLUMBUS	NE	I670	I71	OH	.0	0:00	2/01 @ 9:08
4.0	I670		COLUMBUS	W	I670	I70	OH	4.0	0:04	2/01 @ 9:12
169.0	I70		INDIANAPOLIS	NE	I65	I70	IN	173.0	3:03	2/01 @ 12:11
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	175.0	3:06	2/01 @ 12:13
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	313.0	6:01	2/01 @ 16:09
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	319.0	6:08	2/01 @ 16:15
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	396.0	7:32	2/01 @ 17:39
20.0	I55	I70	ST LOUIS		I55	I64	MO	416.0	7:54	2/01 @ 18:01
1.0	I55		ST LOUIS	S	I44	I55	MO	417.0	7:55	2/01 @ 18:03
290.0	I44		JOPLIN	SW	I44	X1	MO	707.0	12:57	2/01 @ 23:04
17.0	I44 $		MIAMI	E	I44	X313	OK	724.0	13:12	2/01 @ 23:19
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	796.0	14:49	2/02 @ 0:56
20.0	I44		OAKHURST	E	I44	X221	OK	816.0	15:09	2/02 @ 1:16
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	902.0	16:29	2/02 @ 2:36
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	907.0	16:34	2/02 @ 2:42
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	917.0	16:45	2/02 @ 2:52
1217.0	I40		BARSTOW		I15	I40	CA	2134.0	38:27	2/02 @ 22:34
63.0	I15		BAKER		I15	S127	CA	2197.0	39:36	2/02 @ 23:43
56.0	S127		SHOSHONE		S127	S178	CA	2253.0	40:43	2/03 @ 0:50
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2303.0	42:13	2/03 @ 2:20
24.0	U95		MERCURY	S	U95	LOCL	NV	2327.0	42:41	2/03 @ 2:48
6.0	LOCAL		MERCURY				NV	2333.0	42:50	2/03 @ 2:57

From: BROOKHAVEN LAB NY Leaving : 2/02/99 at 7:28 EST
to : MERCURY NV Arriving: 2/04/99 at 15:42 PST

Routing through:

.0			BROOKHAVEN LAB				NY	.0	0:00	2/02 @ 7:28
1.0	LOCAL		YAPHANK	NE	C46	LOCL	NY	1.0	0:02	2/02 @ 7:30
2.0	C46		UPTON	SW	I495	X68	NY	3.0	0:04	2/02 @ 7:32
49.0	I495		LITTLE NECK	S	I495	X30	NY	52.0	0:58	2/02 @ 8:26
4.0	TCIP		BAYSIDE	NW	I295	TCIP	NY	56.0	1:03	2/02 @ 8:31
3.0	I295#		LOCUST POINT		I295	I695	NY	59.0	1:06	2/02 @ 8:34
1.0	I295		BRONX	SE	I678	I95	NY	60.0	1:07	2/02 @ 8:35
1.0	I95	I278	BRONX	E	I278	I95	NY	61.0	1:09	2/02 @ 8:37
7.0	I95		G W BRIDGE	E	I95	X1A	NY	68.0	1:20	2/02 @ 8:48
1.0	I95 #		FT LEE	NE	TPAL	I95	NJ	69.0	1:26	2/02 @ 8:54
4.0	I95		BOGOTA	SE	I80	I95	NJ	73.0	1:30	2/02 @ 8:58
64.0	I80		PAHAQUARRY	S	I80	X1	NJ	137.0	2:40	2/02 @ 10:08
2.0	I80 #		E STROUDSBURG	E	I80	X52	PA	139.0	2:43	2/02 @ 10:11
330.0	I80		NORTH JACKSON	NE	I76	I80	OH	469.0	9:43	2/02 @ 17:10

74.0	I80 $		ELYRIA	NW	I80	I90	OH	543.0	11:04	2/02 @ 18:31
281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	824.0	16:27	2/03 @ 0:54
1.0	I80		LAKE STATION	NE	I80	I94	IN	825.0	16:28	2/03 @ 0:55
19.0	I80	I94	LANSING	W	I294	I94	IL	844.0	16:49	2/03 @ 1:16
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	849.0	16:54	2/03 @ 1:21
326.0	I80		DES MOINES	N	I235	I35	IA	1175.0	23:22	2/03 @ 7:49
14.0	I35	I80	DES MOINES	W	I235	I35	IA	1189.0	23:37	2/03 @ 8:04
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	1308.0	25:27	2/03 @ 9:54
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	1311.0	25:30	2/03 @ 9:57
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1665.0	32:00	2/03 @ 15:27
186.0	I76		ARVADA	S	I70	I76	CO	1851.0	34:54	2/03 @ 18:21
502.0	I70		COVE FORT	W	I15	I70	UT	2353.0	44:39	2/04 @ 4:05
221.0	I15		GARNET		I15	X64	NV	2574.0	48:33	2/04 @ 6:59
85.0	U93		HIKO	S	U93	S375	NV	2659.0	50:15	2/04 @ 8:41
98.0	S375		WARM SPRINGS				NV	2757.0	52:42	2/04 @ 11:09
50.0	U6		TONOPAH				NV	2807.0	54:12	2/04 @ 12:39
146.0	U95		MERCURY	S	U95	LCCL	NV	2953.0	57:07	2/04 @ 15:33
6.0	LOCAL		MERCURY				NV	2959.0	57:16	2/04 @ 15:42

From: CANOGA PARK S27 LOCL CA Leaving : 1/30/99 at 8:39 PST
to : MERCURY NV Arriving: 1/30/99 at 15:41 PST

Routing through:

.0			CANOGA PARK		S27	LOCL	CA	.0	0:00	1/30 @ 8:39
3.0	S27		WOODLAND HILLS		U101	S27	CA	3.0	0:04	1/30 @ 8:43
25.0	U101		LOS ANGELES		I10	I5	CA	28.0	0:31	1/30 @ 9:11
41.0	I10		ONTARIO	E	I10	I15	CA	69.0	1:16	1/30 @ 9:55
137.0	I15		BAKER		I15	S127	CA	206.0	3:47	1/30 @ 12:27
56.0	S127		SHOSHONE		S127	S178	CA	262.0	4:55	1/30 @ 13:34
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	312.0	6:25	1/30 @ 15:04
24.0	U95		MERCURY	S	U95	LOCL	NV	336.0	6:53	1/30 @ 15:32
6.0	LOCAL		MERCURY				NV	342.0	7:02	1/30 @ 15:41

From: FERNALD PLANT OH Leaving : 2/01/99 at 8:34 EST
to : MERCURY NV Arriving: 2/03/99 at 0:59 PST

Routing through:

.0			FERNALD PLANT				OH	.0	0:00	2/01 @ 8:34
7.0	S128		MIAMITOWN	S	I74	X7	OH	7.0	0:11	2/01 @ 8:45
2.0	I275	I74	HARRISON	SE	I275	I74	OH	9.0	0:13	2/01 @ 8:47
81.0	I74		INDIANAPOLIS	SE	I465	I74	IN	90.0	1:34	2/01 @ 10:08
14.0	I465	I74	INDIANAPOLIS	SW	I465	I70	IN	104.0	1:49	2/01 @ 10:23
131.0	I70		TEUTOPOLIS	NW	I57	I70	IL	235.0	4:06	2/01 @ 13:41
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	241.0	4:43	2/01 @ 14:17
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	318.0	6:07	2/01 @ 15:41
20.0	I55	I70	ST LOUIS		I55	I64	MO	338.0	6:29	2/01 @ 16:03
1.0	I55		ST LOUIS	S	I44	I55	MO	339.0	6:30	2/01 @ 16:04

290.0	I44		JOPLIN	SW	I44	X1	MO	629.0	11:32	2/01 @ 21:05
17.0	I44 $		MIAMI	E	I44	X313	OK	646.0	11:47	2/01 @ 21:21
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	718.0	12:54	2/01 @ 22:28
20.0	I44		OAKHURST	E	I44	X221	OK	738.0	13:44	2/01 @ 23:18
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	824.0	15:04	2/02 @ 0:38
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	829.0	15:10	2/02 @ 0:43
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	839.0	15:20	2/02 @ 0:54
1217.0	I40		BARSTOW		I15	I40	CA	2056.0	37:02	2/02 @ 20:36
63.0	I15		BAKER		I15	S127	CA	2119.0	38:11	2/02 @ 21:45
56.0	S127		SHOSHONE		S127	S178	CA	2175.0	39:18	2/02 @ 22:52
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2225.0	40:18	2/02 @ 23:52
24.0	U95		MERCURY	S	U95	LOCL	NV	2249.0	41:16	2/03 @ 0:50
6.0	LOCAL		MERCURY				NV	2255.0	41:25	2/03 @ 0:59

From: GE VALLECITOS CA Leaving : 2/01/99 at 9:23 PST
to : MERCURY NV Arriving: 2/01/99 at 21:41 PST

Routing through:

.0			GE VALLECITOS				CA	.0	0:00	2/01 @ 9:23
10.0	S84		LIVERMORE	NE	I580	S84	CA	10.0	0:14	2/01 @ 9:37
26.0	I580		VERNALIS	W	I5	I580	CA	36.0	0:42	2/01 @ 10:05
196.0	I5		STOCKDALE HWY	W	I5	LOCL	CA	232.0	4:46	2/01 @ 14:09
17.0	LOCAL		BAKERSFIELD	SW	S58	S99	CA	249.0	5:15	2/01 @ 14:38
61.0	S58		MOJAVE	N	S14	S58	CA	310.0	6:22	2/01 @ 15:45
1.0	S14	S58	MOJAVE		S14	S58	CA	311.0	6:23	2/01 @ 15:46
71.0	S58		BARSTOW	E	I15	S58	CA	382.0	7:59	2/01 @ 17:22
60.0	I15		BAKER		I15	S127	CA	442.0	9:04	2/01 @ 18:27
56.0	S127		SHOSHONE		S127	S178	CA	498.0	10:42	2/01 @ 20:04
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	548.0	11:42	2/01 @ 21:04
24.0	U95		MERCURY	S	U95	LOCL	NV	572.0	12:10	2/01 @ 21:32
6.0	LOCAL		MERCURY				NV	578.0	12:19	2/01 @ 21:41

From: GRAND JCT U50 U6 CO Leaving : 2/01/99 at 9:22 MST
to : MERCURY NV Arriving: 2/02/99 at 1:19 PST

Routing through:

.0			GRAND JCT		U50	U6	CO	.0	0:00	2/01 @ 9:22
6.0	U50	U6	GRAND JCT	NW	I70	X26	CO	6.0	0:07	2/01 @ 9:29
258.0	I70		COVE FORT	W	I15	I70	UT	264.0	4:50	2/01 @ 14:13
221.0	I15		GARNET		I15	X64	NV	485.0	8:14	2/01 @ 16:37
85.0	U93		HIKO	S	U93	S375	NV	570.0	9:56	2/01 @ 18:19
98.0	S375		WARM SPRINGS				NV	668.0	12:24	2/01 @ 20:46
50.0	U6		TONOPAH				NV	718.0	13:54	2/01 @ 22:16
146.0	U95		MERCURY	S	U95	LOCL	NV	864.0	16:48	2/02 @ 1:10
6.0	LOCAL		MERCURY				NV	870.0	16:57	2/02 @ 1:19

From: ID NATL ENG LAB U20 LOCL ID Leaving : 2/01/99 at 9:06 MST
to : MERCURY NV Arriving: 2/02/99 at 3:14 PST

Routing through:

.0			ID NATL ENG LAB		U20	LOCL	ID	.0	0:00	2/01 @	9:06
63.0	U20	U26	CAREY		U20	U26	ID	63.0	1:16	2/01 @	10:21
39.0	U26	U93	SHOSHONE		U26	U93	ID	102.0	2:02	2/01 @	11:08
27.0	U26		BLISS		I84	X141	ID	129.0	2:35	2/01 @	11:41
106.0	I84		NAMPA	N	I84	X35	ID	235.0	4:45	2/01 @	13:50
19.0	S55		MARSING	W	U95	S55	ID	254.0	5:13	2/01 @	14:19
220.0	U95		WINNEMUCCA		I80	X178	NV	474.0	10:07	2/01 @	18:13
54.0	I80		BATTLE MTN	NW	I80	X229	NV	528.0	10:57	2/01 @	19:03
89.0	S305		AUSTIN				NV	617.0	12:44	2/01 @	20:49
12.0	U50		AUSTIN	SE	U50	S376	NV	629.0	12:58	2/01 @	21:04
100.0	S376		TONOPAH	E	U6	S376	NV	729.0	14:58	2/01 @	23:04
6.0	U6		TONOPAH				NV	735.0	15:35	2/01 @	23:41
146.0	U95		MERCURY	S	U95	LOCL	NV	881.0	19:00	2/02 @	3:05
6.0	LOCAL		MERCURY				NV	887.0	19:09	2/02 @	3:14

From: SANDIA NATL LBS NM Leaving : 2/01/99 at 9:10 MST
to : MERCURY NV Arriving: 2/02/99 at 0:39 PST

Routing through:

.0			SANDIA NATL LBS				NM	.0	0:00	2/01 @	9:10
3.0	LOCAL		ALBUQUERQUE	E	I40	X165	NM	3.0	0:07	2/01 @	9:17
687.0	I40		BARSTOW		I15	I40	CA	690.0	12:07	2/01 @	20:16
63.0	I15		BAKER		I15	S127	CA	753.0	13:16	2/01 @	21:25
56.0	S127		SHOSHONE		S127	S178	CA	809.0	14:53	2/01 @	23:02
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	859.0	15:53	2/02 @	0:02
24.0	U95		MERCURY	S	U95	LOCL	NV	883.0	16:21	2/02 @	0:30
6.0	LOCAL		MERCURY				NV	889.0	16:30	2/02 @	0:39

From: KAPL-KNOLLS NY Leaving : 2/02/99 at 7:29 EST
to : MERCURY NV Arriving: 2/04/99 at 14:41 PST

Routing through:

.0			KAPL-KNOLLS				NY	.0	0:00	2/02 @	7:29
4.0	LOCAL		SCHENECTADY	E	S146	S7	NY	4.0	0:08	2/02 @	7:37
2.0	S7		SCHENECTADY	SE	I890	X7	NY	6.0	0:10	2/02 @	7:40
2.0	I890		SCHENECTADY	NW	I890	X1	NY	8.0	0:12	2/02 @	7:42
1.0	I890$		SCHENECTADY	NW	I890	I90	NY	9.0	0:13	2/02 @	7:43
258.0	I90 $	TNYT$	BUFFALO	NE	I290	I90	NY	267.0	5:25	2/02 @	12:54
9.0	I90	TNYT	LACKAWANNA	E	I90	X55	NY	276.0	5:35	2/02 @	13:04
66.0	I90 $	TNYT$	RIPLEY	W	I90	X61	NY	342.0	6:47	2/02 @	14:16
124.0	I90		CLEVELAND	S	I71	I90	OH	466.0	9:32	2/02 @	17:01
9.0	I71		BROOK PARK	N	I480	I71	OH	475.0	9:42	2/02 @	17:11
10.0	I480		N RIDGEVILLE	S	I480	I80	OH	485.0	9:53	2/02 @	17:22

8.0	I80 $		ELYRIA	NW	I80	I90	OH	493.0	10:01	2/02 @	17:30
281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	774.0	15:24	2/02 @	23:53
1.0	I80		LAKE STATION	NE	I80	I94	IN	775.0	15:26	2/02 @	23:54
19.0	I80	I94	LANSING	W	I294	I94	IL	794.0	15:46	2/03 @	0:15
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	799.0	15:52	2/03 @	0:21
326.0	I80		DES MOINES	N	I235	I35	IA	1125.0	21:50	2/03 @	6:19
14.0	I35	I80	DES MOINES	W	I235	I35	IA	1139.0	22:35	2/03 @	7:04
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	1258.0	24:25	2/03 @	8:53
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	1261.0	24:28	2/03 @	8:56
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1615.0	30:28	2/03 @	13:56
186.0	I76		ARVADA	S	I70	I76	CO	1801.0	33:52	2/03 @	17:20
502.0	I70		COVE FORT	W	I15	I70	UT	2303.0	43:36	2/04 @	3:04
221.0	I15		GARNET		I15	X64	NV	2524.0	47:30	2/04 @	5:58
85.0	U93		HIKO	S	U93	S375	NV	2609.0	49:12	2/04 @	7:40
98.0	S375		WARM SPRINGS				NV	2707.0	51:40	2/04 @	10:08
50.0	U6		TONOPAH				NV	2757.0	52:40	2/04 @	11:08
146.0	U95		MERCURY	S	U95	LOCL	NV	2903.0	56:04	2/04 @	14:32
6.0	LOCAL		MERCURY				NV	2909.0	56:13	2/04 @	14:41

From: LOS ALAMOS NM Leaving : 2/01/99 at 8:34 MST
to : MERCURY NV Arriving: 2/02/99 at 2:03 PST

Routing through:

.0			LOS ALAMOS				NM	.0	0:00	2/01 @	8:34
6.0	LTRKR		BANDELIER N M	W	S4	LTRK	NM	6.0	0:10	2/01 @	8:44
1.0	S4		BANDELIER N M	N	S4	S502	NM	7.0	0:12	2/01 @	8:46
12.0	S502		POJOAQUE		U285	S502	NM	19.0	0:27	2/01 @	9:01
18.0	U285	U84	SANTA FE		U285	U84	NM	37.0	0:47	2/01 @	9:21
2.0	U84		SANTA FE	S	I25	X282	NM	39.0	0:50	2/01 @	9:23
56.0	I25		ALBUQUERQUE	E	I25	I40	NM	95.0	1:43	2/01 @	10:17
681.0	I40		BARSTOW		I15	I40	CA	776.0	14:07	2/01 @	21:40
63.0	I15		BAKER		I15	S127	CA	839.0	15:15	2/01 @	22:49
56.0	S127		SHOSHONE		S127	S178	CA	895.0	16:22	2/01 @	23:56
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	945.0	17:22	2/02 @	0:56
24.0	U95		MERCURY	S	U95	LOCL	NV	969.0	18:20	2/02 @	1:54
6.0	LOCAL		MERCURY				NV	975.0	18:29	2/02 @	2:03

From: L BERKELEY LAB CA Leaving : 2/02/99 at 9:06 PST
to : MERCURY NV Arriving: 2/02/99 at 22:00 PST

Routing through:

.0			L BERKELEY LAB				CA	.0	0:00	2/02 @	9:06
3.0	LOCAL		BERKELEY	W	I580	LOCL	CA	3.0	0:07	2/02 @	9:13
2.0	I580	I80	OAKLAND	NW	I580	I80	CA	5.0	0:09	2/02 @	9:15
1.0	I580		PIEDMONT	NW	I580	I980	CA	6.0	0:10	2/02 @	9:16
2.0	I980		OAKLAND		I880	I980	CA	8.0	0:13	2/02 @	9:18
11.0	I880		SAN LEANDRO		I238	I880	CA	19.0	0:25	2/02 @	9:30

2.0	I238		CASTRO VALLEY	W	I238	I580	CA	21.0	0:27	2/02 @	9:32
47.0	I580		VERNALIS	W	I5	I580	CA	68.0	1:18	2/02 @	10:24
196.0	I5		STOCKDALE HWY	W	I5	LOCL	CA	264.0	5:22	2/02 @	14:27
17.0	LOCAL		BAKERSFIELD	SW	S58	S99	CA	281.0	5:51	2/02 @	14:56
61.0	S58		MOJAVE	N	S14	S58	CA	342.0	6:58	2/02 @	16:03
1.0	S14	S58	MOJAVE		S14	S58	CA	343.0	6:59	2/02 @	16:04
71.0	S58		BARSTOW	E	I15	S58	CA	414.0	8:35	2/02 @	17:40
60.0	I15		BAKER		I15	S127	CA	474.0	10:10	2/02 @	19:15
56.0	S127		SHOSHONE		S127	S178	CA	530.0	11:17	2/02 @	20:23
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	580.0	12:17	2/02 @	21:23
24.0	U95		MERCURY	S	U95	LOCL	NV	604.0	12:45	2/02 @	21:51
6.0	LOCAL		MERCURY				NV	610.0	12:54	2/02 @	22:00

From: L LIVERMORE LB CA Leaving : 1/30/99 at 8:31 PST
to : MERCURY NV Arriving: 1/30/99 at 20:38 PST

Routing through:

.0			L LIVERMORE LB				CA	.0	0:00	1/30 @	8:31
3.0	LOCAL		ALTAMONT	SW	I580	LOCL	CA	3.0	0:05	1/30 @	8:36
24.0	I580		VERNALIS	W	I5	I580	CA	27.0	0:31	1/30 @	9:02
196.0	I5		STOCKDALE HWY	W	I5	LOCL	CA	223.0	4:05	1/30 @	12:36
17.0	LOCAL		BAKERSFIELD	SW	S58	S99	CA	240.0	5:04	1/30 @	13:35
61.0	S58		MOJAVE	N	S14	S58	CA	301.0	6:11	1/30 @	14:42
1.0	S14	S58	MOJAVE		S14	S58	CA	302.0	6:12	1/30 @	14:43
71.0	S58		BARSTOW	E	I15	S58	CA	373.0	7:48	1/30 @	16:19
60.0	I15		BAKER		I15	S127	CA	433.0	8:53	1/30 @	17:24
56.0	S127		SHOSHONE		S127	S178	CA	489.0	10:31	1/30 @	19:02
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	539.0	11:31	1/30 @	20:02
24.0	U95		MERCURY	S	U95	LOCL	NV	563.0	11:58	1/30 @	20:29
6.0	LOCAL		MERCURY				NV	569.0	12:07	1/30 @	20:38

From: MOUND FACILITY OH Leaving : 2/01/99 at 8:36 EST
to : MERCURY NV Arriving: 2/03/99 at 1:34 PST

Routing through:

.0			MOUND FACILITY				OH	.0	0:00	2/01 @	8:36
1.0	LOCAL		MIAMISBURG		S725	LOCL	OH	1.0	0:02	2/01 @	8:38
3.0	S725		MIAMISBURG	E	I75	X44	OH	4.0	0:06	2/01 @	8:42
8.0	I75		DAYTON		I75	X52	OH	12.0	0:14	2/01 @	8:51
31.0	U35		NEW WESTVILLE	NE	I70	X1	OH	43.0	0:56	2/01 @	9:32
75.0	I70		INDIANAPOLIS	NE	I65	I70	IN	118.0	2:12	2/01 @	10:48
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	120.0	2:14	2/01 @	10:51
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	258.0	5:10	2/01 @	14:46
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	264.0	5:17	2/01 @	14:53
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	341.0	6:41	2/01 @	16:17
20.0	I55	I70	ST LOUIS		I55	I64	MO	361.0	7:03	2/01 @	16:39
1.0	I55		ST LOUIS	S	I44	I55	MO	362.0	7:04	2/01 @	16:40

290.0	I44		JOPLIN	SW	I44	X1	MO	652.0	12:05	2/01 @ 21:41
17.0	I44 $		MIAMI	E	I44	X313	OK	669.0	12:21	2/01 @ 21:57
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	741.0	13:27	2/01 @ 23:03
20.0	I44		OAKHURST	E	I44	X221	OK	761.0	14:17	2/01 @ 23:53
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	847.0	15:38	2/02 @ 1:14
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	852.0	15:43	2/02 @ 1:19
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	862.0	15:54	2/02 @ 1:30
1217.0	I40		BARSTOW		I15	I40	CA	2079.0	37:36	2/02 @ 21:12
63.0	I15		BAKER		I15	S127	CA	2142.0	38:45	2/02 @ 22:20
56.0	S127		SHOSHONE		S127	S178	CA	2198.0	39:52	2/02 @ 23:27
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2248.0	41:22	2/03 @ 0:57
24.0	U95		MERCURY	S	U95	LOCL	NV	2272.0	41:50	2/03 @ 1:25
6.0	LOCAL		MERCURY				NV	2278.0	41:59	2/03 @ 1:34

From: Y-12 TN Leaving : 2/01/99 at 8:33 EST
to : MERCURY NV Arriving: 2/02/99 at 22:27 PST

Routing through:

.0			Y-12				TN	.0	0:00	2/01 @ 8:33
7.0	LOCAL		BEAR CREEK		S95	LOCL	TN	7.0	0:10	2/01 @ 8:43
2.0	S95		OAK RIDGE	SW	S58	S95	TN	9.0	0:13	2/01 @ 8:46
7.0	S58		KINGSTON	E	I40	X356	TN	16.0	0:21	2/01 @ 8:54
145.0	I40		NASHVILLE	E	I24	I40	TN	161.0	2:37	2/01 @ 10:10
2.0	I24	I40	NASHVILLE	SE	I24	I40	TN	163.0	2:39	2/01 @ 10:12
1.0	I40	I65	NASHVILLE	S	I40	I65	TN	164.0	2:41	2/01 @ 10:13
218.0	I40		WEST MEMPHIS	E	I40	I55	AR	382.0	6:36	2/01 @ 14:08
3.0	I40	I55	WEST MEMPHIS	N	I40	I55	AR	385.0	6:39	2/01 @ 14:11
455.0	I40		OKLAHOMA CITY	E	I35	I40	OK	840.0	14:43	2/01 @ 22:15
2.0	I35	I40	OKLAHOMA CITY	S	I235	I35	OK	842.0	14:45	2/01 @ 22:17
1222.0	I40		BARSTOW		I15	I40	CA	2064.0	36:32	2/02 @ 18:04
63.0	I15		BAKER		I15	S127	CA	2127.0	37:41	2/02 @ 19:13
56.0	S127		SHOSHONE		S127	S178	CA	2183.0	38:48	2/02 @ 20:20
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2233.0	39:48	2/02 @ 21:20
24.0	U95		MERCURY	S	U95	LOCL	NV	2257.0	40:46	2/02 @ 22:18
6.0	LOCAL		MERCURY				NV	2263.0	40:55	2/02 @ 22:27

From: PADUCAH GDP KY Leaving : 2/01/99 at 9:11 CST
to : MERCURY NV Arriving: 2/02/99 at 20:38 PST

Routing through:

.0			PADUCAH GDP				KY	.0	0:00	2/01 @ 9:11
3.0	LOCAL		KEVIL	E	U60	LOCL	KY	3.0	0:06	2/01 @ 9:17
19.0	U60		WICKLIFFE		U51	U60	KY	22.0	0:29	2/01 @ 9:40
6.0	U51	U60	CAIRO	S	U51	U60	IL	28.0	0:36	2/01 @ 9:47
12.0	U60	U62	CHARLESTON	E	I57	X12	MO	40.0	0:50	2/01 @ 10:02
13.0	I57		SIKESTON	E	I55	I57	MO	53.0	1:02	2/01 @ 10:14
51.0	U60		POPLAR BLUFF	W	U160	U60	MO	104.0	2:04	2/01 @ 11:15

8.0	U60	U67	POPLAR BLUFF	NW	U60	U67	MO	112.0	2:12	2/01 @ 11:23
96.0	U60		WILLOW SPRINGS	SE	U60	U63	MO	208.0	4:08	2/01 @ 13:19
14.0	U60	U63	CABOOL	SE	U60	U63	MO	222.0	4:53	2/01 @ 14:04
29.0	U60		MANSFIELD	N	U60	S5	MO	251.0	5:24	2/01 @ 14:36
1.0	U60	S5	MANSFIELD	NW	U60	S5	MO	252.0	5:26	2/01 @ 14:37
38.0	U60		SPRINGFIELD	SE	U60	U65	MO	290.0	6:07	2/01 @ 15:18
9.0	U65		SPRINGFIELD	NE	I44	X82	MO	299.0	6:17	2/01 @ 15:28
82.0	I44		JOPLIN	SW	I44	X1	MO	381.0	7:34	2/01 @ 16:45
17.0	I44 $		MIAMI	E	I44	X313	OK	398.0	7:49	2/01 @ 17:01
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	470.0	8:56	2/01 @ 18:07
20.0	I44		OAKHURST	E	I44	X221	OK	490.0	9:46	2/01 @ 18:57
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	576.0	11:06	2/01 @ 20:17
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	581.0	11:12	2/01 @ 20:23
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	591.0	11:23	2/01 @ 20:34
1217.0	I40		BARSTOW		I15	I40	CA	1808.0	33:05	2/02 @ 16:15
63.0	I15		BAKER		I15	S127	CA	1871.0	34:13	2/02 @ 17:24
56.0	S127		SHOSHONE		S127	S178	CA	1927.0	35:21	2/02 @ 18:31
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	1977.0	36:51	2/02 @ 20:01
24.0	U95		MERCURY	S	U95	LOCL	NV	2001.0	37:19	2/02 @ 20:29
6.0	LOCAL		MERCURY				NV	2007.0	37:28	2/02 @ 20:38

From: PORTSMOUTH GDP OH Leaving : 2/01/99 at 9:10 EST
to : MERCURY NV Arriving: 2/03/99 at 3:21 PST

Routing through:

.0			PORTSMOUTH GDP				OH	.0	0:00	2/01 @ 9:10
3.0	U23		PIKETON	S	U23	S32	OH	3.0	0:03	2/01 @ 9:14
75.0	S32		MT CARMEL HGTS	E	I275	X63	OH	78.0	1:25	2/01 @ 10:35
21.0	I275		ERLANGER	N	I275	I71	KY	99.0	1:48	2/01 @ 10:58
12.0	I71	I75	WALTON	NW	I71	I75	KY	111.0	1:59	2/01 @ 11:09
76.0	I71		LOUISVILLE	E	I64	I71	KY	187.0	3:10	2/01 @ 12:20
181.0	I64		MT VERNON	SW	I57	I64	IL	368.0	6:49	2/01 @ 16:59
5.0	I57	I64	MT VERNON	NW	I57	I64	IL	373.0	6:54	2/01 @ 17:04
71.0	I64		EAST ST LOUIS	NE	I55	I64	IL	444.0	8:12	2/01 @ 18:22
3.0	I55	I70	ST LOUIS		I55	I64	MO	447.0	8:15	2/01 @ 18:25
1.0	I55		ST LOUIS	S	I44	I55	MO	448.0	8:16	2/01 @ 18:26
290.0	I44		JOPLIN	SW	I44	X1	MO	738.0	13:48	2/01 @ 23:57
17.0	I44 $		MIAMI	E	I44	X313	OK	755.0	14:03	2/02 @ 0:13
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	827.0	15:10	2/02 @ 1:20
20.0	I44		OAKHURST	E	I44	X221	OK	847.0	15:30	2/02 @ 1:40
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	933.0	16:50	2/02 @ 3:00
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	938.0	16:56	2/02 @ 3:05
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	948.0	17:06	2/02 @ 3:16
1217.0	I40		BARSTOW		I15	I40	CA	2165.0	38:49	2/02 @ 22:58
63.0	I15		BAKER		I15	S127	CA	2228.0	39:57	2/03 @ 0:06
56.0	S127		SHOSHONE		S127	S178	CA	2284.0	41:04	2/03 @ 1:14
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2334.0	42:34	2/03 @ 2:44

24.0	U95		MERCURY	S	U95	LOCL	NV	2358.0	43:02	2/03 @ 3:12
6.0	LOCAL		MERCURY				NV	2364.0	43:11	2/03 @ 3:21

From: PANTEX PLANT F245 F683 TX Leaving : 2/01/99 at 9:20 CST
to : MERCURY NV Arriving: 2/02/99 at 4:52 PST

Routing through:

.0			PANTEX PLANT		F245	F683	TX	.0	0:00	2/01 @ 9:20
4.0	F683		PANTEX	S	U60	F683	TX	4.0	0:08	2/01 @ 9:28
7.0	U60		AMARILLO	E	U60	L335	TX	11.0	0:16	2/01 @ 9:36
2.0	L335		AMARILLO	E	I40	X75	TX	13.0	0:19	2/01 @ 9:39
969.0	I40		BARSTOW		I15	I40	CA	982.0	17:10	2/02 @ 0:30
63.0	I15		BAKER		I15	S127	CA	1045.0	18:19	2/02 @ 1:38
56.0	S127		SHOSHONE		S127	S178	CA	1101.0	19:56	2/02 @ 3:15
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	1151.0	20:56	2/02 @ 4:15
24.0	U95		MERCURY	S	U95	LOCL	NV	1175.0	21:24	2/02 @ 4:43
6.0	LOCAL		MERCURY				NV	1181.0	21:33	2/02 @ 4:52

From: PRINCTN PLASMA U1 LOCL NJ Leaving : 2/01/99 at 9:19 EST
to : MERCURY NV Arriving: 2/03/99 at 13:23 PST

Routing through:

.0			PRINCTN PLASMA		U1	LOCL	NJ	.0	0:00	2/01 @ 9:19
12.0	U1		TRENTON		U1	S29	NJ	12.0	0:14	2/01 @ 9:33
3.0	U1 #		MORRISVILLE	SW	U1	U13	PA	15.0	0:18	2/01 @ 9:37
6.0	U13		BRISTOL	N	I276	X29	PA	21.0	0:25	2/01 @ 9:43
31.0	I276$		VALLEY FORGE	SE	I276	I76	PA	52.0	0:58	2/01 @ 10:17
84.0	I76 $		NEW CUMBERLND	S	I76	X18	PA	136.0	2:30	2/01 @ 11:49
2.0	I83		HARRISBURG	SW	I83	X20	PA	138.0	2:32	2/01 @ 11:51
2.0	S581		CAMP HILL	SW	U11	U15	PA	140.0	2:34	2/01 @ 11:53
10.0	U11		CARLISLE	NE	I76	X16	PA	150.0	2:48	2/01 @ 12:07
66.0	I76 $		BREEZEWOOD	SW	I70	I76	PA	216.0	4:00	2/01 @ 13:19
71.0	I70 $	I76 $	DONEGAL		I70	X9	PA	287.0	5:47	2/01 @ 15:06
.0	I70	XRAMP	DONEGAL	S	I70	S31	PA	287.0	5:47	2/01 @ 15:06
17.0	S31		WYANO	S	I70	X24	PA	304.0	6:13	2/01 @ 15:31
32.0	I70		LABORATORY	NE	I70	I79	PA	336.0	6:48	2/01 @ 16:06
5.0	I70	I79	WASHINGTON	N	I70	I79	PA	341.0	6:53	2/01 @ 16:12
157.0	I70		COLUMBUS	SE	I70	I71	OH	498.0	10:14	2/01 @ 19:33
2.0	I70	I71	COLUMBUS	SW	I70	I71	OH	500.0	10:16	2/01 @ 19:35
172.0	I70		INDIANAPOLIS	NE	I65	I70	IN	672.0	13:49	2/01 @ 23:07
2.0	I65	I70	INDIANAPOLIS	SE	I65	I70	IN	674.0	13:51	2/01 @ 23:10
138.0	I70		TEUTOPOLIS	NW	I57	I70	IL	812.0	16:17	2/02 @ 2:35
6.0	I57	I70	EFFINGHAM	SW	I57	I70	IL	818.0	16:23	2/02 @ 2:42
77.0	I70		EDWARDSVILLE	SE	I270	I55	IL	895.0	17:47	2/02 @ 4:06
20.0	I55	I70	ST LOUIS		I55	I64	MO	915.0	18:39	2/02 @ 4:58
1.0	I55		ST LOUIS	S	I44	I55	MO	916.0	18:41	2/02 @ 4:59
290.0	I44		JOPLIN	SW	I44	X1	MO	1206.0	23:42	2/02 @ 10:00

17.0	I44 $		MIAMI	E	I44	X313	OK	1223.0	23:58	2/02 @ 10:16
72.0	I44 $	TWRT$	CATOOSA	S	I44	X241	OK	1295.0	25:04	2/02 @ 11:22
20.0	I44		OAKHURST	E	I44	X221	OK	1315.0	25:24	2/02 @ 11:42
86.0	I44 $	TTRT$	EDMOND	SE	I35	I44	OK	1401.0	26:44	2/02 @ 13:02
5.0	I35	I44	OKLAHOMA CITY	NE	I35	I44	OK	1406.0	27:20	2/02 @ 13:38
10.0	I44		OKLAHOMA CITY	W	I40	I44	OK	1416.0	27:31	2/02 @ 13:49
1217.0	I40		BARSTOW		I15	I40	CA	2633.0	48:43	2/03 @ 9:00
63.0	I15		BAKER		I15	S127	CA	2696.0	49:52	2/03 @ 10:09
56.0	S127		SHOSHONE		S127	S178	CA	2752.0	51:29	2/03 @ 11:46
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	2802.0	52:29	2/03 @ 12:46
24.0	U95		MERCURY	S	U95	LOCL	NV	2826.0	52:57	2/03 @ 13:14
6.0	LOCAL		MERCURY				NV	2832.0	53:06	2/03 @ 13:23

From: ROCKY FLATS CO Leaving : 2/01/99 at 8:35 MST
to : MERCURY NV Arriving: 2/02/99 at 6:16 PST

Routing through:

.0			ROCKY FLATS				CO	.0	0:00	2/01 @ 8:35
5.0	LOCAL		ARVADA	NW	S72	LOCL	CO	5.0	0:09	2/01 @ 8:44
9.0	S72		WHEAT RIDGE	NW	I70	X266	CO	14.0	0:25	2/01 @ 8:59
498.0	I70		COVE FORT	W	I15	I70	UT	512.0	10:05	2/01 @ 18:39
221.0	I15		GARNET		I15	X64	NV	733.0	13:59	2/01 @ 21:33
85.0	U93		HIKO	S	U93	S375	NV	818.0	15:41	2/01 @ 23:15
98.0	S375		WARM SPRINGS				NV	916.0	17:38	2/02 @ 1:13
50.0	U6		TONOPAH				NV	966.0	19:08	2/02 @ 2:43
146.0	U95		MERCURY	S	U95	LOCL	NV	1112.0	22:02	2/02 @ 5:37
6.0	LOCAL		MERCURY				NV	1118.0	22:41	2/02 @ 6:16

From: SANDIA NATL LBS NM Leaving : 2/01/99 at 9:10 MST
to : MERCURY NV Arriving: 2/02/99 at 0:39 PST

Routing through:

.0			SANDIA NATL LBS				NM	.0	0:00	2/01 @ 9:10
3.0	LOCAL		ALBUQUERQUE	E	I40	X165	NM	3.0	0:07	2/01 @ 9:17
687.0	I40		BARSTOW		I15	I40	CA	690.0	12:07	2/01 @ 20:16
63.0	I15		BAKER		I15	S127	CA	753.0	13:16	2/01 @ 21:25
56.0	S127		SHOSHONE		S127	S178	CA	809.0	14:53	2/01 @ 23:02
50.0	S127	S373	AMARGOSA VALLY		U95	S373	NV	859.0	15:53	2/02 @ 0:02
24.0	U95		MERCURY	S	U95	LOCL	NV	883.0	16:21	2/02 @ 0:30
6.0	LOCAL		MERCURY				NV	889.0	16:30	2/02 @ 0:39

From: WEST VALLEY RP NY Leaving : 2/02/99 at 7:30 EST
to : MERCURY NV Arriving: 2/04/99 at 9:21 PST

Routing through:

.0			WEST VALLEY RP				NY	.0	0:00	2/02 @ 7:30

2.0	C85		SPRINGVILLE	SW	U219	C85	NY	2.0	0:05	2/02 @	7:35
3.0	U219		SPRINGVILLE	W	U219	S39	NY	5.0	0:08	2/02 @	7:38
13.0	S39		COLLINS		U62	S39	NY	18.0	0:26	2/02 @	7:56
2.0	U62		GOWANDA		U62	S39	NY	20.0	0:28	2/02 @	7:58
18.0	S39		SHERIDAN	SW	U20	S39	NY	38.0	0:52	2/02 @	8:22
2.0	U20		FREDONIA	NE	U20	S60	NY	40.0	0:55	2/02 @	8:25
1.0	S60		DUNKIRK	SE	I90	X59	NY	41.0	0:57	2/02 @	8:26
27.0	I90 $	TNYT$	RIPLEY	W	I90	X61	NY	68.0	1:26	2/02 @	8:56
124.0	I90		CLEVELAND	S	I71	I90	OH	192.0	3:41	2/02 @	11:11
9.0	I71		BROOK PARK	N	I480	I71	OH	201.0	3:51	2/02 @	11:21
10.0	I480		N RIDGEVILLE	S	I480	I80	OH	211.0	4:32	2/02 @	12:02
8.0	I80 $		ELYRIA	NW	I80	I90	OH	219.0	4:41	2/02 @	12:10
281.0	I80 $	I90 $	PORTAGE	W	I80	I90	IN	500.0	10:04	2/02 @	18:33
1.0	I80		LAKE STATION	NE	I80	I94	IN	501.0	10:05	2/02 @	18:34
19.0	I80	I94	LANSING	W	I294	I94	IL	520.0	10:26	2/02 @	18:55
5.0	I294$	I80 $	HOMEWOOD	NW	I294	I80	IL	525.0	10:31	2/02 @	19:01
326.0	I80		DES MOINES	N	I235	I35	IA	851.0	16:29	2/03 @	0:59
14.0	I35	I80	DES MOINES	W	I235	I35	IA	865.0	16:44	2/03 @	1:14
119.0	I80		COUNCIL BLUFFS	SE	I29	I80	IA	984.0	19:04	2/03 @	3:33
3.0	I29	I80	COUNCIL BLUFFS	SW	I29	I80	IA	987.0	19:07	2/03 @	3:36
354.0	I80		BIG SPRINGS	SW	I76	I80	NE	1341.0	25:07	2/03 @	8:36
186.0	I76		ARVADA	S	I70	I76	CO	1527.0	28:31	2/03 @	12:00
502.0	I70		COVE FORT	W	I15	I70	UT	2029.0	38:16	2/03 @	21:44
221.0	I15		GARNET		I15	X64	NV	2250.0	42:10	2/04 @	0:38
85.0	U93		HIKO	S	U93	S375	NV	2335.0	43:52	2/04 @	2:20
98.0	S375		WARM SPRINGS				NV	2433.0	45:49	2/04 @	4:18
50.0	U6		TONOPAH				NV	2483.0	47:19	2/04 @	5:48
146.0	U95		MERCURY	S	U95	LOCL	NV	2629.0	50:44	2/04 @	9:12
6.0	LOCAL		MERCURY				NV	2635.0	50:53	2/04 @	9:21

HIGHWAY ROUTES FROM INTERMODAL FACILITIES TO NTS

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From: BARSTOW          E  I15  S58  CA      Leaving :  9/16/98 at 16:47 PDT
to  : MERCURY          SW U95  S160 NV      Arriving:  9/16/98 at 20:19 PDT

   Routing through:
     .0                BARSTOW       E  I15  S58  CA      .0   0:00   9/16 @ 16:47
   60.0 I15            BAKER            I15  S127 CA    60.0   1:05   9/16 @ 17:53
   56.0 S127           SHOSHONE         S127 S178 CA   116.0   2:13   9/16 @ 19:00
   50.0 S127   S373    AMARGOSA VALLY   U95  S373 NV   166.0   3:13   9/16 @ 20:00
   16.0 U95            MERCURY       SW U95  S160 NV   182.0   3:32   9/16 @ 20:19


From: PANACA (modified bb)       NV      Leaving :  2/13/99 at 11:37 PST
to  : MERCURY(- 56 mi for calienteNV     Arriving:  2/13/99 at 19:17 PST

Routing through:
     .0                PANACA                     NV      .0   0:00   2/13 @ 11:37
   57.0 U93            HIKO          S  U93  S375 NV    57.0   1:08   2/13 @ 12:46
   98.0 S375           WARM SPRINGS               NV   155.0   3:06   2/13 @ 14:43
   50.0 U6             TONOPAH                    NV   205.0   4:06   2/13 @ 15:43
  146.0 U95            MERCURY       S  U95  LOCL NV   351.0   7:30   2/13 @ 19:08
    6.0 LOCAL          MERCURY                    NV   357.0   7:39   2/13 @ 19:17
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RAIL ROUTES FROM LLW GENERATORS TO BARSTOW

ROUTE FROM: BNSF 4219-LEMONT IL LENGTH: 2031.3 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 1625.0

RR	NODE	STATE	DIST
BNSF	4219-LEMONT	IL	0.
BNSF	4193-JOLIET	IL	12.
BNSF	4389-STREATOR	IL	64.
BNSF	4478-GALESBURG	IL	148.
BNSF	4491-LOMAX	IL	187.
BNSF	10380-FORT MADISON	IA	203.
BNSF	10501-BUCKLIN	MO	320.
BNSF	10560-CARROLLTON	MO	366.
BNSF	10561-NORBORNE	MO	375.
BNSF	10562-HARDIN	MO	384.
BNSF	10563-HENRIETTA	MO	390.
BNSF	10564-C A JCT	MO	398.
BNSF	15708-SHEFFIELD	MO	425.
BNSF	15709-KANSAS CTY UNION	MO	430.
BNSF	10624-OLATHE	KS	442.
BNSF	11816-EMPORIA	KS	525.
BNSF	11847-AUGUSTA	KS	600.
BNSF	11920-MULVANE	KS	622.
BNSF	11918-WELLINGTON	KS	639.
BNSF	11923-HARPER	KS	676.
BNSF	12206-AVARD	OK	740.
BNSF	12207-WAYNOKA	OK	750.
BNSF	12792-AMARILLO	TX	955.
BNSF	12793-CANYON	TX	972.
BNSF	12806-FARWELL	TX	1048.
BNSF	13025-CLOVIS	NM	1059.
BNSF	13024-VAUGHN	NM	1188.
BNSF	12995-BELEN	NM	1300.
BNSF	12996-DALIES	NM	1309.
BNSF	16077-GRANTS	NM	1369.
BNSF	12999-GALLUP	NM	1438.
BNSF	12949-HOLBROOK	AZ	1532.
BNSF	12945-WINSLOW	AZ	1568.
BNSF	12959-FLAGSTAFF	AZ	1627.
BNSF	12964-WILLIAMS	AZ	1656.
BNSF	12963-KINGMAN	AZ	1799.
BNSF	16320-NEEDLES	CA	1863.
BNSF	14664-BARSTOW	CA	2031.

ROUTE FROM: NYA 1154-CALVERTON NY LENGTH: 3078.4 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 3913.2

RR	NODE	STATE	DIST	
NYA	1154-CALVERTON	NY	0.	
NYA	1146-JAMAICA	NY	63.	
NYA	1156-FRESH POND JCT	NY	68.	
- - - -	- - - - - - - - - -	- - -	- - -	TRANSFER
CR	1156-FRESH POND JCT	NY	68.	
CR	1155-WINFIELD	NY	70.	
CR	1151-MELROSE JCT	NY	78.	
CR	1112-SPUYTEN DUYVIL	NY	83.	
CR	14914-POUGHKEEPSIE	NY	146.	
CR	701-CASTLETON ON HUD	NY	212.	
CR	700-SELKIRK	NY	217.	
CR	698-VOORHEESVILLE	NY	228.	
CR	706-SCHENECTADY	NY	239.	
CR	707-ROTTERDAM JCT	NY	246.	
CR	756-UTICA	NY	317.	
CR	755-ROME	NY	331.	
CR	777-SYRACUSE	NY	376.	
CR	780-SOLVAY	NY	379.	
CR	817-ROCHESTER	NY	455.	
CR	881-NIAGARA JCT	NY	505.	
CR	880-BUFFALO	NY	517.	
CR	938-DUNKIRK	NY	556.	
CR	942-WESTFIELD	NY	576.	
CR	968-ERIE	PA	606.	
CR	2652-CONNEAUT	OH	632.	
CR	2649-ASHTABULA	OH	646.	
CR	2727-PAINESVILLE	OH	672.	
CR	2728-CLEVELAND	OH	702.	
CR	2633-ELYRIA	OH	729.	
CR	14985-OAK HARBOR	OH	786.	
CR	3442-TOLEDO	OH	808.	
CR	3526-GOSHEN	IN	930.	
CR	3525-ELKHART	IN	940.	
CR	4022-SOUTH BEND	IN	955.	
CR	3969-LA PORTE	IN	981.	
CR	4067-PORTER	IN	1000.	
CR	4071-TOLLESTON	IN	1016.	
CR	4077-GIBSON	IN	1022.	
CR	4076-HAMMOND	IN	1025.	
CR	4228-BURNHAM / CALUME	IL	1027.	
CR	4223-DOLTON / RIVERDA	IL	1031.	
CR	4163-BLUE ISLAND	IL	1035.	
- - - -	- - - - - - - - - -	- - -	- - -	TRANSFER
IHB	4163-BLUE ISLAND	IL	1035.	
IHB	4172-ARGO	IL	1047.	

IHB	4170-LA GRANGE	IL	1051.

- TRANSFER

BNSF	4170-LA GRANGE	IL	1051.
BNSF	4190-AURORA	IL	1076.
BNSF	4478-GALESBURG	IL	1195.
BNSF	4491-LOMAX	IL	1234.
BNSF	10380-FORT MADISON	IA	1250.
BNSF	10501-BUCKLIN	MO	1367.
BNSF	10560-CARROLLTON	MO	1413.
BNSF	10561-NORBORNE	MO	1422.
BNSF	10562-HARDIN	MO	1431.
BNSF	10563-HENRIETTA	MO	1437.
BNSF	10564-C A JCT	MO	1445.
BNSF	15708-SHEFFIELD	MO	1472.
BNSF	15709-KANSAS CTY UNION	MO	1477.
BNSF	10624-OLATHE	KS	1489.
BNSF	11816-EMPORIA	KS	1572.
BNSF	11847-AUGUSTA	KS	1647.
BNSF	11920-MULVANE	KS	1669.
BNSF	11918-WELLINGTON	KS	1686.
BNSF	11923-HARPER	KS	1723.
BNSF	12206-AVARD	OK	1787.
BNSF	12207-WAYNOKA	OK	1797.
BNSF	12792-AMARILLO	TX	2002.
BNSF	12793-CANYON	TX	2019.
BNSF	12806-FARWELL	TX	2095.
BNSF	13025-CLOVIS	NM	2106.
BNSF	13024-VAUGHN	NM	2235.
BNSF	12995-BELEN	NM	2347.
BNSF	12996-DALIES	NM	2356.
BNSF	16077-GRANTS	NM	2416.
BNSF	12999-GALLUP	NM	2485.
BNSF	12949-HOLBROOK	AZ	2579.
BNSF	12945-WINSLOW	AZ	2615.
BNSF	12959-FLAGSTAFF	AZ	2674.
BNSF	12964-WILLIAMS	AZ	2703.
BNSF	12963-KINGMAN	AZ	2846.
BNSF	16320-NEEDLES	CA	2910.
BNSF	14664-BARSTOW	CA	3078.

ROUTE FROM: CSXT 3198-FERNALD OH LENGTH: 2339.4 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 2650.3

RR	NODE	STATE	DIST
CSXT	3198-FERNALD	OH	0.
CSXT	3692-COTTAGE GROVE	IN	23.
CSXT	3251-HAMILTON	OH	46.
CSXT	3234-IVORYDALE	OH	63.

CSXT	3228-CINCINNATI	OH	70.
CSXT	3718-SEYMOUR	IN	156.
CSXT	3824-MITCHELL	IN	198.
CSXT	3812-VINCENNES	IN	260.
CSXT	4952-SALEM	IL	338.
CSXT	10825-WASHINGTON PARK	IL	399.
CSXT	10879-NATIONAL STOCK Y	IL	402.
CSXT	10878-NATIONAL CITY	IL	404.
CSXT	10859-EAST ST LOUIS	IL	405.
- TRANSFER			
TRRA	10859-EAST ST LOUIS	IL	405.
TRRA	10878-NATIONAL CITY	IL	406.
TRRA	10880-MADISON	IL	410.
- TRANSFER			
BNSF	10880-MADISON	IL	410.
BNSF	10877-MERCHANTS BRIDGE	MO	412.
BNSF	10492-LOUISIANA	MO	499.
BNSF	10503-HANNIBAL	MO	523.
BNSF	10501-BUCKLIN	MO	628.
BNSF	10560-CARROLLTON	MO	674.
BNSF	10561-NORBORNE	MO	683.
BNSF	10562-HARDIN	MO	692.
BNSF	10563-HENRIETTA	MO	698.
BNSF	10564-C A JCT	MO	706.
BNSF	15708-SHEFFIELD	MO	733.
BNSF	15709-KANSAS CTY UNION	MO	738.
BNSF	10624-OLATHE	KS	750.
BNSF	11816-EMPORIA	KS	833.
BNSF	11847-AUGUSTA	KS	908.
BNSF	11920-MULVANE	KS	930.
BNSF	11918-WELLINGTON	KS	947.
BNSF	11923-HARPER	KS	984.
BNSF	12206-AVARD	OK	1048.
BNSF	12207-WAYNOKA	OK	1058.
BNSF	12792-AMARILLO	TX	1263.
BNSF	12793-CANYON	TX	1280.
BNSF	12806-FARWELL	TX	1356.
BNSF	13025-CLOVIS	NM	1367.
BNSF	13024-VAUGHN	NM	1496.
BNSF	12995-BELEN	NM	1608.
BNSF	12996-DALIES	NM	1617.
BNSF	16077-GRANTS	NM	1677.
BNSF	12999-GALLUP	NM	1746.
BNSF	12949-HOLBROOK	AZ	1840.
BNSF	12945-WINSLOW	AZ	1876.
BNSF	12959-FLAGSTAFF	AZ	1935.
BNSF	12964-WILLIAMS	AZ	1964.
BNSF	12963-KINGMAN	AZ	2107.
BNSF	16320-NEEDLES	CA	2171.

BNSF	14664-BARSTOW	CA	2339.

ROUTE FROM: UP 13336-SCOVILLE ID LENGTH: 1275.5 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 1500.8

RR	NODE	STATE	DIST
UP	13336-SCOVILLE	ID	0.
UP	13370-POCATELLO	ID	56.
UP	13369-MC CAMMON	ID	79.
UP	13568-OGDEN	UT	193.
UP	14795-WELLS	NV	362.
UP	14794-ALAZON	NV	366.
UP	14793-ELKO	NV	416.
UP	14792-CARLIN	NV	436.
UP	14791-BEOWAWE	NV	461.
UP	14813-WINNEMUCCA	NV	545.
UP	14812-HAZEN	NV	679.
UP	14816-SPARKS	NV	711.
UP	14821-RENO	NV	726.
UP	14415-ROSEVILLE	CA	843.
UP	14411-SACRAMENTO	CA	858.
UP	14499-STOCKTON	CA	902.
UP	14498-LATHROP	CA	911.
UP	14529-MODESTO	CA	938.
UP	14570-FRESNO	CA	1036.
UP	14607-GOSHEN JCT	CA	1066.
UP	14622-BAKERSFIELD	CA	1141.
UP	14621-MOJAVE	CA	1206.
UP	14664-BARSTOW	CA	1276.
- TRANSFER			
BNSF	14664-BARSTOW	CA	1276.

ROUTE FROM: BNSF 13028-ALBUQUERQUE NM LENGTH: 765.4 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 617.70

RR	NODE	STATE	DIST
BNSF	13028-ALBUQUERQUE	NM	0.
BNSF	12995-BELEN	NM	34.
BNSF	12996-DALIES	NM	43.
BNSF	16077-GRANTS	NM	103.
BNSF	12999-GALLUP	NM	172.
BNSF	12949-HOLBROOK	AZ	266.
BNSF	12945-WINSLOW	AZ	302.
BNSF	12959-FLAGSTAFF	AZ	361.
BNSF	12964-WILLIAMS	AZ	390.
BNSF	12963-KINGMAN	AZ	533.

BNSF	16320-NEEDLES	CA	597.
BNSF	14664-BARSTOW	CA	765.

ROUTE FROM: UP 14473-LIVERMORE CA LENGTH: 401.0 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 626.56

RR	NODE	STATE	DIST	
UP	14473-LIVERMORE	CA	0.	
UP	14495-LYOTH	CA	26.	
UP	14498-LATHROP	CA	36.	
UP	14529-MODESTO	CA	63.	
UP	14570-FRESNO	CA	161.	
UP	14607-GOSHEN JCT	CA	191.	
UP	14622-BAKERSFIELD	CA	266.	
UP	14621-MOJAVE	CA	331.	
UP	14664-BARSTOW	CA	401.	
- - - -	- - - - - - - - - -	- - -	- - -	TRANSFER
BNSF	14664-BARSTOW	CA	401.	

ROUTE FROM: CR 3185-MIAMISBURG OH LENGTH: 2453.6 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 2665.3

RR	NODE	STATE	DIST	
CR	3185-MIAMISBURG	OH	0.	
CR	3282-DAYTON	OH	12.	
CR	3300-SPRINGFIELD	OH	33.	
CR	14993-COLUMBUS (BUCKEY	OH	75.	
CR	3340-SIDNEY	OH	167.	
CR	3650-MUNCIE	IN	231.	
CR	3662-ANDERSON	IN	249.	
CR	3738-INDIANAPOLIS	IN	278.	
CR	3884-GREENCASTLE	IN	316.	
CR	3863-TERRE HAUTE	IN	348.	
CR	4787-EFFINGHAM	IL	419.	
CR	4951-ST ELMO	IL	437.	
CR	10825-WASHINGTON PARK	IL	511.	
- - - -	- - - - - - - - - -	- - -	- - -	TRANSFER
<TR>	10825-WASHINGTON PARK	IL	511.	
<TR>	10867-VINER	IL	518.	
<TR>	10827-VALLEY JCT	IL	519.	
<TR>	10859-EAST ST LOUIS	IL	521.	
<TR>	10858-ST LOUIS	MO	522.	
- - - -	- - - - - - - - - -	- - -	- - -	TRANSFER
BNSF	10858-ST LOUIS	MO	522.	
BNSF	10840-EADS BRIDGE	MO	523.	
BNSF	10877-MERCHANTS BRIDGE	MO	526.	
BNSF	10492-LOUISIANA	MO	613.	

BNSF	10503-HANNIBAL	MO	637.
BNSF	10501-BUCKLIN	MO	742.
BNSF	10560-CARROLLTON	MO	788.
BNSF	10561-NORBORNE	MO	797.
BNSF	10562-HARDIN	MO	806.
BNSF	10563-HENRIETTA	MO	812.
BNSF	10564-C A JCT	MO	820.
BNSF	15708-SHEFFIELD	MO	847.
BNSF	15709-KANSAS CTY UNION	MO	852.
BNSF	10624-OLATHE	KS	864.
BNSF	11816-EMPORIA	KS	947.
BNSF	11847-AUGUSTA	KS	1022.
BNSF	11920-MULVANE	KS	1045.
BNSF	11918-WELLINGTON	KS	1062.
BNSF	11923-HARPER	KS	1099.
BNSF	12206-AVARD	OK	1162.
BNSF	12207-WAYNOKA	OK	1172.
BNSF	12792-AMARILLO	TX	1377.
BNSF	12793-CANYON	TX	1394.
BNSF	12806-FARWELL	TX	1470.
BNSF	13025-CLOVIS	NM	1481.
BNSF	13024-VAUGHN	NM	1610.
BNSF	12995-BELEN	NM	1722.
BNSF	12996-DALIES	NM	1731.
BNSF	16077-GRANTS	NM	1791.
BNSF	12999-GALLUP	NM	1860.
BNSF	12949-HOLBROOK	AZ	1954.
BNSF	12945-WINSLOW	AZ	1990.
BNSF	12959-FLAGSTAFF	AZ	2049.
BNSF	12964-WILLIAMS	AZ	2078.
BNSF	12963-KINGMAN	AZ	2221.
BNSF	16320-NEEDLES	CA	2285.
BNSF	14664-BARSTOW	CA	2454.

ROUTE FROM: NS 15316-K 25 TN LENGTH: 2337.6 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 2608.3

RR	NODE	STATE	DIST
NS	15316-K 25	TN	0.
NS	7260-HARRIMAN	TN	15.
NS	7259-ROCKWOOD	TN	20.
NS	7233-CITICO JCT.	TN	87.
NS	7235-CHATTANOOGA	TN	94.
NS	7224-WAUHATCHIE	TN	99.
NS	8791-HUNTSVILLE	AL	185.
NS	8786-DECATUR	AL	209.
NS	8768-TUSCUMBIA	AL	261.
NS	8846-CORINTH	MS	303.

NS	17475-NS FORREST YARD	TN	392.

- TRANSFER

BNSF	17475-NS FORREST YARD	TN	392.
BNSF	17482-NS UP CROSSING	TN	395.
BNSF	17483-BN UP CROSSING	TN	395.
BNSF	18042-MEMPHIS	TN	397.
BNSF	7153-BRIDGE JCT	AR	400.
BNSF	7150-TURRELL	AR	418.
BNSF	9377-NETTLETON	AR	457.
BNSF	9376-JONESBORO	AR	461.
BNSF	9375-HOXIE	AR	483.
BNSF	10673-TEED	MO	672.
BNSF	10674-SPRINGFIELD	MO	675.
BNSF	10675-SPRINGFIELD YARD	MO	679.
BNSF	10712-AURORA	MO	706.
BNSF	10715-NEOSHO	MO	751.
BNSF	12037-AFTON	OK	791.
BNSF	12041-VINITA	OK	803.
BNSF	12034-CLAREMORE	OK	841.
BNSF	12033-TULSA PT AUTHORI	OK	852.
BNSF	12016-TULSA	OK	867.
BNSF	12195-BLACK BEAR	OK	944.
BNSF	12196-PERRY	OK	950.
BNSF	12202-ENID	OK	984.
BNSF	12206-AVARD	OK	1046.
BNSF	12207-WAYNOKA	OK	1056.
BNSF	12792-AMARILLO	TX	1261.
BNSF	12793-CANYON	TX	1278.
BNSF	12806-FARWELL	TX	1354.
BNSF	13025-CLOVIS	NM	1365.
BNSF	13024-VAUGHN	NM	1494.
BNSF	12995-BELEN	NM	1606.
BNSF	12996-DALIES	NM	1615.
BNSF	16077-GRANTS	NM	1675.
BNSF	12999-GALLUP	NM	1744.
BNSF	12949-HOLBROOK	AZ	1838.
BNSF	12945-WINSLOW	AZ	1874.
BNSF	12959-FLAGSTAFF	AZ	1933.
BNSF	12964-WILLIAMS	AZ	1962.
BNSF	12963-KINGMAN	AZ	2105.
BNSF	16320-NEEDLES	CA	2169.
BNSF	14664-BARSTOW	CA	2338.

ROUTE FROM: BNSF 13653-PINE CLIFF CO LENGTH: 1271.3 MILES
TO: BNSF 14664-BARSTOW CA POTENTIAL: 1214.8

RR	NODE	STATE	DIST
BNSF	13653-PINE CLIFF	CO	0.

BNSF	16175-NORTH YARD	CO	30.
BNSF	13727-DENVER	CO	33.
BNSF	13760-COLORADO SPRINGS	CO	107.
BNSF	13764-PUEBLO	CO	151.
BNSF	13777-WALSENBURG	CO	204.
BNSF	13750-TRINIDAD	CO	239.
BNSF	16080-LAS VEGAS	NM	374.
BNSF	13028-ALBUQUERQUE	NM	506.
BNSF	12995-BELEN	NM	540.
BNSF	12996-DALIES	NM	549.
BNSF	16077-GRANTS	NM	609.
BNSF	12999-GALLUP	NM	678.
BNSF	12949-HOLBROOK	AZ	772.
BNSF	12945-WINSLOW	AZ	808.
BNSF	12959-FLAGSTAFF	AZ	867.
BNSF	12964-WILLIAMS	AZ	896.
BNSF	12963-KINGMAN	AZ	1039.
BNSF	16320-NEEDLES	CA	1103.
BNSF	14664-BARSTOW	CA	1271.

RAIL ROUTES FROM LLW GENERATORS TO CALIENTE

ROUTE FROM: BNSF 4219-LEMONT IL LENGTH: 1835.9 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 2230.7

RR	NODE	STATE	DIST
BNSF	4219-LEMONT	IL	0.
BNSF	4193-JOLIET	IL	12.
BNSF	4389-STREATOR	IL	64.
BNSF	4478-GALESBURG	IL	148.
BNSF	10381-BURLINGTON	IA	190.
BNSF	10373-OTTUMWA	IA	265.
BNSF	10367-ALBIA	IA	289.
BNSF	10443-CRESTON	IA	381.
BNSF	10435-PACIFIC JCT	IA	463.
BNSF	11537-OREAPOLIS	NE	472.
BNSF	11470-ASHLAND	NE	497.
BNSF	11504-LINCOLN	NE	520.
BNSF	11479-FAIRMONT	NE	575.
BNSF	11405-HASTINGS	NE	616.
BNSF	11348-MC COOK	NE	744.
BNSF	13706-BRUSH	CO	941.
BNSF	13722-COMMERCE CITY	CO	1021.
BNSF	13727-DENVER	CO	1026.
- TRANSFER			
UP	13727-DENVER	CO	1026.
UP	16175-NORTH YARD	CO	1029.
UP	13674-ORESTOD	CO	1155.
UP	13673-DOTSERO	CO	1193.
UP	13645-GLENWOOD SPRINGS	CO	1211.
UP	13646-GRAND JCT	CO	1301.
UP	13613-THISTLE	UT	1506.
UP	13611-SPRINGVILLE	UT	1520.
UP	13610-PROVO	UT	1525.
UP	13630-LYNNDYL	UT	1629.
UP	14770-CALIENTE	NV	1836.
- TRANSFER			
USG	14770-CALIENTE	NV	1836.

ROUTE FROM: NYA 1154-CALVERTON NY LENGTH: 2844.9 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 3979.7

RR	NODE	STATE	DIST
NYA	1154-CALVERTON	NY	0.
NYA	1146-JAMAICA	NY	63.
NYA	1156-FRESH POND JCT	NY	68.
- TRANSFER			

CR	1156-FRESH POND JCT	NY	68.
CR	1155-WINFIELD	NY	70.
CR	1151-MELROSE JCT	NY	78.
CR	1112-SPUYTEN DUYVIL	NY	83.
CR	14914-POUGHKEEPSIE	NY	146.
CR	701-CASTLETON ON HUD	NY	212.
CR	700-SELKIRK	NY	217.
CR	698-VOORHEESVILLE	NY	228.
CR	706-SCHENECTADY	NY	239.
CR	707-ROTTERDAM JCT	NY	246.
CR	756-UTICA	NY	317.
CR	755-ROME	NY	331.
CR	777-SYRACUSE	NY	376.
CR	780-SOLVAY	NY	379.
CR	817-ROCHESTER	NY	455.
CR	881-NIAGARA JCT	NY	505.
CR	880-BUFFALO	NY	517.
CR	938-DUNKIRK	NY	556.
CR	942-WESTFIELD	NY	576.
CR	968-ERIE	PA	606.
CR	2652-CONNEAUT	OH	632.
CR	2649-ASHTABULA	OH	646.
CR	2727-PAINESVILLE	OH	672.
CR	2728-CLEVELAND	OH	702.
CR	2633-ELYRIA	OH	729.
CR	14985-OAK HARBOR	OH	786.
CR	3442-TOLEDO	OH	808.
CR	3526-GOSHEN	IN	930.
CR	3525-ELKHART	IN	940.
CR	4022-SOUTH BEND	IN	955.
CR	3969-LA PORTE	IN	981.
CR	4067-PORTER	IN	1000.
CR	4071-TOLLESTON	IN	1016.
CR	4077-GIBSON	IN	1022.
CR	4076-HAMMOND	IN	1025.
CR	4228-BURNHAM / CALUME	IL	1027.
CR	4223-DOLTON / RIVERDA	IL	1031.
CR	4163-BLUE ISLAND	IL	1035.
- TRANSFER			
IHB	4163-BLUE ISLAND	IL	1035.
IHB	4172-ARGO	IL	1047.
IHB	4234-PROVISO	IL	1058.
- TRANSFER			
UP	4234-PROVISO	IL	1058.
UP	4214-WEST CHICAGO	IL	1073.
UP	4311-DE KALB	IL	1100.
UP	4324-NELSON	IL	1145.
UP	10304-CLINTON	IA	1180.
UP	10289-CEDAR RAPIDS	IA	1262.

UP	10265-MARSHALLTOWN	IA	1331.
UP	10246-NEVADA	IA	1358.
UP	10271-AMES	IA	1369.
UP	10177-ARION	IA	1467.
UP	10176-MISSOURI VALLEY	IA	1503.
UP	10198-CALIFORNIA JCT	IA	1509.
UP	11340-FREMONT	NE	1537.
UP	11473-CENTRAL CITY	NE	1624.
UP	11406-GRAND ISLAND	NE	1646.
UP	11410-GIBBON	NE	1672.
UP	11352-NORTH PLATTE	NE	1791.
UP	11358-O FALLONS	NE	1802.
UP	13703-JULESBURG	CO	1870.
UP	11287-SIDNEY	NE	1913.
UP	13465-CHEYENNE	WY	2016.
UP	13462-LARAMIE	WY	2068.
UP	13494-GRANGER	WY	2344.
UP	13568-OGDEN	UT	2487.
UP	13595-SALT LAKE CITY	UT	2523.
UP	13594-GARFIELD	UT	2535.
UP	13630-LYNNDYL	UT	2638.
UP	14770-CALIENTE	NV	2845.
- TRANSFER			
USG	14770-CALIENTE	NV	2845.

ROUTE FROM: CSXT 3198-FERNALD OH LENGTH: 2164.8 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 2775.7

RR	NODE	STATE	DIST
CSXT	3198-FERNALD	OH	0.
CSXT	3692-COTTAGE GROVE	IN	23.
CSXT	3251-HAMILTON	OH	46.
CSXT	3234-IVORYDALE	OH	63.
CSXT	3228-CINCINNATI	OH	70.
CSXT	3718-SEYMOUR	IN	156.
CSXT	3824-MITCHELL	IN	198.
CSXT	3812-VINCENNES	IN	260.
CSXT	4952-SALEM	IL	338.
CSXT	10825-WASHINGTON PARK	IL	399.
CSXT	10879-NATIONAL STOCK Y	IL	402.
CSXT	10878-NATIONAL CITY	IL	404.
CSXT	10859-EAST ST LOUIS	IL	405.
- TRANSFER			
TRRA	10859-EAST ST LOUIS	IL	405.
- TRANSFER			
UP	10859-EAST ST LOUIS	IL	405.
UP	10858-ST LOUIS	MO	406.
UP	10875-GRAND AVE (ST LO	MO	409.

UP	10860-PACIFIC	MO	433.
UP	10656-JEFFERSON CITY	MO	531.
UP	10659-MARSHALL	MO	623.
UP	15708-SHEFFIELD	MO	703.
UP	15709-KANSAS CTY UNION	MO	708.
UP	10617-KANSAS CITY	KS	709.
UP	11823-LAWRENCE	KS	748.
UP	11697-TOPEKA	KS	778.
UP	11696-MENOKEN	KS	783.
UP	11681-MARYSVILLE	KS	858.
UP	11487-ENDICOTT	NE	890.
UP	11405-HASTINGS	NE	966.
UP	11410-GIBBON	NE	992.
UP	11352-NORTH PLATTE	NE	1111.
UP	11358-O FALLONS	NE	1122.
UP	13703-JULESBURG	CO	1190.
UP	11287-SIDNEY	NE	1233.
UP	13465-CHEYENNE	WY	1336.
UP	13462-LARAMIE	WY	1388.
UP	13494-GRANGER	WY	1664.
UP	13568-OGDEN	UT	1807.
UP	13595-SALT LAKE CITY	UT	1843.
UP	13594-GARFIELD	UT	1855.
UP	13630-LYNNDYL	UT	1958.
UP	14770-CALIENTE	NV	2165.
- TRANSFER			
USG	14770-CALIENTE	NV	2165.

ROUTE FROM: UP 13336-SCOVILLE ID LENGTH: 550.1 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 845.60

RR	NODE	STATE	DIST
UP	13336-SCOVILLE	ID	0.
UP	13370-POCATELLO	ID	56.
UP	13369-MC CAMMON	ID	79.
UP	13568-OGDEN	UT	193.
UP	13595-SALT LAKE CITY	UT	228.
UP	13594-GARFIELD	UT	240.
UP	13630-LYNNDYL	UT	343.
UP	14770-CALIENTE	NV	550.
- TRANSFER			
USG	14770-CALIENTE	NV	550.

ROUTE FROM: BNSF 13028-ALBUQUERQUE NM LENGTH: 1284.5 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 1982.0

RR	NODE	STATE	DIST
BNSF	13028-ALBUQUERQUE	NM	0.
BNSF	16080-LAS VEGAS	NM	132.
BNSF	13750-TRINIDAD	CO	267.
BNSF	13777-WALSENBURG	CO	302.
BNSF	16186-PUEBLO JCT	CO	355.
BNSF	13760-COLORADO SPRINGS	CO	398.
BNSF	13727-DENVER	CO	475.
- - - - - -	- - - - - - - - -	- - -	- - - - TRANSFER
UP	13727-DENVER	CO	475.
UP	16175-NORTH YARD	CO	478.
UP	13674-ORESTOD	CO	604.
UP	13673-DOTSERO	CO	642.
UP	13645-GLENWOOD SPRINGS	CO	660.
UP	13646-GRAND JCT	CO	750.
UP	13613-THISTLE	UT	955.
UP	13611-SPRINGVILLE	UT	969.
UP	13610-PROVO	UT	974.
UP	13630-LYNNDYL	UT	1078.
UP	14770-CALIENTE	NV	1284.
- - - - - -	- - - - - - - - -	- - -	- - - - TRANSFER
USG	14770-CALIENTE	NV	1284.

ROUTE FROM: UP 14473-LIVERMORE CA LENGTH: 1086.0 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 1222.4

RR	NODE	STATE	DIST
UP	14473-LIVERMORE	CA	0.
UP	14495-LYOTH	CA	26.
UP	14498-LATHROP	CA	36.
UP	14499-STOCKTON	CA	45.
UP	14411-SACRAMENTO	CA	88.
UP	14415-ROSEVILLE	CA	103.
UP	14821-RENO	NV	220.
UP	14816-SPARKS	NV	235.
UP	14812-HAZEN	NV	268.
UP	14813-WINNEMUCCA	NV	402.
UP	14791-BEOWAWE	NV	482.
UP	14792-CARLIN	NV	506.
UP	14793-ELKO	NV	526.
UP	14794-ALAZON	NV	577.
UP	14795-WELLS	NV	581.
UP	14797-SHAFTER	NV	627.
UP	13594-GARFIELD	UT	776.
UP	13630-LYNNDYL	UT	879.

UP	14770-CALIENTE	NV	1086.
- TRANSFER			
USG	14770-CALIENTE	NV	1086.

ROUTE FROM: CR 3185-MIAMISBURG OH LENGTH: 2245.8 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 2772.3

RR	NODE	STATE	DIST
CR	3185-MIAMISBURG	OH	0.
CR	3282-DAYTON	OH	12.
CR	3300-SPRINGFIELD	OH	33.
CR	14993-COLUMBUS (BUCKEY	OH	75.
CR	3006-FINDLAY	OH	165.
CR	3446-WALBRIDGE	OH	207.
CR	3442-TOLEDO	OH	210.
CR	3526-GOSHEN	IN	332.
CR	3525-ELKHART	IN	342.
CR	4022-SOUTH BEND	IN	357.
CR	3969-LA PORTE	IN	383.
CR	4067-PORTER	.IN	402.
CR	4069-MILLER	IN	413.
CR	4070-GARY	IN	418.
CR	4073-CLARKE	IN	422.
CR	4074-INDIANA HARBOR	IN	425.
CR	4035-WHITING LAKE FRO	IN	428.
CR	4232-SOUTH CHICAGO	IL	432.
CR	4217-CHICAGO	IL	445.
- TRANSFER			
UP	4217-CHICAGO	IL	445.
UP	4234-PROVISO	IL	459.
UP	4214-WEST CHICAGO	IL	474.
UP	4311-DE KALB	IL	501.
UP	4324-NELSON	IL	546.
UP	10304-CLINTON	IA	581.
UP	10289-CEDAR RAPIDS	IA	663.
UP	10265-MARSHALLTOWN	IA	732.
UP	10246-NEVADA	IA	759.
UP	10271-AMES	IA	770.
UP	10177-ARION	IA	868.
UP	10176-MISSOURI VALLEY	IA	904.
UP	10198-CALIFORNIA JCT	IA	910.
UP	11340-FREMONT	NE	938.
UP	11473-CENTRAL CITY	NE	1025.
UP	11406-GRAND ISLAND	NE	1047.
UP	11410-GIBBON	NE	1073.
UP	11352-NORTH PLATTE	NE	1192.
UP	11358-O FALLONS	NE	1203.
UP	13703-JULESBURG	CO	1271.

UP	11287-SIDNEY	NE	1314.
UP	13465-CHEYENNE	WY	1417.
UP	13462-LARAMIE	WY	1469.
UP	13494-GRANGER	WY	1745.
UP	13568-OGDEN	UT	1888.
UP	13595-SALT LAKE CITY	UT	1924.
UP	13594-GARFIELD	UT	1936.
UP	13630-LYNNDYL	UT	2039.
UP	14770-CALIENTE	NV	2246.
- TRANSFER			
USG	14770-CALIENTE	NV	2246.

ROUTE FROM: NS 15316-K 25 TN LENGTH: 2289.6 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 2794.1

RR	NODE	STATE	DIST
NS	15316-K 25	TN	0.
NS	7260-HARRIMAN	TN	15.
NS	6979-DANVILLE	KY	177.
NS	7008-LOUISVILLE	KY	277.
NS	7009-JEFFERSONVILLE	IN	281.
NS	3821-HUNTINGBURG	IN	355.
NS	3815-OAKLAND CITY	IN	379.
NS	3813-PRINCETON	IN	392.
NS	4797-MOUNT CARMEL	IL	406.
NS	4954-MOUNT VERNON	IL	469.
NS	4953-CENTRALIA	IL	491.
NS	10867-VINER	IL	549.
NS	10827-VALLEY JCT	IL	551.
NS	10879-NATIONAL STOCK Y	IL	554.
NS	10880-MADISON	IL	558.
NS	10877-MERCHANTS BRIDGE	MO	560.
NS	10493-MEXICO	MO	662.
NS	10494-CENTRALIA	MO	677.
NS	10468-CLARK	MO	688.
NS	10498-MOBERLY	MO	700.
NS	10560-CARROLLTON	MO	766.
NS	10561-NORBORNE	MO	775.
NS	10562-HARDIN	MO	784.
NS	10563-HENRIETTA	MO	790.
NS	10564-C A JCT	MO	798.
NS	15707-BIRMINGHAM	MO	822.
NS	10616-KANSAS CITY	MO	832.
- TRANSFER			
UP	10616-KANSAS CITY	MO	832.
UP	10617-KANSAS CITY	KS	834.
UP	11823-LAWRENCE	KS	872.
UP	11697-TOPEKA	KS	902.

UP	11696-MENOKEN	KS	907.
UP	11681-MARYSVILLE	KS	982.
UP	11487-ENDICOTT	NE	1014.
UP	11405-HASTINGS	NE	1090.
UP	11410-GIBBON	NE	1116.
UP	11352-NORTH PLATTE	NE	1235.
UP	11358-O FALLONS	NE	1247.
UP	13703-JULESBURG	CO	1315.
UP	11287-SIDNEY	NE	1358.
UP	13465-CHEYENNE	WY	1461.
UP	13462-LARAMIE	WY	1513.
UP	13494-GRANGER	WY	1789.
UP	13568-OGDEN	UT	1932.
UP	13595-SALT LAKE CITY	UT	1967.
UP	13594-GARFIELD	UT	1980.
UP	13630-LYNNDYL	UT	2083.
UP	14770-CALIENTE	NV	2290.

- TRANSFER

USG	14770-CALIENTE	NV	2290.

ROUTE FROM: UP 13653-PINE CLIFF CO LENGTH: 776.7 MILES
TO: USG 14770-CALIENTE NV POTENTIAL: 921.36

RR	NODE	STATE	DIST
UP	13653-PINE CLIFF	CO	0.
UP	13674-ORESTOD	CO	96.
UP	13673-DOTSERO	CO	134.
UP	13645-GLENWOOD SPRINGS	CO	152.
UP	13646-GRAND JCT	CO	242.
UP	13613-THISTLE	UT	447.
UP.	13611-SPRINGVILLE	UT	461.
UP	13610-PROVO	UT	466.
UP	13630-LYNNDYL	UT	570.
UP	14770-CALIENTE	NV	777.

- TRANSFER

USG	14770-CALIENTE	NV	777.

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APPENDIX B

SELECTED DETAILED RESULTS OF TRANSPORTATION RISK ANALYSIS - RESULTS SORTED FIRST BY STATE AND THEN BY SITE

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APPENDIX B

SELECTED DETAILED REUSLTS OF TRANSPORTATION RISK ANALYSIS – RESULTS SORTED FIRST BY STATE AND THEN BY SITE

This appendix contains raw output data from the RADTRAN 4 risk analyses performed for the various shipping configuration options and waste loading cases in this study. The data that is provided in this appendix includes a summary table of the total risks for the specified shipping campaign (e.g., total risks for transporting all LLW by truck to NTS via routes that avoid Las Vegas). In addition, a table of detailed state-level risk information is provided for each shipping configuration. In these tables, the results are first sorted by the state in which they occur and then by the LLW generator site that is shipping the LLW through the specified state. In Appendix C, the results are first sorted by LLW generator and then the impacts in each state along the transportation corridor between the LLW generator and the NTS are presented.

This appendix is organized as follows:

Example RADTRAN 4 output file

High Waste Volume Case Results

B.1 High Volume Rail Transport to Barstow
B.2 High Volume Truck Transport from Barstow to NTS
B.3 High Volume Rail Transport to Caliente
B.4 High Volume Truck Transport from Caliente to NTS
B.5 High Volume Truck Transport from Generators to NTS – Avoid Las Vegas
B.6 High Volume Truck Transport to NTS –Travel Through Las Vegas

Low Waste Volume Case Results

B.7 Low Volume Rail Transport to Barstow
B.8 Low Volume Truck Transport from Barstow to NTS
B.9 Low Volume Rail Transport to Caliente
B.10 Low Volume Truck Transport from Caliente to NTS
B.11 Low Volume Truck Transport to NTS – Avoid Las Vegas
B.12 Low Volume Truck Transport to NTS – Travel Through Las Vegas

Note that the rail transportation impact results in this appendix do not include the non-linear component of the rail impacts. The non-linear component accounts for marshalling of the cars at the beginning and end of the trip (it is part of the doses at stops in each case. To account for this, a worker dose component equal to 3.25E-03 person-rem/shipment and a public component of 2.11E-03 person-rem/shipment were added to each rail shipment. These are per shipment numbers; half can be attributed to the originating state and the other half to the destination state. The non-linear dose component is included in the summary tables in Chapter 5.

The table below summarizes the route segments included in the calculation of life-cycle risks for each shipping configuration. Note that the risks for the intermodal shipping configurations include the risks of transporting LLW by truck from small generator sites to the NTS, either though or avoiding Las Vegas. The direct truck shipment risks in the intermodal configurations were extracted from the output files for truck transport from all LLW generators to NTS.

High LLW Volume Case						
Configuration	Truck from LLW Generators to NTS	Rail from LLW Generators to Intermodal Facility*		Truck from Intermodal Facility to NTS*		Intermodal Transfer Operations
		Barstow	Caliente	Barstow	Caliente	
1A	Table B.5 (small generators)	Table B.1		Tale B.2		See Section 5.1.2
1B	Table B.5 (small generators)		Table B.3		Table B.4	See Section 5.1.2
2	Table B.5 (all generators)					
3	Table B.6 (all generators)					
Low LLW Volume Case						
1A	Table B.11 (small generators)	Table B.7		Table B.8		See Section 5.1.2
1B	Table B.11 (small generators)		Table B.9		Table B.10	See Section 5.1.2
2	Table B.11 (all generators)					
3	Table B.12 (all generators)					

* Also include non-linear component of public and crew doses to account for marshalling of the shipment at the origin and destination railyards.

To calculate the total risks of a shipping configuration, the components shown above are added together. The following example was prepared to illustrate the calculation process.

Example: Calculate incident-free risks to workers for transportation within the State of Nevada for Configuration 1B, Intermodal at Caliente.

This example was chosen because it illustrates most of the calculations performed to estimate the total risks in a single state. All of the components of the total state-level risk are non-zero in this example. For the Barstow, CA, intermodal configurations, worker risks for the intermodal transfer and rail marshalling/inspection components in Nevada are zero because the activities do not occur in Nevada.

The risk components that are included in this calculation, the sources of component-level risk results, and supplemental calculations leading to the risk estimate within Nevada are shown below. Detailed spreadsheets were developed to automate the calculations.

Example Calculation – Worker Risks in Nevada for High Waste Volume/Configuration 1B		
Component	**Source of Data/Calculation**	**Result (Fatalities)**
Truck transport from small generators to NTS via routes that avoid Las Vegas.	*Find entry for NV, "Small Generators," in Table B.5.* This is the sum of the incident-free crew risks (3rd column) for shipments from WVDP, BCL, Knolls (SPRU), SNL, PGDP, ETEC, ITRI, PORT, PPPL, Pantex, LBNL, Ames, GJPO, and GE-Val.	1.90E-03
Rail transport from large generators to Caliente.	*Find entry for NV in Table B.3.* The "state total" entry in column 3 for NV is taken directly from the table.	1.07E-03
Truck transport from Caliente to NTS.	*Find entry for Nevada in Table B.4.* As shown in the table, all transport from Caliente to NTS is within NV. Therefore, the "state total" entry is taken directly from column 3 of the table.	3.87E-02
Marshalling, inspection.	*This calculation was performed external to the RADTRAN code.* This component is the product of the number of rail shipments (see Table B.3) and the risk per shipment, as follows: Risk = (6.5E-07 fatalities/rail shipment) * (8622 rail shipments) = 5.60E-03 fatalities.	5.60E-03
Intermodal transfer.	*This calculation was performed external to the RADTRAN code.* This component is the product of the number of containers handled (same as the number of truck shipments from Caliente to NTS – see Table B.4) and the risk per shipment, as follows: Risk = (1.36E-07 fatalities/container) * (25,858 truck shipments) = 3.52E-03 fatalities	3.52E-03
TOTAL	*Add together the five components of worker risk in Nevada.*	**5.1E-02** (See NV entry in Table 5.20)

The following is an excerpt from the RADTRAN 4 output file that was developed for this study. Only the input echo, incident-free and accident risk output pages are presented. Intermediate results are not included.

```
RRRR     AAA    DDDD    TTTTT  RRRR     AAA    N    N
R    R  A    A  D    D    T    R    R  A    A  NN   N
R    R  A    A  D    D    T    R    R  A    A  N N  N
RRRR    A    A  D    D    T    RRRR    A    A  N   NN
R R     AAAAA   D    D    T    R R     AAAAA   N    N
R   R   A    A  D    D    T    R   R   A    A  N    N
R    R  A    A  DDDD      T    R    R  A    A  N    N

                           4
                       4   4
                       4   4
                       44444
                           4
                           4
                           4
```

RADTRAN 4.0.19 VERSION DATE: NOVEMBER 14, 1996

MODE DESCRIPTIONS

NUMBER	NAME	CHARACTERIZATION
1	TRUCK	LONG HAUL VEHICLE
2	RAIL	COMMERCIAL TRAIN
3	BARGE	INLAND VESSEL
4	SHIP	OPEN SEA VESSEL
5	CARGO AIR	CARGO AIRCRAFT
6	PASS AIR	PASSENGER AIRCRAFT
7	P-VAN	PASSENGER VAN
8	CVAN-T	COMMERCIAL VAN
9	CVAN-R	COMMERCIAL VAN
10	CVAN-CA	COMMERCIAL VAN

ECHO CHECK

```
&& RADTRAN4 "risk factors" for truck transport, file 3, 1/25/94 bb
&& 3/7/94 bb  25 people at rest stops 6/15/95 bb RH-106m; Ra-226 5/11/98 bb
&& 12/10/98 last 8 nuclides added
 FORM UNIT
 DIMEN 22   6   1  10  18
 PARM    1   3   3   4   1
 POPDEN       1    1    1
 PACKAGE
    LABGRP
       GRP3
 SHIPMENT
    LABISO
       H-3       C-14      P-32      S-35     KR-85      MN-54  CO-58 FE-59
       ZN-65     I-125     RH-106m   RA-226   PA-234     CF-252
       BI-210    BI-214    CF-249    CF-250   PB-210     PB-214
       PO-210    RN-222
 NORMAL
    NMODE=1
      1.00E+00 0.00E+00 0.00E+00 88.49    40.25    24.16
      2.00E+00 4.3      0.00E+00 1.10E-02 0.00E+00 0.00E+00
      0.00E+00 2.50E+01 2.00E+01 0.00E+00 0.00E+00 1.00E+02
      2.00E+00 1.00E-01 5.00E-02 1.00E+00 4.70E+02 7.80E+02
      2.80E+03
 ACCIDENT
    ARATMZ
      NMODE=1   1.00E+00   1.00E+00   1.00E+00
    SEVFRC
      NPOP=1
        NMODE=1
        1.000+00 0.00E+00 0.00E+00 0.00E+00 0.000+00 0.00E+00
    SEVFRC
      NPOP=2
        NMODE=1
        1.000+00 0.00E+00 0.00E+00 0.00E+00 0.000+00 0.00E+00
    SEVFRC
      NPOP=3
        NMODE=1
        1.000+00 0.00E+00 0.00E+00 0.00E+00 0.000+00 0.00E+00
 RELEASE
    RFRAC
      GROUP=1
        1.000+00 1.00E+00 1.00E+00 1.00E+00 1.000+00 1.00E+00
    AERSOL
      DISP=2
        1.000+00 1.00E+00 1.00E+00 1.00E+00 1.000+00 1.00E+00
    RESP
      DISP=2
        1.000+00 1.00E+00 1.00E+00 1.00E+00 1.000+00 1.00E+00
    PSPROB
        0.00E+00 0.00E+00 0.00E+00 1.00E+00 0.00E+00 0.00E+00
```

Note that many of the input parameter values are set equal to 1.0 or 0.0. This is done because many of the parameters (e.g., accident rates, conditional probabilities, aerosol fraction, dose rate, and number of shipments) are applied external to RADTRAN 4 to model the actual shipments. This simplifies the RADTRAN 4 calculations. For more information on this approach, the reader is referred to Biwer et al. (1994).

```
OTHER
   BDF    8.60E-03
   XFARM  4.40E-01
   CULVL  1.00E+10
   BRATE  3.30E-04
DEFINE H-3
   4.51E+03 0.00E+00 0.00E+00 6.30E+01 6.30E+01
   1.00E+00 0.00E+00 1.00E-02 2 0.00E+00 0.00E+00
DEFINE C-14
   2.09E+06 0.00E+00 0.00E+00 2.40E+01 0.00E+00
   1.00E+00 0.00E+00 1.00E-02 2 0.00E+00 0.00E+00
DEFINE P-32
   1.43E+01 0.00E+00 0.00E+00 1.30E+04 8.10E+03
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE S-35
   8.74E+01 0.00E+00 0.00E+00 2.30E+03 6.50E+02
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE KR-85
   3.92E+03 2.21E-03 3.55E-04 0.00E+00 0.00E+00
   1.00E+00 0.00E+00 1.00E-02 2 0.00E+00 0.00E+00
DEFINE MN-54
   3.13E+02 8.35E-01 1.39E-01 6.40E+03 2.70E+03
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE CO-58
   7.08E+01 9.75E-01 1.60E-01 7.10E+03 3.50E+03
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE FE-59
   4.45E+01 1.19E+00 1.96E-01 1.50E+04 6.60E+03
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE ZN-65
   2.44E+02 5.84E-01 9.57E-02 1.80E+04 1.40E+04
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE I-125
   6.01E+01 4.20E-02 1.77E-03 2.40E+04 3.80E+04
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE RH-106m
   3.46E-04 2.91E+00 3.33E-02 2.0E+02 6.1E+02
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE RA-226
   5.84E+05 6.74E-03 1.17E-03 7.9E+06 1.1E+06
   1.00E+00 0.00E+00 1.00E-02 3 0.00E+00 0.00E+00
DEFINE PA-234
   2.79E-01   1.75E+00   3.24E-01   7.40E+02   2.10E+03
   1.00E+00   0.00E+00   1.00E-02   1 0.00E+00   0.00E+00
DEFINE CF-252
   9.64E+02   1.20E-03   1.19E-05   1.30E+08   9.40E+05
   1.00E+00   0.00E+00   1.00E-02   3 0.00E+00   0.00E+00
DEFINE  BI-210
  5.01E+00 0.00E+00 1.22E-04 1.96E+05 6.40E+03
  1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
DEFINE  BI-214
   1.38E-02 1.51E+00 2.83E-01 6.59E+03 2.83E+02
   1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
```

```
 DEFINE  CF-249
    1.28E+05 3.35E-01 5.85E-02 5.77E+08 4.74E+06
    1.00E+00 0.00E+00 1.00E-02 3 0.00E+00 0.00E+00
 DEFINE  CF-250
    4.78E+03 1.20E-03 1.67E-05 2.62E+08 2.13E+06
    1.00E+00 0.00E+00 1.00E-02 3 0.00E+00 0.00E+00
 DEFINE  PB-210
    8.15E+03 4.80E-03 2.09E-04 1.36E+07 5.37E+06
    1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
 DEFINE  PB-214
    1.86E-02 2.50E-01 4.37E-02 7.81E+03 6.25E+02
    1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
 DEFINE  PO-210
    1.38E+02 0.00E+00 1.54E-06 9.40E+06 1.90E+06
    1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
 DEFINE  RN-222
    3.82E+00 3.00E-04 7.07E-05 0.00E+00 0.00E+00
    1.00E+00 0.00E+00 1.00E-02 1 0.00E+00 0.00E+00
EOF
 ISOTOPES  1 1.00E+00 1.00E+00 1.00E+00 1.00E+00 0.00E+00 HLW
    H-3      1.00E+00 GRP3 2
    C-14     1.00E+00 GRP3 2
    P-32     1.00E+00 GRP3 2
    S-35     1.00E+00 GRP3 2
    KR-85    1.00E+00 GRP3 2
    MN-54    1.00E+00 GRP3 2
    CO-58    1.00E+00 GRP3 2
    FE-59    1.00E+00 GRP3 2
    ZN-65    1.00E+00 GRP3 2
    I-125    1.00E+00 GRP3 2
    RH-106m  1.00E+00 GRP3 2
    RA-226   1.00E+00 GRP3 2
    PA-234   1.00E+00 GRP3 2
    CF-252   1.00E+00 GRP3 2
    BI-210   1.00E+00 GRP3 2
    BI-214   1.00E+00 GRP3 2
    CF-249   1.00E+00 GRP3 2
    CF-250   1.00E+00 GRP3 2
    PB-210   1.00E+00 GRP3 2
    PB-214   1.00E+00 GRP3 2
    PO-210   1.00E+00 GRP3 2
    RN-222   1.00E+00 GRP3 2
 DISTKM
    NMODE=1 1.0
 PKGSIZ
    HLW      3.00
 EOF
```

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

	PASSENGR	CREW	HANDLERS	OFF LINK	ON LINK	STOPS	STORAGE	TOTALS
LINK 1	0.00E+00	7.70E-06	0.00E+00	1.47E-09	3.59E-07	4.30E-06	0.00E+00	1.24E-05
TOTALS:	0.00E+00	7.70E-06	0.00E+00	1.47E-09	3.59E-07	4.30E-06	0.00E+00	1.24E-05

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 2.39E-08 REM

INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY FOR LINK 1
****

INDEX	DESCRIPTION OF PARAMETER	IMPORTANCE
1	DISTANCE TRAVELED	1.236E-07
2	PACKAGES PER SHIPMENT	1.236E-07
3	DOSE RATE (TRANSPORT INDEX)	1.236E-07
4	K ZERO	1.236E-07
5	NUMBER OF SHIPMENTS	1.236E-07
6	FRACTION OF TRAVEL - RURAL	8.062E-08
7	NUMBER OF CREW MEMBERS	7.701E-08
8	PERSONS EXPOSED WHILE STOPPED	4.297E-08
9	STOP TIME	4.297E-08
10	FRACTION OF TRAVEL ON FREEWAYS	3.607E-09
11	TRAFFIC COUNT - RURAL	3.592E-09
12	NUMBER OF PEOPLE PER VEHICLE	3.592E-09
13	POPULATION DENSITY - RURAL	1.469E-11
14	STORAGE EXPOSURE DISTANCE	0.000E+00
15	NUMBER OF HANDLINGS	0.000E+00
16	EXPOSURE TIME FOR HANDLERS	0.000E+00
17	PERSONS EXPOSED PER HANDLING	0.000E+00
18	NUMBER OF FLIGHT ATTENDANTS	0.000E+00
19	TRAFFIC COUNT - URBAN	0.000E+00
20	TRAFFIC COUNT - SUBURBAN	0.000E+00
21	HANDLER EXPOSURE DISTANCE	0.000E+00
22	NUMBER OF PERSONS EXPOSED DURING STORAGE	0.000E+00
23	STORAGE TIME PER SHIPMENT	0.000E+00
24	SUBURBAN SHIELDING FACTOR (RS)	0.000E+00
25	VELOCITY - SUBURBAN	0.000E+00
26	POPULATION DENSITY - SUBURBAN	0.000E+00
27	FRACTION OF TRAVEL - SUBURBAN	0.000E+00
28	RATIO OF PEDESTRIAN DENSITY (RPD)	0.000E+00
29	FRACTION OF TRAVEL - URBAN	0.000E+00
30	POPULATION DENSITY - URBAN	0.000E+00
31	URBAN SHIELDING FACTOR (RU)	0.000E+00
32	FRACTION OF TRAVEL ON CITY STREETS	0.000E+00
33	VELOCITY - URBAN	0.000E+00
34	RURAL SHIELDING FACTOR (RR)	0.000E+00
35	FRACTION OF RUSH HOUR TRAVEL	-2.831E-17
36	VELOCITY - RURAL	-8.421E-08
37	EXPOSURE DISTANCE WHILE STOPPED	-8.594E-08
38	DISTANCE FROM SOURCE TO CREW	-1.540E-07

THE IMPORTANCE VALUE ESTIMATES THE PERSON-REM INFLUENCE
OF A ONE PERCENT INCREASE IN THE PARAMETER

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

	GROUND	INHALED	RESUSPD	CLOUDSH	*INGESTION	TOTAL
HLW						
H-3	0.00E+00	1.05E-06	4.44E-06	0.00E+00	2.56E+01	2.56E+01
C-14	0.00E+00	4.01E-07	1.83E-06	0.00E+00	0.00E+00	2.23E-06
P-32	0.00E+00	2.17E-04	3.73E-05	0.00E+00	3.29E+03	3.29E+03
S-35	0.00E+00	3.84E-05	3.38E-05	0.00E+00	2.64E+02	2.64E+02
KR-85	5.47E-04	0.00E+00	0.00E+00	1.80E-08	0.00E+00	5.47E-04
MN-54	2.84E-02	1.07E-04	2.25E-04	7.04E-06	1.10E+03	1.10E+03
CO-58	9.42E-03	1.19E-04	8.77E-05	8.10E-06	1.42E+03	1.42E+03
FE-59	7.25E-03	2.51E-04	1.24E-04	9.93E-06	2.68E+03	2.68E+03
ZN-65	1.64E-02	3.01E-04	5.49E-04	4.85E-06	5.69E+03	5.69E+03
I-125	3.46E-04	4.01E-04	2.58E-04	8.96E-08	1.54E+04	1.54E+04
RH-106m	1.80E-07	3.34E-06	1.43E-11	1.69E-06	2.48E+02	2.48E+02
RA-226	4.80E-03	1.32E-01	6.02E-01	5.93E-08	4.47E+05	4.47E+05
PA-234	7.98E-05	1.24E-05	4.30E-08	1.64E-05	8.54E+02	8.54E+02
CF-252	9.73E-05	2.17E+00	7.17E+00	6.03E-10	3.82E+05	3.82E+05
BI-210	0.00E+00	3.28E-03	2.02E-04	6.18E-09	2.60E+03	2.60E+03
BI-214	3.72E-06	1.10E-04	1.89E-08	1.43E-05	1.15E+02	1.15E+02
CF-249	2.30E-01	9.64E+00	4.39E+01	2.96E-06	1.93E+06	1.93E+06
CF-250	3.42E-04	4.38E+00	1.85E+01	8.46E-10	8.66E+05	8.66E+05
PB-210	1.88E-03	2.27E-01	9.92E-01	1.06E-08	2.18E+06	2.18E+06
PB-214	8.29E-07	1.31E-04	3.03E-08	2.21E-06	2.54E+02	2.54E+02
PO-210	0.00E+00	1.57E-01	1.96E-01	7.80E-11	7.72E+05	7.72E+05
RN-222	6.62E-08	0.00E+00	0.00E+00	3.58E-09	0.00E+00	6.98E-08
TOTALS:	3.00E-01	1.67E+01	7.14E+01	6.77E-05	6.61E+06	6.61E+06

* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

Table B.1 RADTRAN 4 Results - High Volume Rail Transport To Barstow

Expected Fatalities for the Shipping Campaign

Exposure Group	Rail
Radiological	
Normal Crew	4.2E-02
Normal Public	5.1E-02
Accident Public	4.9E-06
Nonradiological	
Emission	1.0E-01
Accident	4.1E+00

Note: Results are given in abbreviated scientific notation. For example, 4.2E-02 = $4.2x10^{-2}$ = 0.042.

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Rail							
AL							
	Oak Ridge Reserv.	3283	9.89E-04	1.49E-03	5.40E-08	2.34E-03	1.32E-01
	State Total	3283	9.89E-04	1.49E-03	5.40E-08	2.34E-03	1.32E-01
AZ							
	Oak Ridge Reserv.	3283	2.41E-03	1.91E-03	2.17E-08	3.16E-03	3.23E-01
	Los Alamos NL	1277	9.38E-04	7.44E-04	8.42E-09	1.23E-03	1.25E-01
	Fernald (FEMP)	1046	7.69E-04	6.09E-04	6.90E-09	1.01E-03	1.03E-01
	Rocky Flats Plant	814	5.98E-04	4.74E-04	5.37E-09	7.83E-04	8.00E-02
	Mound Plant	803	5.90E-04	4.68E-04	5.29E-09	7.73E-04	7.89E-02
	Brookhaven NL	446	3.28E-04	2.60E-04	2.94E-09	4.29E-04	4.38E-02
	Argonne - East	176	1.29E-04	1.03E-04	1.16E-09	1.69E-04	1.73E-02
	State Total	7845	5.77E-03	4.57E-03	5.17E-08	7.55E-03	7.71E-01
AR							
	Oak Ridge Reserv.	3283	8.62E-04	8.37E-04	1.22E-07	8.24E-04	1.15E-01
	State Total	3283	8.62E-04	8.37E-04	1.22E-07	8.24E-04	1.15E-01
CA							
	Oak Ridge Reserv.	3283	1.12E-03	6.06E-04	7.19E-08	1.37E-04	1.50E-01
	Los Alamos NL	1277	4.37E-04	2.36E-04	2.80E-08	5.34E-05	5.84E-02
	Fernald (FEMP)	1046	3.58E-04	1.93E-04	2.29E-08	4.38E-05	4.78E-02
	Rocky Flats Plant	814	2.78E-04	1.50E-04	1.78E-08	3.41E-05	3.72E-02
	Mound Plant	803	2.75E-04	1.48E-04	1.76E-08	3.36E-05	3.67E-02
	Lawrence Livermore	466	3.52E-04	1.26E-03	6.09E-08	5.44E-03	4.70E-02
	Brookhaven NL	446	1.52E-04	8.23E-05	9.76E-09	1.87E-05	2.04E-02
	INEL	311	3.14E-04	1.35E-03	6.13E-08	5.79E-03	4.20E-02
	Argonne - East	176	6.02E-05	3.25E-05	3.85E-09	7.36E-06	8.04E-03
	State Total	8622	3.35E-03	4.06E-03	2.94E-07	1.16E-02	4.48E-01

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
CO							
	Rocky Flats Plant	814	4.04E-04	1.38E-03	5.28E-08	5.35E-03	5.40E-02
	State Total	814	4.04E-04	1.38E-03	5.28E-08	5.35E-03	5.40E-02
GA							
	Oak Ridge Reserv.	3283	1.67E-05	8.77E-06	5.44E-10	0.00E+00	2.23E-03
	State Total	3283	1.67E-05	8.77E-06	5.44E-10	0.00E+00	2.23E-03
ID							
	INEL	311	7.49E-05	9.26E-05	8.31E-09	3.12E-04	1.00E-02
	State Total	311	7.49E-05	9.26E-05	8.31E-09	3.12E-04	1.00E-02
IL							
	Fernald (FEMP)	1046	2.98E-04	5.73E-04	5.20E-07	1.36E-03	3.99E-02
	Mound Plant	803	2.51E-04	4.34E-04	4.48E-07	1.18E-03	3.35E-02
	Brookhaven NL	446	1.87E-04	9.18E-04	3.30E-07	4.12E-03	2.50E-02
	Argonne - East	176	6.63E-05	8.97E-05	1.22E-07	1.91E-04	8.86E-03
	State Total	2471	8.02E-04	2.01E-03	1.42E-06	6.85E-03	1.07E-01
IN							
	Fernald (FEMP)	1046	3.72E-04	4.19E-04	2.27E-07	7.44E-04	4.98E-02
	Mound Plant	803	2.37E-04	9.39E-04	1.23E-07	3.19E-03	3.18E-02
	Brookhaven NL	446	1.24E-04	6.65E-04	7.03E-08	2.69E-03	1.66E-02
	State Total	2295	7.34E-04	2.02E-03	4.20E-07	6.62E-03	9.81E-02
IA							
	Brookhaven NL	446	1.85E-05	1.25E-05	2.26E-08	0.00E+00	2.47E-03
	Argonne - East	176	7.29E-06	4.95E-06	8.94E-09	0.00E+00	9.75E-04
	State Total	622	2.58E-05	1.75E-05	3.16E-08	0.00E+00	3.44E-03
KS							
	Fernald (FEMP)	1046	5.56E-04	7.64E-04	1.69E-07	2.14E-03	7.44E-02
	Mound Plant	803	4.27E-04	5.87E-04	1.30E-07	1.65E-03	5.71E-02
	Brookhaven NL	446	2.37E-04	3.26E-04	7.20E-08	9.14E-04	3.17E-02
	Argonne - East	176	9.36E-05	1.29E-04	2.84E-08	3.61E-04	1.25E-02
	State Total	2471	1.31E-03	1.80E-03	3.99E-07	5.07E-03	1.76E-01
MS							
	Oak Ridge Reserv.	3283	1.97E-04	1.91E-04	4.45E-08	0.00E+00	2.64E-02
	State Total	3283	1.97E-04	1.91E-04	4.45E-08	0.00E+00	2.64E-02
MO							
	Oak Ridge Reserv.	3283	1.51E-03	1.65E-03	2.18E-07	2.47E-03	2.02E-01
	Fernald (FEMP)	1046	6.42E-04	8.92E-04	9.57E-08	2.49E-03	8.59E-02
	Mound Plant	803	4.99E-04	7.32E-04	7.53E-08	2.05E-03	6.67E-02
	Brookhaven NL	446	1.75E-04	1.93E-04	2.50E-08	4.85E-04	2.34E-02
	Argonne - East	176	6.89E-05	7.62E-05	9.87E-09	1.91E-04	9.22E-03
	State Total	5754	2.89E-03	3.54E-03	4.24E-07	7.69E-03	3.87E-01
NV							
	INEL	311	2.57E-04	2.66E-04	8.05E-10	7.03E-04	3.44E-02
	State Total	311	2.57E-04	2.66E-04	8.05E-10	7.03E-04	3.44E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
NM							
	Oak Ridge Reserv.	3283	2.54E-03	1.52E-03	1.01E-08	9.62E-04	3.39E-01
	Los Alamos NL	1277	4.64E-04	2.94E-04	2.09E-09	2.14E-04	6.21E-02
	Fernald (FEMP)	1046	8.08E-04	4.83E-04	3.22E-09	3.06E-04	1.08E-01
	Rocky Flats Plant	814	6.67E-04	4.28E-04	2.83E-09	4.09E-04	8.92E-02
	Mound Plant	803	6.20E-04	3.71E-04	2.47E-09	2.35E-04	8.29E-02
	Brookhaven NL	446	3.44E-04	2.06E-04	1.37E-09	1.31E-04	4.60E-02
	Argonne - East	176	1.36E-04	8.13E-05	5.42E-10	5.16E-05	1.82E-02
	State Total	7845	5.57E-03	3.38E-03	2.26E-08	2.31E-03	7.45E-01
NY							
	Brookhaven NL	446	4.90E-04	3.46E-03	5.95E-07	1.25E-02	6.55E-02
	State Total	446	4.90E-04	3.46E-03	5.95E-07	1.25E-02	6.55E-02
OH							
	Fernald (FEMP)	1046	1.41E-04	9.81E-04	4.43E-08	3.63E-03	1.88E-02
	Mound Plant	803	3.01E-04	1.22E-03	8.58E-08	4.40E-03	4.02E-02
	Brookhaven NL	446	2.07E-04	1.30E-03	5.92E-08	5.00E-03	2.77E-02
	State Total	2295	6.49E-04	3.51E-03	1.89E-07	1.30E-02	8.68E-02
OK							
	Oak Ridge Reserv.	3283	2.19E-03	2.70E-03	2.91E-07	5.36E-03	2.93E-01
	Fernald (FEMP)	1046	2.32E-04	1.14E-04	2.32E-08	0.00E+00	3.10E-02
	Mound Plant	803	1.78E-04	8.79E-05	1.78E-08	0.00E+00	2.38E-02
	Brookhaven NL	446	9.90E-05	4.88E-05	9.88E-09	0.00E+00	1.32E-02
	Argonne - East	176	3.91E-05	1.93E-05	3.90E-09	0.00E+00	5.22E-03
	State Total	5754	2.74E-03	2.97E-03	3.45E-07	5.36E-03	3.66E-01
PA							
	Brookhaven NL	446	3.90E-05	2.85E-04	2.18E-08	1.25E-03	5.21E-03
	State Total	446	3.90E-05	2.85E-04	2.18E-08	1.25E-03	5.21E-03
TN							
	Oak Ridge Reserv.	3283	1.26E-03	3.82E-03	1.98E-07	1.18E-02	1.68E-01
	State Total	3283	1.26E-03	3.82E-03	1.98E-07	1.18E-02	1.68E-01
TX							
	Oak Ridge Reserv.	3283	1.35E-03	1.32E-03	1.40E-07	1.10E-03	1.80E-01
	Fernald (FEMP)	1046	4.29E-04	4.20E-04	4.47E-08	3.50E-04	5.74E-02
	Mound Plant	803	3.29E-04	3.22E-04	3.43E-08	2.69E-04	4.40E-02
	Brookhaven NL	446	1.83E-04	1.79E-04	1.90E-08	1.49E-04	2.45E-02
	Argonne - East	176	7.22E-05	7.06E-05	7.52E-09	5.89E-05	9.65E-03
	State Total	5754	2.36E-03	2.31E-03	2.46E-07	1.93E-03	3.16E-01
UT							
	INEL	311	1.00E-04	5.79E-05	1.56E-09	0.00E+00	1.34E-02
	State Total	311	1.00E-04	5.79E-05	1.56E-09	0.00E+00	1.34E-02
	Mode Totals		3.09E-02	4.21E-02	4.94E-06	1.03E-01	4.13E+00

Table B.2 RADTRAN 4 Results - High Volume Truck Transport From Barstow To NTS

accident rate for primary highways in NV
alternate route files used

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	2.6E-02
Normal Public	4.0E-02
Accident Public	4.9E-07
Nonradiological	
Emission	5.8E-03
Accident	1.5E-01

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
CA							
	Barstow, CA	25858	1.99E-02	3.09E-02	4.86E-07	5.83E-03	8.91E-02
	State Total	25858	1.99E-02	3.09E-02	4.86E-07	5.83E-03	8.91E-02
NV							
	Barstow, CA	25858	5.90E-03	9.15E-03	7.37E-09	0.00E+00	6.39E-02
	State Total	25858	5.90E-03	9.15E-03	7.37E-09	0.00E+00	6.39E-02
	Mode Totals		2.58E-02	4.00E-02	4.94E-07	5.83E-03	1.53E-01

Table B.3 RADTRAN 4 Results - High Volume Rail Transport To Caliente

Expected Fatalities for the Shipping Campaign

Exposure Group	Rail
Radiological	
Normal Crew	4.2E-02
Normal Public	6.1E-02
Accident Public	9.3E-06
Nonradiological	
Emission	1.4E-01
Accident	4.1E+00

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Rail							
CA							
	Lawrence Livermore	466	1.82E-04	1.22E-03	4.94E-08	5.42E-03	2.43E-02
	State Total	466	1.82E-04	1.22E-03	4.94E-08	5.42E-03	2.43E-02
CO							
	Oak Ridge Reserv.	3283	6.18E-05	5.23E-05	3.21E-09	0.00E+00	8.26E-03
	Los Alamos NL	1277	1.30E-03	2.49E-03	1.11E-07	7.37E-03	1.73E-01
	Fernald (FEMP)	1046	1.97E-05	1.67E-05	1.02E-09	0.00E+00	2.63E-03
	Rocky Flats Plant	814	4.20E-04	3.33E-04	2.14E-08	2.38E-04	5.61E-02
	Mound Plant	803	1.51E-05	1.28E-05	7.84E-10	0.00E+00	2.02E-03
	Brookhaven NL	446	8.40E-06	7.11E-06	4.36E-10	0.00E+00	1.12E-03
	Argonne - East	176	1.59E-04	2.15E-04	1.03E-08	6.04E-04	2.12E-02
	State Total	7845	1.98E-03	3.13E-03	1.48E-07	8.22E-03	2.65E-01
ID							
	INEL	311	7.49E-05	9.68E-05	8.31E-09	3.12E-04	1.00E-02
	State Total	311	7.49E-05	9.68E-05	8.31E-09	3.12E-04	1.00E-02
IL							
	Oak Ridge Reserv.	3283	9.71E-04	2.74E-03	1.72E-06	9.48E-03	1.30E-01
	Fernald (FEMP)	1046	2.86E-04	5.29E-04	5.04E-07	1.18E-03	3.83E-02
	Mound Plant	803	2.28E-04	2.74E-03	4.05E-07	1.16E-02	3.05E-02
	Brookhaven NL	446	1.28E-04	1.02E-03	2.08E-07	4.57E-03	1.72E-02
	Argonne - East	176	5.99E-05	9.51E-05	1.11E-07	2.43E-04	8.01E-03
	State Total	5754	1.67E-03	7.12E-03	2.95E-06	2.71E-02	2.24E-01
IN							
	Oak Ridge Reserv.	3283	7.60E-04	1.03E-03	4.76E-07	2.34E-03	1.02E-01
	Fernald (FEMP)	1046	3.72E-04	4.40E-04	2.27E-07	7.44E-04	4.98E-02
	Mound Plant	803	2.24E-04	9.79E-04	1.25E-07	3.49E-03	3.00E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Brookhaven NL	446	1.24E-04	6.72E-04	7.03E-08	2.69E-03	1.66E-02
	State Total	5578	1.48E-03	3.12E-03	8.98E-07	9.26E-03	1.98E-01
IA							
	Mound Plant	803	5.08E-04	1.15E-03	6.60E-07	3.63E-03	6.80E-02
	Brookhaven NL	446	2.82E-04	6.38E-04	3.67E-07	2.02E-03	3.78E-02
	Argonne - East	176	9.47E-05	1.40E-04	1.27E-07	3.17E-04	1.27E-02
	State Total	1425	8.86E-04	1.93E-03	1.15E-06	5.96E-03	1.18E-01
KS							
	Oak Ridge Reserv.	3283	1.07E-03	1.07E-03	3.24E-07	1.65E-03	1.43E-01
	Fernald (FEMP)	1046	3.42E-04	3.48E-04	1.04E-07	5.25E-04	4.58E-02
	State Total	4329	1.41E-03	1.42E-03	4.28E-07	2.17E-03	1.89E-01
KY							
	Oak Ridge Reserv.	3283	1.25E-03	2.49E-03	1.23E-07	8.65E-03	1.68E-01
	State Total	3283	1.25E-03	2.49E-03	1.23E-07	8.65E-03	1.68E-01
MO							
	Oak Ridge Reserv.	3283	1.69E-03	3.55E-03	2.79E-07	1.10E-02	2.26E-01
	Fernald (FEMP)	1046	5.95E-04	1.40E-03	1.02E-07	4.64E-03	7.95E-02
	State Total	4329	2.29E-03	4.95E-03	3.81E-07	1.56E-02	3.06E-01
NE							
	Oak Ridge Reserv.	3283	2.49E-03	1.86E-03	1.10E-06	1.51E-03	3.33E-01
	Fernald (FEMP)	1046	7.94E-04	5.92E-04	3.50E-07	4.81E-04	1.06E-01
	Mound Plant	803	6.82E-04	6.63E-04	2.99E-07	1.01E-03	9.13E-02
	Brookhaven NL	446	3.79E-04	3.68E-04	1.66E-07	5.60E-04	5.07E-02
	Argonne - East	176	1.28E-04	1.49E-04	5.62E-08	3.53E-04	1.71E-02
	State Total	5754	4.48E-03	3.63E-03	1.97E-06	3.91E-03	5.99E-01
NV							
	Oak Ridge Reserv.	3283	2.55E-04	1.33E-04	5.84E-11	0.00E+00	3.41E-02
	Los Alamos NL	1277	9.93E-05	5.16E-05	2.27E-11	0.00E+00	1.33E-02
	Fernald (FEMP)	1046	8.13E-05	4.23E-05	1.86E-11	0.00E+00	1.09E-02
	Rocky Flats Plant	814	6.33E-05	3.29E-05	1.45E-11	0.00E+00	8.46E-03
	Mound Plant	803	6.24E-05	3.25E-05	1.43E-11	0.00E+00	8.35E-03
	Lawrence Livermore	466	4.40E-04	4.48E-04	1.21E-09	1.05E-03	5.89E-02
	Brookhaven NL	446	3.47E-05	1.80E-05	7.93E-12	0.00E+00	4.64E-03
	INEL	311	2.42E-05	1.26E-05	5.53E-12	0.00E+00	3.23E-03
	Argonne - East	176	1.37E-05	7.12E-06	3.13E-12	0.00E+00	1.83E-03
	State Total	8622	1.07E-03	7.77E-04	1.36E-09	1.05E-03	1.44E-01
NM							
	Los Alamos NL	1277	5.82E-04	4.00E-04	2.27E-09	3.74E-04	7.79E-02
	State Total	1277	5.82E-04	4.00E-04	2.27E-09	3.74E-04	7.79E-02
NY							
	Brookhaven NL	446	4.90E-04	3.49E-03	5.95E-07	1.25E-02	6.55E-02
	State Total	446	4.90E-04	3.49E-03	5.95E-07	1.25E-02	6.55E-02

This value used in example calculation on page B.2

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
OH							
	Fernald (FEMP)	1046	1.41E-04	9.89E-04	4.43E-08	3.63E-03	1.88E-02
	Mound Plant	803	4.22E-04	1.70E-03	1.16E-07	5.85E-03	5.64E-02
	Brookhaven NL	446	2.07E-04	1.31E-03	5.92E-08	5.00E-03	2.77E-02
	State Total	2295	7.70E-04	4.01E-03	2.19E-07	1.45E-02	1.03E-01
PA							
	Brookhaven NL	446	3.90E-05	2.87E-04	2.18E-08	1.25E-03	5.21E-03
	State Total	446	3.90E-05	2.87E-04	2.18E-08	1.25E-03	5.21E-03
TN							
	Oak Ridge Reserv.	3283	4.75E-04	4.04E-04	3.82E-08	1.37E-04	6.35E-02
	State Total	3283	4.75E-04	4.04E-04	3.82E-08	1.37E-04	6.35E-02
UT							
	Oak Ridge Reserv.	3283	2.41E-03	3.76E-03	1.46E-07	1.18E-02	3.22E-01
	Los Alamos NL	1277	1.11E-03	8.24E-04	2.22E-08	6.95E-04	1.48E-01
	Fernald (FEMP)	1046	7.67E-04	1.20E-03	4.67E-08	3.76E-03	1.03E-01
	Rocky Flats Plant	814	7.07E-04	5.25E-04	1.41E-08	4.43E-04	9.45E-02
	Mound Plant	803	5.89E-04	9.19E-04	3.58E-08	2.89E-03	7.87E-02
	Lawrence Livermore	466	3.31E-04	1.83E-04	2.52E-09	0.00E+00	4.42E-02
	Brookhaven NL	446	3.27E-04	5.11E-04	1.99E-08	1.60E-03	4.37E-02
	INEL	311	2.23E-04	3.25E-04	1.32E-08	9.24E-04	2.98E-02
	Argonne - East	176	1.53E-04	1.14E-04	3.05E-09	9.57E-05	2.04E-02
	State Total	8622	6.61E-03	8.36E-03	3.04E-07	2.22E-02	8.84E-01
WY							
	Oak Ridge Reserv.	3283	2.71E-03	1.92E-03	2.98E-08	2.20E-03	3.62E-01
	Fernald (FEMP)	1046	8.64E-04	6.10E-04	9.46E-09	7.00E-04	1.15E-01
	Mound Plant	803	6.63E-04	4.68E-04	7.26E-09	5.38E-04	8.86E-02
	Brookhaven NL	446	3.68E-04	2.60E-04	4.03E-09	2.99E-04	4.92E-02
	State Total	5578	4.60E-03	3.25E-03	5.05E-08	3.73E-03	6.16E-01
	Mode Totals		3.04E-02	5.01E-02	9.34E-06	1.42E-01	4.06E+00

Table B.4 RADTRAN 4 Results - High Volume Truck Transport From Caliente To NTS

accident rate for primary highways in NV
alternate route files used

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	3.9E-02
Normal Public	6.0E-02
Accident Public	5.9E-08
Nonradiological	
Emission	0.0E+00
Accident	4.2E-01

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
NV							
	Caliente, NV	25858	3.87E-02	5.99E-02	5.89E-08	0.00E+00	4.18E-01
	State Total	25858	3.87E-02	5.99E-02	5.89E-08	0.00E+00	4.18E-01
	Mode Totals		3.87E-02	5.99E-02	5.89E-08	0.00E+00	4.18E-01

This value used in example calculation on page B.2

Table B.5 RADTRAN 4 Results - High Volume Truck Transport From Generators To NTS - Avoid Las Vegas

accident rate for primary highways in NV
alternate route files used

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	2.9E-01
Normal Public	4.2E-01
Accident Public	1.9E-05
Nonradiological	
Emission	2.1E-01
Accident	1.8E+00

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
AZ							
	Oak Ridge Reserv.	9848	1.90E-02	2.85E-02	1.30E-07	5.39E-03	1.09E-01
	Los Alamos NL	3829	7.38E-03	1.11E-02	5.04E-08	2.10E-03	4.25E-02
	Fernald (FEMP)	3137	6.05E-03	9.09E-03	4.13E-08	1.72E-03	3.48E-02
	Rocky Flats Plant	2441	3.52E-04	5.46E-04	1.20E-09	0.00E+00	2.15E-03
	Mound Plant	2409	4.65E-03	6.98E-03	3.17E-08	1.32E-03	2.67E-02
	Brookhaven NL	1338	1.93E-04	2.99E-04	6.57E-10	0.00E+00	1.18E-03
	Argonne - East	526	7.59E-05	1.18E-04	2.58E-10	0.00E+00	4.63E-04
	West Valley DP	424	6.12E-05	9.49E-05	2.08E-10	0.00E+00	3.73E-04
	Battelle Columbus	345	6.65E-04	9.99E-04	4.54E-09	1.89E-04	3.83E-03
	Knolls Atomic	309	4.46E-05	6.91E-05	1.52E-10	0.00E+00	2.72E-04
	SNL - Albuquerque	191	3.68E-04	5.53E-04	2.51E-09	1.05E-04	2.12E-03
	Paducah GDP	165	3.18E-04	4.78E-04	2.17E-09	9.03E-05	1.83E-03
	ITRI	87	1.68E-04	2.52E-04	1.15E-09	4.76E-05	9.66E-04
	Portsmouth GDP	77	1.48E-04	2.23E-04	1.01E-09	4.21E-05	8.55E-04
	Princeton PPL	74	1.43E-04	2.14E-04	9.74E-10	4.05E-05	8.22E-04
	Pantex Plant	53	1.02E-04	1.53E-04	6.98E-10	2.90E-05	5.89E-04
	Ames Laboratory	5	7.21E-07	1.12E-06	2.45E-12	0.00E+00	4.40E-06
	Grand Junction PO	3	4.33E-07	6.71E-07	1.47E-12	0.00E+00	2.64E-06
	State Total	25261	3.97E-02	5.97E-02	2.69E-07	1.11E-02	2.29E-01
	Small Generators	1733	2.02E-03	3.04E-03	1.34E-08	5.44E-04	1.17E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
AR							
	Oak Ridge Reserv.	9848	1.65E-02	2.25E-02	4.30E-07	2.22E-03	5.58E-02
	State Total	9848	1.65E-02	2.25E-02	4.30E-07	2.22E-03	5.58E-02
	Small Generators	0					
CA							
	Oak Ridge Reserv.	9848	1.55E-02	2.36E-02	3.93E-07	3.17E-03	6.81E-02
	Los Alamos NL	3829	6.04E-03	9.19E-03	1.53E-07	1.23E-03	2.65E-02
	Fernald (FEMP)	3137	4.95E-03	7.53E-03	1.25E-07	1.01E-03	2.17E-02
	Mound Plant	2409	3.80E-03	5.78E-03	9.62E-08	7.75E-04	1.67E-02
	Lawrence Livermore	1397	3.83E-03	5.82E-03	9.64E-08	2.07E-03	1.65E-02
	Battelle Columbus	345	5.44E-04	8.28E-04	1.38E-08	1.11E-04	2.38E-03
	SNL - Albuquerque	191	3.01E-04	4.58E-04	7.63E-09	6.15E-05	1.32E-03
	Paducah GDP	165	2.60E-04	3.96E-04	6.59E-09	5.31E-05	1.14E-03
	ETEC	128	2.95E-04	4.73E-04	9.15E-09	2.03E-03	8.53E-04
	ITRI	87	1.37E-04	2.09E-04	3.47E-09	2.80E-05	6.01E-04
	Portsmouth GDP	77	1.21E-04	1.85E-04	3.07E-09	2.48E-05	5.32E-04
	Princeton PPL	74	1.17E-04	1.78E-04	2.95E-09	2.38E-05	5.12E-04
	Pantex Plant	53	8.36E-05	1.27E-04	2.12E-09	1.71E-05	3.66E-04
	Lawrence Berkeley	17	5.43E-05	8.26E-05	1.47E-09	9.41E-05	2.16E-04
	General Electric	1	2.84E-06	4.31E-06	7.24E-11	2.35E-06	1.20E-05
	State Total	21758	3.61E-02	5.49E-02	9.14E-07	1.07E-02	1.57E-01
	Small Generators	1138	1.92E-03	2.94E-03	5.03E-08	2.45E-03	7.93E-03
CO							
	Rocky Flats Plant	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
	Brookhaven NL	1338	3.41E-03	4.87E-03	2.34E-07	1.12E-03	2.23E-02
	Argonne - East	526	1.34E-03	1.91E-03	9.20E-08	4.40E-04	8.76E-03
	West Valley DP	424	1.08E-03	1.54E-03	7.42E-08	3.55E-04	7.06E-03
	Knolls Atomic	309	7.87E-04	1.12E-03	5.41E-08	2.59E-04	5.15E-03
	Ames Laboratory	5	1.27E-05	1.82E-05	8.75E-10	4.18E-06	8.33E-05
	Grand Junction PO	3	5.54E-07	7.62E-07	3.44E-11	0.00E+00	3.53E-06
	State Total	5046	1.06E-02	1.50E-02	7.34E-07	3.75E-03	6.84E-02
	Small Generators	741	1.88E-03	2.68E-03	1.29E-07	6.18E-04	1.23E-02
ID							
	INEL	933	1.41E-03	2.08E-03	6.87E-08	5.41E-04	3.19E-03
	State Total	933	1.41E-03	2.08E-03	6.87E-08	5.41E-04	3.19E-03
	Small Generators	0					
IL							
	Fernald (FEMP)	3137	2.95E-03	4.11E-03	1.32E-06	1.01E-03	1.35E-02
	Mound Plant	2409	2.27E-03	3.16E-03	1.01E-06	7.75E-04	1.04E-02
	Brookhaven NL	1338	1.47E-03	1.98E-03	5.24E-07	2.41E-03	5.90E-03
	Argonne - East	526	4.81E-04	6.60E-04	1.97E-07	3.56E-04	2.10E-03
	West Valley DP	424	4.65E-04	6.27E-04	1.66E-07	7.64E-04	1.87E-03
	Battelle Columbus	345	3.25E-04	4.52E-04	1.45E-07	1.11E-04	1.48E-03

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Knolls Atomic	309	3.39E-04	4.57E-04	1.21E-07	5.57E-04	1.36E-03
	Paducah GDP	165	1.64E-06	2.54E-06	9.65E-10	0.00E+00	8.82E-06
	Portsmouth GDP	77	6.04E-05	8.69E-05	2.66E-08	8.43E-05	2.71E-04
	Princeton PPL	74	6.97E-05	9.70E-05	3.11E-08	2.38E-05	3.18E-04
	State Total	8804	8.43E-03	1.16E-02	3.54E-06	6.09E-03	3.71E-02
	Small Generators	1394	1.26E-03	1.72E-03	4.91E-07	1.54E-03	5.31E-03
IN							
	Fernald (FEMP)	3137	3.26E-03	4.22E-03	8.65E-07	7.07E-04	1.10E-02
	Mound Plant	2409	2.51E-03	3.39E-03	6.30E-07	4.42E-03	8.05E-03
	Brookhaven NL	1338	1.45E-03	1.85E-03	3.26E-07	1.94E-03	4.42E-03
	West Valley DP	424	4.60E-04	5.87E-04	1.03E-07	6.14E-04	1.40E-03
	Battelle Columbus	345	3.60E-04	4.85E-04	9.02E-08	6.33E-04	1.15E-03
	Knolls Atomic	309	3.35E-04	4.28E-04	7.54E-08	4.48E-04	1.02E-03
	Portsmouth GDP	77	5.21E-05	7.43E-05	1.76E-08	4.96E-06	2.03E-04
	Princeton PPL	74	7.71E-05	1.04E-04	1.94E-08	1.36E-04	2.47E-04
	State Total	8113	8.50E-03	1.11E-02	2.13E-06	8.90E-03	2.75E-02
	Small Generators	1229	1.28E-03	1.68E-03	3.06E-07	1.84E-03	4.02E-03
IA							
	Brookhaven NL	1338	2.32E-03	3.25E-03	5.93E-07	1.72E-04	1.24E-02
	Argonne - East	526	9.12E-04	1.28E-03	2.33E-07	6.77E-05	4.87E-03
	West Valley DP	424	7.36E-04	1.03E-03	1.88E-07	5.46E-05	3.93E-03
	Knolls Atomic	309	5.36E-04	7.51E-04	1.37E-07	3.98E-05	2.86E-03
	Ames Laboratory	5	5.05E-06	6.99E-06	1.18E-09	3.38E-06	2.56E-05
	State Total	2602	4.51E-03	6.32E-03	1.15E-06	3.38E-04	2.41E-02
	Small Generators	738	1.28E-03	1.79E-03	3.26E-07	9.78E-05	6.82E-03
KY							
	Paducah GDP	165	2.40E-05	3.47E-05	2.14E-09	0.00E+00	1.83E-04
	Portsmouth GDP	77	6.25E-05	8.15E-05	5.79E-09	1.83E-04	3.33E-04
	State Total	242	8.64E-05	1.16E-04	7.93E-09	1.83E-04	5.16E-04
	Small Generators	242	8.65E-05	1.16E-04	7.93E-09	1.83E-04	5.16E-04
MO							
	Fernald (FEMP)	3137	6.00E-03	8.24E-03	1.00E-06	1.08E-02	3.64E-02
	Mound Plant	2409	4.60E-03	6.33E-03	7.71E-07	8.30E-03	2.79E-02
	Battelle Columbus	345	6.59E-04	9.06E-04	1.10E-07	1.19E-03	4.00E-03
	Paducah GDP	165	3.45E-04	4.75E-04	6.41E-08	1.43E-04	2.32E-03
	Portsmouth GDP	77	1.47E-04	2.02E-04	2.47E-08	2.65E-04	8.93E-04
	Princeton PPL	74	1.41E-04	1.94E-04	2.37E-08	2.55E-04	8.58E-04
	State Total	6207	1.19E-02	1.63E-02	2.00E-06	2.10E-02	7.24E-02
	Small Generators	661	1.29E-03	1.78E-03	2.23E-07	1.85E-03	8.07E-03
NE							
	Brookhaven NL	1338	2.59E-03	3.90E-03	8.80E-07	2.58E-03	2.10E-02
	Argonne - East	526	1.02E-03	1.53E-03	3.46E-07	1.02E-03	8.24E-03
	West Valley DP	424	8.21E-04	1.24E-03	2.79E-07	8.19E-04	6.64E-03

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Knolls Atomic	309	5.98E-04	9.00E-04	2.03E-07	5.97E-04	4.84E-03
	Ames Laboratory	5	9.68E-06	1.46E-05	3.29E-09	9.66E-06	7.83E-05
	State Total	2602	5.04E-03	7.58E-03	1.71E-06	5.03E-03	4.07E-02
	Small Generators	738	1.43E-03	2.15E-03	4.85E-07	1.43E-03	1.16E-02
NV							
	Oak Ridge Reserv.	9848	2.25E-03	3.48E-03	2.81E-09	0.00E+00	2.44E-02
	Los Alamos NL	3829	8.73E-04	1.35E-03	1.09E-09	0.00E+00	9.47E-03
	Fernald (FEMP)	3137	7.15E-04	1.11E-03	8.95E-10	0.00E+00	7.76E-03
	Rocky Flats Plant	2441	5.39E-03	8.36E-03	7.96E-09	0.00E+00	5.84E-02
	Mound Plant	2409	5.49E-04	8.52E-04	6.87E-10	0.00E+00	5.96E-03
	Lawrence Livermore	1397	3.19E-04	4.94E-04	3.98E-10	0.00E+00	3.45E-03
	Brookhaven NL	1338	2.96E-03	4.58E-03	4.36E-09	0.00E+00	3.20E-02
	INEL	933	2.29E-03	3.51E-03	9.35E-09	1.50E-04	2.44E-02
	Argonne - East	526	1.16E-03	1.80E-03	1.72E-09	0.00E+00	1.26E-02
	West Valley DP	424	9.37E-04	1.45E-03	1.38E-09	0.00E+00	1.01E-02
	Battelle Columbus	345	7.87E-05	1.22E-04	9.84E-11	0.00E+00	8.53E-04
	Knolls Atomic	309	6.83E-04	1.06E-03	1.01E-09	0.00E+00	7.39E-03
	SNL - Albuquerque	191	4.36E-05	6.76E-05	5.45E-11	0.00E+00	4.72E-04
	Paducah GDP	165	3.76E-05	5.84E-05	4.71E-11	0.00E+00	4.08E-04
	ETEC	128	2.92E-05	4.53E-05	3.65E-11	0.00E+00	3.16E-04
	ITRI	87	1.98E-05	3.08E-05	2.48E-11	0.00E+00	2.15E-04
	Portsmouth GDP	77	1.76E-05	2.72E-05	2.20E-11	0.00E+00	1.90E-04
	Princeton PPL	74	1.69E-05	2.62E-05	2.11E-11	0.00E+00	1.83E-04
	Pantex Plant	53	1.21E-05	1.87E-05	1.51E-11	0.00E+00	1.31E-04
	Lawrence Berkeley	17	3.88E-06	6.01E-06	4.85E-12	0.00E+00	4.20E-05
	Ames Laboratory	5	1.10E-05	1.71E-05	1.63E-11	0.00E+00	1.20E-04
	Grand Junction PO	3	6.63E-06	1.03E-05	9.79E-12	0.00E+00	7.18E-05
	General Electric	1	2.28E-07	3.54E-07	2.85E-13	0.00E+00	2.47E-06
	State Total	27737	1.84E-02	2.85E-02	3.20E-08	1.50E-04	1.99E-01
	Small Generators	1879	1.90E-03	2.94E-03	2.74E-09	0.00E+00	2.05E-02
NJ							
	Brookhaven NL	1338	9.46E-04	1.27E-03	1.28E-07	5.81E-03	3.60E-03
	Princeton PPL	74	1.02E-05	1.27E-05	1.48E-09	4.76E-05	3.75E-05
	State Total	1412	9.57E-04	1.28E-03	1.30E-07	5.86E-03	3.63E-03
	Small Generators	74	1.02E-05	1.27E-05	1.48E-09	4.76E-05	3.75E-05
NM							
	Oak Ridge Reserv.	9848	2.02E-02	3.05E-02	1.41E-07	2.47E-02	1.40E-01
	Los Alamos NL	3829	5.52E-03	7.96E-03	5.60E-08	3.20E-03	3.71E-02
	Fernald (FEMP)	3137	6.43E-03	9.72E-03	4.48E-08	7.88E-03	4.44E-02
	Mound Plant	2409	4.94E-03	7.47E-03	3.44E-08	6.05E-03	3.41E-02
	Battelle Columbus	345	7.07E-04	1.07E-03	4.93E-09	8.66E-04	4.89E-03

This value used in example calculation on page B.2

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	SNL - Albuquerque	191	1.91E-04	2.80E-04	2.13E-09	3.32E-04	1.23E-03
	Paducah GDP	165	3.38E-04	5.12E-04	2.36E-09	4.14E-04	2.34E-03
	ITRI	87	8.69E-05	1.28E-04	9.70E-10	1.51E-04	5.59E-04
	Portsmouth GDP	77	1.58E-04	2.39E-04	1.10E-09	1.93E-04	1.09E-03
	Princeton PPL	74	1.52E-04	2.29E-04	1.06E-09	1.86E-04	1.05E-03
	Pantex Plant	53	1.09E-04	1.64E-04	7.57E-10	1.33E-04	7.51E-04
	State Total	20215	3.88E-02	5.83E-02	2.89E-07	4.41E-02	2.67E-01
	Small Generators	992	1.74E-03	2.62E-03	1.33E-08	2.28E-03	1.19E-02
NY							
	Brookhaven NL	1338	1.15E-03	1.62E-03	1.85E-07	9.56E-03	5.78E-03
	West Valley DP	424	2.09E-04	2.47E-04	1.37E-08	5.46E-05	1.53E-03
	Knolls Atomic	309	8.27E-04	9.65E-04	7.22E-08	8.75E-04	5.72E-03
	State Total	2071	2.19E-03	2.84E-03	2.71E-07	1.05E-02	1.30E-02
	Small Generators	733	1.04E-03	1.21E-03	8.59E-08	9.30E-04	7.25E-03
OH							
	Fernald (FEMP)	3137	3.85E-04	3.85E-04	2.02E-08	0.00E+00	5.51E-04
	Mound Plant	2409	9.54E-04	1.16E-03	7.35E-08	2.79E-03	1.36E-03
	Brookhaven NL	1338	2.38E-03	2.80E-03	1.96E-07	1.38E-03	4.01E-03
	West Valley DP	424	8.06E-04	1.04E-03	6.90E-08	2.10E-03	1.32E-03
	Battelle Columbus	345	2.57E-04	3.22E-04	2.22E-08	4.44E-04	4.33E-04
	Knolls Atomic	309	5.88E-04	7.60E-04	5.03E-08	1.53E-03	9.62E-04
	Portsmouth GDP	77	4.38E-05	5.64E-05	4.69E-09	9.91E-06	8.50E-05
	Princeton PPL	74	1.23E-04	1.59E-04	1.06E-08	2.67E-04	2.10E-04
	State Total	8113	5.53E-03	6.69E-03	4.47E-07	8.52E-03	8.94E-03
	Small Generators	1229	1.82E-03	2.34E-03	1.57E-07	4.35E-03	3.01E-03
OK							
	Oak Ridge Reserv.	9848	1.91E-02	2.64E-02	1.21E-06	6.66E-03	1.40E-01
	Fernald (FEMP)	3137	6.75E-03	9.36E-03	4.40E-07	5.96E-03	4.78E-02
	Mound Plant	2409	5.19E-03	7.19E-03	3.38E-07	4.57E-03	3.67E-02
	Battelle Columbus	345	7.43E-04	1.03E-03	4.84E-08	6.55E-04	5.25E-03
	Paducah GDP	165	3.55E-04	4.92E-04	2.32E-08	3.13E-04	2.51E-03
	Portsmouth GDP	77	1.66E-04	2.30E-04	1.08E-08	1.46E-04	1.17E-03
	Princeton PPL	74	1.59E-04	2.21E-04	1.04E-08	1.41E-04	1.13E-03
	State Total	16055	3.24E-02	4.49E-02	2.09E-06	1.84E-02	2.34E-01
	Small Generators	661	1.42E-03	1.97E-03	9.28E-08	1.26E-03	1.01E-02
OR							
	INEL	933	5.60E-04	8.68E-04	5.55E-09	0.00E+00	4.07E-03
	State Total	933	5.60E-04	8.68E-04	5.55E-09	0.00E+00	4.07E-03
	Small Generators	0					
PA							
	Brookhaven NL	1338	2.46E-03	3.37E-03	1.94E-07	7.32E-04	1.81E-02
	West Valley DP	424	1.49E-04	1.66E-04	9.92E-09	0.00E+00	8.64E-04
	Knolls Atomic	309	1.09E-04	1.21E-04	7.23E-09	0.00E+00	6.30E-04

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Princeton PPL	74	2.09E-04	2.40E-04	2.08E-08	2.72E-04	1.11E-03
	State Total	2145	2.93E-03	3.90E-03	2.32E-07	1.00E-03	2.07E-02
	Small Generators	807	4.67E-04	5.27E-04	3.80E-08	2.72E-04	2.60E-03
TN							
	Oak Ridge Reserv.	9848	2.38E-02	3.26E-02	5.85E-07	3.49E-02	1.20E-01
	State Total	9848	2.38E-02	3.26E-02	5.85E-07	3.49E-02	1.20E-01
	Small Generators	0					
TX							
	Oak Ridge Reserv.	9848	9.54E-03	1.43E-02	1.21E-06	8.24E-03	7.29E-02
	Fernald (FEMP)	3137	3.04E-03	4.55E-03	3.85E-07	2.63E-03	2.32E-02
	Mound Plant	2409	2.33E-03	3.49E-03	2.96E-07	2.02E-03	1.78E-02
	Battelle Columbus	345	3.34E-04	5.00E-04	4.23E-08	2.89E-04	2.56E-03
	Paducah GDP	165	1.60E-04	2.39E-04	2.03E-08	1.38E-04	1.22E-03
	Portsmouth GDP	77	7.46E-05	1.12E-04	9.45E-09	6.44E-05	5.70E-04
	Princeton PPL	74	7.17E-05	1.07E-04	9.08E-09	6.19E-05	5.48E-04
	Pantex Plant	53	2.84E-05	4.07E-05	4.02E-09	4.44E-05	1.95E-04
	State Total	16108	1.56E-02	2.33E-02	1.97E-06	1.35E-02	1.19E-01
	Small Generators	714	6.69E-04	9.99E-04	8.52E-08	5.98E-04	5.09E-03
UT							
	Rocky Flats Plant	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	Brookhaven NL	1338	2.55E-03	3.83E-03	2.62E-08	6.03E-04	1.86E-02
	Argonne - East	526	1.00E-03	1.50E-03	1.03E-08	2.37E-04	7.33E-03
	West Valley DP	424	8.07E-04	1.21E-03	8.30E-09	1.91E-04	5.91E-03
	Knolls Atomic	309	5.88E-04	8.84E-04	6.05E-09	1.39E-04	4.31E-03
	Ames Laboratory	5	9.52E-06	1.43E-05	9.79E-11	2.25E-06	6.97E-05
	Grand Junction PO	3	5.71E-06	8.58E-06	5.87E-11	1.35E-06	4.18E-05
	State Total	5046	9.61E-03	1.44E-02	9.88E-08	2.27E-03	7.03E-02
	Small Generators	741	1.41E-03	2.12E-03	1.45E-08	3.34E-04	1.03E-02
WV							
	Princeton PPL	74	9.53E-06	1.29E-05	3.30E-10	5.48E-05	5.64E-05
	State Total	74	9.53E-06	1.29E-05	3.30E-10	5.48E-05	5.64E-05
	Small Generators	74	9.53E-06	1.29E-05	3.30E-10	5.48E-05	5.64E-05
	Mode Totals						
	All Generators		2.93E-01	4.25E-01	1.91E-05	2.09E-01	1.78E+00
	Small Generators		2.29E-02	3.26E-02	2.52E-06	2.07E-02	1.39E-01

Table B.6 RADTRAN 4 Results - High Volume Truck Transport To NTS - Travel Through Las Vegas

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	2.7E-01
Normal Public	3.8E-01
Accident Public	1.9E-05
Nonradiological	
Emission	2.8E-01
Accident	1.5E+00

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
AZ							
	Oak Ridge Reserv.	9848	1.97E-02	2.95E-02	1.33E-07	5.39E-03	1.13E-01
	Los Alamos NL	3829	7.65E-03	1.15E-02	5.19E-08	2.10E-03	4.40E-02
	Fernald (FEMP)	3137	6.27E-03	9.40E-03	4.25E-08	1.72E-03	3.61E-02
	Rocky Flats Plant	2441	3.52E-04	5.46E-04	1.20E-09	0.00E+00	2.15E-03
	Mound Plant	2409	4.81E-03	7.22E-03	3.26E-08	1.32E-03	2.77E-02
	Brookhaven NL	1338	1.93E-04	2.99E-04	6.57E-10	0.00E+00	1.18E-03
	INEL	933	1.35E-04	2.09E-04	4.58E-10	0.00E+00	8.21E-04
	Argonne - East	526	7.59E-05	1.18E-04	2.58E-10	0.00E+00	4.63E-04
	West Valley DP	424	6.12E-05	9.49E-05	2.08E-10	0.00E+00	3.73E-04
	Battelle Columbus	345	6.89E-04	1.03E-03	4.67E-09	1.89E-04	3.97E-03
	Knolls Atomic	309	4.46E-05	6.91E-05	1.52E-10	0.00E+00	2.72E-04
	SNL - Albuquerque	191	3.82E-04	5.73E-04	2.59E-09	1.05E-04	2.20E-03
	Paducah GDP	165	3.30E-04	4.95E-04	2.23E-09	9.03E-05	1.90E-03
	ITRI	87	1.74E-04	2.61E-04	1.18E-09	4.76E-05	1.00E-03
	Portsmouth GDP	77	1.54E-04	2.31E-04	1.04E-09	4.21E-05	8.85E-04
	Princeton PPL	74	1.48E-04	2.22E-04	1.00E-09	4.05E-05	8.51E-04
	Pantex Plant	53	1.06E-04	1.59E-04	7.18E-10	2.90E-05	6.09E-04
	Ames Laboratory	5	7.21E-07	1.12E-06	2.45E-12	0.00E+00	4.40E-06
	Grand Junction PO	3	4.33E-07	6.71E-07	1.47E-12	0.00E+00	2.64E-06
	State Total	26194	4.13E-02	6.19E-02	2.77E-07	1.11E-02	2.38E-01

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
AR							
	Oak Ridge Reserv.	9848	1.65E-02	2.25E-02	4.30E-07	2.22E-03	5.58E-02
	State Total	9848	1.65E-02	2.25E-02	4.30E-07	2.22E-03	5.58E-02
CA							
	Lawrence Livermore	1397	3.55E-03	5.37E-03	8.96E-08	2.07E-03	1.52E-02
	ETEC	128	2.69E-04	4.33E-04	8.52E-09	2.03E-03	7.35E-04
	Lawrence Berkeley	17	5.08E-05	7.72E-05	1.39E-09	9.41E-05	2.00E-04
	General Electric	1	2.64E-06	3.99E-06	6.76E-11	2.35E-06	1.11E-05
	State Total	1543	3.87E-03	5.89E-03	9.96E-08	4.20E-03	1.61E-02
CO							
	Rocky Flats Plant	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
	Brookhaven NL	1338	3.41E-03	4.87E-03	2.34E-07	1.12E-03	2.23E-02
	Argonne - East	526	1.34E-03	1.91E-03	9.20E-08	4.40E-04	8.76E-03
	West Valley DP	424	1.08E-03	1.54E-03	7.42E-08	3.55E-04	7.06E-03
	Knolls Atomic	309	7.87E-04	1.12E-03	5.41E-08	2.59E-04	5.15E-03
	Ames Laboratory	5	1.27E-05	1.82E-05	8.75E-10	4.18E-06	8.33E-05
	Grand Junction PO	3	5.54E-07	7.62E-07	3.44E-11	0.00E+00	3.53E-06
	State Total	5046	1.06E-02	1.50E-02	7.34E-07	3.75E-03	6.84E-02
ID							
	INEL	933	6.70E-04	9.79E-04	3.25E-08	1.80E-04	1.51E-03
	State Total	933	6.70E-04	9.79E-04	3.25E-08	1.80E-04	1.51E-03
IL							
	Fernald (FEMP)	3137	2.95E-03	4.11E-03	1.32E-06	1.01E-03	1.35E-02
	Mound Plant	2409	2.27E-03	3.16E-03	1.01E-06	7.75E-04	1.04E-02
	Brookhaven NL	1338	1.47E-03	1.98E-03	5.24E-07	2.41E-03	5.90E-03
	Argonne - East	526	4.81E-04	6.60E-04	1.97E-07	3.56E-04	2.10E-03
	West Valley DP	424	4.65E-04	6.27E-04	1.66E-07	7.64E-04	1.87E-03
	Battelle Columbus	345	3.25E-04	4.52E-04	1.45E-07	1.11E-04	1.48E-03
	Knolls Atomic	309	3.39E-04	4.57E-04	1.21E-07	5.57E-04	1.36E-03
	Paducah GDP	165	1.64E-06	2.54E-06	9.65E-10	0.00E+00	8.82E-06
	Portsmouth GDP	77	6.04E-05	8.69E-05	2.66E-08	8.43E-05	2.71E-04
	Princeton PPL	74	6.97E-05	9.70E-05	3.11E-08	2.38E-05	3.18E-04
	State Total	8804	8.43E-03	1.16E-02	3.54E-06	6.09E-03	3.71E-02
IN							
	Fernald (FEMP)	3137	3.26E-03	4.22E-03	8.65E-07	7.07E-04	1.10E-02
	Mound Plant	2409	2.51E-03	3.39E-03	6.30E-07	4.42E-03	8.05E-03
	Brookhaven NL	1338	1.45E-03	1.85E-03	3.26E-07	1.94E-03	4.42E-03
	West Valley DP	424	4.60E-04	5.87E-04	1.03E-07	6.14E-04	1.40E-03
	Battelle Columbus	345	3.60E-04	4.85E-04	9.02E-08	6.33E-04	1.15E-03
	Knolls Atomic	309	3.35E-04	4.28E-04	7.54E-08	4.48E-04	1.02E-03
	Portsmouth GDP	77	5.21E-05	7.43E-05	1.76E-08	4.96E-06	2.03E-04
	Princeton PPL	74	7.71E-05	1.04E-04	1.94E-08	1.36E-04	2.47E-04
	State Total	8113	8.50E-03	1.11E-02	2.13E-06	8.90E-03	2.75E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
IA							
	Brookhaven NL	1338	2.32E-03	3.25E-03	5.93E-07	1.72E-04	1.24E-02
	Argonne - East	526	9.12E-04	1.28E-03	2.33E-07	6.77E-05	4.87E-03
	West Valley DP	424	7.36E-04	1.03E-03	1.88E-07	5.46E-05	3.93E-03
	Knolls Atomic	309	5.36E-04	7.51E-04	1.37E-07	3.98E-05	2.86E-03
	Ames Laboratory	5	5.05E-06	6.99E-06	1.18E-09	3.38E-06	2.56E-05
	State Total	2602	4.51E-03	6.32E-03	1.15E-06	3.38E-04	2.41E-02
KY							
	Paducah GDP	165	2.40E-05	3.47E-05	2.14E-09	0.00E+00	1.83E-04
	Portsmouth GDP	77	6.25E-05	8.15E-05	5.79E-09	1.83E-04	3.33E-04
	State Total	242	8.64E-05	1.16E-04	7.93E-09	1.83E-04	5.16E-04
MO							
	Fernald (FEMP)	3137	6.00E-03	8.24E-03	1.00E-06	1.08E-02	3.64E-02
	Mound Plant	2409	4.60E-03	6.33E-03	7.71E-07	8.30E-03	2.79E-02
	Battelle Columbus	345	6.59E-04	9.06E-04	1.10E-07	1.19E-03	4.00E-03
	Paducah GDP	165	3.45E-04	4.75E-04	6.41E-08	1.43E-04	2.32E-03
	Portsmouth GDP	77	1.47E-04	2.02E-04	2.47E-08	2.65E-04	8.93E-04
	Princeton PPL	74	1.41E-04	1.94E-04	2.37E-08	2.55E-04	8.58E-04
	State Total	6207	1.19E-02	1.63E-02	2.00E-06	2.10E-02	7.24E-02
NE							
	Brookhaven NL	1338	2.59E-03	3.90E-03	8.80E-07	2.58E-03	2.10E-02
	Argonne - East	526	1.02E-03	1.53E-03	3.46E-07	1.02E-03	8.24E-03
	West Valley DP	424	8.21E-04	1.24E-03	2.79E-07	8.19E-04	6.64E-03
	Knolls Atomic	309	5.98E-04	9.00E-04	2.03E-07	5.97E-04	4.84E-03
	Ames Laboratory	5	9.68E-06	1.46E-05	3.29E-09	9.66E-06	7.83E-05
	State Total	2602	5.04E-03	7.58E-03	1.71E-06	5.03E-03	4.07E-02
NV							
	Oak Ridge Reserv.	9848	6.94E-03	1.02E-02	2.20E-07	3.04E-02	2.05E-02
	Los Alamos NL	3829	2.70E-03	3.97E-03	8.54E-08	1.18E-02	7.97E-03
	Fernald (FEMP)	3137	2.21E-03	3.25E-03	7.00E-08	9.69E-03	6.53E-03
	Rocky Flats Plant	2441	2.06E-03	3.04E-03	4.82E-08	2.67E-03	7.58E-03
	Mound Plant	2409	1.70E-03	2.50E-03	5.37E-08	7.44E-03	5.02E-03
	Lawrence Livermore	1397	8.75E-04	1.26E-03	1.68E-08	8.54E-04	3.18E-03
	Brookhaven NL	1338	1.13E-03	1.67E-03	2.64E-08	1.46E-03	4.15E-03
	INEL	933	7.88E-04	1.16E-03	1.84E-08	1.02E-03	2.90E-03
	Argonne - East	526	4.44E-04	6.55E-04	1.04E-08	5.76E-04	1.63E-03
	West Valley DP	424	3.58E-04	5.28E-04	8.37E-09	4.64E-04	1.32E-03
	Battelle Columbus	345	2.43E-04	3.58E-04	7.70E-09	1.07E-03	7.18E-04
	Knolls Atomic	309	2.61E-04	3.85E-04	6.10E-09	3.38E-04	9.59E-04
	SNL - Albuquerque	191	1.35E-04	1.98E-04	4.26E-09	5.90E-04	3.98E-04
	Paducah GDP	165	1.16E-04	1.71E-04	3.68E-09	5.10E-04	3.44E-04
	ETEC	128	8.01E-05	1.15E-04	1.54E-09	7.83E-05	2.91E-04
	ITRI	87	6.13E-05	9.02E-05	1.94E-09	2.69E-04	1.81E-04

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Portsmouth GDP	77	5.43E-05	7.98E-05	1.72E-09	2.38E-04	1.60E-04
	Princeton PPL	74	5.21E-05	7.67E-05	1.65E-09	2.29E-04	1.54E-04
	Pantex Plant	53	3.73E-05	5.49E-05	1.18E-09	1.64E-04	1.10E-04
	Lawrence Berkeley	17	1.06E-05	1.53E-05	2.05E-10	1.04E-05	3.86E-05
	Ames Laboratory	5	4.22E-06	6.23E-06	9.87E-11	5.47E-06	1.55E-05
	Grand Junction PO	3	2.53E-06	3.74E-06	5.92E-11	3.28E-06	9.31E-06
	General Electric	1	6.26E-07	8.99E-07	1.21E-11	6.12E-07	2.27E-06
	State Total	27737	2.03E-02	2.98E-02	5.88E-07	6.99E-02	6.41E-02
NJ							
	Brookhaven NL	1338	9.46E-04	1.27E-03	1.28E-07	5.81E-03	3.60E-03
	Princeton PPL	74	1.02E-05	1.27E-05	1.48E-09	4.76E-05	3.75E-05
	State Total	1412	9.57E-04	1.28E-03	1.30E-07	5.86E-03	3.63E-03
NM							
	Oak Ridge Reserv.	9848	2.02E-02	3.05E-02	1.41E-07	2.47E-02	1.40E-01
	Los Alamos NL	3829	5.52E-03	7.96E-03	5.60E-08	3.20E-03	3.71E-02
	Fernald (FEMP)	3137	6.43E-03	9.72E-03	4.48E-08	7.88E-03	4.44E-02
	Mound Plant	2409	4.94E-03	7.47E-03	3.44E-08	6.05E-03	3.41E-02
	Battelle Columbus	345	7.07E-04	1.07E-03	4.93E-09	8.66E-04	4.89E-03
	SNL - Albuquerque	191	1.91E-04	2.80E-04	2.13E-09	3.32E-04	1.23E-03
	Paducah GDP	165	3.38E-04	5.12E-04	2.36E-09	4.14E-04	2.34E-03
	ITRI	87	8.69E-05	1.28E-04	9.70E-10	1.51E-04	5.59E-04
	Portsmouth GDP	77	1.58E-04	2.39E-04	1.10E-09	1.93E-04	1.09E-03
	Princeton PPL	74	1.52E-04	2.29E-04	1.06E-09	1.86E-04	1.05E-03
	Pantex Plant	53	1.09E-04	1.64E-04	7.57E-10	1.33E-04	7.51E-04
	State Total	20215	3.88E-02	5.83E-02	2.89E-07	4.41E-02	2.67E-01
NY							
	Brookhaven NL	1338	1.15E-03	1.62E-03	1.85E-07	9.56E-03	5.78E-03
	West Valley DP	424	2.09E-04	2.47E-04	1.37E-08	5.46E-05	1.53E-03
	Knolls Atomic	309	8.27E-04	9.65E-04	7.22E-08	8.75E-04	5.72E-03
	State Total	2071	2.19E-03	2.84E-03	2.71E-07	1.05E-02	1.30E-02
OH							
	Fernald (FEMP)	3137	3.85E-04	3.85E-04	2.02E-08	0.00E+00	5.51E-04
	Mound Plant	2409	9.54E-04	1.16E-03	7.35E-08	2.79E-03	1.36E-03
	Brookhaven NL	1338	2.38E-03	2.80E-03	1.96E-07	1.38E-03	4.01E-03
	West Valley DP	424	8.06E-04	1.04E-03	6.90E-08	2.10E-03	1.32E-03
	Battelle Columbus	345	2.57E-04	3.22E-04	2.22E-08	4.44E-04	4.33E-04
	Knolls Atomic	309	5.88E-04	7.60E-04	5.03E-08	1.53E-03	9.62E-04
	Portsmouth GDP	77	4.38E-05	5.64E-05	4.69E-09	9.91E-06	8.50E-05
	Princeton PPL	74	1.23E-04	1.59E-04	1.06E-08	2.67E-04	2.10E-04
	State Total	8113	5.53E-03	6.69E-03	4.47E-07	8.52E-03	8.94E-03
OK							
	Oak Ridge Reserv.	9848	1.91E-02	2.64E-02	1.21E-06	6.66E-03	1.40E-01
	Fernald (FEMP)	3137	6.75E-03	9.36E-03	4.40E-07	5.96E-03	4.78E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	Mound Plant	2409	5.19E-03	7.19E-03	3.38E-07	4.57E-03	3.67E-02
	Battelle Columbus	345	7.43E-04	1.03E-03	4.84E-08	6.55E-04	5.25E-03
	Paducah GDP	165	3.55E-04	4.92E-04	2.32E-08	3.13E-04	2.51E-03
	Portsmouth GDP	77	1.66E-04	2.30E-04	1.08E-08	1.46E-04	1.17E-03
	Princeton PPL	74	1.59E-04	2.21E-04	1.04E-08	1.41E-04	1.13E-03
	State Total	16055	3.24E-02	4.49E-02	2.09E-06	1.84E-02	2.34E-01
PA							
	Brookhaven NL	1338	2.46E-03	3.37E-03	1.94E-07	7.32E-04	1.81E-02
	West Valley DP	424	1.49E-04	1.66E-04	9.92E-09	0.00E+00	8.64E-04
	Knolls Atomic	309	1.09E-04	1.21E-04	7.23E-09	0.00E+00	6.30E-04
	Princeton PPL	74	2.09E-04	2.40E-04	2.08E-08	2.72E-04	1.11E-03
	State Total	2145	2.93E-03	3.90E-03	2.32E-07	1.00E-03	2.07E-02
TN							
	Oak Ridge Reserv.	9848	2.38E-02	3.26E-02	5.85E-07	3.49E-02	1.20E-01
	State Total	9848	2.38E-02	3.26E-02	5.85E-07	3.49E-02	1.20E-01
TX							
	Oak Ridge Reserv.	9848	9.54E-03	1.43E-02	1.21E-06	8.24E-03	7.29E-02
	Fernald (FEMP)	3137	3.04E-03	4.55E-03	3.85E-07	2.63E-03	2.32E-02
	Mound Plant	2409	2.33E-03	3.49E-03	2.96E-07	2.02E-03	1.78E-02
	Battelle Columbus	345	3.34E-04	5.00E-04	4.23E-08	2.89E-04	2.56E-03
	Paducah GDP	165	1.60E-04	2.39E-04	2.03E-08	1.38E-04	1.22E-03
	Portsmouth GDP	77	7.46E-05	1.12E-04	9.45E-09	6.44E-05	5.70E-04
	Princeton PPL	74	7.17E-05	1.07E-04	9.08E-09	6.19E-05	5.48E-04
	Pantex Plant	53	2.84E-05	4.07E-05	4.02E-09	4.44E-05	1.95E-04
	State Total	16108	1.56E-02	2.33E-02	1.97E-06	1.35E-02	1.19E-01
UT							
	Rocky Flats Plant	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	Brookhaven NL	1338	2.55E-03	3.83E-03	2.62E-08	6.03E-04	1.86E-02
	INEL	933	2.44E-03	3.37E-03	9.40E-08	4.29E-03	1.44E-02
	Argonne - East	526	1.00E-03	1.50E-03	1.03E-08	2.37E-04	7.33E-03
	West Valley DP	424	8.07E-04	1.21E-03	8.30E-09	1.91E-04	5.91E-03
	Knolls Atomic	309	5.88E-04	8.84E-04	6.05E-09	1.39E-04	4.31E-03
	Ames Laboratory	5	9.52E-06	1.43E-05	9.79E-11	2.25E-06	6.97E-05
	Grand Junction PO	3	5.71E-06	8.58E-06	5.87E-11	1.35E-06	4.18E-05
	State Total	5979	1.20E-02	1.78E-02	1.93E-07	6.57E-03	8.47E-02
WV							
	Princeton PPL	74	9.53E-06	1.29E-05	3.30E-10	5.48E-05	5.64E-05
	State Total	74	9.53E-06	1.29E-05	3.30E-10	5.48E-05	5.64E-05
	Mode Totals		2.66E-01	3.81E-01	1.89E-05	2.76E-01	1.52E+00

Table B.7 RADTRAN 4 Results - Low Volume Rail Transport To Barstow

Expected Fatalities for the Shipping Campaign

Exposure Group	Rail
Radiological	
Normal Crew	1.2E-02
Normal Public	1.4E-02
Accident Public	1.1E-06
Nonradiological	
Emission	2.7E-02
Accident	1.0E+00

Alternative Risks Per State (fatalities)

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Trip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
AZ							
	Los Alamos NL	1264	9.29E-04	7.65E-04	8.34E-09	1.22E-03	1.24E-01
	Rocky Flats Plant	814	5.98E-04	4.93E-04	5.37E-09	7.83E-04	8.00E-02
	Mound Plant	803	5.90E-04	4.86E-04	5.29E-09	7.73E-04	7.89E-02
	State Total	2881	2.12E-03	1.74E-03	1.90E-08	2.77E-03	2.83E-01
CA							
	Los Alamos NL	1264	4.32E-04	2.47E-04	2.77E-08	5.29E-05	5.78E-02
	Rocky Flats Plant	814	2.78E-04	1.59E-04	1.78E-08	3.41E-05	3.72E-02
	Mound Plant	803	2.75E-04	1.57E-04	1.76E-08	3.36E-05	3.67E-02
	Lawrence Livermore	466	3.52E-04	1.27E-03	6.09E-08	5.44E-03	4.70E-02
	State Total	3347	1.34E-03	1.83E-03	1.24E-07	5.56E-03	1.79E-01
CO							
	Rocky Flats Plant	814	4.04E-04	1.39E-03	5.28E-08	5.35E-03	5.40E-02
	State Total	814	4.04E-04	1.39E-03	5.28E-08	5.35E-03	5.40E-02
IL							
	Mound Plant	803	2.51E-04	4.42E-04	4.48E-07	1.18E-03	3.35E-02
	State Total	803	2.51E-04	4.42E-04	4.48E-07	1.18E-03	3.35E-02
IN							
	Mound Plant	803	2.37E-04	9.47E-04	1.23E-07	3.19E-03	3.18E-02
	State Total	803	2.37E-04	9.47E-04	1.23E-07	3.19E-03	3.18E-02
KS							
	Mound Plant	803	4.27E-04	6.00E-04	1.30E-07	1.65E-03	5.71E-02
	State Total	803	4.27E-04	6.00E-04	1.30E-07	1.65E-03	5.71E-02
MO							
	Mound Plant	803	4.99E-04	7.48E-04	7.53E-08	2.05E-03	6.67E-02
	State Total	803	4.99E-04	7.48E-04	7.53E-08	2.05E-03	6.67E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
NM							
	Los Alamos NL	1264	4.59E-04	3.05E-04	2.07E-09	2.12E-04	6.14E-02
	Rocky Flats Plant	814	6.67E-04	4.49E-04	2.83E-09	4.09E-04	8.92E-02
	Mound Plant	803	6.20E-04	3.90E-04	2.47E-09	2.35E-04	8.29E-02
State Total		2881	1.75E-03	1.14E-03	7.37E-09	8.55E-04	2.34E-01
OH							
	Mound Plant	803	3.01E-04	1.23E-03	8.58E-08	4.40E-03	4.02E-02
State Total		803	3.01E-04	1.23E-03	8.58E-08	4.40E-03	4.02E-02
OK							
	Mound Plant	803	1.78E-04	9.34E-05	1.78E-08	0.00E+00	2.38E-02
State Total		803	1.78E-04	9.34E-05	1.78E-08	0.00E+00	2.38E-02
TX							
	Mound Plant	803	3.29E-04	3.32E-04	3.43E-08	2.69E-04	4.40E-02
State Total		803	3.29E-04	3.32E-04	3.43E-08	2.69E-04	4.40E-02
Mode Totals			7.83E-03	1.05E-02	1.12E-06	2.73E-02	1.05E+00

Table B.8 RADTRAN 4 Results - Low Volume Truck Transport From Barstow To NTS

accident rate for primary highways in NV

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	1.0E-02
Normal Public	1.6E-02
Accident Public	1.9E-07
Nonradiological	
Emission	2.3E-03
Accident	5.9E-02

Alternative Risks Per State (fatalities)

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
CA							
	Barstow, CA	10038	7.71E-03	1.20E-02	1.89E-07	2.26E-03	3.46E-02
	State Total	10038	7.71E-03	1.20E-02	1.89E-07	2.26E-03	3.46E-02
NV							
	Barstow, CA	10038	2.29E-03	3.55E-03	2.86E-09	0.00E+00	2.48E-02
	State Total	10038	2.29E-03	3.55E-03	2.86E-09	0.00E+00	2.48E-02
	Mode Totals		1.00E-02	1.55E-02	1.92E-07	2.26E-03	5.94E-02

Table B.9 RADTRAN 4 Results - Low Volume Rail Transport To Caliente

Expected Fatalities for the Shipping Campaign

Exposure Group	Rail
Radiological	
Normal Crew	1.3E-02
Normal Public	1.9E-02
Accident Public	1.9E-06
Nonradiological	
Emission	4.5E-02
Accident	1.1E+00

Alternative Risks Per State (fatalities)

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
CA							
	Lawrence Livermore	466	1.82E-04	1.22E-03	4.94E-08	5.42E-03	2.43E-02
	State Total	466	1.82E-04	1.22E-03	4.94E-08	5.42E-03	2.43E-02
CO							
	Los Alamos NL	1264	1.28E-03	2.52E-03	1.10E-07	7.30E-03	1.72E-01
	Rocky Flats Plant	814	4.20E-04	3.48E-04	2.14E-08	2.38E-04	5.61E-02
	Mound Plant	803	1.51E-05	1.33E-05	7.84E-10	0.00E+00	2.02E-03
	State Total	2881	1.72E-03	2.88E-03	1.32E-07	7.54E-03	2.30E-01
IL							
	Mound Plant	803	2.28E-04	2.74E-03	4.05E-07	1.16E-02	3.05E-02
	State Total	803	2.28E-04	2.74E-03	4.05E-07	1.16E-02	3.05E-02
IN							
	Mound Plant	803	2.24E-04	9.87E-04	1.25E-07	3.49E-03	3.00E-02
	State Total	803	2.24E-04	9.87E-04	1.25E-07	3.49E-03	3.00E-02
IA							
	Mound Plant	803	5.08E-04	1.17E-03	6.60E-07	3.63E-03	6.80E-02
	State Total	803	5.08E-04	1.17E-03	6.60E-07	3.63E-03	6.80E-02
NE							
	Mound Plant	803	6.82E-04	6.87E-04	2.99E-07	1.01E-03	9.13E-02
	State Total	803	6.82E-04	6.87E-04	2.99E-07	1.01E-03	9.13E-02
NV							
	Los Alamos NL	1264	9.83E-05	5.46E-05	2.25E-11	0.00E+00	1.31E-02
	Rocky Flats Plant	814	6.33E-05	3.52E-05	1.45E-11	0.00E+00	8.46E-03
	Mound Plant	803	6.24E-05	3.47E-05	1.43E-11	0.00E+00	8.35E-03
	Lawrence Livermore	466	4.40E-04	4.64E-04	1.21E-09	1.05E-03	5.89E-02
	State Total	3347	6.64E-04	5.88E-04	1.26E-09	1.05E-03	8.88E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
NM							
	Los Alamos NL	1264	5.77E-04	4.16E-04	2.25E-09	3.70E-04	7.71E-02
	State Total	1264	5.77E-04	4.16E-04	2.25E-09	3.70E-04	7.71E-02
OH							
	Mound Plant	803	4.22E-04	1.72E-03	1.16E-07	5.85E-03	5.64E-02
	State Total	803	4.22E-04	1.72E-03	1.16E-07	5.85E-03	5.64E-02
UT							
	Los Alamos NL	1264	1.10E-03	8.55E-04	2.19E-08	6.88E-04	1.47E-01
	Rocky Flats Plant	814	7.07E-04	5.51E-04	1.41E-08	4.43E-04	9.45E-02
	Mound Plant	803	5.89E-04	9.41E-04	3.58E-08	2.89E-03	7.87E-02
	Lawrence Livermore	466	3.31E-04	1.95E-04	2.52E-09	0.00E+00	4.42E-02
	State Total	3347	2.72E-03	2.54E-03	7.44E-08	4.02E-03	3.64E-01
WY							
	Mound Plant	803	6.63E-04	4.92E-04	7.26E-09	5.38E-04	8.86E-02
	State Total	803	6.63E-04	4.92E-04	7.26E-09	5.38E-04	8.86E-02
	Mode Totals		8.59E-03	1.54E-02	1.87E-06	4.45E-02	1.15E+00

Table B.10 RADTRAN 4 Results - Low Volume Truck Transport From Caliente To NTS

accident rate for primary highways in NV
alternate route files used

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	1.5E-02
Normal Public	2.3E-02
Accident Public	2.3E-08
Nonradiological	
Emission	0.0E+00
Accident	1.6E-01

Alternative Risks Per State (fatalities)

State	Generator	No. Ship- ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
NV							
	Caliente, NV	10038	1.50E-02	2.32E-02	2.29E-08	0.00E+00	1.62E-01
	State Total	10038	1.50E-02	2.32E-02	2.29E-08	0.00E+00	1.62E-01
	Mode Totals		1.50E-02	2.32E-02	2.29E-08	0.00E+00	1.62E-01

Table B.11 RADTRAN 4 Results - Low Volume Truck Transport To NTS - Avoid Las Vegas

accident rate for primary highways in NV
alternate route files used

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	7.5E-02
Normal Public	1.1E-01
Accident Public	4.2E-06
Nonradiological	
Emission	4.7E-02
Accident	4.7E-01

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
AZ							
	Los Alamos NL	3791	7.31E-03	1.10E-02	4.99E-08	2.07E-03	4.21E-02
	Rocky Flats Plant	2441	3.52E-04	5.46E-04	1.20E-09	0.00E+00	2.15E-03
	Mound Plant	2409	4.65E-03	6.98E-03	3.17E-08	1.32E-03	2.67E-02
	SNL - Albuquerque	191	3.68E-04	5.53E-04	2.51E-09	1.05E-04	2.12E-03
	Paducah GDP	165	3.18E-04	4.78E-04	2.17E-09	9.03E-05	1.83E-03
	ITRI	87	1.68E-04	2.52E-04	1.15E-09	4.76E-05	9.66E-04
	Portsmouth GDP	77	1.48E-04	2.23E-04	1.01E-09	4.21E-05	8.55E-04
	Pantex Plant	53	1.02E-04	1.53E-04	6.98E-10	2.90E-05	5.89E-04
	State Total	9214	1.34E-02	2.02E-02	9.04E-08	3.71E-03	7.74E-02
CA							
	Los Alamos NL	3791	5.98E-03	9.10E-03	1.51E-07	1.22E-03	2.62E-02
	Mound Plant	2409	3.80E-03	5.78E-03	9.62E-08	7.75E-04	1.67E-02
	Lawrence Livermore	1397	3.83E-03	5.82E-03	9.64E-08	2.07E-03	1.65E-02
	SNL - Albuquerque	191	3.01E-04	4.58E-04	7.63E-09	6.15E-05	1.32E-03
	Paducah GDP	165	2.60E-04	3.96E-04	6.59E-09	5.31E-05	1.14E-03
	ETEC	104	2.40E-04	3.84E-04	7.43E-09	1.65E-03	6.93E-04
	ITRI	87	1.37E-04	2.09E-04	3.47E-09	2.80E-05	6.01E-04
	Portsmouth GDP	77	1.21E-04	1.85E-04	3.07E-09	2.48E-05	5.32E-04
	Pantex Plant	53	8.36E-05	1.27E-04	2.12E-09	1.71E-05	3.66E-04
	State Total	8274	1.48E-02	2.25E-02	3.74E-07	5.90E-03	6.40E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
CO							
	Rocky Flats Plant	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
	State Total	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
IL							
	Mound Plant	2409	2.27E-03	3.16E-03	1.01E-06	7.75E-04	1.04E-02
	Paducah GDP	165	1.64E-06	2.54E-06	9.65E-10	0.00E+00	8.82E-06
	Portsmouth GDP	77	6.04E-05	8.69E-05	2.66E-08	8.43E-05	2.71E-04
	State Total	2651	2.33E-03	3.25E-03	1.04E-06	8.60E-04	1.06E-02
IN							
	Mound Plant	2409	2.51E-03	3.39E-03	6.30E-07	4.42E-03	8.05E-03
	Portsmouth GDP	77	5.21E-05	7.43E-05	1.76E-08	4.96E-06	2.03E-04
	State Total	2486	2.56E-03	3.46E-03	6.48E-07	4.42E-03	8.25E-03
KY							
	Paducah GDP	165	2.40E-05	3.47E-05	2.14E-09	0.00E+00	1.83E-04
	Portsmouth GDP	77	6.25E-05	8.15E-05	5.79E-09	1.83E-04	3.33E-04
	State Total	242	8.64E-05	1.16E-04	7.93E-09	1.83E-04	5.16E-04
MO							
	Mound Plant	2409	4.60E-03	6.33E-03	7.71E-07	8.30E-03	2.79E-02
	Paducah GDP	165	3.45E-04	4.75E-04	6.41E-08	1.43E-04	2.32E-03
	Portsmouth GDP	77	1.47E-04	2.02E-04	2.47E-08	2.65E-04	8.93E-04
	State Total	2651	5.10E-03	7.00E-03	8.60E-07	8.71E-03	3.12E-02
NV							
	Los Alamos NL	3791	8.64E-04	1.34E-03	1.08E-09	0.00E+00	9.37E-03
	Rocky Flats Plant	2441	5.39E-03	8.36E-03	7.96E-09	0.00E+00	5.84E-02
	Mound Plant	2409	5.49E-04	8.52E-04	6.87E-10	0.00E+00	5.96E-03
	Lawrence Livermore	1397	3.19E-04	4.94E-04	3.98E-10	0.00E+00	3.45E-03
	SNL - Albuquerque	191	4.36E-05	6.76E-05	5.45E-11	0.00E+00	4.72E-04
	Paducah GDP	165	3.76E-05	5.84E-05	4.71E-11	0.00E+00	4.08E-04
	ETEC	104	2.37E-05	3.68E-05	2.97E-11	0.00E+00	2.57E-04
	ITRI	87	1.98E-05	3.08E-05	2.48E-11	0.00E+00	2.15E-04
	Portsmouth GDP	77	1.76E-05	2.72E-05	2.20E-11	0.00E+00	1.90E-04
	Pantex Plant	53	1.21E-05	1.87E-05	1.51E-11	0.00E+00	1.31E-04
	State Total	10715	7.28E-03	1.13E-02	1.03E-08	0.00E+00	7.88E-02
NM							
	Los Alamos NL	3791	5.47E-03	7.88E-03	5.54E-08	3.17E-03	3.67E-02
	Mound Plant	2409	4.94E-03	7.47E-03	3.44E-08	6.05E-03	3.41E-02
	SNL - Albuquerque	191	1.91E-04	2.80E-04	2.13E-09	3.32E-04	1.23E-03
	Paducah GDP	165	3.38E-04	5.12E-04	2.36E-09	4.14E-04	2.34E-03
	ITRI	87	8.69E-05	1.28E-04	9.70E-10	1.51E-04	5.59E-04
	Portsmouth GDP	77	1.58E-04	2.39E-04	1.10E-09	1.93E-04	1.09E-03
	Pantex Plant	53	1.09E-04	1.64E-04	7.57E-10	1.33E-04	7.51E-04
	State Total	6773	1.13E-02	1.67E-02	9.71E-08	1.04E-02	7.68E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Trip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
OH							
	Mound Plant	2409	9.54E-04	1.16E-03	7.35E-08	2.79E-03	1.36E-03
	Portsmouth GDP	77	4.38E-05	5.64E-05	4.69E-09	9.91E-06	8.50E-05
	State Total	2486	9.97E-04	1.22E-03	7.82E-08	2.80E-03	1.45E-03
OK							
	Mound Plant	2409	5.19E-03	7.19E-03	3.38E-07	4.57E-03	3.67E-02
	Paducah GDP	165	3.55E-04	4.92E-04	2.32E-08	3.13E-04	2.51E-03
	Portsmouth GDP	77	1.66E-04	2.30E-04	1.08E-08	1.46E-04	1.17E-03
	State Total	2651	5.71E-03	7.91E-03	3.72E-07	5.03E-03	4.04E-02
TX							
	Mound Plant	2409	2.33E-03	3.49E-03	2.96E-07	2.02E-03	1.78E-02
	Paducah GDP	165	1.60E-04	2.39E-04	2.03E-08	1.38E-04	1.22E-03
	Portsmouth GDP	77	7.46E-05	1.12E-04	9.45E-09	6.44E-05	5.70E-04
	Pantex Plant	53	2.84E-05	4.07E-05	4.02E-09	4.44E-05	1.95E-04
	State Total	2704	2.60E-03	3.88E-03	3.29E-07	2.26E-03	1.98E-02
UT							
	Rocky Flats Plant	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	State Total	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	Mode Totals		7.47E-02	1.10E-01	4.23E-06	4.70E-02	4.68E-01

Table B.12 RADTRAN 4 Results - Low Volume Truck Transport To NTS - Travel Through Las Vegas

Expected Fatalities for the Shipping Campaign

Exposure Group	Truck
Radiological	
Normal Crew	6.5E-02
Normal Public	9.4E-02
Accident Public	4.2E-06
Nonradiological	
Emission	6.9E-02
Accident	3.7E-01

Alternative Risks Per State (fatalities)

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Truck							
AZ							
	Los Alamos NL	3791	7.57E-03	1.14E-02	5.13E-08	2.07E-03	4.36E-02
	Rocky Flats Plant	2441	3.52E-04	5.46E-04	1.20E-09	0.00E+00	2.15E-03
	Mound Plant	2409	4.81E-03	7.22E-03	3.26E-08	1.32E-03	2.77E-02
	SNL - Albuquerque	191	3.82E-04	5.73E-04	2.59E-09	1.05E-04	2.20E-03
	Paducah GDP	165	3.30E-04	4.95E-04	2.23E-09	9.03E-05	1.90E-03
	ITRI	87	1.74E-04	2.61E-04	1.18E-09	4.76E-05	1.00E-03
	Portsmouth GDP	77	1.54E-04	2.31E-04	1.04E-09	4.21E-05	8.85E-04
	Pantex Plant	53	1.06E-04	1.59E-04	7.18E-10	2.90E-05	6.09E-04
	State Total	9214	1.39E-02	2.08E-02	9.29E-08	3.71E-03	8.00E-02
CA							
	Lawrence Livermore	1397	3.55E-03	5.37E-03	8.96E-08	2.07E-03	1.52E-02
	ETEC	104	2.18E-04	3.52E-04	6.93E-09	1.65E-03	5.97E-04
	State Total	1501	3.77E-03	5.73E-03	9.66E-08	3.72E-03	1.58E-02
CO							
	Rocky Flats Plant	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
	State Total	2441	3.97E-03	5.54E-03	2.79E-07	1.57E-03	2.51E-02
IL							
	Mound Plant	2409	2.27E-03	3.16E-03	1.01E-06	7.75E-04	1.04E-02
	Paducah GDP	165	1.64E-06	2.54E-06	9.65E-10	0.00E+00	8.82E-06
	Portsmouth GDP	77	6.04E-05	8.69E-05	2.66E-08	8.43E-05	2.71E-04
	State Total	2651	2.33E-03	3.25E-03	1.04E-06	8.60E-04	1.06E-02

State	Generator	No. Shipments	Cargo-Related Risks			Vehicle-Related Risks (Round-Trip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
IN							
	Mound Plant	2409	2.51E-03	3.39E-03	6.30E-07	4.42E-03	8.05E-03
	Portsmouth GDP	77	5.21E-05	7.43E-05	1.76E-08	4.96E-06	2.03E-04
	State Total	2486	2.56E-03	3.46E-03	6.48E-07	4.42E-03	8.25E-03
KY							
	Paducah GDP	165	2.40E-05	3.47E-05	2.14E-09	0.00E+00	1.83E-04
	Portsmouth GDP	77	6.25E-05	8.15E-05	5.79E-09	1.83E-04	3.33E-04
	State Total	242	8.64E-05	1.16E-04	7.93E-09	1.83E-04	5.16E-04
MO							
	Mound Plant	2409	4.60E-03	6.33E-03	7.71E-07	8.30E-03	2.79E-02
	Paducah GDP	165	3.45E-04	4.75E-04	6.41E-08	1.43E-04	2.32E-03
	Portsmouth GDP	77	1.47E-04	2.02E-04	2.47E-08	2.65E-04	8.93E-04
	State Total	2651	5.10E-03	7.00E-03	8.60E-07	8.71E-03	3.12E-02
NV							
	Los Alamos NL	3791	2.67E-03	3.93E-03	8.46E-08	1.17E-02	7.89E-03
	Rocky Flats Plant	2441	2.06E-03	3.04E-03	4.82E-08	2.67E-03	7.58E-03
	Mound Plant	2409	1.70E-03	2.50E-03	5.37E-08	7.44E-03	5.02E-03
	Lawrence Livermore	1397	8.75E-04	1.26E-03	1.68E-08	8.54E-04	3.18E-03
	SNL - Albuquerque	191	1.35E-04	1.98E-04	4.26E-09	5.90E-04	3.98E-04
	Paducah GDP	165	1.16E-04	1.71E-04	3.68E-09	5.10E-04	3.44E-04
	ETEC	104	6.51E-05	9.34E-05	1.25E-09	6.36E-05	2.36E-04
	ITRI	87	6.13E-05	9.02E-05	1.94E-09	2.69E-04	1.81E-04
	Portsmouth GDP	77	5.43E-05	7.98E-05	1.72E-09	2.38E-04	1.60E-04
	Pantex Plant	53	3.73E-05	5.49E-05	1.18E-09	1.64E-04	1.10E-04
	State Total	10715	7.77E-03	1.14E-02	2.17E-07	2.45E-02	2.51E-02
NM							
	Los Alamos NL	3791	5.47E-03	7.88E-03	5.54E-08	3.17E-03	3.67E-02
	Mound Plant	2409	4.94E-03	7.47E-03	3.44E-08	6.05E-03	3.41E-02
	SNL - Albuquerque	191	1.91E-04	2.80E-04	2.13E-09	3.32E-04	1.23E-03
	Paducah GDP	165	3.38E-04	5.12E-04	2.36E-09	4.14E-04	2.34E-03
	ITRI	87	8.69E-05	1.28E-04	9.70E-10	1.51E-04	5.59E-04
	Portsmouth GDP	77	1.58E-04	2.39E-04	1.10E-09	1.93E-04	1.09E-03
	Pantex Plant	53	1.09E-04	1.64E-04	7.57E-10	1.33E-04	7.51E-04
	State Total	6773	1.13E-02	1.67E-02	9.71E-08	1.04E-02	7.68E-02
OH							
	Mound Plant	2409	9.54E-04	1.16E-03	7.35E-08	2.79E-03	1.36E-03
	Portsmouth GDP	77	4.38E-05	5.64E-05	4.69E-09	9.91E-06	8.50E-05
	State Total	2486	9.97E-04	1.22E-03	7.82E-08	2.80E-03	1.45E-03
OK							
	Mound Plant	2409	5.19E-03	7.19E-03	3.38E-07	4.57E-03	3.67E-02
	Paducah GDP	165	3.55E-04	4.92E-04	2.32E-08	3.13E-04	2.51E-03
	Portsmouth GDP	77	1.66E-04	2.30E-04	1.08E-08	1.46E-04	1.17E-03
	State Total	2651	5.71E-03	7.91E-03	3.72E-07	5.03E-03	4.04E-02

State	Generator	No. Ship-ments	Cargo-Related Risks			Vehicle-Related Risks (Round-Tip)	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
TX							
	Mound Plant	2409	2.33E-03	3.49E-03	2.96E-07	2.02E-03	1.78E-02
	Paducah GDP	165	1.60E-04	2.39E-04	2.03E-08	1.38E-04	1.22E-03
	Portsmouth GDP	77	7.46E-05	1.12E-04	9.45E-09	6.44E-05	5.70E-04
	Pantex Plant	53	2.84E-05	4.07E-05	4.02E-09	4.44E-05	1.95E-04
	State Total	2704	2.60E-03	3.88E-03	3.29E-07	2.26E-03	1.98E-02
UT							
	Rocky Flats Plant	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	State Total	2441	4.65E-03	6.98E-03	4.78E-08	1.10E-03	3.40E-02
	Mode Totals		6.47E-02	9.40E-02	4.17E-06	6.93E-02	3.69E-01

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APPENDIX C

SELECTED RADTRAN 4 RISK ANALYSIS RESULTS SORTED BY LLW GENERATOR SITE AND THEN BY STATE IN WHICH IMPACTS OCCUR

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APPENDIX C

SELECTED RADTRAN 4 RISK ANALYSIS RESULTS SORTED BY LLW GENERATOR SITE AND THEN BY STATE IN WHICH IMPACTS OCCUR

This appendix contains raw output data from the RADTRAN 4 risk analyses performed for the various shipping configuration options and waste loading cases in this study. The data provided in this appendix includes detailed state-level risk information for each shipping configuration. In these tables, the results are first sorted by LLW generator site and then the impacts in each state along the transportation corridor from the generator's site to the NTS are presented.

This appendix is organized as follows:

High Waste Volume Cases

Table C.1	Rail transport from LLW generators to Barstow
Table C.2	Rail transport from LLW generators to Caliente
Table C.3	Truck transport from LLW generators to NTS – Avoid Las Vegas
Table C.4	Truck transport from LLW generators to NTS – Travel through Las Vegas

Low Waste Volume Cases

Table C.5	Rail transport from LLW generators to Barstow
Table C.6	Rail transport from LLW generators to Caliente
Table C.7	Truck transport from LLW generators to NTS – Avoid Las Vegas
Table C.8	Truck transport from LLW generators to NTS – Travel through Las Vegas

Note that the truck transport segments from the intermodal facilities to NTS are not included in this appendix. The results for these legs are shown in Appendix B. Note also that the rail transportation impact results in this appendix do not include the non-linear component of the rail impacts. The non-linear component accounts for marshalling of the cars at the beginning and end of the trip (it is part of the stops dose in each case). Since all railcar shipments are equal in the analysis, each shipment (railcar) has a non-linear worker component of 3.25E-03 and a non-linear public component of 2.11E-03 person-rem/shipment. These are per shipment numbers; half can be attributed to the originating state and the other half to the destination state.

Table C.1. Rail Transport From LLW Generators To Barstow - High Waste Volume

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
ANL-E	AZ	176	1.3E-04	1.0E-04	1.2E-09	1.7E-04	2.4E-03
	CA	176	6.0E-05	3.3E-05	3.9E-09	7.4E-06	3.6E-03
	IA	176	7.3E-06	5.0E-06	8.9E-09	0.0E+00	2.9E-03
	IL	176	6.6E-05	9.0E-05	1.2E-07	1.9E-04	1.5E-04
	KS	176	9.4E-05	1.3E-04	2.8E-08	3.6E-04	1.6E-03
	MO	176	6.9E-05	7.6E-05	9.9E-09	1.9E-04	1.4E-03
	NM	176	1.4E-04	8.1E-05	5.4E-10	5.2E-05	1.6E-03
	OK	176	3.9E-05	1.9E-05	3.9E-09	0.0E+00	1.5E-03
	TX	176	7.2E-05	7.1E-05	7.5E-09	5.9E-05	3.1E-03
Site Total		176	6.7E-04	6.1E-04	1.9E-07	1.0E-03	1.8E-02
BNL	AZ	446	3.3E-04	2.6E-04	2.9E-09	4.3E-04	6.0E-03
	CA	446	1.5E-04	8.2E-05	9.8E-09	1.9E-05	9.2E-03
	IA	446	1.9E-05	1.3E-05	2.3E-08	0.0E+00	8.2E-03
	IL	446	1.9E-04	9.2E-04	3.3E-07	4.1E-03	6.0E-03
	IN	446	1.2E-04	6.7E-04	7.0E-08	2.7E-03	3.8E-04
	KS	446	2.4E-04	3.3E-04	7.2E-08	9.1E-04	4.0E-03
	MO	446	1.8E-04	1.9E-04	2.5E-08	4.9E-04	3.4E-03
	NM	446	3.4E-04	2.1E-04	1.4E-09	1.3E-04	4.1E-03
	NY	446	4.9E-04	3.5E-03	6.0E-07	1.3E-02	5.1E-02
	OH	446	2.1E-04	1.3E-03	5.9E-08	5.0E-03	7.3E-03
	OK	446	9.9E-05	4.9E-05	9.9E-09	0.0E+00	3.8E-03
	PA	446	3.9E-05	2.9E-04	2.2E-08	1.3E-03	1.5E-03
	TX	446	1.8E-04	1.8E-04	1.9E-08	1.5E-04	7.7E-03
Site Total		446	2.6E-03	7.9E-03	1.2E-06	2.8E-02	1.1E-01
FEMP	AZ	1046	7.7E-04	6.1E-04	6.9E-09	1.0E-03	1.4E-02
	CA	1046	3.6E-04	1.9E-04	2.3E-08	4.4E-05	2.2E-02
	IL	1046	3.0E-04	5.7E-04	5.2E-07	1.4E-03	1.3E-02
	IN	1046	3.7E-04	4.2E-04	2.3E-07	7.4E-04	1.8E-02
	KS	1046	5.6E-04	7.6E-04	1.7E-07	2.1E-03	9.4E-03
	MO	1046	6.4E-04	8.9E-04	9.6E-08	2.5E-03	1.3E-02
	NM	1046	8.1E-04	4.8E-04	3.2E-09	3.1E-04	9.6E-03
	OH	1046	1.4E-04	9.8E-04	4.4E-08	3.6E-03	5.0E-03
	OK	1046	2.3E-04	1.1E-04	2.3E-08	0.0E+00	9.0E-03
	TX	1046	4.3E-04	4.2E-04	4.5E-08	3.5E-04	1.8E-02
Site Total		1046	4.6E-03	5.4E-03	1.2E-06	1.2E-02	1.3E-01
INEL	CA	311	3.1E-04	1.4E-03	6.1E-08	5.8E-03	1.9E-02
	ID	311	7.5E-05	9.3E-05	8.3E-09	3.1E-04	2.3E-03
	NV	311	2.6E-04	2.7E-04	8.1E-10	7.0E-04	1.2E-03

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	UT	311	1.0E-04	5.8E-05	1.6E-09	0.0E+00	4.4E-03
Site Total		311	7.5E-04	1.8E-03	7.2E-08	6.8E-03	2.7E-02
LLNL	CA	466	3.5E-04	1.3E-03	6.1E-08	5.4E-03	2.1E-02
Site Total		466	3.5E-04	1.3E-03	6.1E-08	5.4E-03	2.1E-02
LANL	AZ	1277	9.4E-04	7.4E-04	8.4E-09	1.2E-03	1.7E-02
	CA	1277	4.4E-04	2.4E-04	2.8E-08	5.3E-05	2.6E-02
	NM	1277	4.6E-04	2.9E-04	2.1E-09	2.1E-04	5.5E-03
Site Total		1277	1.8E-03	1.3E-03	3.9E-08	1.5E-03	4.9E-02
Mound	AZ	803	5.9E-04	4.7E-04	5.3E-09	7.7E-04	1.1E-02
	CA	803	2.8E-04	1.5E-04	1.8E-08	3.4E-05	1.7E-02
	IL	803	2.5E-04	4.3E-04	4.5E-07	1.2E-03	1.1E-02
	IN	803	2.4E-04	9.4E-04	1.2E-07	3.2E-03	1.2E-02
	KS	803	4.3E-04	5.9E-04	1.3E-07	1.7E-03	7.2E-03
	MO	803	5.0E-04	7.3E-04	7.5E-08	2.1E-03	9.8E-03
	NM	803	6.2E-04	3.7E-04	2.5E-09	2.4E-04	7.4E-03
	OH	803	3.0E-04	1.2E-03	8.6E-08	4.4E-03	1.1E-02
	OK	803	1.8E-04	8.8E-05	1.8E-08	0.0E+00	6.9E-03
	TX	803	3.3E-04	3.2E-04	3.4E-08	2.7E-04	1.4E-02
Site Total		803	3.7E-03	5.3E-03	9.4E-07	1.4E-02	1.1E-01
ORR	AL	3283	9.9E-04	1.5E-03	5.4E-08	2.3E-03	3.6E-02
	AR	3283	8.6E-04	8.4E-04	1.2E-07	8.2E-04	4.4E-02
	AZ	3283	2.4E-03	1.9E-03	2.2E-08	3.2E-03	4.0E-02
	CA	3283	1.1E-03	6.1E-04	7.2E-08	1.4E-04	6.7E-02
	GA	3283	1.7E-05	8.8E-06	5.4E-10	0.0E+00	4.6E-04
	MO	3283	1.5E-03	1.7E-03	2.2E-07	2.5E-03	1.4E-02
	MS	3283	2.0E-04	1.9E-04	4.5E-08	0.0E+00	3.0E-02
	NM	3283	2.5E-03	1.5E-03	1.0E-08	9.6E-04	3.0E-02
	OK	3283	2.2E-03	2.7E-03	2.9E-07	5.4E-03	8.5E-02
	TN	3283	1.3E-03	3.8E-03	2.0E-07	1.2E-02	3.9E-02
	TX	3283	1.4E-03	1.3E-03	1.4E-07	1.1E-03	5.7E-02
Site Total		3283	1.4E-02	1.6E-02	1.2E-06	2.8E-02	4.4E-01
RFETS	AZ	814	6.0E-04	4.7E-04	5.4E-09	7.8E-04	1.1E-02
	CA	814	2.8E-04	1.5E-04	1.8E-08	3.4E-05	1.7E-02
	CO	814	4.0E-04	1.4E-03	5.3E-08	5.4E-03	7.0E-03
	NM	814	6.7E-04	4.3E-04	2.8E-09	4.1E-04	7.9E-03
Site Total		814	1.9E-03	2.4E-03	7.9E-08	6.6E-03	4.3E-02

Table C.2. Rail Transport From LLW Generators To Caliente - High Waste Volume

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
ANL-E	CO	176	1.6E-04	2.2E-04	1.0E-08	6.0E-04	2.7E-03
	IA	176	9.5E-05	1.4E-04	1.3E-07	3.2E-04	2.6E-03
	IL	176	6.0E-05	9.5E-05	1.1E-07	2.4E-04	2.0E-03
	NE	176	1.3E-04	1.5E-04	5.6E-08	3.5E-04	1.6E-03
	NV	176	1.4E-05	7.1E-06	3.1E-12	0.0E+00	6.2E-05
	UT	176	1.5E-04	1.1E-04	3.1E-09	9.6E-05	6.6E-03
Site Total			6.1E-04	7.2E-04	3.1E-07	1.6E-03	1.6E-02
BNL	CO	446	8.4E-06	7.1E-06	4.4E-10	0.0E+00	1.4E-04
	IA	446	2.8E-04	6.4E-04	3.7E-07	2.0E-03	5.7E-03
	IL	446	1.3E-04	1.0E-03	2.1E-07	4.6E-03	6.0E-03
	IN	446	1.2E-04	6.7E-04	7.0E-08	2.7E-03	5.9E-03
	NE	446	3.8E-04	3.7E-04	1.7E-07	5.6E-04	4.8E-03
	NV	446	3.5E-05	1.8E-05	7.9E-12	0.0E+00	1.6E-04
	NY	446	4.9E-04	3.5E-03	6.0E-07	1.3E-02	5.1E-02
	OH	446	2.1E-04	1.3E-03	5.9E-08	5.0E-03	7.3E-03
	PA	446	3.9E-05	2.9E-04	2.2E-08	1.3E-03	1.5E-03
	UT	446	3.3E-04	5.1E-04	2.0E-08	1.6E-03	1.4E-02
	WY	446	3.7E-04	2.6E-04	4.0E-09	3.0E-04	1.5E-03
Site Total			2.4E-03	8.6E-03	1.5E-06	3.0E-02	9.8E-02
FEMP	CO	1046	2.0E-05	1.7E-05	1.0E-09	0.0E+00	3.4E-04
	IL	1046	2.9E-04	5.3E-04	5.0E-07	1.2E-03	1.3E-02
	IN	1046	3.7E-04	4.4E-04	2.3E-07	7.4E-04	1.8E-02
	KS	1046	3.4E-04	3.5E-04	1.0E-07	5.3E-04	5.8E-03
	MO	1046	6.0E-04	1.4E-03	1.0E-07	4.6E-03	1.2E-02
	NE	1046	7.9E-04	5.9E-04	3.5E-07	4.8E-04	1.0E-02
	NV	1046	8.1E-05	4.2E-05	1.9E-11	0.0E+00	3.7E-04
	OH	1046	1.4E-04	9.9E-04	4.4E-08	3.6E-03	5.0E-03
	UT	1046	7.7E-04	1.2E-03	4.7E-08	3.8E-03	3.3E-02
	WY	1046	8.6E-04	6.1E-04	9.5E-09	7.0E-04	3.5E-03
Site Total			4.3E-03	6.2E-03	1.4E-06	1.6E-02	1.0E-01
INEL	ID	311	7.5E-05	9.7E-05	8.3E-09	3.1E-04	2.3E-03
	NV	311	2.4E-05	1.3E-05	5.5E-12	0.0E+00	1.1E-04
	UT	311	2.2E-04	3.3E-04	1.3E-08	9.2E-04	9.7E-03
Site Total			3.2E-04	4.3E-04	2.2E-08	1.2E-03	1.2E-02

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
LLNL	CA	466	1.8E-04	1.2E-03	4.9E-08	5.4E-03	1.1E-02
	NV	466	4.4E-04	4.5E-04	1.2E-09	1.1E-03	2.0E-03
	UT	466	3.3E-04	1.8E-04	2.5E-09	0.0E+00	1.4E-02
Site Total			9.5E-04	1.9E-03	5.3E-08	6.5E-03	2.7E-02
LANL	CO	1277	1.3E-03	2.5E-03	1.1E-07	7.4E-03	2.2E-02
	NM	1277	5.8E-04	4.0E-04	2.3E-09	3.7E-04	4.5E-04
	NV	1277	9.9E-05	5.2E-05	2.3E-11	0.0E+00	6.9E-03
	UT	1277	1.1E-03	8.2E-04	2.2E-08	7.0E-04	4.8E-02
Site Total			3.1E-03	3.8E-03	1.4E-07	8.4E-03	7.8E-02
Mound	CO	803	1.5E-05	1.3E-05	7.8E-10	0.0E+00	2.6E-04
	IA	803	5.1E-04	1.2E-03	6.6E-07	3.6E-03	1.0E-02
	IL	803	2.3E-04	2.7E-03	4.1E-07	1.2E-02	1.1E-02
	IN	803	2.2E-04	9.8E-04	1.3E-07	3.5E-03	1.1E-02
	NE	803	6.8E-04	6.6E-04	3.0E-07	1.0E-03	8.6E-03
	NV	803	6.2E-05	3.3E-05	1.4E-11	0.0E+00	2.8E-04
	OH	803	4.2E-04	1.7E-03	1.2E-07	5.9E-03	1.5E-02
	UT	803	5.9E-04	9.2E-04	3.6E-08	2.9E-03	2.6E-02
	WY	803	6.6E-04	4.7E-04	7.3E-09	5.4E-04	2.7E-03
Site Total			3.4E-03	8.7E-03	1.6E-06	2.9E-02	8.4E-02
ORR	CO	3283	6.2E-05	5.2E-05	3.2E-09	0.0E+00	1.1E-03
	IL	3283	9.7E-04	2.7E-03	1.7E-06	9.5E-03	4.3E-02
	IN	3283	7.6E-04	1.0E-03	4.8E-07	2.3E-03	3.7E-02
	KS	3283	1.1E-03	1.1E-03	3.2E-07	1.7E-03	1.8E-02
	KY	3283	1.3E-03	2.5E-03	1.2E-07	8.7E-03	3.1E-02
	MO	3283	1.7E-03	3.6E-03	2.8E-07	1.1E-02	3.3E-02
	NE	3283	2.5E-03	1.9E-03	1.1E-06	1.5E-03	3.1E-02
	NV	3283	2.6E-04	1.3E-04	5.8E-11	0.0E+00	1.2E-03
	TN	3283	4.8E-04	4.0E-04	3.8E-08	1.4E-04	1.5E-02
	UT	3283	2.4E-03	3.8E-03	1.5E-07	1.2E-02	1.0E-01
	WY	3283	2.7E-03	1.9E-03	3.0E-08	2.2E-03	1.1E-02
Site Total			1.4E-02	1.9E-02	4.2E-06	4.9E-02	3.3E-01
RFETS	CO	814	4.2E-04	3.3E-04	2.1E-08	2.4E-04	7.3E-03
	NV	814	6.3E-05	3.3E-05	1.5E-11	0.0E+00	2.9E-04
	UT	814	7.1E-04	5.3E-04	1.4E-08	4.4E-04	3.1E-02
Site Total			1.2E-03	8.9E-04	3.6E-08	6.8E-04	3.8E-02

Table C.3. Truck Transport From LLW Generators To NTS - High Waste Volume - Avoid Las Vegas

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks: Incident-Free Crew	Cargo-Related Risks: Incident-Free Public	Cargo-Related Risks: Accident Public	Round-Trip Vehicle-Related Risks: Emission	Round-Trip Vehicle-Related Risks: Accident
Ames	AZ	5	7.2E-07	1.1E-06	2.5E-12	0.0E+00	4.4E-06
	CO	5	1.3E-05	1.8E-05	8.8E-10	4.2E-06	8.3E-05
	IA	5	5.1E-06	7.0E-06	1.2E-09	3.4E-06	2.6E-05
	NE	5	9.7E-06	1.5E-05	3.3E-09	9.7E-06	7.8E-05
	NV	5	1.1E-05	1.7E-05	1.6E-11	0.0E+00	1.2E-04
	UT	5	9.5E-06	1.4E-05	9.8E-11	2.3E-06	7.0E-05
Site Total			4.9E-05	7.2E-05	5.5E-09	1.9E-05	3.8E-04
ANL-E	AZ	526	7.6E-05	1.2E-04	2.6E-10	0.0E+00	4.6E-04
	CO	526	1.3E-03	1.9E-03	9.2E-08	4.4E-04	8.8E-03
	IA	526	9.1E-04	1.3E-03	2.3E-07	6.8E-05	4.9E-03
	IL	526	4.8E-04	6.6E-04	2.0E-07	3.6E-04	2.1E-03
	NE	526	1.0E-03	1.5E-03	3.5E-07	1.0E-03	8.2E-03
	NV	526	1.2E-03	1.8E-03	1.7E-09	0.0E+00	1.3E-02
	UT	526	1.0E-03	1.5E-03	1.0E-08	2.4E-04	7.3E-03
Site Total			6.0E-03	8.8E-03	8.8E-07	2.1E-03	4.4E-02
BCL	AZ	345	6.7E-04	1.0E-03	4.5E-09	1.9E-04	3.8E-03
	CA	345	5.4E-04	8.3E-04	1.4E-08	1.1E-04	2.4E-03
	IL	345	3.3E-04	4.5E-04	1.5E-07	1.1E-04	1.5E-03
	IN	345	3.6E-04	4.9E-04	9.0E-08	6.3E-04	1.2E-03
	MO	345	6.6E-04	9.1E-04	1.1E-07	1.2E-03	4.0E-03
	NM	345	7.1E-04	1.1E-03	4.9E-09	8.7E-04	4.9E-03
	NV	345	7.9E-05	1.2E-04	9.8E-11	0.0E+00	8.5E-04
	OH	345	2.6E-04	3.2E-04	2.2E-08	4.4E-04	4.3E-04
	OK	345	7.4E-04	1.0E-03	4.8E-08	6.6E-04	5.3E-03
	TX	345	3.3E-04	5.0E-04	4.2E-08	2.9E-04	2.6E-03
Site Total			4.7E-03	6.7E-03	4.8E-07	4.5E-03	2.7E-02
BNL	AZ	1338	1.9E-04	3.0E-04	6.6E-10	0.0E+00	1.2E-03
	CO	1338	3.4E-03	4.9E-03	2.3E-07	1.1E-03	2.2E-02
	IA	1338	2.3E-03	3.3E-03	5.9E-07	1.7E-04	1.2E-02
	IL	1338	1.5E-03	2.0E-03	5.2E-07	2.4E-03	5.9E-03
	IN	1338	1.5E-03	1.9E-03	3.3E-07	1.9E-03	4.4E-03
	NE	1338	2.6E-03	3.9E-03	8.8E-07	2.6E-03	2.1E-02
	NJ	1338	9.5E-04	1.3E-03	1.3E-07	5.8E-03	3.6E-03
	NV	1338	3.0E-03	4.6E-03	4.4E-09	0.0E+00	3.2E-02
	NY	1338	1.2E-03	1.6E-03	1.9E-07	9.6E-03	5.8E-03
	OH	1338	2.4E-03	2.8E-03	2.0E-07	1.4E-03	4.0E-03
	PA	1338	2.5E-03	3.4E-03	1.9E-07	7.3E-04	1.8E-02

Site	State	No. of Trips	Cargo-Related Risks: Incident-Free Crew	Cargo-Related Risks: Incident-Free Public	Cargo-Related Risks: Accident Public	Round-Trip Vehicle-Related Risks: Emission	Round-Trip Vehicle-Related Risks: Accident
	UT	1338	2.6E-03	3.8E-03	2.6E-08	6.0E-04	1.9E-02
Site Total			2.4E-02	3.4E-02	3.3E-06	2.6E-02	1.5E-01
ETEC	CA	128	3.0E-04	4.7E-04	9.2E-09	2.0E-03	8.5E-04
	NV	128	2.9E-05	4.5E-05	3.7E-11	0.0E+00	3.2E-04
Site Total			3.2E-04	5.2E-04	9.2E-09	2.0E-03	1.2E-03
FEMP	AZ	3137	6.1E-03	9.1E-03	4.1E-08	1.7E-03	3.5E-02
	CA	3137	5.0E-03	7.5E-03	1.3E-07	1.0E-03	2.2E-02
	IL	3137	3.0E-03	4.1E-03	1.3E-06	1.0E-03	1.4E-02
	IN	3137	3.3E-03	4.2E-03	8.7E-07	7.1E-04	1.1E-02
	MO	3137	6.0E-03	8.2E-03	1.0E-06	1.1E-02	3.6E-02
	NM	3137	6.4E-03	9.7E-03	4.5E-08	7.9E-03	4.4E-02
	NV	3137	7.2E-04	1.1E-03	9.0E-10	0.0E+00	7.8E-03
	OH	3137	3.9E-04	3.9E-04	2.0E-08	0.0E+00	5.5E-04
	OK	3137	6.8E-03	9.4E-03	4.4E-07	6.0E-03	4.8E-02
	TX	3137	3.0E-03	4.6E-03	3.9E-07	2.6E-03	2.3E-02
Site Total			4.1E-02	5.8E-02	4.2E-06	3.2E-02	2.4E-01
GE-Val	CA	1	2.8E-06	4.3E-06	7.2E-11	2.4E-06	1.2E-05
	NV	1	2.3E-07	3.5E-07	2.9E-13	0.0E+00	2.5E-06
Site Total			3.1E-06	4.7E-06	7.3E-11	2.4E-06	1.4E-05
GJPO	AZ	3	4.3E-07	6.7E-07	1.5E-12	0.0E+00	2.6E-06
	CO	3	5.5E-07	7.6E-07	3.4E-11	0.0E+00	3.5E-06
	NV	3	6.6E-06	1.0E-05	9.8E-12	0.0E+00	7.2E-05
	UT	3	5.7E-06	8.6E-06	5.9E-11	1.4E-06	4.2E-05
Site Total			1.3E-05	2.0E-05	1.0E-10	1.4E-06	1.2E-04
INEL	ID	933	1.4E-03	2.1E-03	6.9E-08	5.4E-04	3.2E-03
	NV	933	2.3E-03	3.5E-03	9.4E-09	1.5E-04	2.4E-02
	OR	933	5.6E-04	8.7E-04	5.6E-09	0.0E+00	4.1E-03
Site Total			4.3E-03	6.5E-03	8.4E-08	6.9E-04	3.2E-02
ITRI	AZ	87	1.7E-04	2.5E-04	1.2E-09	4.8E-05	9.7E-04
	CA	87	1.4E-04	2.1E-04	3.5E-09	2.8E-05	6.0E-04
	NM	87	8.7E-05	1.3E-04	9.7E-10	1.5E-04	5.6E-04
	NV	87	2.0E-05	3.1E-05	2.5E-11	0.0E+00	2.2E-04
Site Total			4.1E-04	6.2E-04	5.6E-09	2.3E-04	2.3E-03
SPRU	AZ	309	4.5E-05	6.9E-05	1.5E-10	0.0E+00	2.7E-04
	CO	309	7.9E-04	1.1E-03	5.4E-08	2.6E-04	5.2E-03
	IA	309	5.4E-04	7.5E-04	1.4E-07	4.0E-05	2.9E-03
	IL	309	3.4E-04	4.6E-04	1.2E-07	5.6E-04	1.4E-03

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	IN	309	3.4E-04	4.3E-04	7.5E-08	4.5E-04	1.0E-03
	NE	309	6.0E-04	9.0E-04	2.0E-07	6.0E-04	4.8E-03
	NV	309	6.8E-04	1.1E-03	1.0E-09	0.0E+00	7.4E-03
	NY	309	8.3E-04	9.7E-04	7.2E-08	8.8E-04	5.7E-03
	OH	309	5.9E-04	7.6E-04	5.0E-08	1.5E-03	9.6E-04
	PA	309	1.1E-04	1.2E-04	7.2E-09	0.0E+00	6.3E-04
	UT	309	5.9E-04	8.8E-04	6.1E-09	1.4E-04	4.3E-03
Site Total			5.4E-03	7.5E-03	7.3E-07	4.4E-03	3.5E-02
LBNL	CA	17	5.4E-05	8.3E-05	1.5E-09	9.4E-05	2.2E-04
	NV	17	3.9E-06	6.0E-06	4.9E-12	0.0E+00	4.2E-05
	CA	1397	3.8E-03	5.8E-03	9.6E-08	2.1E-03	1.7E-02
	NV	1397	3.2E-04	4.9E-04	4.0E-10	0.0E+00	3.5E-03
Site Total			4.2E-03	6.4E-03	9.8E-08	2.2E-03	2.0E-02
LLNL	CA	1397	3.8E-03	5.8E-03	9.6E-08	2.1E-03	1.7E-02
	NV	1397	3.2E-04	4.9E-04	4.0E-10	0.0E+00	3.5E-03
Site Total			4.1E-03	6.3E-03	9.7E-08	2.1E-03	2.0E-02
LANL	AZ	3829	7.4E-03	1.1E-02	5.0E-08	2.1E-03	4.3E-02
	CA	3829	6.0E-03	9.2E-03	1.5E-07	1.2E-03	2.7E-02
	NM	3829	5.5E-03	8.0E-03	5.6E-08	3.2E-03	3.7E-02
	NV	3829	8.7E-04	1.4E-03	1.1E-09	0.0E+00	9.5E-03
Site Total			2.0E-02	3.0E-02	2.6E-07	6.5E-03	1.2E-01
Mound	AZ	2409	4.7E-03	7.0E-03	3.2E-08	1.3E-03	2.7E-02
	CA	2409	3.8E-03	5.8E-03	9.6E-08	7.8E-04	1.7E-02
	IL	2409	2.3E-03	3.2E-03	1.0E-06	7.8E-04	1.0E-02
	IN	2409	2.5E-03	3.4E-03	6.3E-07	4.4E-03	8.1E-03
	MO	2409	4.6E-03	6.3E-03	7.7E-07	8.3E-03	2.8E-02
	NM	2409	4.9E-03	7.5E-03	3.4E-08	6.1E-03	3.4E-02
	NV	2409	5.5E-04	8.5E-04	6.9E-10	0.0E+00	6.0E-03
	OH	2409	9.5E-04	1.2E-03	7.4E-08	2.8E-03	1.4E-03
	OK	2409	5.2E-03	7.2E-03	3.4E-07	4.6E-03	3.7E-02
	TX	2409	2.3E-03	3.5E-03	3.0E-07	2.0E-03	1.8E-02
Site Total			3.2E-02	4.6E-02	3.3E-06	3.1E-02	1.9E-01
ORR	AR	9848	1.7E-02	2.3E-02	4.3E-07	2.2E-03	5.6E-02
	AZ	9848	1.9E-02	2.9E-02	1.3E-07	5.4E-03	1.1E-01
	CA	9848	1.6E-02	2.4E-02	3.9E-07	3.2E-03	6.8E-02
	NM	9848	2.0E-02	3.1E-02	1.4E-07	2.5E-02	1.4E-01
	NV	9848	2.3E-03	3.5E-03	2.8E-09	0.0E+00	2.4E-02
	OK	9848	1.9E-02	2.6E-02	1.2E-06	6.7E-03	1.4E-01

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	TN	9848	2.4E-02	3.3E-02	5.9E-07	3.5E-02	1.2E-01
	TX	9848	9.5E-03	1.4E-02	1.2E-06	8.2E-03	7.3E-02
Site Total			1.3E-01	1.8E-01	4.1E-06	8.5E-02	7.3E-01
PGDP	AZ	165	3.2E-04	4.8E-04	2.2E-09	9.0E-05	1.8E-03
	CA	165	2.6E-04	4.0E-04	6.6E-09	5.3E-05	1.1E-03
	IL	165	1.6E-06	2.5E-06	9.7E-10	0.0E+00	8.8E-06
	KY	165	2.4E-05	3.5E-05	2.1E-09	0.0E+00	1.8E-04
	MO	165	3.5E-04	4.8E-04	6.4E-08	1.4E-04	2.3E-03
	NM	165	3.4E-04	5.1E-04	2.4E-09	4.1E-04	2.3E-03
	NV	165	3.8E-05	5.8E-05	4.7E-11	0.0E+00	4.1E-04
	OK	165	3.6E-04	4.9E-04	2.3E-08	3.1E-04	2.5E-03
	TX	165	1.6E-04	2.4E-04	2.0E-08	1.4E-04	1.2E-03
Site Total			1.8E-03	2.7E-03	1.2E-07	1.2E-03	1.2E-02
Pantex	AZ	53	1.0E-04	1.5E-04	7.0E-10	2.9E-05	5.9E-04
	CA	53	8.4E-05	1.3E-04	2.1E-09	1.7E-05	3.7E-04
	NM	53	1.1E-04	1.6E-04	7.6E-10	1.3E-04	7.5E-04
	NV	53	1.2E-05	1.9E-05	1.5E-11	0.0E+00	1.3E-04
	TX	53	2.8E-05	4.1E-05	4.0E-09	4.4E-05	2.0E-04
Site Total			3.4E-04	5.0E-04	7.6E-09	2.2E-04	2.0E-03
Ports	AZ	77	1.5E-04	2.2E-04	1.0E-09	4.2E-05	8.6E-04
	CA	77	1.2E-04	1.9E-04	3.1E-09	2.5E-05	5.3E-04
	IL	77	6.0E-05	8.7E-05	2.7E-08	8.4E-05	2.7E-04
	IN	77	5.2E-05	7.4E-05	1.8E-08	5.0E-06	2.0E-04
	KY	77	6.3E-05	8.2E-05	5.8E-09	1.8E-04	3.3E-04
	MO	77	1.5E-04	2.0E-04	2.5E-08	2.7E-04	8.9E-04
	NM	77	1.6E-04	2.4E-04	1.1E-09	1.9E-04	1.1E-03
	NV	77	1.8E-05	2.7E-05	2.2E-11	0.0E+00	1.9E-04
	OH	77	4.4E-05	5.6E-05	4.7E-09	9.9E-06	8.5E-05
	OK	77	1.7E-04	2.3E-04	1.1E-08	1.5E-04	1.2E-03
	TX	77	7.5E-05	1.1E-04	9.5E-09	6.4E-05	5.7E-04
Site Total			1.1E-03	1.5E-03	1.0E-07	1.0E-03	6.2E-03
PPPL	AZ	74	1.4E-04	2.1E-04	9.7E-10	4.1E-05	8.2E-04
	CA	74	1.2E-04	1.8E-04	3.0E-09	2.4E-05	5.1E-04
	IL	74	7.0E-05	9.7E-05	3.1E-08	2.4E-05	3.2E-04
	IN	74	7.7E-05	1.0E-04	1.9E-08	1.4E-04	2.5E-04
	MO	74	1.4E-04	1.9E-04	2.4E-08	2.6E-04	8.6E-04
	NJ	74	1.0E-05	1.3E-05	1.5E-09	4.8E-05	3.8E-05
	NM	74	1.5E-04	2.3E-04	1.1E-09	1.9E-04	1.1E-03
	NV	74	1.7E-05	2.6E-05	2.1E-11	0.0E+00	1.8E-04
	OH	74	1.2E-04	1.6E-04	1.1E-08	2.7E-04	2.1E-04

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	OK	74	1.6E-04	2.2E-04	1.0E-08	1.4E-04	1.1E-03
	PA	74	2.1E-04	2.4E-04	2.1E-08	2.7E-04	1.1E-03
	TX	74	7.2E-05	1.1E-04	9.1E-09	6.2E-05	5.5E-04
	WV	74	9.5E-06	1.3E-05	3.3E-10	5.5E-05	5.6E-05
Site Total			1.3E-03	1.8E-03	1.3E-07	1.5E-03	7.1E-03
RFETS	AZ	2441	3.5E-04	5.5E-04	1.2E-09	0.0E+00	2.2E-03
	CO	2441	4.0E-03	5.5E-03	2.8E-07	1.6E-03	2.5E-02
	NV	2441	5.4E-03	8.4E-03	8.0E-09	0.0E+00	5.8E-02
	UT	2441	4.7E-03	7.0E-03	4.8E-08	1.1E-03	3.4E-02
Site Total			1.4E-02	2.1E-02	3.4E-07	2.7E-03	1.2E-01
SNLA	AZ	191	3.7E-04	5.5E-04	2.5E-09	1.1E-04	2.1E-03
	CA	191	3.0E-04	4.6E-04	7.6E-09	6.2E-05	1.3E-03
	NM	191	1.9E-04	2.8E-04	2.1E-09	3.3E-04	1.2E-03
	NV	191	4.4E-05	6.8E-05	5.5E-11	0.0E+00	4.7E-04
Site Total			9.0E-04	1.4E-03	1.2E-08	5.0E-04	5.1E-03
WVDP	AZ	424	6.1E-05	9.5E-05	2.1E-10	0.0E+00	3.7E-04
	CO	424	1.1E-03	1.5E-03	7.4E-08	3.6E-04	7.1E-03
	IA	424	7.4E-04	1.0E-03	1.9E-07	5.5E-05	3.9E-03
	IL	424	4.7E-04	6.3E-04	1.7E-07	7.6E-04	1.9E-03
	IN	424	4.6E-04	5.9E-04	1.0E-07	6.1E-04	1.4E-03
	NE	424	8.2E-04	1.2E-03	2.8E-07	8.2E-04	6.6E-03
	NV	424	9.4E-04	1.5E-03	1.4E-09	0.0E+00	1.0E-02
	NY	424	2.1E-04	2.5E-04	1.4E-08	5.5E-05	1.5E-03
	OH	424	8.1E-04	1.0E-03	6.9E-08	2.1E-03	1.3E-03
	PA	424	1.5E-04	1.7E-04	9.9E-09	0.0E+00	8.6E-04
	UT	424	8.1E-04	1.2E-03	8.3E-09	1.9E-04	5.9E-03
Site Total			6.5E-03	9.2E-03	9.1E-07	5.0E-03	4.1E-02

Table C.4 Truck Transport From LLW Generators To NTS - High Waste Volume - Travel Through Las Vegas

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Ames	AZ	5	7.2E-07	1.1E-06	2.5E-12	0.0E+00	4.4E-06
	CO	5	1.3E-05	1.8E-05	8.8E-10	4.2E-06	8.3E-05
	IA	5	5.1E-06	7.0E-06	1.2E-09	3.4E-06	2.6E-05
	NE	5	9.7E-06	1.5E-05	3.3E-09	9.7E-06	7.8E-05
	NV	5	4.2E-06	6.2E-06	9.9E-11	5.5E-06	1.6E-05
	UT	5	9.5E-06	1.4E-05	9.8E-11	2.3E-06	7.0E-05
Site Total			4.2E-05	6.1E-05	5.5E-09	2.5E-05	2.8E-04
ANL-E	AZ	526	7.6E-05	1.2E-04	2.6E-10	0.0E+00	4.6E-04
	CO	526	1.3E-03	1.9E-03	9.2E-08	4.4E-04	8.8E-03
	IA	526	9.1E-04	1.3E-03	2.3E-07	6.8E-05	4.9E-03
	IL	526	4.8E-04	6.6E-04	2.0E-07	3.6E-04	2.1E-03
	NE	526	1.0E-03	1.5E-03	3.5E-07	1.0E-03	8.2E-03
	NV	526	4.4E-04	6.6E-04	1.0E-08	5.8E-04	1.6E-03
	UT	526	1.0E-03	1.5E-03	1.0E-08	2.4E-04	7.3E-03
Site Total			5.3E-03	7.7E-03	8.9E-07	2.7E-03	3.3E-02
BCL	AZ	345	6.9E-04	1.0E-03	4.7E-09	1.9E-04	4.0E-03
	IL	345	3.3E-04	4.5E-04	1.5E-07	1.1E-04	1.5E-03
	IN	345	3.6E-04	4.9E-04	9.0E-08	6.3E-04	1.2E-03
	MO	345	6.6E-04	9.1E-04	1.1E-07	1.2E-03	4.0E-03
	NM	345	7.1E-04	1.1E-03	4.9E-09	8.7E-04	4.9E-03
	NV	345	2.4E-04	3.6E-04	7.7E-09	1.1E-03	7.2E-04
	OH	345	2.6E-04	3.2E-04	2.2E-08	4.4E-04	4.3E-04
	OK	345	7.4E-04	1.0E-03	4.8E-08	6.6E-04	5.3E-03
	TX	345	3.3E-04	5.0E-04	4.2E-08	2.9E-04	2.6E-03
Site Total			4.3E-03	6.2E-03	4.8E-07	5.4E-03	2.4E-02
BNL	AZ	1338	1.9E-04	3.0E-04	6.6E-10	0.0E+00	1.2E-03
	CO	1338	3.4E-03	4.9E-03	2.3E-07	1.1E-03	2.2E-02
	IA	1338	2.3E-03	3.3E-03	5.9E-07	1.7E-04	1.2E-02
	IL	1338	1.5E-03	2.0E-03	5.2E-07	2.4E-03	5.9E-03
	IN	1338	1.5E-03	1.9E-03	3.3E-07	1.9E-03	4.4E-03
	NE	1338	2.6E-03	3.9E-03	8.8E-07	2.6E-03	2.1E-02
	NJ	1338	9.5E-04	1.3E-03	1.3E-07	5.8E-03	3.6E-03
	NV	1338	1.1E-03	1.7E-03	2.6E-08	1.5E-03	4.2E-03
	NY	1338	1.2E-03	1.6E-03	1.9E-07	9.6E-03	5.8E-03
	OH	1338	2.4E-03	2.8E-03	2.0E-07	1.4E-03	4.0E-03
	PA	1338	2.5E-03	3.4E-03	1.9E-07	7.3E-04	1.8E-02

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	UT	1338	2.6E-03	3.8E-03	2.6E-08	6.0E-04	1.9E-02
Site Total			2.2E-02	3.1E-02	3.3E-06	2.8E-02	1.2E-01
ETEC	CA	128	2.7E-04	4.3E-04	8.5E-09	2.0E-03	7.4E-04
	NV	128	8.0E-05	1.2E-04	1.5E-09	7.8E-05	2.9E-04
Site Total			3.5E-04	5.5E-04	1.0E-08	2.1E-03	1.0E-03
FEMP	AZ	3137	6.3E-03	9.4E-03	4.3E-08	1.7E-03	3.6E-02
	IL	3137	3.0E-03	4.1E-03	1.3E-06	1.0E-03	1.4E-02
	IN	3137	3.3E-03	4.2E-03	8.7E-07	7.1E-04	1.1E-02
	MO	3137	6.0E-03	8.2E-03	1.0E-06	1.1E-02	3.6E-02
	NM	3137	6.4E-03	9.7E-03	4.5E-08	7.9E-03	4.4E-02
	NV	3137	2.2E-03	3.3E-03	7.0E-08	9.7E-03	6.5E-03
	OH	3137	3.9E-04	3.9E-04	2.0E-08	0.0E+00	5.5E-04
	OK	3137	6.8E-03	9.4E-03	4.4E-07	6.0E-03	4.8E-02
	TX	3137	3.0E-03	4.6E-03	3.9E-07	2.6E-03	2.3E-02
Site Total			3.7E-02	5.3E-02	4.2E-06	4.0E-02	2.2E-01
GE-Val	CA	1	2.6E-06	4.0E-06	6.8E-11	2.4E-06	1.1E-05
	NV	1	6.3E-07	9.0E-07	1.2E-11	6.1E-07	2.3E-06
Site Total			3.3E-06	4.9E-06	8.0E-11	3.0E-06	1.3E-05
GJPO	AZ	3	4.3E-07	6.7E-07	1.5E-12	0.0E+00	2.6E-06
	CO	3	5.5E-07	7.6E-07	3.4E-11	0.0E+00	3.5E-06
	NV	3	2.5E-06	3.7E-06	5.9E-11	3.3E-06	9.3E-06
	UT	3	5.7E-06	8.6E-06	5.9E-11	1.4E-06	4.2E-05
Site Total			9.2E-06	1.4E-05	1.5E-10	4.6E-06	5.7E-05
INEL	AZ	933	1.4E-04	2.1E-04	4.6E-10	0.0E+00	8.2E-04
	ID	933	6.7E-04	9.8E-04	3.3E-08	1.8E-04	1.5E-03
	NV	933	7.9E-04	1.2E-03	1.8E-08	1.0E-03	2.9E-03
	UT	933	2.4E-03	3.4E-03	9.4E-08	4.3E-03	1.4E-02
Site Total			4.0E-03	5.7E-03	1.5E-07	5.5E-03	2.0E-02
ITRI	AZ	87	1.7E-04	2.6E-04	1.2E-09	4.8E-05	1.0E-03
	NM	87	8.7E-05	1.3E-04	9.7E-10	1.5E-04	5.6E-04
	NV	87	6.1E-05	9.0E-05	1.9E-09	2.7E-04	1.8E-04
Site Total			3.2E-04	4.8E-04	4.1E-09	4.7E-04	1.7E-03
SPRU	AZ	309	4.5E-05	6.9E-05	1.5E-10	0.0E+00	2.7E-04
	CO	309	7.9E-04	1.1E-03	5.4E-08	2.6E-04	5.2E-03
	IA	309	5.4E-04	7.5E-04	1.4E-07	4.0E-05	2.9E-03
	IL	309	3.4E-04	4.6E-04	1.2E-07	5.6E-04	1.4E-03
	IN	309	3.4E-04	4.3E-04	7.5E-08	4.5E-04	1.0E-03

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
	NE	309	6.0E-04	9.0E-04	2.0E-07	6.0E-04	4.8E-03
	NV	309	2.6E-04	3.9E-04	6.1E-09	3.4E-04	9.6E-04
	NY	309	8.3E-04	9.7E-04	7.2E-08	8.8E-04	5.7E-03
	OH	309	5.9E-04	7.6E-04	5.0E-08	1.5E-03	9.6E-04
	PA	309	1.1E-04	1.2E-04	7.2E-09	0.0E+00	6.3E-04
	UT	309	5.9E-04	8.8E-04	6.1E-09	1.4E-04	4.3E-03
Site Total			5.0E-03	6.8E-03	7.3E-07	4.8E-03	2.8E-02
LBNL	CA	17	5.1E-05	7.7E-05	1.4E-09	9.4E-05	2.0E-04
	NV	17	1.1E-05	1.5E-05	2.1E-10	1.0E-05	3.9E-05
	CA	1397	3.6E-03	5.4E-03	9.0E-08	2.1E-03	1.5E-02
	NV	1397	8.8E-04	1.3E-03	1.7E-08	8.5E-04	3.2E-03
Site Total			4.5E-03	6.7E-03	1.1E-07	3.0E-03	1.9E-02
LLNL	CA	1397	3.6E-03	5.4E-03	9.0E-08	2.1E-03	1.5E-02
	NV	1397	8.8E-04	1.3E-03	1.7E-08	8.5E-04	3.2E-03
Site Total			4.4E-03	6.6E-03	1.1E-07	2.9E-03	1.8E-02
LANL	AZ	3829	7.7E-03	1.2E-02	5.2E-08	2.1E-03	4.4E-02
	NM	3829	5.5E-03	8.0E-03	5.6E-08	3.2E-03	3.7E-02
	NV	3829	2.7E-03	4.0E-03	8.5E-08	1.2E-02	8.0E-03
Site Total			1.6E-02	2.3E-02	1.9E-07	1.7E-02	8.9E-02
Mound	AZ	2409	4.8E-03	7.2E-03	3.3E-08	1.3E-03	2.8E-02
	IL	2409	2.3E-03	3.2E-03	1.0E-06	7.8E-04	1.0E-02
	IN	2409	2.5E-03	3.4E-03	6.3E-07	4.4E-03	8.1E-03
	MO	2409	4.6E-03	6.3E-03	7.7E-07	8.3E-03	2.8E-02
	NM	2409	4.9E-03	7.5E-03	3.4E-08	6.1E-03	3.4E-02
	NV	2409	1.7E-03	2.5E-03	5.4E-08	7.4E-03	5.0E-03
	OH	2409	9.5E-04	1.2E-03	7.4E-08	2.8E-03	1.4E-03
	OK	2409	5.2E-03	7.2E-03	3.4E-07	4.6E-03	3.7E-02
	TX	2409	2.3E-03	3.5E-03	3.0E-07	2.0E-03	1.8E-02
Site Total			2.9E-02	4.2E-02	3.2E-06	3.8E-02	1.7E-01
ORR	AR	9848	1.7E-02	2.3E-02	4.3E-07	2.2E-03	5.6E-02
	AZ	9848	2.0E-02	3.0E-02	1.3E-07	5.4E-03	1.1E-01
	NM	9848	2.0E-02	3.1E-02	1.4E-07	2.5E-02	1.4E-01
	NV	9848	6.9E-03	1.0E-02	2.2E-07	3.0E-02	2.1E-02
	OK	9848	1.9E-02	2.6E-02	1.2E-06	6.7E-03	1.4E-01
	TN	9848	2.4E-02	3.3E-02	5.9E-07	3.5E-02	1.2E-01
	TX	9848	9.5E-03	1.4E-02	1.2E-06	8.2E-03	7.3E-02
Site Total			1.2E-01	1.7E-01	3.9E-06	1.1E-01	6.6E-01

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
PGDP	AZ	165	3.3E-04	5.0E-04	2.2E-09	9.0E-05	1.9E-03
	IL	165	1.6E-06	2.5E-06	9.7E-10	0.0E+00	8.8E-06
	KY	165	2.4E-05	3.5E-05	2.1E-09	0.0E+00	1.8E-04
	MO	165	3.5E-04	4.8E-04	6.4E-08	1.4E-04	2.3E-03
	NM	165	3.4E-04	5.1E-04	2.4E-09	4.1E-04	2.3E-03
	NV	165	1.2E-04	1.7E-04	3.7E-09	5.1E-04	3.4E-04
	OK	165	3.6E-04	4.9E-04	2.3E-08	3.1E-04	2.5E-03
	TX	165	1.6E-04	2.4E-04	2.0E-08	1.4E-04	1.2E-03
Site Total			1.7E-03	2.4E-03	1.2E-07	1.6E-03	1.1E-02
Pantex	AZ	53	1.1E-04	1.6E-04	7.2E-10	2.9E-05	6.1E-04
	NM	53	1.1E-04	1.6E-04	7.6E-10	1.3E-04	7.5E-04
	NV	53	3.7E-05	5.5E-05	1.2E-09	1.6E-04	1.1E-04
	TX	53	2.8E-05	4.1E-05	4.0E-09	4.4E-05	2.0E-04
Site Total			2.8E-04	4.2E-04	6.7E-09	3.7E-04	1.7E-03
Ports	AZ	77	1.5E-04	2.3E-04	1.0E-09	4.2E-05	8.9E-04
	IL	77	6.0E-05	8.7E-05	2.7E-08	8.4E-05	2.7E-04
	IN	77	5.2E-05	7.4E-05	1.8E-08	5.0E-06	2.0E-04
	KY	77	6.3E-05	8.2E-05	5.8E-09	1.8E-04	3.3E-04
	MO	77	1.5E-04	2.0E-04	2.5E-08	2.7E-04	8.9E-04
	NM	77	1.6E-04	2.4E-04	1.1E-09	1.9E-04	1.1E-03
	NV	77	5.4E-05	8.0E-05	1.7E-09	2.4E-04	1.6E-04
	OH	77	4.4E-05	5.6E-05	4.7E-09	9.9E-06	8.5E-05
	OK	77	1.7E-04	2.3E-04	1.1E-08	1.5E-04	1.2E-03
	TX	77	7.5E-05	1.1E-04	9.5E-09	6.4E-05	5.7E-04
Site Total			9.7E-04	1.4E-03	1.0E-07	1.2E-03	5.7E-03
PPPL	AZ	74	1.5E-04	2.2E-04	1.0E-09	4.1E-05	8.5E-04
	IL	74	7.0E-05	9.7E-05	3.1E-08	2.4E-05	3.2E-04
	IN	74	7.7E-05	1.0E-04	1.9E-08	1.4E-04	2.5E-04
	MO	74	1.4E-04	1.9E-04	2.4E-08	2.6E-04	8.6E-04
	NJ	74	1.0E-05	1.3E-05	1.5E-09	4.8E-05	3.8E-05
	NM	74	1.5E-04	2.3E-04	1.1E-09	1.9E-04	1.1E-03
	NV	74	5.2E-05	7.7E-05	1.7E-09	2.3E-04	1.5E-04
	OH	74	1.2E-04	1.6E-04	1.1E-08	2.7E-04	2.1E-04
	OK	74	1.6E-04	2.2E-04	1.0E-08	1.4E-04	1.1E-03
	PA	74	2.1E-04	2.4E-04	2.1E-08	2.7E-04	1.1E-03
	TX	74	7.2E-05	1.1E-04	9.1E-09	6.2E-05	5.5E-04
	WV	74	9.5E-06	1.3E-05	3.3E-10	5.5E-05	5.6E-05
Site Total			1.2E-03	1.7E-03	1.3E-07	1.7E-03	6.6E-03

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
RFETS	AZ	2441	3.5E-04	5.5E-04	1.2E-09	0.0E+00	2.2E-03
	CO	2441	4.0E-03	5.5E-03	2.8E-07	1.6E-03	2.5E-02
	NV	2441	2.1E-03	3.0E-03	4.8E-08	2.7E-03	7.6E-03
	UT	2441	4.7E-03	7.0E-03	4.8E-08	1.1E-03	3.4E-02
Site Total			1.1E-02	1.6E-02	3.8E-07	5.3E-03	6.9E-02
SNLA	AZ	191	3.8E-04	5.7E-04	2.6E-09	1.1E-04	2.2E-03
	NM	191	1.9E-04	2.8E-04	2.1E-09	3.3E-04	1.2E-03
	NV	191	1.4E-04	2.0E-04	4.3E-09	5.9E-04	4.0E-04
Site Total			7.1E-04	1.1E-03	9.0E-09	1.0E-03	3.8E-03
WVDP	AZ	424	6.1E-05	9.5E-05	2.1E-10	0.0E+00	3.7E-04
	CO	424	1.1E-03	1.5E-03	7.4E-08	3.6E-04	7.1E-03
	IA	424	7.4E-04	1.0E-03	1.9E-07	5.5E-05	3.9E-03
	IL	424	4.7E-04	6.3E-04	1.7E-07	7.6E-04	1.9E-03
	IN	424	4.6E-04	5.9E-04	1.0E-07	6.1E-04	1.4E-03
	NE	424	8.2E-04	1.2E-03	2.8E-07	8.2E-04	6.6E-03
	NV	424	3.6E-04	5.3E-04	8.4E-09	4.6E-04	1.3E-03
	NY	424	2.1E-04	2.5E-04	1.4E-08	5.5E-05	1.5E-03
	OH	424	8.1E-04	1.0E-03	6.9E-08	2.1E-03	1.3E-03
	PA	424	1.5E-04	1.7E-04	9.9E-09	0.0E+00	8.6E-04
	UT	424	8.1E-04	1.2E-03	8.3E-09	1.9E-04	5.9E-03
Site Total			6.0E-03	8.3E-03	9.2E-07	5.4E-03	3.2E-02

Table C.5. Rail Transport From LLW Generators To Barstow - Low Waste Volume

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
LLNL	CA	466	3.5E-04	1.3E-03	6.1E-08	5.4E-03	2.1E-02
Site Total			3.5E-04	1.3E-03	6.1E-08	5.4E-03	2.1E-02
LANL	AZ	1264	9.3E-04	7.7E-04	8.3E-09	1.2E-03	1.7E-02
	CA	1264	4.3E-04	2.5E-04	2.8E-08	5.3E-05	2.6E-02
	NM	1264	4.6E-04	3.1E-04	2.1E-09	2.1E-04	5.5E-03
Site Total			1.8E-03	1.3E-03	3.8E-08	1.5E-03	4.8E-02
Mound	AZ	803	5.9E-04	4.9E-04	5.3E-09	7.7E-04	1.1E-02
	CA	803	2.8E-04	1.6E-04	1.8E-08	3.4E-05	1.7E-02
	IL	803	2.5E-04	4.4E-04	4.5E-07	1.2E-03	1.1E-02
	IN	803	2.4E-04	9.5E-04	1.2E-07	3.2E-03	1.2E-02
	KS	803	4.3E-04	6.0E-04	1.3E-07	1.7E-03	7.2E-03
	MO	803	5.0E-04	7.5E-04	7.5E-08	2.1E-03	9.8E-03
	NM	803	6.2E-04	3.9E-04	2.5E-09	2.4E-04	7.4E-03
	OH	803	3.0E-04	1.2E-03	8.6E-08	4.4E-03	1.1E-02
	OK	803	1.8E-04	9.3E-05	1.8E-08	0.0E+00	6.9E-03
	TX	803	3.3E-04	3.3E-04	3.4E-08	2.7E-04	1.4E-02
Site Total			3.7E-03	5.4E-03	9.4E-07	1.4E-02	1.1E-01
RFETS	AZ	814	6.0E-04	4.9E-04	5.4E-09	7.8E-04	1.1E-02
	CA	814	2.8E-04	1.6E-04	1.8E-08	3.4E-05	1.7E-02
	CO	814	4.0E-04	1.4E-03	5.3E-08	5.4E-03	7.0E-03
	NM	814	6.7E-04	4.5E-04	2.8E-09	4.1E-04	7.9E-03
Site Total			1.9E-03	2.5E-03	7.9E-08	6.6E-03	4.3E-02

Table C.6. Rail Transport From LLW Generators To Caliente - Low Waste Volume

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
LLNL	CA	466	1.8E-04	1.2E-03	4.9E-08	5.4E-03	1.1E-02
	NV	466	4.4E-04	4.6E-04	1.2E-09	1.1E-03	2.0E-03
	UT	466	3.3E-04	2.0E-04	2.5E-09	0.0E+00	1.4E-02
Site Total			9.5E-04	1.9E-03	5.3E-08	6.5E-03	2.7E-02
LANL	CO	1264	1.3E-03	2.5E-03	1.1E-07	7.3E-03	2.2E-02
	NM	1264	5.8E-04	4.2E-04	2.3E-09	3.7E-04	4.5E-04
	NV	1264	9.8E-05	5.5E-05	2.3E-11	0.0E+00	6.9E-03
	UT	1264	1.1E-03	8.6E-04	2.2E-08	6.9E-04	4.8E-02
Site Total			3.1E-03	3.8E-03	1.3E-07	8.4E-03	7.7E-02
Mound	CO	803	1.5E-05	1.3E-05	7.8E-10	0.0E+00	2.6E-04
	IA	803	5.1E-04	1.2E-03	6.6E-07	3.6E-03	1.0E-02
	IL	803	2.3E-04	2.7E-03	4.1E-07	1.2E-02	1.1E-02
	IN	803	2.2E-04	9.9E-04	1.3E-07	3.5E-03	1.1E-02
	NE	803	6.8E-04	6.9E-04	3.0E-07	1.0E-03	8.6E-03
	NV	803	6.2E-05	3.5E-05	1.4E-11	0.0E+00	2.8E-04
	OH	803	4.2E-04	1.7E-03	1.2E-07	5.9E-03	1.5E-02
	UT	803	5.9E-04	9.4E-04	3.6E-08	2.9E-03	2.6E-02
	WY	803	6.6E-04	4.9E-04	7.3E-09	5.4E-04	2.7E-03
Site Total			3.4E-03	8.8E-03	1.6E-06	2.9E-02	8.4E-02
RFETS	CO	814	4.2E-04	3.5E-04	2.1E-08	2.4E-04	7.3E-03
	NV	814	6.3E-05	3.5E-05	1.5E-11	0.0E+00	2.9E-04
	UT	814	7.1E-04	5.5E-04	1.4E-08	4.4E-04	3.1E-02
Site Total			1.2E-03	9.3E-04	3.6E-08	6.8E-04	3.8E-02

Table C.7. Truck Transport From LLW Generators To NTS - Low Waste Volume - Avoid Las Vegas

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
ETEC	CA	104	2.4E-04	3.8E-04	7.4E-09	1.7E-03	6.9E-04
	NV	104	2.4E-05	3.7E-05	3.0E-11	0.0E+00	2.6E-04
Site Total			2.6E-04	4.2E-04	7.5E-09	1.7E-03	9.5E-04
ITRI	AZ	87	1.7E-04	2.5E-04	1.2E-09	4.8E-05	9.7E-04
	CA	87	1.4E-04	2.1E-04	3.5E-09	2.8E-05	6.0E-04
	NM	87	8.7E-05	1.3E-04	9.7E-10	1.5E-04	5.6E-04
	NV	87	2.0E-05	3.1E-05	2.5E-11	0.0E+00	2.2E-04
Site Total			4.1E-04	6.2E-04	5.6E-09	2.3E-04	2.3E-03
LLNL	CA	1397	3.8E-03	5.8E-03	9.6E-08	2.1E-03	1.7E-02
	NV	1397	3.2E-04	4.9E-04	4.0E-10	0.0E+00	3.5E-03
Site Total			4.1E-03	6.3E-03	9.7E-08	2.1E-03	2.0E-02
LANL	AZ	3791	7.3E-03	1.1E-02	5.0E-08	2.1E-03	4.2E-02
	CA	3791	6.0E-03	9.1E-03	1.5E-07	1.2E-03	2.6E-02
	NM	3791	5.5E-03	7.9E-03	5.5E-08	3.2E-03	3.7E-02
	NV	3791	8.6E-04	1.3E-03	1.1E-09	0.0E+00	9.4E-03
Site Total			2.0E-02	2.9E-02	2.6E-07	6.5E-03	1.1E-01
Mound	AZ	2409	4.7E-03	7.0E-03	3.2E-08	1.3E-03	2.7E-02
	CA	2409	3.8E-03	5.8E-03	9.6E-08	7.8E-04	1.7E-02
	IL	2409	2.3E-03	3.2E-03	1.0E-06	7.8E-04	1.0E-02
	IN	2409	2.5E-03	3.4E-03	6.3E-07	4.4E-03	8.1E-03
	MO	2409	4.6E-03	6.3E-03	7.7E-07	8.3E-03	2.8E-02
	NM	2409	4.9E-03	7.5E-03	3.4E-08	6.1E-03	3.4E-02
	NV	2409	5.5E-04	8.5E-04	6.9E-10	0.0E+00	6.0E-03
	OH	2409	9.5E-04	1.2E-03	7.4E-08	2.8E-03	1.4E-03
	OK	2409	5.2E-03	7.2E-03	3,4E-07	4.6E-03	3.7E-02
	TX	2409	2.3E-03	3.5E-03	3.0E-07	2.0E-03	1.8E-02
Site Total			3.2E-02	4.6E-02	3.3E-06	3.1E-02	1.9E-01
PGDP	AZ	165	3.2E-04	4.8E-04	2.2E-09	9.0E-05	1.8E-03
	CA	165	2.6E-04	4.0E-04	6.6E-09	5.3E-05	1.1E-03
	IL	165	1.6E-06	2.5E-06	9.7E-10	0.0E+00	8.8E-06
	KY	165	2.4E-05	3.5E-05	2.1E-09	0.0E+00	1.8E-04
	MO	165	3.5E-04	4.8E-04	6.4E-08	1.4E-04	2.3E-03
	NM	165	3.4E-04	5.1E-04	2.4E-09	4.1E-04	2.3E-03
	NV	165	3.8E-05	5.8E-05	4.7E-11	0.0E+00	4.1E-04

Site	State	No. of Trips	Cargo-Related Risks: Incident-Free Crew	Cargo-Related Risks: Incident-Free Public	Cargo-Related Risks: Accident Public	Round-Trip Vehicle-Related Risks: Emission	Round-Trip Vehicle-Related Risks: Accident
	OK	165	3.6E-04	4.9E-04	2.3E-08	3.1E-04	2.5E-03
	TX	165	1.6E-04	2.4E-04	2.0E-08	1.4E-04	1.2E-03
Site Total			1.8E-03	2.7E-03	1.2E-07	1.2E-03	1.2E-02
Pantex	AZ	53	1.0E-04	1.5E-04	7.0E-10	2.9E-05	5.9E-04
	CA	53	8.4E-05	1.3E-04	2.1E-09	1.7E-05	3.7E-04
	NM	53	1.1E-04	1.6E-04	7.6E-10	1.3E-04	7.5E-04
	NV	53	1.2E-05	1.9E-05	1.5E-11	0.0E+00	1.3E-04
	TX	53	2.8E-05	4.1E-05	4.0E-09	4.4E-05	2.0E-04
Site Total			3.4E-04	5.0E-04	7.6E-09	2.2E-04	2.0E-03
Ports	AZ	77	1.5E-04	2.2E-04	1.0E-09	4.2E-05	8.6E-04
	CA	77	1.2E-04	1.9E-04	3.1E-09	2.5E-05	5.3E-04
	IL	77	6.0E-05	8.7E-05	2.7E-08	8.4E-05	2.7E-04
	IN	77	5.2E-05	7.4E-05	1.8E-08	5.0E-06	2.0E-04
	KY	77	6.3E-05	8.2E-05	5.8E-09	1.8E-04	3.3E-04
	MO	77	1.5E-04	2.0E-04	2.5E-08	2.7E-04	8.9E-04
	NM	77	1.6E-04	2.4E-04	1.1E-09	1.9E-04	1.1E-03
	NV	77	1.8E-05	2.7E-05	2.2E-11	0.0E+00	1.9E-04
	OH	77	4.4E-05	5.6E-05	4.7E-09	9.9E-06	8.5E-05
	OK	77	1.7E-04	2.3E-04	1.1E-08	1.5E-04	1.2E-03
	TX	77	7.5E-05	1.1E-04	9.5E-09	6.4E-05	5.7E-04
Site Total			1.1E-03	1.5E-03	1.0E-07	1.0E-03	6.2E-03
RFETS	AZ	2441	3.5E-04	5.5E-04	1.2E-09	0.0E+00	2.2E-03
	CO	2441	4.0E-03	5.5E-03	2.8E-07	1.6E-03	2.5E-02
	NV	2441	5.4E-03	8.4E-03	8.0E-09	0.0E+00	5.8E-02
	UT	2441	4.7E-03	7.0E-03	4.8E-08	1.1E-03	3.4E-02
Site Total			1.4E-02	2.1E-02	3.4E-07	2.7E-03	1.2E-01
SNLA	AZ	191	3.7E-04	5.5E-04	2.5E-09	1.1E-04	2.1E-03
	CA	191	3.0E-04	4.6E-04	7.6E-09	6.2E-05	1.3E-03
	NM	191	1.9E-04	2.8E-04	2.1E-09	3.3E-04	1.2E-03
	NV	191	4.4E-05	6.8E-05	5.5E-11	0.0E+00	4.7E-04
Site Total			9.0E-04	1.4E-03	1.2E-08	5.0E-04	5.1E-03

Table C.8. Truck Transport From LLW Generators To NTS - Low Waste Volume - Travel Through Las Vegas

Alternative Risks by Site (fatalities)

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
ETEC	CA	104	2.2E-04	3.5E-04	6.9E-09	1.7E-03	6.0E-04
	NV	104	6.5E-05	9.3E-05	1.3E-09	6.4E-05	2.4E-04
Site Total			2.8E-04	4.5E-04	8.2E-09	1.7E-03	8.3E-04
ITRI	AZ	87	1.7E-04	2.6E-04	1.2E-09	4.8E-05	1.0E-03
	NM	87	8.7E-05	1.3E-04	9.7E-10	1.5E-04	5.6E-04
	NV	87	6.1E-05	9.0E-05	1.9E-09	2.7E-04	1.8E-04
Site Total			3.2E-04	4.8E-04	4.1E-09	4.7E-04	1.7E-03
LLNL	CA	1397	3.6E-03	5.4E-03	9.0E-08	2.1E-03	1.5E-02
	NV	1397	8.8E-04	1.3E-03	1.7E-08	8.5E-04	3.2E-03
Site Total			4.4E-03	6.6E-03	1.1E-07	2.9E-03	1.8E-02
LANL	AZ	3791	7.6E-03	1.1E-02	5.1E-08	2.1E-03	4.4E-02
	NM	3791	5.5E-03	7.9E-03	5.5E-08	3.2E-03	3.7E-02
	NV	3791	2.7E-03	3.9E-03	8.5E-08	1.2E-02	7.9E-03
Site Total			1.6E-02	2.3E-02	1.9E-07	1.7E-02	8.8E-02
Mound	AZ	2409	4.8E-03	7.2E-03	3.3E-08	1.3E-03	2.8E-02
	IL	2409	2.3E-03	3.2E-03	1.0E-06	7.8E-04	1.0E-02
	IN	2409	2.5E-03	3.4E-03	6.3E-07	4.4E-03	8.1E-03
	MO	2409	4.6E-03	6.3E-03	7.7E-07	8.3E-03	2.8E-02
	NM	2409	4.9E-03	7.5E-03	3.4E-08	6.1E-03	3.4E-02
	NV	2409	1.7E-03	2.5E-03	5.4E-08	7.4E-03	5.0E-03
	OH	2409	9.5E-04	1.2E-03	7.4E-08	2.8E-03	1.4E-03
	OK	2409	5.2E-03	7.2E-03	3.4E-07	4.6E-03	3.7E-02
	TX	2409	2.3E-03	3.5E-03	3.0E-07	2.0E-03	1.8E-02
Site Total			2.9E-02	4.2E-02	3.2E-06	3.8E-02	1.7E-01
PGDP	AZ	165	3.3E-04	5.0E-04	2.2E-09	9.0E-05	1.9E-03
	IL	165	1.6E-06	2.5E-06	9.7E-10	0.0E+00	8.8E-06
	KY	165	2.4E-05	3.5E-05	2.1E-09	0.0E+00	1.8E-04
	MO	165	3.5E-04	4.8E-04	6.4E-08	1.4E-04	2.3E-03
	NM	165	3.4E-04	5.1E-04	2.4E-09	4.1E-04	2.3E-03
	NV	165	1.2E-04	1.7E-04	3.7E-09	5.1E-04	3.4E-04
	OK	165	3.6E-04	4.9E-04	2.3E-08	3.1E-04	2.5E-03
	TX	165	1.6E-04	2.4E-04	2.0E-08	1.4E-04	1.2E-03
Site Total			1.7E-03	2.4E-03	1.2E-07	1.6E-03	1.1E-02

Site	State	No. of Trips	Cargo-Related Risks			Round-Trip Vehicle-Related Risks	
			Incident-Free		Accident		
			Crew	Public	Public	Emission	Accident
Pantex	AZ	53	1.1E-04	1.6E-04	7.2E-10	2.9E-05	6.1E-04
	NM	53	1.1E-04	1.6E-04	7.6E-10	1.3E-04	7.5E-04
	NV	53	3.7E-05	5.5E-05	1.2E-09	1.6E-04	1.1E-04
	TX	53	2.8E-05	4.1E-05	4.0E-09	4.4E-05	2.0E-04
Site Total			2.8E-04	4.2E-04	6.7E-09	3.7E-04	1.7E-03
Port	AZ	77	1.5E-04	2.3E-04	1.0E-09	4.2E-05	8.9E-04
	IL	77	6.0E-05	8.7E-05	2.7E-08	8.4E-05	2.7E-04
	IN	77	5.2E-05	7.4E-05	1.8E-08	5.0E-06	2.0E-04
	KY	77	6.3E-05	8.2E-05	5.8E-09	1.8E-04	3.3E-04
	MO	77	1.5E-04	2.0E-04	2.5E-08	2.7E-04	8.9E-04
	NM	77	1.6E-04	2.4E-04	1.1E-09	1.9E-04	1.1E-03
	NV	77	5.4E-05	8.0E-05	1.7E-09	2.4E-04	1.6E-04
	OH	77	4.4E-05	5.6E-05	4.7E-09	9.9E-06	8.5E-05
	OK	77	1.7E-04	2.3E-04	1.1E-08	1.5E-04	1.2E-03
	TX	77	7.5E-05	1.1E-04	9.5E-09	6.4E-05	5.7E-04
Site Total			9.7E-04	1.4E-03	1.0E-07	1.2E-03	5.7E-03
RFETS	AZ	2441	3.5E-04	5.5E-04	1.2E-09	0.0E+00	2.2E-03
	CO	2441	4.0E-03	5.5E-03	2.8E-07	1.6E-03	2.5E-02
	NV	2441	2.1E-03	3.0E-03	4.8E-08	2.7E-03	7.6E-03
	UT	2441	4.7E-03	7.0E-03	4.8E-08	1.1E-03	3.4E-02
Site Total			1.1E-02	1.6E-02	3.8E-07	5.3E-03	6.9E-02
SNLA	AZ	191	3.8E-04	5.7E-04	2.6E-09	1.1E-04	2.2E-03
	NM	191	1.9E-04	2.8E-04	2.1E-09	3.3E-04	1.2E-03
	NV	191	1.4E-04	2.0E-04	4.3E-09	5.9E-04	4.0E-04
Site Total			7.1E-04	1.1E-03	9.0E-09	1.0E-03	3.8E-03

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