Final WERC Report

Independent Technical Peer Review of the U.S. Department of Energy Sandia National Laboratories' "Working Draft" Corrective Measures Study November 2002 Mixed Waste Landfill

January 31, 2003

Performed by WERC:
A Consortium for Environmental Education and Technology Development

Notice

Executive Summary

In November 2002, WERC: A Consortium for Environmental Education and Technology Development was requested by the U.S. Department of Energy (DOE) to perform an independent peer review of the Sandia National Laboratories (SNL) in-progress document titled *Mixed Waste Landfill Draft Corrective Measures Study,* November 2002. The purpose of the peer review is to ensure that the appropriate set of technologies was considered and that the alternatives are appropriately evaluated on technical, environmental, human health, institutional concerns, and costs. The intent of the review is to provide DOE and SNL with an independent assessment on the quality of the document to ensure that a high-quality product is being produced.

High professional standards and extraordinary technical knowledge demonstrated by the SNL staff during public meetings (December 9 and 10, 2002 and January 10, 2003) and in the preparation of the Corrective Measures Study (CMS) document helped the Panel substantially in learning, understanding, and accepting information related to the MWL history, design, and operation. The limited time factor for this review, however, did not allow the Panel to perform a complete review of all documents pertaining to the site. The principal documents reviewed were the *Draft Corrective Measures Study*, the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, and documentation provided by presenters.

Representatives of the Citizen Action group demonstrated true and vital interests of various citizens' groups. They provided invaluable information obtained through documents released under the Freedom of Information Act (FOIA). Their civil, professional, and engaged actions contributed significantly to the outcome of the review process. Their candid assessment of SNL operations and technical recommendations were thoroughly considered by the Panel in their assessment procedures.

The Peer Panel realizes that the Draft CMS is actually a "working draft" that is a work-in-progress and therefore, the Panel understands that many of the issues raised are likely already being addressed in the final preparation of the CMS. The Panel also understands the difficulty of the public to comment on a document that is not yet available to them. A summary of the Panel's primary recommendations and conclusions are presented below.

1. MWL original inventory data for the period 1958-1964 were destroyed as part of normal record keeping protocol; however, SNL explained at the January 10 meeting that duplicate copies were made onto microfiche and/or placed in the Solid Waste Inventory Management System maintained at DOE's Idaho National Engineering and Environmental Laboratory. The site operational history (Section 1.0 of the Draft CMS) does not indicate this situation for the MWL inventory data and does not report that during the early years of operation the MWL was probably used for some disposal of chemicals prior to the opening of the Chemical Waste Landfill. Cases in point include:

a) Anecdotal testimony in the records refers to disposal of non-stabilized free liquids.

b) Location of many dangerous materials appears to be unknown, such as nuclear fuel canisters and possibly radioactive sealed sources.

c) Amount of hazardous waste is not well understood. For instance, the inventory does not match the characterization of Pit 35, and Trenches B and C.

d) The estimates pertaining to the volume of waste deposited in the MWL vary widely in different sections of the report. A table showing the amount of waste in each pit and trench would be valuable.

e) The meaning of the words "debris" and "all wastes" in the Draft CMS report is uncertain. These terms are not defined in the document but the implication of their use appears to exclude surrounding soil, and possibly concrete demolition debris. Regardless of the meaning of these terms, there appear to be inconsistencies in the evaluation of excavation volumes that may be attributed to different interpretations of its meaning. Such discrepancies may result not only in significant volume estimates but in their associated excavation, characterization, and disposal costs.

At the January 10 meeting much of the confusion on these five items was cleared up to the satisfaction of the Panel; however, this confusion will still remain for the public. Therefore it is essential that the CMS make an attempt to clarify these points in the document. SNL has stated that . . . "the inventory is very good, but not perfect". The Panel agrees with this statement, excluding the caveats mentioned in this report, and feels that SNL has done its best at estimating the nature of the wastes, given the data sources available. However, with the uncertainty present and concomitant potential risk, it is important to make available in the document the methodology for collecting and tracking down information and the outlier information sources that raise concerns.

2. In general, the Panel was impressed with the process that was developed for alternative development and evaluation. The following alternatives are ones that the Panel believes should be carried forward through evaluation in Section 4.0 of the Draft CMS. The Panel feels that it is important to clarify that a recommendation by the Panel to include an alternative is not a suggestion that an alternative be selected. Alternatives recommended for inclusion in the CMS are ones that the Panel believes are appropriate to be evaluated. Evaluation does not mean selection. The final selection of the alternative that gets implemented is a decision that is made between DOE and the State of New Mexico, not by this Panel.

a) The Panel's strongest recommendation is to include a scenario that would be titled "Cover with Future Excavation". The suggested cover could be the current vegetative cover option, or the vegetative cover with a low profile bio-intrusion barrier. The Panel felt strongly that the uncertainty of the contents in the MWL could eventually lead to the requirement (or choice) of excavation followed by subsequent final disposal of the MWL contents.

b) The Resource Conservation and Recovery Act (RCRA) cap alternative was eliminated from consideration based on a history of failure in the arid southwestern U.S. The Draft CMS report attributes this to the desiccation and shrinkage of the clay layer. The Panel believes it is important to carry this alternative forward with possibly a synthetic flexible liner (e.g., high density polyethylene) versus clay because it represents the baseline RCRA technology.

c) All current excavation alternatives include off-site disposal. The Panel recommends that an alternative be considered that uses existing, planned, and/or new on-site disposal facilities. These facilities would include an on-site RCRA approved landfill for contaminated low-level mixed waste materials, an on-site retrievable and secure facility for higher level radioactive wastes, and a conventional municipal type landfill for materials that are both non-radioactive and non-hazardous.

d) Finally, the Panel was concerned that the alternatives did not account for other contaminants of concern, even though volatile organic compounds (VOCs) were detected at low levels in the soil beneath the MWL. Again, the uncertainty regarding the type and quantity of the wastes placed in combination with a detectable level of VOCs would suggest that this finding cannot be ignored. The Panel was specifically concerned with the fact that inventory information was limited (or not available at all) for the years after the MWL opened and before the Chemical Waste Landfill opened (i.e., 1958 to 1962). These concerns led to the discussion of a soil vapor extraction alternative as part of a long-term monitoring strategy that would offer SNL several advantages. First, the system could be utilized in combination with many of the lower-cost cover scenarios. Second, installation of the system would allow for regular, periodic sampling of the vadose zone beneath the MWL. The system would be in place and operational and, therefore, could be employed with a substantially quicker response time (as compared to groundwater monitoring) in an emergency situation should a subsurface release occur or be detected.

3. It is clear to the Panel that there is a high risk in the present removal of the buried waste. Currently, with levels of tritium and cobalt-60 present and many other unknowns in the risk assessment, removal at this time is both risky and may present problems to the environment and to both onsite and offsite human

population. It would appear from the risk assessment that the recommended plan identified in the CMS (institutional control with a vegetative cap) is protective of human health and the environment. However, questions remain to be addressed in order to support the remedy of choice, or other remedies that are found acceptable. For example:

a) The risk assessment appears to be based on accepted U.S. Environmental Protection Agency methodology, reference doses, etc. However, it was pointed out by SNL staff at the January 10 public meeting that these risk assessments were only relative to the different remedies being investigated and did not relate directly to the predicted risk. This issue needs to be clarified as it only adds uncertainty to the overall remedy if the risk assessment is not modeled relative to a conservative model of the site situation. While SNL indicated this point at the public meeting on January 10, the CMS document does not qualify the risk assessment in this manner (First paragraph, page I-1). Thus, the panel views the risk assessment as a conservative model evaluation, as was done in the risk assessment of the Phase 2 RCRA Facility Investigation (RFI), which provided the basis for industrial use with controls. While the matter seems clear at this point, the CMS refers to the Phase 2 RFI risk assessment as being "detailed" (page 1-13 of CMS, last paragraph section 1.7.3, first sentence).

b) The risk assessment is based on known releases from the site. However, questions about the inventory warrant another approach to be considered. A significant portion of the public's concern rests on the composition and amount of waste in the MWL. In fact, several questions remained unanswered, while certainly qualified on January 10, during the meetings about the amount and type of waste present. The Panel feels that SNL has done its best at estimating the nature and volume of waste; however, with the uncertainty present, it would seem that a sensitivity analysis of the risk assessment would give some indication of the significance of this concern, especially in light of the relative nature of the assessment noted above. Further, the relative risk <u>will</u> change depending on the remedy, as was stated in the risk assessment of the CMS, due to changes in the contaminants of concern (COCs), so a sensitivity analysis <u>will</u> vary for the remedies being considered and will not have the same range for each case, contrary to what was expressed by SNL on January 10. (See Risk Assessment 11/22/02, page I-12 (Appendix I to CMS), third paragraph – "COC selection criteria identical…However, due to remedial options, the COCs may vary")

c) DOE should assess the MWL for non-DOE land ownership in the future. This is a realistic possibility (although not necessarily probable for the SNL site) considering the fact that the federal government has actively transferred or is in the act of transferring DOE and Department of Defense sites to state and local entities.

d) A key component of future excavation and/or capping alternatives, based on risk assessment, is to use monitoring "triggers" (i.e., a predetermined target level for a contaminant that triggers a need for a response). Trigger concentrations at monitoring points would ensure protection of the underlying aquifer and risk from air emissions. Risk assessments can identify these triggers that would become evident during long-term monitoring so that the remedy can be revisited if radiological or non-radiological contamination limits are exceeded outside the MWL. The panel understands that such vadose zone monitoring would not be implemented until the work is well into the approved remedy and that no monitoring currently exists in the vadose zone under the MWL. It is recommended that vadose zone monitoring be implemented as soon as possible to assess and monitor the region between the MWL and aquifer. Obviously, vadose zone monitoring is essential to establish the appropriate trigger levels. Such monitoring and assessment may affect the remedy selection process and/or risk assessment in both the short and/or long term.

4. The Panel strongly recommends the development of an integral numerical "fate and transport" model for the simulation of the MWL. It is regrettable that such a model was not yet developed to take advantage of sophisticated software that are available in academia, national laboratories, and private industry. This software should be calibrated with existing MWL data and fine tuned with the results of future monitoring and fundamental developments. The results of the numerical modeling should be used as inputs to the risk assessment model, and to probe into the sensitivity of different MWL options.

5. The Panel agrees with the overall cost estimates (not necessarily with the exact value of the estimates), and appreciates the detail provided with these estimates and the fact that cost was not used as a selection criterion in the screening process. Several points are important to clarify in the final CMS.

   a) Definitions for terms and assumptions for costs merit further explanation, such as: escalation, markup, percentage interest used for net present worth; inflation factors for direct costs; modifiers for materials, labor and equipment; etc.

   b) It would be helpful to explain, as was done at the public meetings, the different cost estimates and their value in the decision making process. For instance, Appendix J is an independent analysis of the Near-Term Excavation Alternative, but it is not used or even referenced within the main part of the report.

   c) Since the closed MWL may have to be maintained and monitored for a very long time into the future, the Panel suggests that cost projections over a period of 30 to 100 years be used to identify the impact of such costs on the different alternatives. Although regulatory guidance does not require this extended time period for cost estimates, these long-term life cycle costs are important in making decisions.

d) It would also be useful to include alternative cost models that take into account a sustainable approach; i.e., looking at land value and future land use and ownership.

6. If a future waste extraction option is selected among the feasible alternatives, it is important for all parties to understand the capabilities of the federal government to establish the legal and financial frameworks to support this future action. This issue, while not technical or scientific in nature, is essential for the success of future technical solutions and therefore cannot be ignored or invalidated. The Peer Panel clearly recognizes that the CMS is not the instrument for resolving this issue, but rather it is one that should be resolved directly between DOE and the State of New Mexico.

7. SNL must be commended for the general high quality of the Draft CMS. This work-in-progress can be improved by overall editorial guidance to ensure that the document does not appear as segmented and discontinuous. The document should also clearly indicate the assumptions and methodology leading to conclusive information.

8. In general, the Draft CMS report is comprehensive and highly detailed. However, a consistent deficiency is the lack of supporting information in several critical areas. The lack of engineering assumptions and the absence of information graphics make it difficult for peers to assess engineering design merits of the proposed concepts. For instance, the use of diagrams, topographic maps, and schematics would greatly increase the understanding of alternative cap designs. This is not an inclusive list. Additionally, peer evaluation requires the use of acceptable engineering design standards and assumptions made prior to presenting conclusions and recommendations. Such criteria must be clearly delineated in the final version of the CMS report.

A final observation by the Peer Panel is that SNL should continue to maintain a positive and aggressive good-neighbor policy. An open communication policy with the public is fundamental in the development of such policy. The legacy of the present exercise is an excellent reminder to SNL policy makers that in the long range, the citizens' "right to know" is upheld as an essential public involvement principle and that dissemination of relevant information along with clearly delineated interpretation is judicious and constructive in promoting a better understanding and hopefully cooperation among stakeholders. Likewise on the citizens' organization end – this is a two-way street. If DOE, SNL, and the state of New Mexico are to select a reasonable and rationally acceptable solution, citizen groups must also share findings and work constructively with these agencies. Everyone involved must also recognize that risk, uncertainty, and future cost consequences are inherent with all proposed alternatives (including no further action) and that while no decision is perfect, a decision must be made.

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Agreement of Report Contents

The panel members who performed the peer review of the U.S. Department of Energy, Sandia National Laboratories, *Mixed Waste Landfill Draft Corrective Measures Study*, November 2002 have read the entirety of this final report dated January 31, 2003, and concur with the contents herein.

Fernando Cadena, Ph.D.	1-31-03 Date
David Constant, Ph.D.	1-31-03 Date
Goran Jovanovic, Ph.D.	1-31-03 Date
Wolfgang Mueller, Ph.D.	1-31-03 Date
Ben Stuart, Ph.D.	1-31-03 Date

1.0 Introduction and Purpose

In November 2002, WERC: A Consortium for Environmental Education and Technology Development was requested by the U.S. Department of Energy (DOE) to perform an independent peer review of Sandia National Laboratories in-progress document titled *Mixed Waste Landfill Draft Corrective Measures Study,* November 2002. The purpose for the peer review is to ensure that the appropriate set of technologies was considered and that the alternatives are appropriately evaluated on technical, environmental, human health, institutional concerns, and costs. The intent of the review is to provide Sandia National Laboratories (SNL) with an independent assessment on the quality of the document to ensure that a high-quality product is being produced.

The *Corrective Measures Study* (CMS) is being conducted under the regulatory authority of the Resource Conservation and Recovery Act (RCRA) for submittal to the New Mexico Environment Department at the end of February 2003. This document will provide DOE, the state of New Mexico, and the public with information needed to select an alternative that provides long-term protection of human health and the environment. The Peer Panel realizes that the Draft CMS is actually a "working draft" that is a work-in-progress and therefore, the Panel understands that many of the issues raised are likely already being addressed in the final preparation of the CMS.

Peer panel members who wrote this independent peer review come from an academic setting with considerable current and past experience on environmental problems for both industry and government. Their affiliation are:

Fernando Cadena, Ph.D.	New Mexico State University
David Constant, Ph.D.	Louisiana State University
Goran Jovanovic, Ph.D.	Oregon State University
Wolfgang Mueller, Ph.D.	New Mexico State University
Ben Stuart, Ph.D.	Ohio University

Panel facilitators who conducted the public sessions and their affiliations are:

Ron Bhada, Ph.D.	New Mexico State University and WERC (retired)
Tim Carlson	Sensible Environmental Solutions

WERC staff members who provided coordination of public sessions and logistics are Jim Loya, project manager, and Brenda Dunn. Abbas Ghassemi, Ph.D. of WERC served as liaison between all parties. Biographic sketches of the panel members, facilitators, and WERC staff are included in Appendix A.

2.0 Peer Review Process

2.1 Peer Panel Selection

The peer review requested by DOE was developed to ensure that panel members had the appropriate experience, were unbiased, had no conflict of interest issues, no vested interest in the outcome, and were available. The selection process was intended to be open with key stakeholders requested to suggest possible technical panel members. Stakeholders were also apprised of

- The intent of the technical peer review,
- The process of reviewing and evaluating the Draft CMS,
- The process for nominating technical reviewers,
- The planned approach for incorporating stakeholders' technical input on the Draft CMS into the final report, and
- The process for publishing the technical peer review panel's findings and disseminating the final report.

WERC first assembled a list of experts from its network of professionals and from stakeholder recommendations. These individuals were identified based on their knowledge and expertise in the areas of groundwater, fate and transport, landfill performance, radioactive waste disposal, health physics, and analytical chemistry. Prospective panel members also did not have any direct working relationship with SNL or the Mixed Waste Landfill (MWL), or have any other real or perceived conflict of interest. From this list of potential panel members, five were selected.

2.2 Public Meeting Presentations

The Peer Panel received the Draft CMS during the week prior to the public meetings held on December 9 and 10, 2002 in Albuquerque (see Appendix B for advertisement of meeting). A second public meeting was held on January 10, 2003 in Albuquerque to provide clarification on several issues. Dr. Bhada chaired these meetings, presented the Peer Panel and their credentials, WERC's basic values associated with the conduct of the meetings, the peer review process, and the scope of the peer review. At the first two-day meeting the Peer Panel was provided presentations by SNL and the public on a variety of topics. After each presentation, a question and answer time was provided that also accommodated written questions submitted by the audience. The Peer Panel also requested additional reports from SNL, which were received the following day. Eight presentations were made to the Peer Panel over the two days of public meetings. A synopsis of each with emphasis on the significant points that were made or brought up during the question and answer discussions are presented in Appendix C.

At the second meeting, DOE and the public provided short presentations to the panel with much of the time spent with questions by the panel (see Appendix C).

2.3 Review of the CMS

The Peer Panel discussed relevant issues and developed consensus on the contents of this report using information found in the various documents provided by both SNL and the public, and from information provided during the presentations. Technical review of the CMS and recommendations that the Panel is presenting in this document are produced in a specific work environment, and are based on information obtained from diverse sources. The panel recognizes that the review process and set of values, clearly defined and accepted by all participants, along with the created work environment have greatly contributed to the outcomes of this review.

Unmistakable understanding of the review process and adopted values are particularly important for the acceptance of the findings presented in this document. All participants at the beginning of the review process embraced the following values:

- Information evaluation is performed entirely by the Peer Panel,
- Science and technical input from all parties is requested in writing through facilitators,
- Evaluation is performed with emphasis that errs on the side of safety,
- No biases nor perception of biases,
- No hidden agenda,
- No personal attacks,
- No contact of Peer Panel members from outside except through WERC, and
- Conclusions will be specific and substantial; i.e., recommendations for CMS will be based on facts, science, and engineering.

High professional standards and extraordinary technical knowledge demonstrated by the SNL staff during public hearings and in the preparation of the Draft CMS document helped the Panel substantially in learning, understanding, and accepting information related to the MWL history, design, and operation. The limited time factor for this review, however, did not allow the Panel to perform a complete review of all documents pertaining to the site (see Appendix D). The principal documents reviewed were the Draft CMS, the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, and documentation provided by presenters.

Representatives of the Citizen Action group demonstrated true and vital interests of various citizens' groups. They also provided invaluable information obtained through documents released under the Freedom of Information Act (FOIA). Their civil, professional, and engaged actions contributed significantly to the outcome of the review process. The Panel also understands the difficulty of the public to comment on a document that is not yet available to them.

SNL staff and representatives of the Citizen Action group offered, for the purpose of this review, a large number of documents that could potentially be the source of new and/or corroborative information. This is an important evidence of the cooperation that the Peer Panel enjoyed from all stakeholders in the CMS review.

2.4 Peer Report

The Peer Panel, with administrative assistance from WERC staff, is preparing this interim report for use by DOE and SNL. The final report will be completed by January 31, 2003. The purpose for the peer review is to ensure that the appropriate set of technologies was considered and that the alternatives are appropriately evaluated on technical, environmental, human health, institutional concerns, and costs.

An engineering evaluation of the cover design itself was not a part of this peer review. Additionally, the peer review was not to assess the appropriateness of DOE’s historic or existing waste disposal practices, nor future missions or uses at Sandia National Laboratories. The review conducted was a high-level analysis, focused on determining the reasonableness of conclusions reached by SNL. The intent of the review is to provide DOE and SNL with an independent assessment on the quality of the document to ensure that a high-quality product is being produced.

3.0 Background on the Mixed Waste Landfill

This peer review is principally being developed for SNL's use to finalize the *Corrective Measures Study*. As such, it would be unnecessary to include background information on the MWL because SNL staff are intimately knowledgeable of the site. However, this report also will be used by the public, some of whom may not be totally familiar with the site. Therefore, a brief historic review of the site is presented in this section and in Appendix E. The following background information is taken verbatim from the *Peer Review of the U.S. Department of Energy Sandia National Laboratories Mixed Waste Landfill Final Report*, August 31, 2001. It is important to note that the Peer Panel raises some specific questions with the inventory portion of this data with discussion of these issues subsequently developed in latter portions of this current peer review report.

3.1 Landfill Setting

Background on the MWL is summarized from documents provided by DOE and Sandia and is intended to provide the reader with a general understanding of the physical setting and history of the landfill (see Appendix D – documents 2, 3, 4, 5, and 6). The MWL is located five miles southeast of the Albuquerque International Airport on Sandia National Laboratories property known as Technical Area 3 (see Figure 1). The site is situated within a large north-south trending basin in the Rio Grande trough. The basin is a compound graben that has been filled, up to a depth of 12,000 feet, from the erosion of the surrounding highlands. Situated on coalescing alluvial fans emanating from the Manzanita Mountains to the east, the site has underlying deposits that are characterized by great internal variability. The alluvium, which makes up the vadose zone, is a well-graded, fine sand with occasional layers of gravel, coarse sands, or finer material.

An extensive vadose zone underlies the landfill with the water table being approximately 460 feet below the ground surface. This unconfined aquifer in the unconsolidated Santa Fe Group sediments is part of the primary drinking water supply for the City of Albuquerque and surrounding communities. Recharge resulting from direct infiltration of precipitation is insignificant due to the high evapotranspiration, low precipitation, and extensive vadose zone. Groundwater gradients in the area average 10 feet per mile.

At and near the MWL there are few natural surface run-off features. Surface runoff is regionally controlled and flows generally to the west. There are no man-made surface runoff controls. All surface runoff from the landfill is to dirt roads that surround the site. Precipitation averages about 8.5 inches per year of which snowfall averages about 11 inches per year. Summer precipitation, particularly in July and August, is usually in the form of heavy thunderstorms that typically last less than one hour at any given location. The average annual potential evapotranspiration is estimated at 75.4 inches. Winds speeds seldom exceed 32 miles per hour and are generally less than 8 miles per hour.

3.2 MWL Inventory of Disposed Materials

The MWL occupies approximately 2.6 acres and was operated between March 1959 and December 1988. During this period of time, it was the primary disposal site for Sandia's nuclear weapons research and development activities. The MWL was originally opened as the "Area 3 Low-Level Radioactive Dump" when the radioactive dump in the Technical Area 2, which is closer to the airport was closed in March 1959. As stated in DOE documentation, approximately 100,000 cubic feet of low-level radioactive waste and minor amounts of mixed waste containing approximately 6,300 Curies of activity (at the time of disposal) were disposed at the MWL. Mixed waste is defined as waste that contains both hazardous waste, as defined by the U.S. Environmental Protection Agency (EPA), and radioactive waste. Because hazardous wastes were disposed at the MWL, the State of New Mexico is authorized by the EPA to implement the hazardous waste management provisions of RCRA for treatment, storage, and disposal facilities within the state. Under RCRA, the New Mexico Environment Department regulates the MWL as a Solid Waste Management Unit (SWMU) as a corrective action. DOE orders also provide requirements for landfill closure and cover design, and establish long-term performance requirements for the closed facility.

The MWL consists of two distinct disposal areas: the classified area, occupying 0.6 acres, and the unclassified area, occupying 2.0 acres (Figures 2 and 3). Classified wastes are materials that are considered to have national security value and are not subject to public disclosure and are disposed in Pits 1 through 37, Pits SP-1 through SP-5, and Pits U-1 through U-3. They may include documents, materials, or physical configurations. Wastes in the classified area were disposed in a series of vertical, cylindrical pits. Historic records indicate that early pits were 3 to 5 feet in diameter and 15 feet deep. Later pits were 10 feet in diameter and 25 feet deep. A typical disposal of classified materials is represented in Figure 4. Once pits were filled with waste, they were backfilled with soil then capped with concrete. Wastes in the unclassified area (Trenches A through G) were disposed in a series of parallel, north-south excavated trenches. Records indicate that the trenches were 15 to 25 feet wide, 150 feet to 180 feet long, and 15 to 20 feet deep. Trenches were reportedly backfilled with soil on a quarterly basis and, once filled with waste, capped with originally excavated soils that had been stockpiled locally. Figures 5 through 8 show how wastes were typically disposed in the unclassified area.

Wastes disposed in the classified area pits included depleted, natural, and enriched uranium; thorium; barium; enriched lithium; liquid scintillation vials and beakers; neutron generator tubes and targets; plutonium contaminated wastes; and plutonium contaminated weapons test debris from DOE's Nevada test site. Figure 9 presents the location and radioactive content of tritium disposed in the classified area between 1959 and 1983. Between 1959 and 1962, small quantities of radioactively contaminated inorganic acids and organic solvents were disposed in Pit SP-1 located in the southeast corner of the classified area. Wastes disposed in the unclassified area trenches included construction and demolition materials, contaminated equipment and soils, lead shielding, shipping casks, cardboard, dry solids, and various crates, drums, and boxes. Wastes were disposed in this area at random with no regard to waste source or type.

In 1967, trench D in the unclassified area was used for disposal of an estimated 204,000 gallons of reactor coolant water. Sandia's records estimate that 1 curie of total radioactivity (primarily from tritium, and possibly from Na-24 and Mn-56) was discharged into the trench over a period of one month. Disposal began at 11:30 a.m. May 11, 1967, and continued more or less continuously until 12:45 p.m. on June 22, 1967.

Containment and disposal of waste commonly occurred in tied, double polyethylene bags, sealed A/N cans (military ordnance metal containers of various sizes), fiberboard drums, wooden crates, cardboard boxes, 55-gallon drums, and 55-gallon polyethylene drums. Larger items such as glove boxes and spent fuel shipping casks were disposed in bulk without any additional containment. Except as noted above, disposal of free liquids was not allowed at the MWL. Liquids such as acids, bases, and solvents were solidified with commercially available agents such as Aquaset®, Safe-T-Set®, Petroset®, vermiculite, marble chips, or yellow powder before containerization and disposal.

Most pits and trenches also contain routine operational and miscellaneous decontamination waste such as: gloves, paper, mop heads, brushes, rags, tape, wire, metal and PVC tubing, cables, towels, quartz clothe, swipes, disposable lab coats, shoe covers, overalls, HEPA filters, prefilters, tygon tubing, watch glasses, polyethylene bottles, beakers, balances, pH meters, screws, bolts, saw blades, Kleenex®, petri dishes, scouring pads, metal scrap and shavings, foam, plastic, glass, rubber scrap, electrical connectors, ground cloth, wooden shipping crates and pallets, wooden and Lucite® dosimeter holders, and expended or obsolete experimental equipment.

The MWL waste inventory, by pit and trench, is provided in Appendix E. The greatest risk is to workers is from high activity waste, principally cobalt 60, if retrieval is used. In the future, this risk will be much less because of natural decay. Table 1 provides a listing of the radionuclides present in the MWL, their respective half-life in years, the estimated total Curie levels in 1989 (6,736 Ci), in 1999 (2,971 Ci), in 2009 (1,560 Ci), in 2019 (933 Ci), 2029 (608 Ci), in 2039 (419 Ci), and so on through the year 2289.

To investigate the potential for contamination in the soil and the vadose zone, 13 angled boreholes and 2 vertical boreholes were drilled around the perimeter of the landfill to a depth of approximately 120 feet (Figure 10). An additional 18 bore-holes were drilled around the perimeter of the MWL during the Phase 1 RCRA Facility Investigation, conducted in 1989 and 1990. To monitor for groundwater contamination, 7 monitoring wells were drilled around the perimeter of the landfill, one of which was in a generally upgradient location. Additionally, one monitoring well was placed inside the unclassified area of the landfill. Monitoring well locations are presented in Figure 11 and penetrate the underlying aquifer a minimum of 110 feet to a maximum of 160 feet.

Figure 1: Location of Kirtland Air Force Base and Sandia National Laboratories

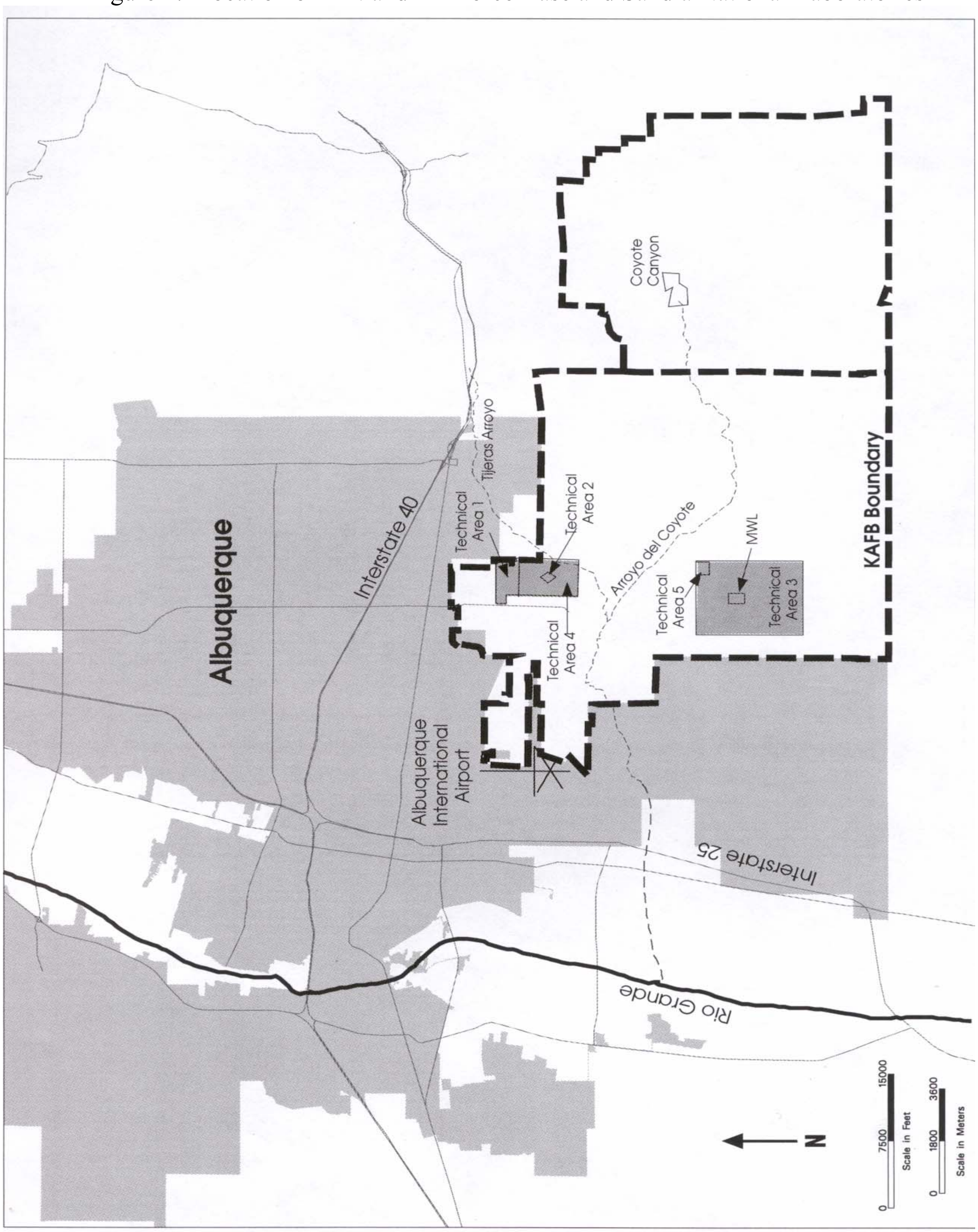


Figure 2: Mixed Waste Landfill Trenches and Pits

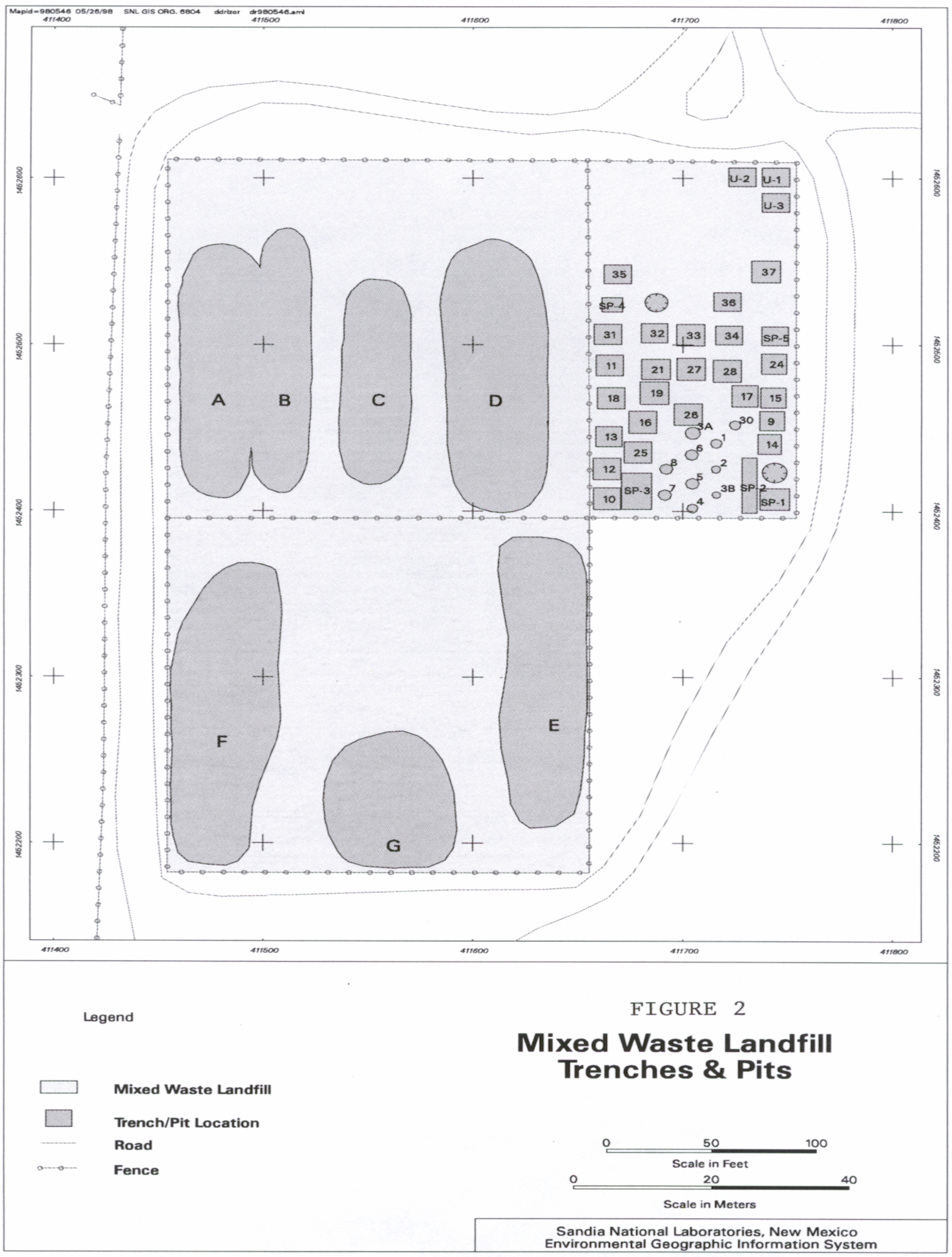


Figure 3: Oblique Areal View of Mixed Waste Landfill, looking Southwest, circa 1987

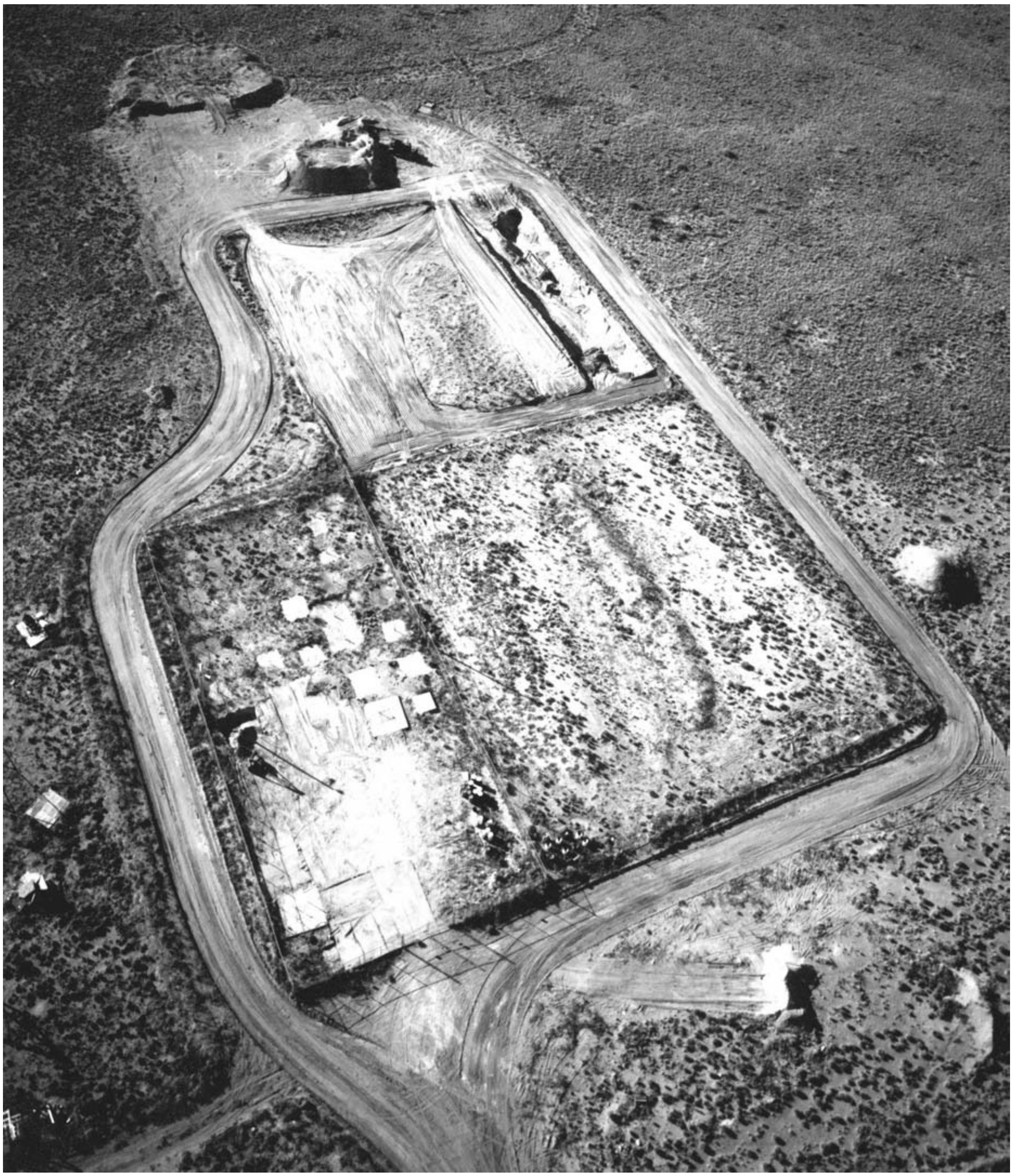


Figure 4: Mixed Waste Landfill, "Classified Waste" Disposal, circa 1974

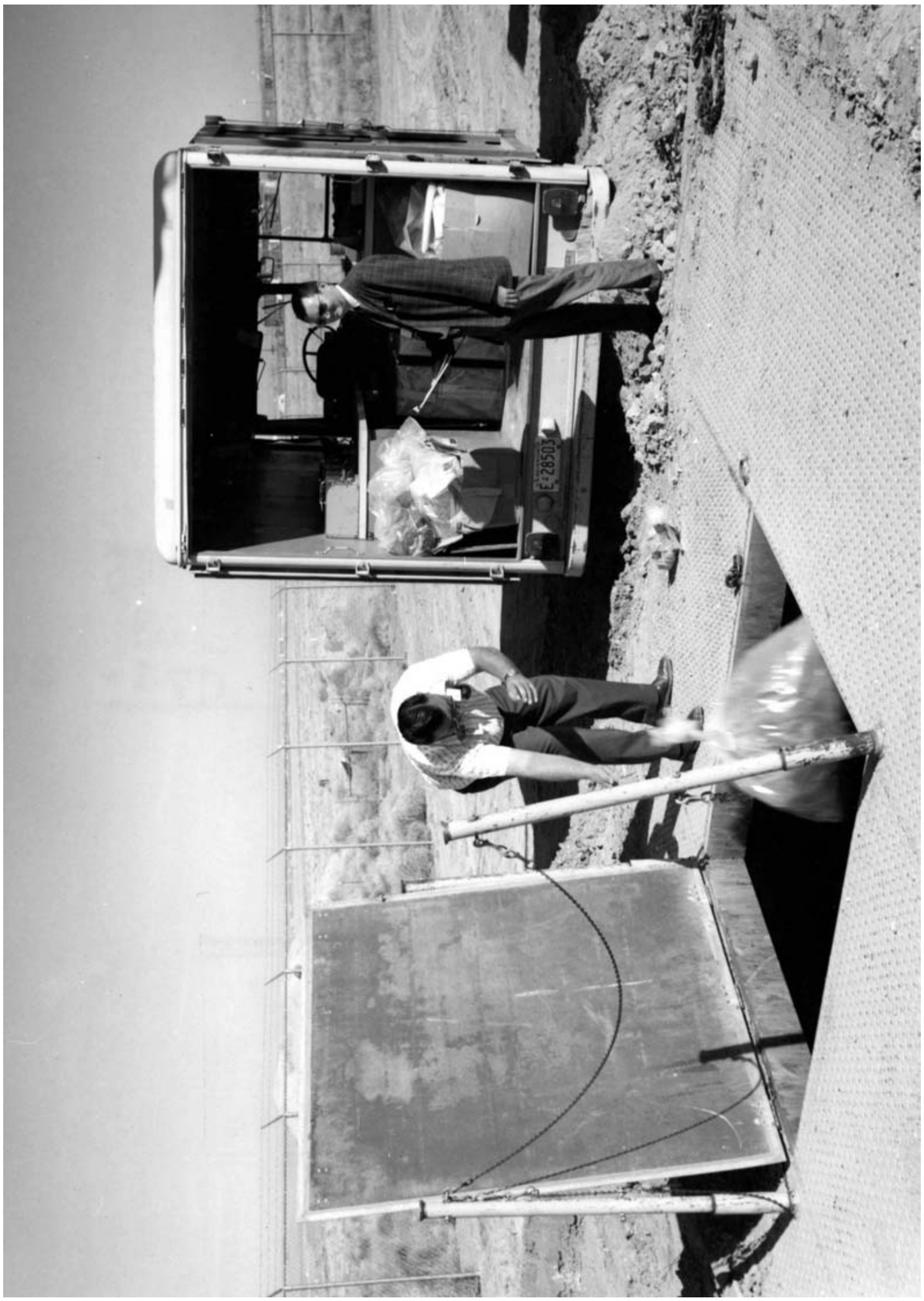


Figure 5: Lovelace Waste in Trench E, looking South, May 1980

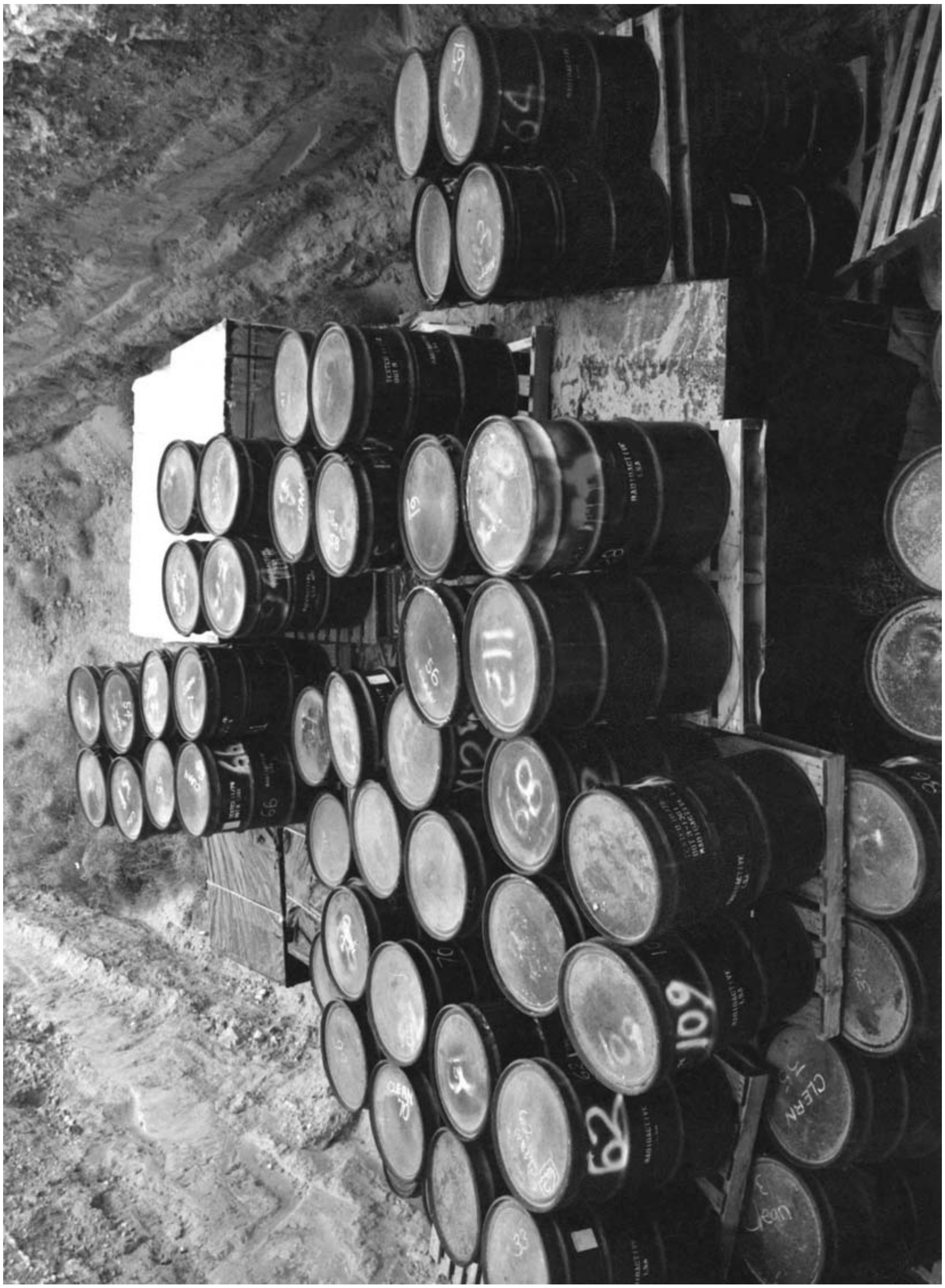


Figure 6: "Unclassified Waste" Disposal in Trench B, looking South, circa 1974

Figure 7: Trench F looking South, circa 1987

Figure 8: Trench D looking South, circa 1966

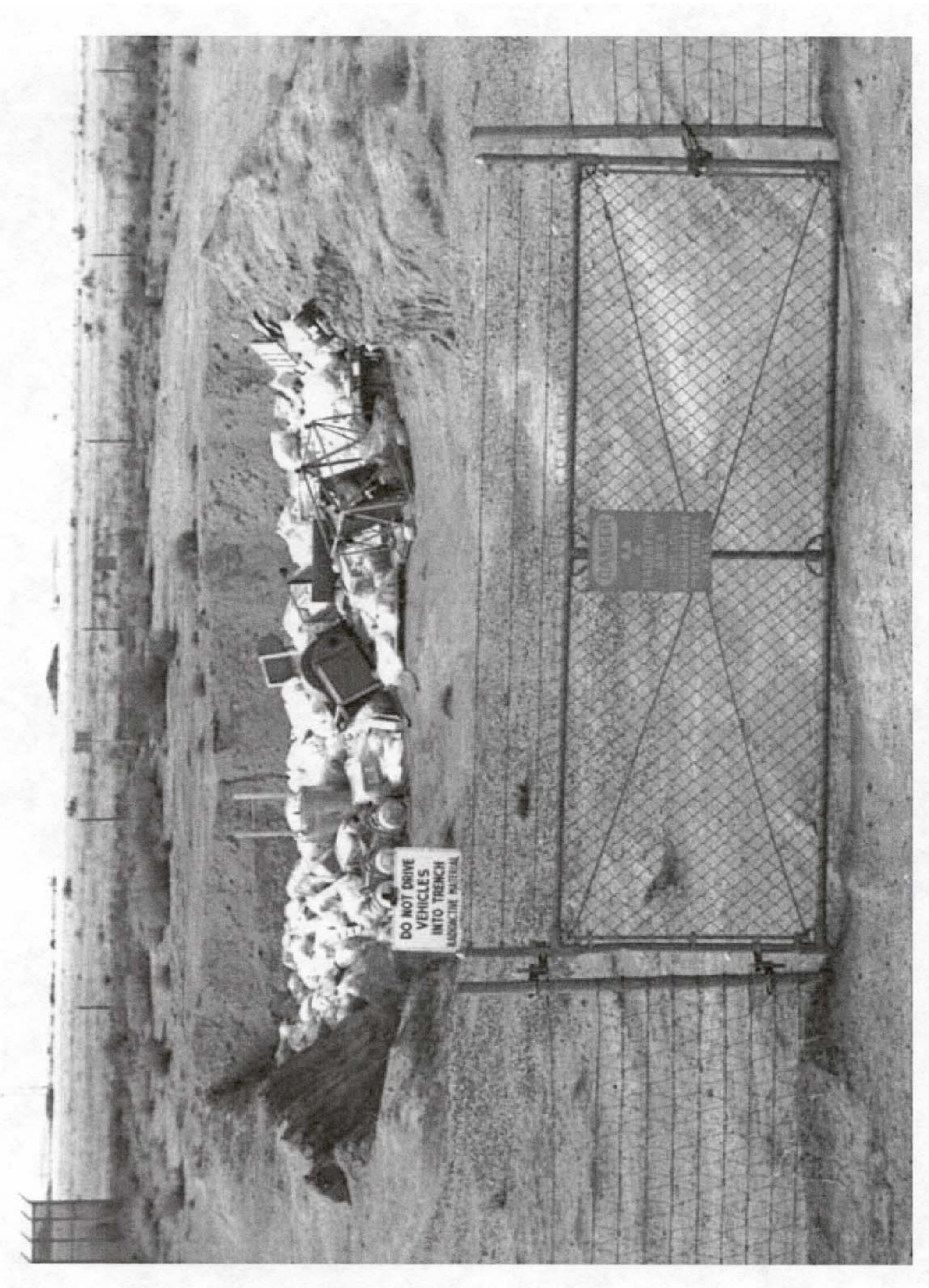


Figure 9: Classified Area Tritium Disposal, 1959-1983

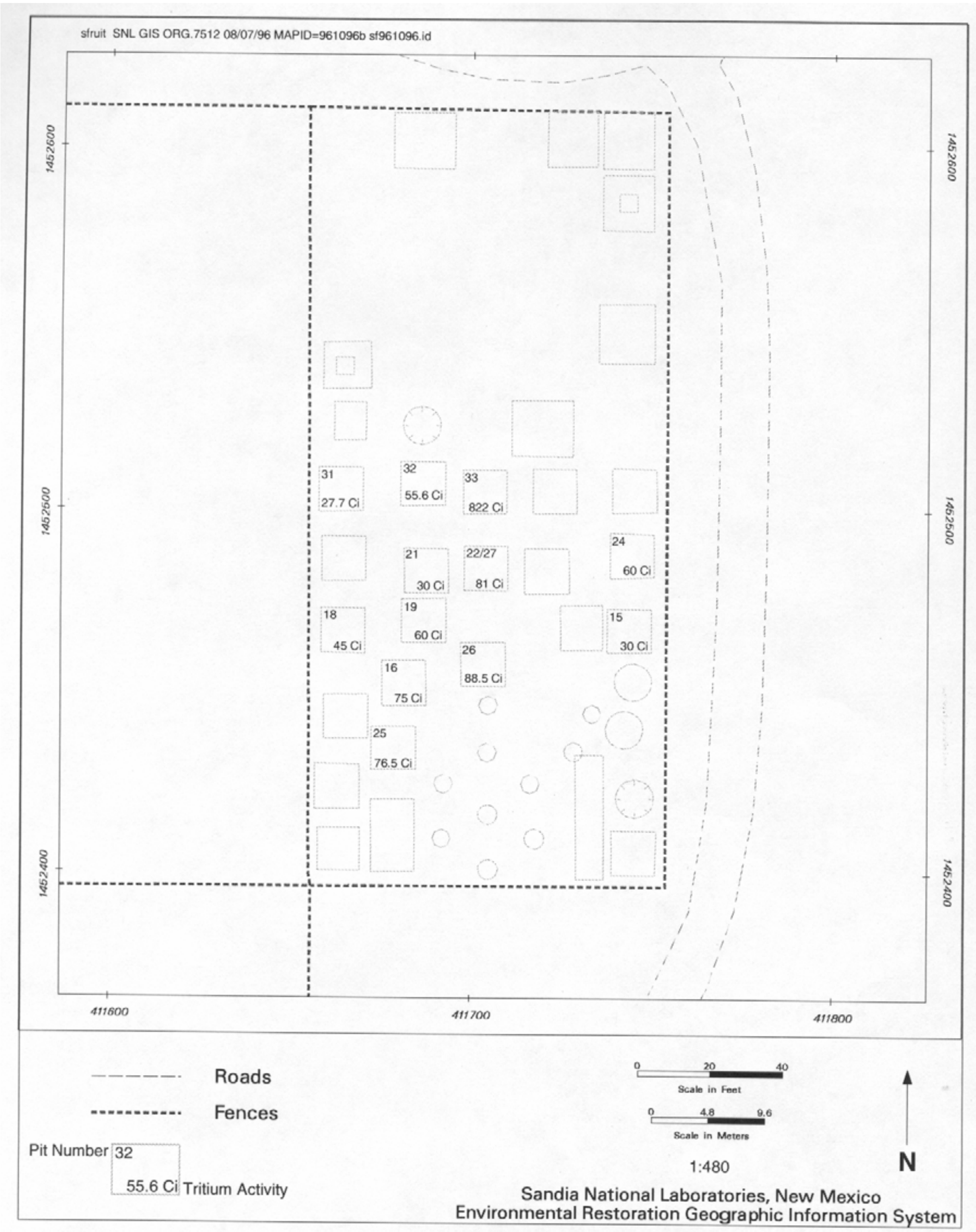


FIGURE 9: **Classified Area Tritium Disposal, 1959-1983**

Figure 10: Phase 2 RFI Soil Boring Locations

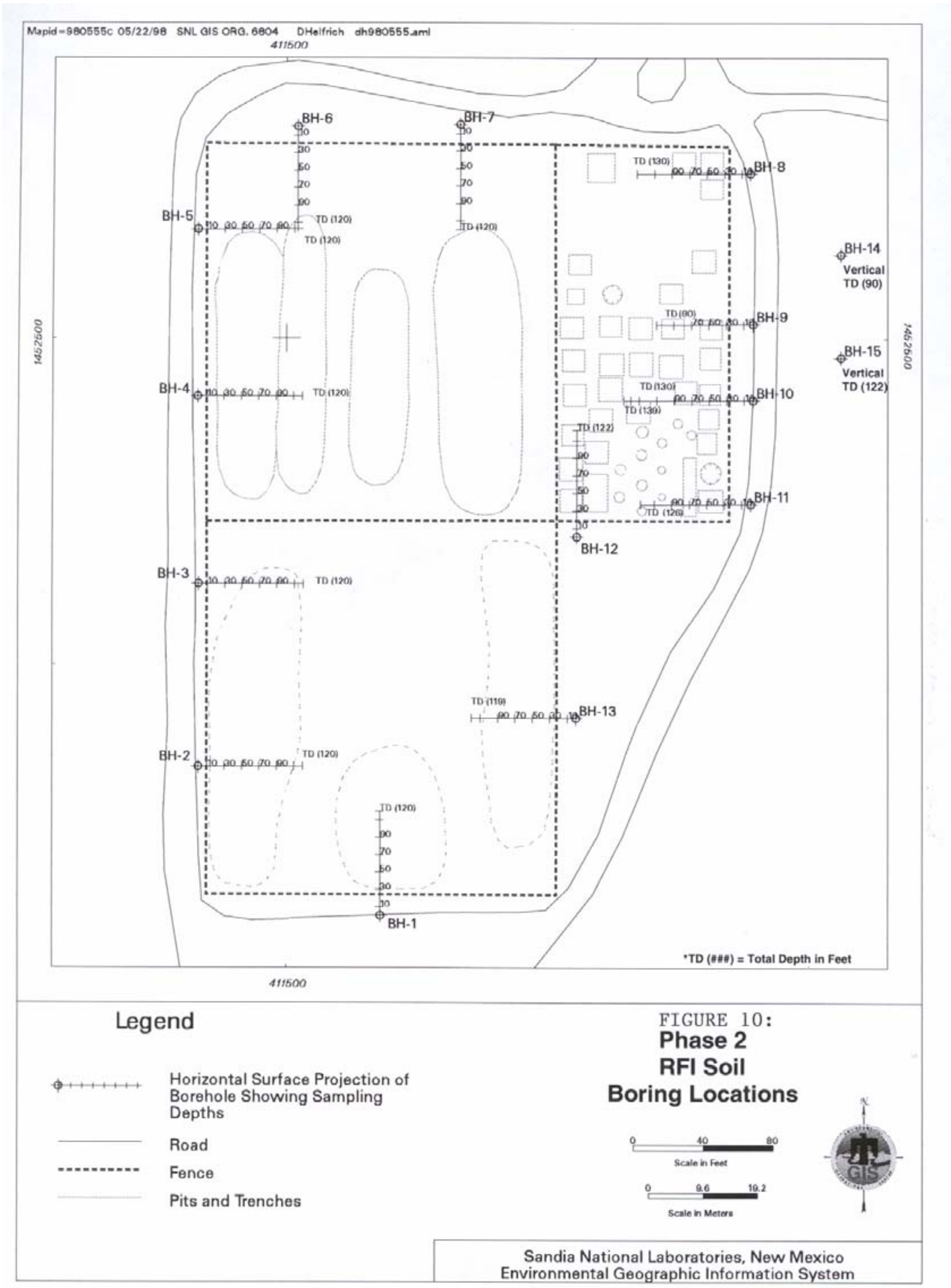


Figure 11: Monitoring Wells in the Vicinity of the Mixed Waste Landfill

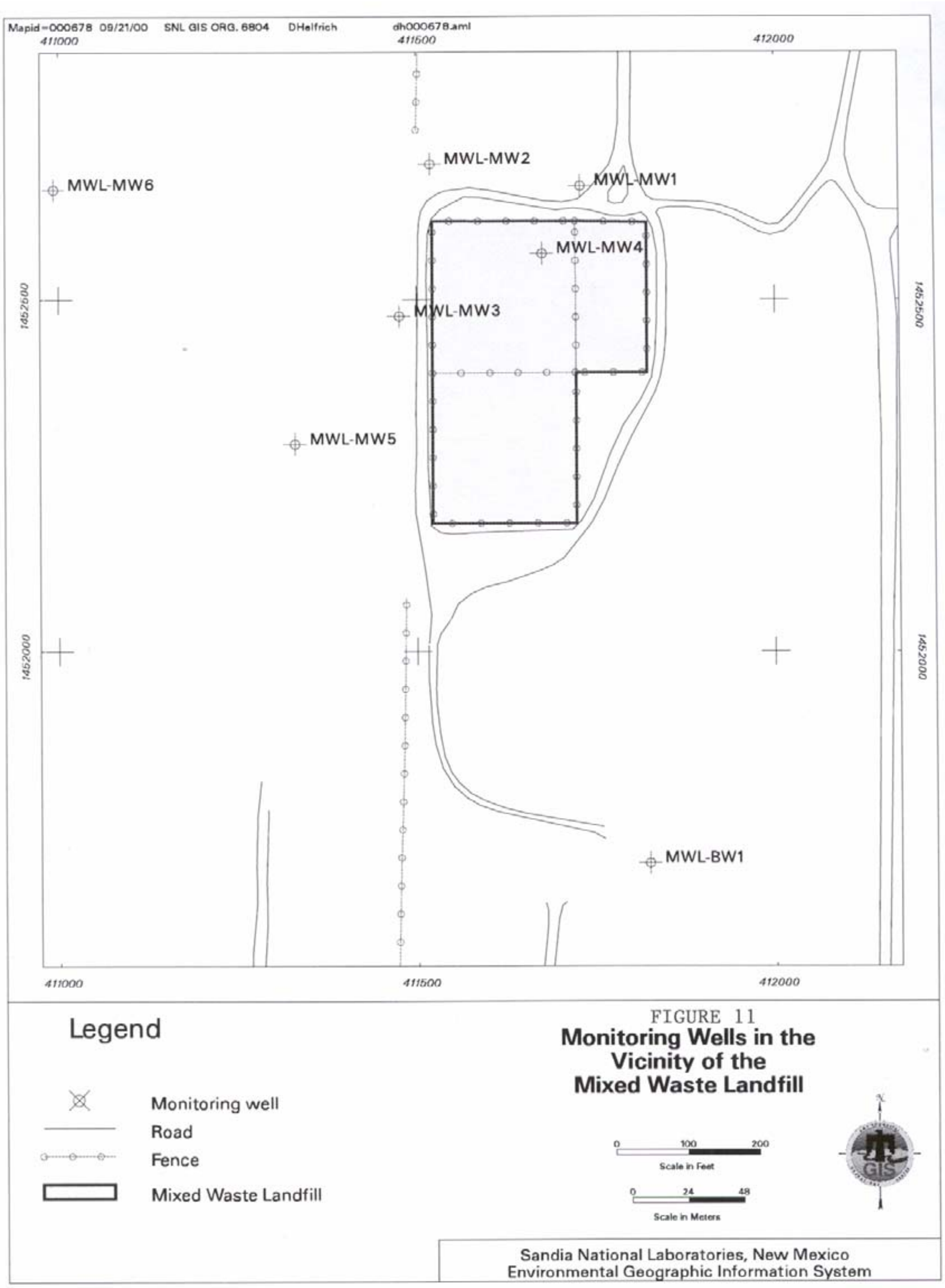


Table 1: Radionuclides Present in the Mixed Waste Landfill and Estimated Curie Levels Over Time

Radionuclide	Half-Life (years)	Estimated Ci in 1989	Estimated Ci in 1999	Estimated Ci in 2009	Estimated Ci in 2019	Estimated Ci in 2029	Estimated Ci in 2039	Estimated Ci in 2049	Estimated Ci in 2059	Estimated Ci in 2089	Estimated Ci in 2189	Estimated Ci in 2289
	Year >>	1989	1999	2009	2019	2029	2039	2049	2059	2089	2189	2289
Co-60	5.27	3500	939.7	252.3	67.7	18.2	4.9	1.3	0.4	0.0	0.0	0.0
H-3	12.30	2400	1366.2	777.7	442.7	252.0	143.5	81.7	46.5	8.6	0.0	0.0
Sr-90	29.10	410	323.1	254.6	200.7	158.2	124.6	98.2	77.4	37.9	3.5	0.3
Cs-137	30.17	410	325.9	259.0	205.8	163.6	130.0	103.3	82.1	41.2	4.1	0.4
Pu-238	87.70	1.2E-03	1.1E-03	1.0E-03	9.5E-04	8.7E-04	8.1E-04	7.5E-04	6.9E-04	5.4E-04	2.5E-04	1.1E-04
Am-241	432.00	1.2E-03	1.2E-03	1.2E-03	1.1E-03	1.1E-03	1.1E-03	1.1E-03	1.1E-03	1.0E-03	8.7E-04	7.4E-04
Ra-226	1602.00	6.0	6.0	5.9	5.9	5.9	5.9	5.8	5.8	5.7	5.5	5.3
Pu-239	24100.00	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
U-238	4470000000.00	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Th-232	14000000000.00	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
al Ci in Future Years		6736	2971	1560	933	608	419	301	223	104	23	16

4.0 General Comments on the Draft Corrective Measures Report

General comments on the Draft CMS are developed by the Peer Panel to provide the setting for evaluations that are subsequently presented.

4.1 Inventory

Information pertaining to the inventory of the MWL needs to be further explained in the CMS to avoid confusion. Areas that the Panel saw as problematic are:

- MWL inventory data for the period 1958-1964 were destroyed as part of normal record keeping protocol This is particularly disconcerting information because the site operational history (Section 1.0 of the Draft CMS) does not indicate this situation for the MWL inventory data and does not report that in the early years of operation the MWL was probably used as the chemical dump prior to the opening of the Chemical Waste Landfill.

- Anecdotal testimony exists that refers to deposition of non-stabilized free liquids (possibly solvents) in addition to the 204,000 gallons of cooling water discharged in Trench D during 1967. This event is not reported in the Draft CMS report.

- Location of many dangerous materials appears to be unknown, such as nuclear fuel canisters (FOIA doc#22) MS-1148 Jerry Peace (2,20,97)

- Amount of hazardous waste is not well understood – the inventory does not match the characterization of Pit 35, Trenches B and C. For instance, the inventory provides no plausible explanation for the levels of solvents (TCE, PCE, TCA, CFCs) found by the *Phase 2 RCRA Facility Investigation*.

The estimates pertaining to the volume of the waste deposited in the MWL vary in the range from approximately 380,000 ft^3 (14,000 cubic yards listed in Appendix J of the Draft CMS as soil and debris volume) to 720,000 ft^3 (Appendix F of the Draft CMS listed as "Volume of all wastes" FOIA Document 38, Memorandum from G.J. Smith, 1984) while the introductory section of the Draft CMS cites the most commonly-used volume of 100,000 ft^3 that is stated in the inventory. These information variations may indicate that potential wastes present in the MWL inventory could be substantially different from the inventory used in the CMS estimates.

The meaning of the words "debris" and "wastes" in the Draft CMS report is uncertain. In particular the term "debris" is not defined in the document but the implication of its use in the document appears to exclude surrounding soil, and possibly concrete demolition debris.

Regardless of its meaning, there appears to be inconsistencies in the evaluation of excavation volumes that may be attributed to different interpretations of its meaning. Such discrepancies may result not only in disparate volume estimates but in their associated excavation, characterization, and disposal costs. Thus, attempting to compare alternatives using different volume estimates may lead to wrong interpretation of cost and risk estimates.

SNL did a good job of addressing most of these issues at the January 10, 2003 meeting to the satisfaction of the Panel. It remains for the CMS to incorporate much of this discussion so that the public will also understand the process of collecting and analyzing information and that the New Mexico Environment Department has been intimately involved with the review and acceptance of the inventory results.

4.2 Legal and Financial

It is difficult to assure, should future waste removal be selected, that it will be completed without having both a comprehensive legal and a financial framework established. Both legal and financial issues were discussed in some detail during the public meetings by stakeholders. These issues, while not technical or scientific in nature, are essential for the success of future technical solutions and therefore cannot be ignored or invalidated. The Peer Panel clearly recognizes that the CMS is not the instrument for resolving this issue, but rather it is one that should be resolved directly between DOE and the State of New Mexico.

4.3 General

The following are general comments that are considered by the panel to be important to provide the reader a clearer understanding of contents of the Draft CMS.

- The use of diagrams, topographic maps, and schematics would greatly increase the understanding of alternative cap designs.

- Explanation of terms is lacking or was difficult to find, such as the cost estimate notation "with Markups", the definition of "debris", and the often-used "engineering factor" term.

- SNL must be commended for the general high quality of the Draft CMS. However, the quality of the product can be significantly improved by overall editorial guidance assuring that the document does not appear segmented and discontinuous. This methodology could turn out a product that further reduces possible misunderstandings, corrects possible defects, and improves readability of the contents. Editorial comments are included in Appendix F and are representative of a work-in-progress.

5.0 Alternatives

5.1 Alternative Screening and Selection

SNL expended substantial effort in defining a process for the purpose of identifying preliminary corrective measures categories and specific alternatives, defining and applying screening criteria, developing alternatives that have potential application to the MWL, evaluating these alternatives and selecting alternatives that meet the stated criteria. The members of the independent technical review Panel have performed an extensive review of the CMS rough draft, supplemental documents provided by SNL, additional documents provided by concerned stakeholders from the local community, and testimony heard during open public meetings held on December 9 and 10, 2002 and January 10, 2003. In general, the Panel was positively impressed with the process that was developed and the effort that was involved in its implementation and subsequent analysis. The following issues were identified during closed-door panel discussions and are intended to assist SNL in addressing specific concerns and assessing additional alternatives and should not be interpreted to suggest any fundamental flaws in the alternatives screening and selection process.

The Draft CMS identified four objectives for the screening evaluation process [Note that these were not numerically listed as such in Section 2.2 of the draft CMS report]. These were:

1. Minimize exposure to site workers, the public, and wildlife;
2. Limit migration of contaminants to groundwater such that regulatory limits are not exceeded;
3. Minimize biological intrusion into buried waste and any resulting release and redistribution of contaminants to potential receptors; and
4. Prevent or limit human intrusion.

It is stated that the objectives were determined, in part, under EPA guidance and considering applicable state and federal regulations. The Panel acknowledged that the corrective action objectives are fundamental to the selection of alternatives and are based on currently acceptable exposure and regulatory limits. Some questions were raised by the Panel with regard to how specific limits were identified and selected, and while the final choice may be appropriate, it would be desirable to have similar cases identified and referenced that have utilized the same limits. Additionally, it is highly probable that regulatory guidance and understanding of risk may change in the future, and while we cannot expect SNL to predict what these changes might be, an acknowledgement of the need to address this for future site activities would seem appropriate.

The Draft CMS states in multiple places that combinations of alternatives should be considered, however, with the exception of adding institutional controls to all alternatives and bio-intrusion added to cap alternatives, the Panel felt that the potential for using complementary technologies was not fully explored. It was further discussed that institutional controls are reasonable for the near-term but offer no guarantee in the future. Several of the community stakeholders expressed this concern and the Panel felt that institutional controls contingencies for the future should be addressed in the CMS (this issue is covered more fully in a Section 5.2 of this report). Further, as addressed previously in this report, the uncertainty of the types and quantities of waste placed in the MWL should also drive the alternative selection. While the Panel agreed that current monitoring data does not suggest any major-scale migration of contaminant species out of the MWL boundaries (with the exception of tritium), the elevated levels of some contaminants of concern (COCs) do indicate that a potential for migration exists should a release occur. While not knowing the exact contents of the MWL does increase the risk to workers during the implementation of any alternative (particularly excavation scenarios), it also offers enough reason for community stakeholders to seek a more aggressive alternative; e.g., retrieval versus capping.

The Panel devoted substantial time to discussing issues that have a direct impact on the screening and selection process. Several issues possessed the common thread of the MWL as a dynamic system that can be expected to continually change with time. SNL acknowledges this fact in several locations in the Draft CMS, but there were additional concerns that the Panel would like to be addressed. For example, SNL appropriately uses the decay in radioactivity to recommend future excavation over near-term waste removal based on safety concerns for the workers involved with site cleanup (which also drive the cost of the excavation alternatives). In another example, however, the RCRA cap is eliminated from consideration due to a history of failure in the arid southwestern U.S. This arises from the desiccation and shrinkage of the clay layer that places the flexible membrane under tensile and shear stress to the point of failure and offers the potential for subsequent preferential flow pathways. However, other cover scenarios assume cap integrity over time. The Panel questioned the effects of differential settling of the operational cover or the planned base/sub-base layers and/or animal/insect/root intrusion and the potential for preferential flow pathways to develop in the other cover alternatives.

In general, cover design alternatives seem limited. If settling or bio-intrusion were concerns, each of the cover scenarios would most likely be affected. It should be noted that any cover alternative would place additional weight on the MWL debris, not to mention the compaction of these materials that may encourage waste compaction and the possibility for containerized waste to become more mobile. Alternatively, if differential settlement is not a concern, it could be possible that flexible (or other synthetic) liners are incorporated into a cover design that does not include a compacted clay liner, thereby substantially decreasing the potential for failure. Further, the bio-intrusion barrier materials suggested are rock/cobble or wire mesh, but the potential use of synthetic materials (geo-textiles, geo-grids, or composite geo-synthetics) appeared lacking. Finally, identification of the biological agent (human, animal, insect, or plant) targeted for blockage and the relative importance of each would have a strong influence on the choice of barrier material and should be clearly identified early in the process.

5.2 Specific Suggestions for Additional CM Alternatives

In the process of discussing all of the alternatives presented in the CMS, the Panel members arrived at four alternatives that they felt should be given some consideration in the final report. It should also be noted that these suggestions are but a few examples of other potential alternatives and that additional alternatives, or scenarios which incorporated one of these or others in combination, could also be developed. The Panel feels that it is important to clarify that a recommendation by the Panel to include an alternative is not a suggestion that an alternative be selected. Alternatives recommended for inclusion in the CMS are ones that the Panel believes are appropriate to be evaluated. Evaluation does not mean selection. The final selection of the alternative that gets implemented is a decision that is made between DOE and the State of New Mexico, not by this Panel. The four alternatives that the Panel considered for further consideration are:

- The Panel's strongest recommendation is to include a scenario that would be titled "Cover with Future Excavation". The suggested cover could be the current vegetative cover option, or the vegetative cover with a low-profile (i.e. wire-mesh or geo-textile) bio-intrusion barrier. The Panel felt strongly that the uncertainty of the contents in the MWL could eventually lead to the requirement (or choice) of excavation followed by subsequent final disposal of the MWL contents. A cover at this time would offer the additional reduction in risk that community stakeholders’ desire and future excavation would offer the worker safety improvement resulting from the radioactive waste to decay before excavation begins. The Panel felt that the inclusion of the "future excavation" caveat with a capping alternative is important to evaluate because it provides greater assurance to the community stakeholders that removal of the MWL contents at a specified future time is an option. This alternative would also allow for new technologies to be developed concurrently and for financial planning to assure the funds required to accomplish the excavation portion of this alternative are available when needed. It is suggested that the excavation plan portion of this alternative be fully developed, designed, and permitted through the state for a rapid response action if monitoring identifies a release that is considered threatening to the public or the environment (see discussion on monitoring “triggers” in Section 6.0 Human Health and Ecological Risk). Periodic review of this plan would be appropriate to maintain relevancy with newer technologies.

- The Panel believes it is important to carry a RCRA style cap alternative forward with possibly a synthetic flexible liner (e.g., high density polyethylene) versus clay because it represents the baseline RCRA technology.

- The Panel recommends that an alternative be considered that uses existing, planned, and/or new on-site disposal facilities. These facilities would include an on-site RCRA approved landfill for contaminated low-level mixed waste materials, an on-site retrievable and secure facility for higher level radioactive wastes, and possibly a conventional municipal type landfill for both non-radioactive and non-hazardous debris disposal. While worker exposure would still be a risk issue, the transportation risk and concomitant expenditures would be dramatically reduced and waste management costs (as compared to above ground retrievable storage for all material) could also be reduced. It is acknowledged that SNL would need to assess the risks and cost of construction, permitting, and post closure monitoring of the new landfill(s) to determine the viability of this option.

- Finally, the Panel had the following concerns that may need further discussion:

  a) The alternatives did not account for other COCs, even though volatile organic compounds (VOCs) were detected at low levels in the soil beneath the MWL.

  b) Again, the uncertainty of the type and quantity of the wastes placed in combination with a detectable level of VOCs would suggest that this finding cannot be ignored. It is also interesting to note that concern for VOC exposure risk appears to be minimized in the CMS draft report except for the excavation scenarios that mention VOCs with regard to the need for personal protective equipment in Appendix J.

  c) The Panel was specifically concerned with the fact that inventory information was limited (or not available at all) for the years after the MWL opened and before the Chemical Waste Landfill opened, 1958 to 1962.

These concerns led to the discussion of a soil vapor extraction alternative that would offer SNL several advantages. First, the system could be utilized in combination with many of the lower-cost cover scenarios. Second, installation of the system would allow for regular, periodic sampling of the vadose zone beneath the MWL. The system would be in place and operational and, therefore, could be employed with a substantially quicker response time (as compared to groundwater monitoring) in an emergency situation should a subsurface release occur or be detected. Finally, the system could be employed continuously for the purpose of reducing the levels of currently identified constituents in the soil vapor, including tritium at greater depths.

6.0 Human Health and Ecological Risk

The Peer Panel reviewed numerous documents before, during, and after presentations that were received December 9-10, 2002 and January 10, 2003 from stakeholders in Albuquerque, NM. The Draft CMS and Appendix I present a level of effort that is typical for risk assessments used for screening purposes. Assessment considers the maximum concentration of waste found outside the pit areas of the MWL, and uses typical pathway and rate data to determine radiological and non-radiological risk levels, both as a cancer risk, i.e., relative to 1 in a million, and as a hazard index, i.e., relative to published acceptable dose/response levels. It would appear from the Risk Assessment that the method of choice presented in the CMS (institutional control with a vegetative cap) is protective of human health and the environment. However, questions remain to be addressed in order to support the remedy of choice, or other remedies that are found acceptable via risk assessment. The following considerations were generated by the Panel and serve as recommendations herein. Each concern is briefly described below:

- The Risk Assessment is based on known releases from the site. However, questions about the inventory warrant another approach to be considered. A significant portion of the public's concern rests on the composition and amount of waste in the MWL. In fact, several questions were unanswered during the meetings about the amount and type of waste present. The Panel feels that SNL has done its best at estimating the nature and volume of waste, however, with the uncertainty present, it would seem that a sensitivity analysis of the Risk Assessment would indicate how realistic the problem and concerns really are at the MWL. If the quantities and types and locations of wastes are uncertain, then so are the risks as presented in the CMS.

- The Risk Assessment is defined in Appendix I as "screening" and that definition itself indicates that more work needs to be done to more accurately assess the level of risk. Therefore, the recommendation for a sensitivity analysis approach to assess the risk assessment seems reasonable. The Panel recommends that SNL place realistic bounds on the numbers used in this sensitivity analysis to adjust for the fact that the waste volume and content is uncertain. While these high-low numbers are best determined by SNL, the Panel recommends that they consider ranges of 1) exposure scenarios/routes, 2) fate and transport, and 3) wastes present/released. It should be noted that the concept here is not to be burdensome, rather it should be geared to finding out where the MWL falls within both acceptable and unacceptable risk. In other words, these ranges should be driven to failure – to identify when the risk becomes unacceptable to the ecosystem and human health for both radiological and non-radiological risks. In this manner, remedies can be evaluated not only to determine a specific risk level, but where that level falls in a range of possible situations that may occur in the future. Below are some examples of ranges that can be varied in assessment:

- Range of exposure scenarios/routes:
  - Example – changing land ownership in the future;
  - Example – (excavation scenario) assess risks for exposure to workers and nearby neighbors;
  - Example – excavation may also be by workers, animals/plants, or public;
  - Example – source itself compared to what is outside of source;
  - Example – cap versus no cap;
  - Example – removal of surface soil, exposure of pits; and
  - Example – residential exposure versus industrial worker, both on-site.

- Range of fate and transport:
  - Rainfall event(s) driving contamination to groundwater;
  - Wind erosion of cap;
  - Uptake and transport by plants; and
  - Uptake and transport by animals;

- Range of wastes
  - Consider COCs that the stakeholders (public) are most concerned about that are present on the site, and
  - Especially cause this risk assessment to be driven to failure.

➢ Utilize a stochastic approach to the assessment of risk. This approach would be appropriate if a given value in the assessment could have ± values assigned, as in a statistical approach. However, the uncertainty may be too high (real or perceived) for this approach to have merit.

➢ The Peer Panel also made the following observations which are recommended for improved risk assessment of the MWL:

- DOE should assess the MWL for non-DOE land ownership in the future. This is a realistic possibility (although not necessarily probable for the SNL site) considering the fact that the federal government has actively transferred or is in the act of transferring DOE and Department of Defense sites to state and local entities. This situation needs to be incorporated in the range of scenarios for exposure.

- The risk assessment of a cap failure should be looked into.

- It is better for DOE to be conservative and err on safe side. Even with a range placed on the risk assessment values, it is best to remain conservative.

  - It is clear to the Panel that there is a high risk in the present removal of the buried waste. Currently, with the levels of tritium and cobalt-60 present and many other unknowns in the Risk Assessment, removal at this time is both risky and may present problems to the environment and both on-site and off-site humans. A more refined risk assessment may show that removal of the waste in the very near future is or is not acceptable.

- A key component of future excavation alternatives, based on risk assessment, is the use of monitoring "triggers" (i.e., a predetermined target level for a contaminant that triggers a need for a response). Risk assessments can identify the triggers that would become evident during long-term monitoring so that the remedy can be reconsidered if excessive levels of radiological or hazardous contamination are reached outside the MWL. For example, a high level of tritium below or above the site would indicate a release problem that would need to be addressed in the remedy. Also, a low-level trigger on tritium monitoring would also signal when to excavate the MWL, if tritium is the only concern. Triggers are commonly used in monitoring a waste site to determine if there is a problem before waste reaches a receptor. An example would be a certain concentration of a solvent in a formation below a site that is still well away from a drinking water source (receptor). These triggers indicate that there is a problem with the current remedy and a new course or corrective measures needs to be taken. This tool is fundamental in the assessment of future risk and should be included in the MWL Risk Assessment. Institutional controls can only be maintained properly if there is proper and correct monitoring and contingency plans are in place for future adverse events.

- The Risk Assessment lacks modeling of the fate and transport of tritium in the subsurface in the gas and liquid phases. The migration/release of tritium (and other COCs) needs to be modeled to failure; i.e., when in time or at what level of source concentration will the COCs reach the groundwater. This sort of modeling work will allow SNL to establish the proper trigger levels described above.

- In addition and related to the above sections, the following are specific comments regarding Appendix I in the CMS. These comments are linked to specific pages of Appendix I and therein provide more detail to the above points in many cases. First, the document is a screening tool only (by definition and title); thus, a more detailed risk assessment is needed to fully evaluate the risk. The following comments may assist in that more detailed future assessment.

  - Page I-11, second paragraph under Section III.4: second statement indicates that a more rigorous risk assessment is needed to look at what-ifs should material be released.

- Page I-26 – Section V: Fate and transport assessment does not include a model for the fate of tritium or organics with time and space. SNL needs to run tritium diffusion and tritium water migration, calibrated with the historical data from sampling over time, to the point of contact with the groundwater. In this manner SNL can determine where the contaminants migrate, how long it takes to reach a given boundary condition, and what the concentrations/source energies are at that location and time.

- Table 12, page I-28: No migration to groundwater is noted (see above comment).

- Table 17, page I-40: Heading is incorrect; it should be with institutional controls.

- Page I-42: What is the impact of someone digging into the vegetative cap on the risk? Also what is the effect of compaction by overburden of cap and construction on the risk?

- Page I-59 and ecological risk in general: There is a need for sensitivity analysis here as well; e.g., how much animal activity will cause a problem? Is this much animal activity reasonable for the size of the site?

In summary, the key elements in the assessment of risks at the MWL are waste inventory, future land use and populations, proper monitoring and modeling of contaminant(s) migration, and the structure of the risk assessment relative to the remedies under consideration for implementation with contingency plans for the future of the site.

7.0 Environmental Impacts and Institutional Concerns

7.1 Institutional Concerns

The success to any environmental venture at SNL hinges on the active participation and cooperation of DOE, SNL, stakeholders, and independent citizen organizations. The CMS study, leading to recommendation and implementation of the most favorable alternative, is no exception to this rule. SNL should be commended for the detailed information provided to the Panel and presumably to these other groups. Such information is abundant in details but is oftentimes highly deficient in providing overarching conceptual information that could shed light on critical conclusions. SNL is encouraged to provide a better global understanding of the problems and their potential solutions by clearly delineating assumptions, development of regulatory constraints, design criteria, supporting graphics, etc.

It is imperative to underscore that the Citizen Action group, using legal resources provided under the Freedom of Information Act, or FOIA, were able to obtain relevant information that was not provided to the Peer Panel directly by SNL. The controversial nature of the documents obtained through FOIA oftentimes requires clarification from SNL in a setting that is not conducive to furthering cooperation among participants. Consequently, SNL should continue to maintain a positive and aggressive good-neighbor policy. An open communication policy with the public is fundamental in the development of such policy. The legacy of the present exercise is an excellent reminder to SNL policy makers that in the long range, the citizens' "right to know" is upheld as an essential public involvement principle and that information dissemination of relevant information along with clearly delineated interpretation is judicious and constructive in promoting a better understanding and hopefully cooperation among participants. Likewise on the citizens' organization end – this is a two-way street. If DOE, SNL, and the state of New Mexico are to select a reasonable and rationally acceptable solution, citizen groups must also share findings and work constructively with these agencies. Everyone involved must also recognize that risk, uncertainty, and future cost consequences are inherent with all proposed alternatives (including no further action) and that while no decision is perfect, a decision must be made.

An ethical issue that has been raised by the public is the principle that the proposed program should not present an undue burden on future generations. This burden includes both risk to the human population and the financial liability incurred as a result of the selected plan of action. The long-term duration of the proposed solutions are of particular concern since institutional controls and monitoring programs may extend far beyond the present generation. The question is – should equitable distribution of this long-term commitment be mainly carried by the present generation to avoid encumbrance of generations that did not profit from the assets that produced the wastes in question? This ethical question is one that is not within the capacity of the Panel to answer but resides within the U.S. Congress to address.

The lengthy time frame of this project presents some interesting questions that may need to be addressed presently to prevent future misunderstandings related to ownership of responsibility. Land ownership, which at the present time is fully under DOE authority, may someday be transferred to second parties. The regulatory framework should consider this unlikely, but possible, scenario so that the present responsible parties maintain legal liability of the site while transferring ownership rights to future land owners.

Implementation of corrective measures should carefully address the lessons learned through RCRA. This piece of legislation has undergone extensive testing both, in the legislative arena and in the technical community. One needs to remember that activities exempted under this legislation may someday have these exemptive privileges eliminated and that grandfathering of present remedial actions may in the future have to comply with new future constraints. It is therefore advisable to proceed in a safe manner by adopting as many components of RCRA to prevent either unforeseen pitfalls or burdensome future corrective actions.

The Peer Panel was charged with the review of the Draft CMS report. In general, this report is comprehensive and highly detailed. However, a consistent deficiency is the lack of supporting information in several critical areas. The lack of several engineering assumptions, as pointed out in other sections of this report, makes it difficult, if not impossible for peers to assess engineering design merits of the proposed concepts. Delivery of selective information, in particular the exclusion of information relevant to records that were destroyed as part of normal record keeping protocol, combined with the potential impact of reactor water (this information was not recorded in the Draft CMS report) on landfill performance created significant confusion among Panel members. The Panel also noted the absence of Attachment 1 in the CMS report.

7.2 Environmental Impacts

The information provided in the Draft CMS document is developed based on an extensive waste inventory. Sources used to create the waste database include both documented factual data and anecdotal information as pointed out in the background section of this report. The later source was used to fill in some of the incomplete data. The Panel agrees with the statements pointed out in the SNL presentation that the inventory is very good, but not perfect. Although very good, it never the less is incomplete. Uncertainties remain regarding the disposal of liquid hazardous and radioactive wastes in the early years of the landfill due to data gaps in documents before 1964.

Areas of concern to the Peer Panel include the potential leakage of radioactive sealed sources (documented and possibly undocumented) and the possible leakage of unstabilized hazardous liquids; in particular those that are not documented because they may have been disposed during the first years of operation. The presence of trace concentrations of VOCs within and in areas surrounding the landfill may be an indication that unaccounted sources may be starting to migrate out of their respective containers into the core of the landfill. It is also possible that additional liquid containers may, under the present environmental conditions in the landfill, leak their contents into the bulk of the landfill in the future. Additionally, there is the possibility that one or more of the radioactive sealed sources may have their seals compromised and expose their contents to the surrounding environment prior to the natural radioactive decay of the source to safe levels. The increase of overburden and the construction activities of cap placement could exasperate these potential problems. Therefore, presence of heavy equipment on the landfill surface and an increase in overburden should be carefully evaluated for their potential impact to prevent possible damage to the stability of contained radioactive and possible liquid and semi-solidified wastes.

A secondary event that the Panel considered is the possibility that tritium and other radioactive materials may be generated in situ by radiochemical reactions. For instance, neutron radiation (from neutron emitters in the MWL) of lithium 6 is known to produce both tritium and non-radioactive helium. Lithium, though not necessarily abundant in natural soils, may be present in sufficient concentrations in the MWL to promote such reaction. The Panel lacked the resources to pursue such pathway and recommends that SNL investigate this situation if their nuclear scientists deem these reactions to be feasible within the MWL and would result in any significant environmental consequences.

Two non-invasive approaches are possible to determine the potential impact of the known wastes within the landfill on surrounding air, soil, and water media in the future. SNL must be commended for addressing the first one, long-term monitoring. The Panel suggests that this fundamental part of all alternatives be augmented with modeling that incorporates:

- Data management GIS 3D model to visually show contaminant migration or changes.
- Fate and transport modeling of contaminants in soil and vapor for identified species with potential to groundwater, flora, and fauna; and
- Different modeling scenarios for potential contaminants to feed into risk assessment:
    - Air
    - Soil
    - Water

8.0 Costs

The Panel agrees with the overall cost estimates (not necessarily with the exact value of each category or the total cost of each alternative) made in SNL's Draft CMS. The Panel appreciates the detail of the estimates provided and the fact that cost was not used as a selection criterion in the screening process. Principal areas of improvement to the report are:

- Definitions for terms and assumptions for costs need explanation, such as escalation, markup, percentage interest used for net present worth; inflation factors for direct costs; modifiers for materials, labor and equipment; excavation would be for the entire 2.6 acre site to bottom of trenches with side slopes of 3:1 for stability; etc.

- It would be helpful to explain, as was done at the public meetings, the different cost estimates and their value in the decision-making process. For instance, Appendix J is an independent analysis of the Near-Term Excavation Alternative yet it is not used or even referenced within the main part of the report.

- Some assumptions made in Appendix J may lead to unrealistic cost estimates. For example, the figure "Assumed Excavated Waste Criteria" shows the cross-section of an unclassified trench with alternating 3.5 foot layers of debris separated by 1.5-foot layers marked "Quarterly Soil", which is to be treated as low-level waste. Photographs in Section 3.0, Background of the Mixed Waste Landfill, seem to show more of a bulk fill of the trenches with a top cover. The assumption of intermediate soil layers between debris fill layers may lead to an underestimation of the debris volume and thus to a low disposal cost estimate.

- There are widely varying estimates of total waste volume in the unclassified section of the MWL. The CMS begins with a statement that approximately 100,000 cubic feet of waste was deposited in the MWL; other estimates go as high as 720,000 cubic feet (SNL ER Program Information Sheet, 1987, FOIA 90). It is unlikely that these large differences can be attributed to the fill material only for that would represent an inordinate high ratio of fill to debris. Clearly, such discrepancies in the estimated waste volume will result in large cost differences. Clarification made during the January 10, 2003 meeting helped the Panel understand the nature of the discrepancies. The final CMS report must clearly explain the nature of the discrepancies and should attempt to reconcile the differences as explained during this meeting.

- The CMS needs to clarify the assumptions that were made to arrive at the costs for continued monitoring and maintenance after capping of the MWL, particularly to explain the significant differences in monitoring and maintenance of the different caps – the RCRA cap has a $2,400,000 cost while the vegetative cap has a $300,000 cost for essentially the same level of maintenance. The duration of the post-closure monitoring and maintenance budgeted should also be specified.

- Since the closed MWL may have to be maintained and monitored for a very long time into the future, the Panel suggests that cost projections over a period of 30 to 100 years be used to identify the impact of such costs on the different alternatives. Although RCRA guidance does not require this extended time period for cost estimates, these long-term life cycle costs are important in making decisions. It would also be useful to include alternative cost models that take into account a sustainable approach; i.e., looking at land value and future land use and ownership.

Appendix A
Biographic Sketches of Peer Panel Members

CADENA, Fernando – Dr. Cadena received his B.S. in civil engineering from Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) in Mexico in 1970. He proceeded to obtain his degree in civil (sanitary) engineering at New Mexico State University (NMSU) in Las Cruces, New Mexico in 1973. Dr. Cadena's terminal degree is a Ph.D. in environmental engineering from California Institute of Technology in 1977. Dr. Cadena's academic experience started in 1977 at ITESM where he was assistant professor of civil engineering until 1980. In 1980, Dr. Cadena accepted a staff engineering position with Engineering Science (a subsidiary of Parson's Engineering). His duties included design of several environmental engineering projects both in the U.S. and overseas. Dr. Cadena has been a faculty member at NMSU since the fall of 1980 where he holds a position of professor in the Civil and Environmental Engineering Department. Dr. Cadena teaches graduate and undergraduate courses in civil and environmental engineering. He conducted consulting services that address the chemical behavior of actinides in environmental systems for Los Alamos National Laboratories (LANL). He also participated as a subcontractor on the Phase II design of the mixed waste facility for LANL through Leedshill-Hernkenhoff, Inc. Dr. Cadena was a team member with Physical Science Laboratories (PSL) based in Las Cruces, NM performing environmental assessments for Sandia National Laboratory. He spent a one-year sabbatical at Argonne National Laboratory conducting research and engineering practice on environmental assessments for several air force bases throughout the U.S. Dr. Cadena served as a consultant for the International Atomic Energy Agency (IAEA), during the year 2000. His responsibility was to conduct radioactive waste disposal assessments of IAEA-sponsored projects in 10 countries located on five different continents. He also was a participant in the evaluation of the IAEA-sponsored conferences on radioactive waste management in Cordoba, Spain and Vienna, Austria.

CONSTANT, David – Dr. W. David Constant is a Professor of Civil and Environmental Engineering and Asst. Director of the U.S. EPA Hazardous Substance Research Center/South & Southwest at Louisiana State University (LSU). He received his B.S., M.S., and Ph.D. in chemical engineering from LSU and is a registered Professional Engineer (Chemical and Environmental) in Louisania. Memberships in professional organizations include the AIChE, the Association of Environmental Engineering and Science Professors, the Universities Council on Water Resources, the Society of Petroleum Engineers, the American Society of Mechanical Engineers (ASME) and four engineering honor societies. He serves on several advisory committees and review panels for the U.S. EPA and Department of Defense and is associate editor of the ASME Journal of Energy Resources Technology. Dr. Constant has authored or co-authored more than 150 publications, reports and presentations in the past 18 years, including 40 plus refereed publications and five book chapters on environmental topics. Integrated in his research are more than 12 years of administrative experience in research units, programs and contract management. He has advised senior environmental engineering student task teams over the past five years in the WERC Environmental Design Contest. His teams have won the overall first place award and two firsts and one second place. In 2000 Dr. Constant received the Mike Berger Outstanding Faculty Advisor Award at this contest. In 2002 he received an achievement award from the Department of Civil and Environmental Engineering at LSU for his accomplishments in research, teaching and service. Research interests include fate and transport of hazardous substances in subsurface environments and in-situ waste site remediation technology. He has worked with other faculty and students over the past 13 years in research related to the Petro Processors, Inc. site north of Baton Rouge. He is currently principal investigator for LSU’s assistance to the U.S. District Court in cleanup of the site. Teaching activity has included courses in hazardous and solid waste management, wastewater treatment, water quality analysis, basic and applied environmental engineering, and in-situ site remediation design and technology.

JOVANOVIC, Goran – Dr. Jovanovic received his B.S. in chemical engineering from Belgrade University, Belgrade Yugoslavia in 1970. After two years of industrial experience he proceeded to obtain an M.S. and Ph.D. in chemical engineering at Oregon State University. He started his academic carrier at Belgrade University where he advanced to the full professor position in 1990. During his tenure there, he received intensive training in radiation safety, and radioactive and mixed waste management. Dr. Jovanovic has directed more than 39 research projects in the areas: chemical reaction, environmental engineering, microscale reaction engineering, and biomedical engineering. Dr. Jovanovic’s professional activities include consulting (in his own name) with several companies in Europe and USA. He has designed 4 industrial pilot plants. These plants are built in cooperation with industry as a part of industrial development projects. His current research and academic interest is centered in the development of fluidized bed technology for the catalytic dechlorination of chlorinated hydrocarbons in soil remediation processes. Dr. Jovanovic also leads a development project for implementation of microscale technologies for the destruction of chlorinated hydrocarbons in mixed waste. Dr. Jovanovic is a member of American Institute of Chemical Engineers, American Chemical Society and European Society of Chemical Engineering. He has more than 60 published refereed papers out of which 12 are monograph contributions. He has written 32 un-refereed publications, presented 24 invited lectures and seminars, given more than 90 presentations at scientific conferences, conducted 39 research projects, and done one book-translation from English into Serbo-Croatian. Dr. Jovanovic is the recipient of many academic and professional awards.

MUELLER, Wolfgang – Dr. Mueller received a degree of Dipl. Chem. and Dr. rer. nat. in chemistry with a minor in pharmacology from the University of Bonn, Germany. He is currently a professor of chemistry and toxicology at New Mexico State University, where he serves as Toxicology Program Coordinator and has taught courses in general, environmental, analytical and regulatory toxicology for the past 18 years. From 1971 to 1985, Dr. Mueller was employed by the Gesellschaft fuer Strahlen-und Umweltforschung (GSF) in Munich, Germany, where he directed a research group "Dispersion Tendencies of Chemicals in the Environment" (Munich 1971-1973) and a research group "Fate and Effects of Environmental Chemicals in Non-Human

Primates (Alamogordo, NM, 1973-1985). In the early 1990s, he established the section for analysis of organic chemicals of the Soil, Water and Air Testing Laboratory at NMSU with funding from WERC/DOE. His more recent research experience has been in the area of bioremediation of explosives-contaminated soils by higher plants. Dr. Mueller's primary experience is in analytical chemistry and environmental toxicology; over much of his research career he has utilized radioactive tracer techniques.

STUART, Ben – Dr. Ben J. Stuart received his B.S., M.S., and Ph.D. in 1990, 1993, and 1995 from the Department of Chemical and Biochemical Engineering at Rutgers, the State University of New Jersey. Dr. Stuart is currently an Assistant Professor in the Department of Civil Engineering at Ohio University. He is a registered professional environmental engineer in the state of Ohio. Dr. Stuart has participated on research projects totaling $2 million supported from a blend of federal, state, private, and industrial sponsors. Past research efforts have included the monitoring and modeling the environmental impact of the release of tritium or tritium conversion products, the fate and transport of aromatics during enhanced bioremediation in soil/groundwater systems, and assessments of the biological and habitat impacts of acid mine drainage (AMD) in local watersheds as well as the design and evaluation of AMD abatement and treatment systems. Dr. Stuart has served on numerous review panels and steering committees as well as serving as a reviewer for several technical journals. He has more than 10 refereed publications and has presented more than 30 papers and co-authored an additional 15 presentations on his research.

Biographic Sketches of Peer Panel Facilitators

BHADA, Rohinton (Ron) - Dr. Bhada received his B.S., M.S., and Ph.D. degrees in chemical engineering from the University of Michigan and earned an M.B.A. in management from the University of Akron. He joined New Mexico State University as Department Head of Chemical Engineering in 1988, retired in 1999, and is currently Emeritus Associate Dean of Engineering, Chemical Engineering Head, and Executive Director of WERC: A Consortium for Environmental Education and Technology Development). Prior to joining NMSU, Dr Bhada was employed for 29 years at Babcock and Wilcox Company, a major energy systems company actively engaged in environmental management. At Babcox and Wilcox, Dr. Bhada was involved in activities ranging from applied research to field demonstrations in environmental control, waste stream chemical recovery, coal gasification, advanced power generation, fluidized bed combustion, and refuse incineration. He has more than 80 publications and papers, has published more than 100 reports on original research, and holds a U.S. Patent on chemical recovery from a waste stream. He is a registered professional engineer, Diplomat of the American Association of Environmental Engineers, a Councilor of the Oak Ridge Associated Universities, and a member of the National Research Committee of the American Institute of Chemical Engineers.

CARLSON, Timothy - Mr. Carlson received his B.S. in civil engineering and M.S. in environmental engineering at Arizona State University and is a registered Professional Engineer in Colorado. He has more than 30 years experience in the environmental cleanup arena working in the private sector with various states, EPA regions, and federal agencies (DOE, Department of Defense, Corps of Engineers, and the National Park Service). He is currently the president of Sensible Environmental Solutions, a small non-profit environmental research corporation; and executive director of the Tamarisk Coalition, a non-profit riparian restoration organization. Mr. Carlson's projects have included the planning, design, construction management, and operation assistance for numerous waste treatment systems under the regulatory authority of the Clean Water Act and CERCLA. As a principal scientist for RUST Geotech, Inc. at the Grand Junction Projects Office, work on DOE projects has included several CERCLA actions that have lead to Records of Decisions; DOE Headquarters support on the identification of needs for the Environmental Restoration Program and the relationship of technology efforts to meeting those needs; and the development and coordination of a comprehensive implementation program for several innovative treatment technologies. He is principally known for his abilities to gain acceptance by the public and regulatory agencies on difficult and controversial projects from planning and design through construction. These projects oftentimes involved innovative approaches that required the acceptance by a public with diverse priorities and agendas. Several of these projects received not only local acclaim, but also regional and national recognition for environmental engineering excellence. Another aspect of Mr. Carlson's capabilities has been the organization and performance of high-level peer reviews of environmental technologies.

Biographic Sketches of WERC Staff Members

GHASSEMI, Abbas – As executive director of WERC, Dr. Ghassemi is the chief operating officer for programs totaling more than $6 million annually in education and research, managing activities between four academic institutions, two national laboratories and several industrial organizations. He is responsible for administrative duties, operation, budget, planning, and personnel supervision. Dr. Ghassemi is also responsible for formulation, coordination and implementation of WERC's activities. In addition, he is responsible for interaction and involvement of 70 industrial and government agencies in all aspects of WERC programs. Dr. Ghassemi initiated, developed and continues to have primary responsibility for the International Environmental Design Contest that has been hosted at New Mexico State University since 1990. Previously, Dr. Ghassemi served as director of Research and director Special Projects and Technology Transfer for WERC, where he initiated and directed several major projects totaling $4-5 million annually. Prior to joining NMSU/WERC in 1989, Dr. Ghassemi was employed for more than 10 years by Monsanto and its subsidiary, Fisher Controls. There, Dr. Ghassemi was involved in activities ranging from project and technical development to marketing management. Dr. Ghassemi received his BS in chemical engineering from the University of Oklahoma, and an MS and Ph.D., also in chemical engineering, from New Mexico State University. Dr. Ghassemi has written more than 75 articles and papers the areas of waste management, process control, sensors, thermodynamics, transport phenomena, education management and innovative teaching methods. His research areas of interest include risk-based decision making, pollution prevention, multiphase flow and process control. Dr. Ghassemi serves on a number of public and private boards and as a peer review panel member for the U.S. Department of Energy and the U.S. Environmental Protection Agency. Recently, he was appointed by the governor of the State of New Mexico to serve on the New Mexico Environmental Improvement Board.

LOYA, Jim – Mr. Loya received his M.S. in environmental engineering in 1996 from New Mexico State University. During his studies he was awarded three fellowships and became a member of the prestigious CHI EPSILON, an engineering honor society. He received his B. S. in civil engineering from New Mexico State University in 1974. During the time period of 1974 to 1986 he served as an U.S. Army officer. He received professional management training at Ft Knox Kentucky, where he was recognized as the Distinguished Graduate. At Ft. Leavenworth Kansas he received advanced management training to prepare him to serve as a training officer in Europe. He severed as a project officer for four years in the training development department at Ft. Knox, Kentucky. During that time he was the project officer responsible for developing the threat based training methodology that the U.S. Army still uses today. Mr. Loya has been with WERC since 1996. He has managed educational as well as research projects. His duties have encompassed a multitude of task within the consortium as well as with partners outside of it. It has required him to perform activities from concept development through budget development to implementation and evaluation. He has managed projects for WERC coordinating and reporting to federal, state and local government agencies. He has designed, planned, developed, organized, obtained funding for, implemented and evaluated the Tri-City, Tri-State, Bi-National Water Festival 1999 – 2001. During those first three years more than 30,000 students from the region participated in the annual event. He has formed collaboration with more than 40 bi-national, federal, state and local government agencies and NGOs in the Paso del Norte region. This region includes the states of New Mexico and Texas on the U.S. side and the Mexican state of Chihuahua.

Appendix B
Notices of Public Meetings

Notice of Public Meeting
Sandia Laboratories' Mixed-Waste Landfill

WERC: A Consortium for Environmental Education and Technology Development invites all interested parties to make technical presentations regarding the Corrective Measures Study of the Mixed-Waste Landfill located on Sandia National Laboratory's property in Albuquerque, NM. Participants will have 30 minutes to make technical presentations and must submit their presentations in writing (PDF or hard copy) to WERC by noon on Thu., Dec. 5 to the address listed below. This will be the only public meeting prior to WERC's submission of a final report on the Corrective Measures Study.

Meeting Information	Technical Presentation Information
Date/Time: Dec. 9, 1-6:30 p.m. Dec. 10, 9 a.m.-12 p.m. Location: Hilton Albuquerque 1901 University Blvd., NE Albuquerque, NM 87102 (505) 884-2500	Due Date: December 5, noon Send to (PDF format): Mr. Jim Loya PO Box 30001, MSC WERC Las Cruces, NM 88003-8001 jloya@nmsu.edu (800) 523-5996, fax (505) 646-5474

Notice of Public Meeting
Sandia Laboratories' Mixed-Waste Landfill

WERC: A Consortium for Environmental Education and Technology Development received vital technical presentations from interested parties on Dec. 9-10, 2002 regarding the Corrective Measures Study of the Mixed-Waste Landfill located on Sandia National Laboratory's property in Albuquerque, NM. WERC invites all interested parties to make additional presentations that may clarify or compliment the information received to date. Participants will have 30 minutes to make technical presentations. All comments must be submitted in writing prior to or at the meeting. This will be the last public meeting prior to WERC's submission of a final report on the Corrective Measures Study.

Meeting Information	Technical Presentation Information
Date/Time: Jan. 10, 9 a.m.-noon Location: Hilton Albuquerque 1901 University Blvd., NE Albuquerque, NM 87102 (505) 884-2500	Due Date: Jan. 2, 2003, noon Send to (PDF format): Mr. Jim Loya PO Box 30001, MSC WERC Las Cruces, NM 88003-8001 jloya@nmsu.edu (800) 523-5996, fax (505) 646-5474

Dear Stakeholder:

As a follow-up to earlier communication with you and as stated on the WERC web site in the section on the Independent Technical Peer Review of the Corrective Measures Study (CMS) of the Mixed Waste Landfill, WERC has issued an interim report as of today, January 15, 2003. Due to an NMSU server problem the interim report can not be viewed on the WERC web site. It can be viewed at (http://wercstation.nmsu.edu/public).

This interim report is being made available for review of its factual accuracy only.

Technical comment regarding the interim report should be directed to the project manager and must arrive not later than (NLT) close of business (COB) January 21, 2003. Those arriving after the deadline will not be considered for this report.

Electronic comments can be sent to the project manager at jloya@nmsu.edu.
Hard copy comments can be sent to:
New Mexico State University
ATTN: James Loya
Box 30001, MSC WERC
Las Cruces, NM 88003

Fax: 505-646-5474

Dear Stakeholder:

In light of a number of requests from all sectors WERC has extended the deadline for review of the interim report on the Independent Technical Peer Review of the (Draft) Corrective Measures Study (CMS) of the Mixed Waste Landfill until Noon, Thursday January 23, 2003.

This interim report is being made available for review of its factual accuracy only.

Technical comment regarding the interim report should be directed to the project manager and must arrive not later than (NLT) Noon January 23, 2003. Those arriving after the deadline will not be considered for this report.

Electronic comments can be sent to the project manager at jloya@nmsu.edu.
Hard copy comments can be sent to:

New Mexico State University
ATTN: James Loya
Box 30001, MSC WERC
Las Cruces, NM 88003

Fax: 505-646-5474

Appendix C
Presentations at Public Meetings

December 9 and 10, 2002 Public Meeting

Eight presentations were made to the Peer Panel over the two days of public meetings, December 9 and 10, 2002. A synopsis of each with emphasis on the significant points that were made or brought up during the question and answer discussions is presented below.

Dick Fate, Sandia National Laboratories, Project Manager for the MWL Corrective Measures Study – Mr. Fate gave an overview of the work being done on the project and historical perspective of the facility. Tim Goering and Jerry Peace of SNL also provided input.

- Investigations and studies on the site have been occurring over the past 10 years with $10,000,000 spent on characterization and other studies.

- Cost estimates were developed using the RACER model developed by Department of Defense and have provided reliable data.

- Inventory of wastes is considered to be very good, but since it is a landfill they are not perfect. Information on wastes placed before 1964 is not complete [with original records.] MWL original inventory data for the period 1958-1964 were destroyed as part of normal record keeping protocol; however, SNL explained (see January 10 meeting presentation by SNL) that duplicate copies were made onto microfiche and/or placed in the Solid Waste Inventory Management System maintained at DOE's Idaho National Engineering and Environmental Laboratory.

- Tritium is the principal contaminant of concern.

- Excavation alternatives in Section 3.0 of the Draft CMS report assumed that excavation would be for the entire 2.6-acre site to bottom of trenches with side slopes of 3:1 for stability.

- To provide an independent cost analysis on the excavation alternative, SNL directed the people who had performed the excavation of the SNL Chemical Waste Landfill to perform a separate estimate for the MWL. This estimate, in Appendix J of the Draft CMS, is based on their experience on an actual remediation and provides another perspective on the retrieval option. Because it assumes a near-term excavation and approaches somewhat differently than that found in the Section 3.0 of the report, volumes and costs are different.

- The plan that is recommended by SNL is Alternative III.b Vegetative Soil Cover with Institutional Controls and Long-term Monitoring. The performance characteristics of the cover are predicted by SNL to achieve the regulatory goals of providing long-term protection of human health and the environment. The vegetative soil cover will emulate the natural surface analog using all local native materials.

- Additional information was requested and provided on characterization data, topography, groundwater movement, tritium plume, and waste volumes.

W. Paul Robinson, Research Director, Southwest Research and Information Center – Mr. Robinson was contracted by Citizen Action, a non-profit organization representing 16 local Albuquerque community organizations, for the report titled *Is 'Trust Us, We're the Government' Really A Guarantee? A Review of Financial Assurance Options for Long-Term Stewardship at the Mixed Waste Landfill, Sandia*. His comments included:

- Risk assessment should also look at hazardous chemicals and metals, not just the radiological component.

- The site will have dangerous chemical and nuclear materials remaining if retrieval does not occur; therefore, cost must assume that long-term monitoring and maintenance will be performed for 1,000 years or longer.

- Risk assessment should assume unrestricted use because it is doubtful that DOE will control the land throughout the future.

- Long-term cost impacts to adjacent lands with the dump remaining are important as well as loss of property value associated with federal lands that might be transferred to the public in the future, i.e., lost land use opportunity.

- Need guarantees that future costs for long-term monitoring and maintenance and future retrieval are available. Four models to consider: Oak Ridge trust fund, private operator's financial assurance as initially implemented at the Waste Isolation Pilot Plant, Oregon/Army private insurance from private site operator, and trust fund used by the Nuclear Regulatory Commission for remediation of uranium mill tailings.

Dr. Eric Nuttal Ph.D., Professor of Chemical/Nuclear Engineering at the University of New Mexico. – Dr. Nuttal served on the 2001 Peer Panel that evaluated the historic performance of the MWL and its safety. His comments were:

- Migration has occurred for tritium and waste in plastic and other containers will eventually be released to the soils in the landfill.

- A cap can increase runoff to the edges which might impact horizontal flows.
- A major development, Mesa Del Sol, is located less than two miles away and will have more than 90,000 people and will use groundwater that could be impacted by the MWL.
- Precipitation events are rare but when they do occur they are torrential.
- Landfill should be excavated if human exposure and environmental damage are imminent.
- Comprehensive analysis of alternatives should be part of CMS.
- Risk assessment should consider tritium exposure to workers.
- All relevant information on the MWL should be cataloged and made available to the public in central location.
- Naturally occurring arsenic in the groundwater below the Mesa Del Sol development is probably in excess of new standards and was confirmed by Douglas Earp from City of Albuquerque.

John McCall, attorney for Citizens for Alternative to Radioactive Dumping (CARD) – Mr. McCall provided the following comments:

- Current lawsuits over the Waste Isolation Pilot Plant may be an appropriate model for the MWL under the National Environmental Policy Act and as a public nuisance, if wastes are left in place.
- Is DOE doing the same thing as it has done elsewhere by setting up a peer panel that is biased towards DOE solutions?
- Institutional and land use controls, are they doable for long-term?
- Future citizens, unborn, have constitutional rights.
- The interconnection between the groundwater under Mesa Del Sol and the MWL present a future legal cost which should be part of cost estimates.
- Failure to use the most recent modeling is grounds for legal action.
- Property loss impacts to nearby communities must be considered.

Pete Neil, Officer of Citizen Action – Mr. Neil's comments are:

- FOIA materials show a problematic situation with the inventory. Very patchy information is available in the early years; therefore, characterization is inadequate.
- Biological impacts of site have not been properly addressed, such as deep-rooted plants, ants, and borrowing animals.
- Well-developed techniques have been used for excavation and should be used.
- DOE has stated that minimizing risk to the community is why they have selected the less costly cap solution.

Dr. Miles Nelson M.D., Emergency Physician and co-founder of Citizen Action. – Dr. Nelson's comments are:

- Risk assessment appears to be based on policy and not on science with statements such as too risky for workers, excellent inventory, no disposal pathways, no liquids except those solidified, only liquid is 200,000 gallon discharge, and no liquid solvents. These assumptions are false based on FOIA materials presented to panel. These include:
    - In contrast to statements from SNL/DOE free liquids in the form of organic solvents were dumped in the landfill;
    - In contrast to statements from SNL/DOE the MWL inventory is lacking; and
    - In contrast to statements from SNL/DOE significant amounts of water were dumped in and around the MWL and substantial amounts of water were allowed to accumulate in the trenches during rainfall events.
- The problem was created by our generation and our generation should handle the problem.
- Recommend that the Peer Panel hold DOE to a higher standard.
- Peer Panel should advocate for current and future generations.
- Only by excavation will we be able to be certain that a future risk can be avoided.

Sue Dayton, co-founder Citizen Action – Ms. Dayton provided comments on the study commissioned by Citizen Action titled *Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill* by Dr. Tom Hakonson, Ph.D., Environmental Evaluation Services, LLC. The comments in quotes were provided to the Panel by Ms. Dayton. The remaining comments are comments made during the presentation.

- “Buried waste can be mobilized to the ground surface through plant roots and animals and insect burrowing can dramatically increase infiltration of water into landfill with covers as thick as those proposed.”
- "Vertical transport of contaminants to the ground surface by biota may be small on a short time scale, but over many decades these processes may become dominant in mobilizing buried waste.”
- "The long-term consequences of biointrusion into low level waste landfills located in arid areas estimated that doses to humans from biological transport of contaminants by plants and animals were as high as doses calculated from a human intruding into the landfill itself (Pacific Northwest Laboratory).”
- "One of the more important deficiencies in Sandia National Lab's (SNL) closure plan proposed for the MWL is the assumption that vertical and horizontal transport of contaminants resulting from biological processes is not an important contributor to exposure pathways.”
- "Both cap designs (Dwyer et, al., SNL Environmental Restoration group) do a credible job of analyzing the evapotranspiration (ET) cover, and in the reviewer's opinion both cap designs will provide adequate protection of contaminants to ground water *assuming the site is diligently monitored and maintained throughout the post closure monitoring period while assuming the surface pathway proves to be unimportant in contributing doses to humans”*.
- "Under the right conditions the roots of ALL types of vegetation have the ability to extend several meters into the soil and transport contaminants to the surface.”
- "While an ET cap can minimize soil moisture it can contribute to vapor phase transport of volatiles.”
- "SNL's conclusion that waste has not been mobilized to the ground surface by animals is poorly supported as it is: 1) based on soil samples taken (in part) from areas of landfill recently backfilled; 2) sampling was coarse in resolution; 3) samples were non-random in space; and 4) samples purposely did not include disturbed areas created by burrowing animals.”

- "Once contaminants are transported to ground surface a complex distribution process occurs that can result in widespread transport of contaminants across the landfill surface to offsite areas."
- "Human intrusion scenarios should take a conservative approach such as the loss of institutional controls under a subsistence farmer scenario."

- "Changes in climate can radically affect the integrity of cap."

- "SNL's proposed plan to use a neutron moisture gage (NMG) are vague on how the monitoring data will be used to conclude that percolation is or is not occurring. NMG is labor intensive (data must be downloaded and managed); NMG must be calibrated to soil (difficult when layered soils are involved); reliable measurements are limited to volumetric water contents above 5%; NMG integrates moisture content over a relatively large area making it difficult to pinpoint the specific zone depth being interrogated; NMG provides instantaneous estimates of soil moisture so that measuring after precipitation is critical; NMG should not be used as an early warning system (see page 50 for detailed review)";

- "Little or no planning has been done on the post-closure phase of Mixed Waste Landfill (MWL) closure and there is no contingency plan should the ET cap not perform as predicted. Vegetative roots can penetrate landfill caps and transport wastes to the atmosphere and animals."

- SNL contention that wastes have not been brought to the surface is false.

- Monitoring program and equipment use is vague and problematic.

- Changes in climate over time could affect cap and caps don't last forever.

- No financial plan has been provided to guarantee long-term monitoring and maintenance.

- Biological sampling plan is "Mickey Mouse".

- DOE is going under drastic reductions in funding. Where is funding for the future going to come from?

- National Academy of Science has called DOE's Long Term Maintenance and Surveillance program flawed.

- If, in fact, it is too dangerous to dig up now, plan for future cleanup when it is safe.

- What about nuclear fuel rods buried in the dump?

Marvin Resnikoff, Ph.D., Radioactive Waste Management Associates – Dr. Resnikoff was contracted by Citizen Action for the report titled *Review of the Risk Screening Assessment for the Mixed Waste Landfill, WMU76*, July 2001. His comments are:

- Unclear why New Mexico Environment Department didn't direct a decommissioning or closure plan. A post-closure plan would have 25 mrem/year exposure value versus the 75 mrem/year under RCRA.
- There are high-level wastes greater than Class C materials and should be excavated and stored properly for future burial in the High-level Waste Repository in Nevada. Tritium is less of a concern because it decays quickly with time.
- Inventory is not complete, Pit 35 shows high gamma readings. Question why high surface readings don't match with inventory.
- Ignitable wastes such as uranium might burn if exposed to air.
- Hazardous chemicals were dumped into landfill based on FOIA materials.
- Risk assessment should consider that administrative controls no longer exist and land use has changed. What happens in 100 years?
- Water had been placed in Trench D and 19,000,000 gallons in nearby disposal fields. Ion exchange resins also have water in them.
- DOE is pressing a law suit that would exempt it from state and EPA rules.

Additional presentations were provided at the request of the Peer Panel by SNL, Dick Fate, Tim Goering and Jerry Peace to clarify some aspects of the MWL.

- Inventory has been in the works for 10 years and SNL believes it is better than most inventories for similar sites in the country, but certainly not perfect – but good enough to make decisions from.
- No absolutes on liquid disposal, but believe there was none disposed without solidification.
- Manager of reactor fuels absolutely certain none are disposed at MWL. These are controlled extremely well.

- Post Closure plan will be developed with New Mexico Environment Department and public input.
- Tritium modeling has not been done. [Note: While this statement was made at the presentation, SNL informed the Panel that there was some modeling done by Dr. Ross Wolford in his 1997 to model infiltration of reactor coolant water at the MWL and its affect on tritium migration.]

- Sensitivity analysis for risk assessment could be performed to determine what conditions are needed to drive risks to unacceptable levels.

January 10, 2003 Public Meeting

Two presentations were made to the Peer Panel at the January 10, 2003 public meeting. A synopsis of each with emphasis on the significant points that were made or brought up during the question and answer discussions is presented below.

Dick Fate, Jerry Peace, Tim Goering and other representatives from Sandia National Laboratories

- The RCRA process was discussed with a time line for work plan, RCRA Facilities Investigation, CMS report, closure plan, and post-closure plan. The post-closure plan will be negotiated with the New Mexico Environment Department as to the details of long-term monitoring and maintenance.

- SNL believes the inventory is very sound and has a high degree of confidence in its contents. This work took many years of reviewing disposal records, operational practices, personal interviews, maps, construction notes, and notes of past workers. It also included searches of microfiche records of disposal records and the Solid Waste Inventory Management System maintained at the DOE's Idaho National Engineering and Environmental Laboratory.

- The volume of the waste that is often cited as 100,000 ft^3 is actually 103,012 ft^3 of actual waste. This volume excludes the packaging and uncontaminated debris disposed in the MWL. More information was provided on the amounts of combined waste and debris as well as potentially contaminated soil and how these volumes were calculated. The Panel at this point better understood the information and suggested that this type of explanation be provided in the CMS.

- The MWL calculated relative risk for remedial alternatives, not for no further action determination.

- Risk assessment method was negotiated with state.
- Sensitivity analysis will be difficult to perform because information on source term, degradation rates for containers, and release rates for solidified wastes is not known.
- Risk assessment performed to aid in selection process with the understanding that the MWL is performing its designed task, and monitoring program is in place.

Sue Dayton, co-founder Citizen Action

- SNL is requiring that the public pay a high cost ($3,200) for copies of data and believes this to be unfair.
- Excavation could occur now for those pits and trenches that are safer. Other sites have performed cleanup of very hazardous wastes, why not SNL for the MWL?
- Citizen Actions believes that SNL is using risk to workers as a reason to not cleanup the MWL because it might set a precedent.
- Tritium and cobalt are the real risk drivers and can be detected easily and other sites have cleaned up similar sites.
- Biointrusion of a cover has been an issue that Sandia has expressed little concern over.
- There is a need to explain statements by SNL of there being small amounts of high-level wastes in the MWL.
- Future land ownership and financial assurances for future activities are critical issues.

Appendix D
Documents Available to Peer Panel

WERC

DOCUMENT #	DOCUMENT NAME
1	Strategy for Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories, New Mexico (April 1999)
2	Mixed Waste Landfill Map and Inventory, Volume 1
3	Mixed Waste Landfill Map and Inventory, Volume 2
4	Mixed Waste Landfill Map and Inventory, Volume 3
5	Report of the Phase 1 RCRA Facility Investigation of the Mixed Waste Landfill (September 1990)
6	Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, New Mexico (September 1996)
7	DOE Oversight Bureau's Comments on Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, New Mexico (September 1996)
8	Environmental Restoration Project DOE/SNL/NM Response to NMED October 30, 1998, NOD for Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, New Mexico (January 1999)
9	Geologic Study of Near-Surface Sediments, Volume I (September 1998)
10	Geologic Study of Near-Surface Sediments, Volume II (September 1998)

11	Addendum to Geologic Study of Near Surface Sediments (December 1998)
12	Solute Interactions and Transport in Soils from Waste Disposal Sites at Sandia National Laboratories (June 1982)
13	Analysis of Instantaneous Profile Test Data from Soils near Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories, New Mexico (February 1996)
14	Results of the 1992 Sandia National Laboratories Hazardous Air Pollutant Baseline Study (November 1992)
15	Measurement of Tritium and VOC Fluxes from the Mixed Waste Landfill at Sandia National Laboratories, New Mexico (January 1994)
16	Tritium in Surface Soils at the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories, New Mexico (March 1996)
17	Mixed Waste Landfill Semiannual Groundwater Monitoring Report, April 1999, Sandia National Laboratories/New Mexico (August 1999)
18	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 1
19	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 2
20	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 3
21	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 4

22	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 5
23	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 6
24	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 7
25	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 8
26	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 9
27	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 10
28	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 11
29	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 12
30	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 13
31	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 14

32	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 14-a
33	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 14-b
34	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 14-c
35	Semiannual Groundwater Sampling at the Mixed Waste Landfill, Sandia National Laboratories/New Mexico, Volume 14-c2
36	Mixed Waste Landfill Review by Mark Baskaran-Final Report, July 5, 2000
37	City of Albuquerque-Mixed Waste Landfill Data Analysis by Douglas Earp, November 29, 2000
38	Draft Report on Background Groundwater Sampling at the Mixed Waste Landfill Sandia National Laboratories, Albuquerque - September 1990 - Prepared by International Technology Corporation (April 1991)
39	Draft Report - Comprehensive Environmental Assessment and Response Program - Phase I: Installation Assessment - Sandia National Laboratories - Prepared by the Department of Energy, Albuquerque Operations Office - Environment, Safety and Health Division - Environmental Programs Branch (September 30, 1987)
40	Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories, New Mexico - Prepared by Environmental Restoration Project, Sandia National Laboratories (September 23, 1999)
41	Report on Quarterly Ground-Water Sampling at the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, July 1991 - Prepared by IT Corporation (May 1992)

42 Groundwater Monitoring Wells Installation Mixed Waste Landfill - Prepared by Ecology and Environment, Inc. (December 1989)

43 Draft Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque - Prepared by A.T. Kearney, Inc. and Harding Lawson Associates (April 1987)

44 Groundwater Monitoring Program - Mixed Waste Landfill Ground Water Sampling and Analysis Plan (September 1990)

45 Strategy for Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories (April 12, 1999)

46 Report on Quarterly Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories, Albuquerque, April 1991 - Prepared by IT Corporation (October 1991)

47 Application of Non-Intrusive Geophysical Techniques at the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories, New Mexico - Printed March 1996

48 Unsaturated Hydrologic Flow Parameters Based on Laboratory and Field Data for Soils Near the Mixed Waste Landfill, Technical Area III, Sandia National Laboratories/New Mexico - Printed August 1996

49 Report on Semiannual Groundwater Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico, March Through May 1994, Volume 1 - Prepared by IT Corporation (February 1995)

50 Preliminary Data From an Instantaneous Profile Test Conducted Near the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories/New Mexico - Printed April 1996

51	Analysis of Instantaneous Profile Test Data from Soils Near the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories/New Mexico - Printed February 1996
52	Report on Semiannual Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico, January 1993 - Prepared by IT Corporation (July 1993)
53	A Preliminary Human Health Risk Assessment for the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, New Mexico - Prepared by Argonne National Laboratory (January 1995)
54	Report on Semiannual Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico - November 1993 - Prepared by IT Corporation (May 1994)
55	Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill Sandia National Laboratories, New Mexico (September 23, 1999)
56	Compliance Activities Work Plan for the Mixed Waste Landfill (August 26, 1991)
57	Mixed Waste Landfill Phase 2 RCRA Facility Investigation Work Plan
58	Responses to NMED Technical Comments on the Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, September 1996, Volume 1 (June 15, 1998)
58a	Attachment to #58 - Nickel Concentrations in Groundwater at the Mixed Waste Landfill
59	Draft Report on Quarterly Ground-water Sampling at the Mixed Waste Landfill, October 1991 - Prepared by IT Corporation (May 1992)
60	Fiscal Year 1998 Annual Groundwater Monitoring Report (March 1999)

61 Report on Quarterly Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories, Albuquerque, January 1991 - Prepared by IT Corporation (July 1991)

62 Draft Report on Semiannual Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories, New Mexico July 1992 - Prepared by IT Corporation (January 1993)

63 Mixed Waste Landfill Project Location Maps

64 Mixed Waste Landfill Semiannual Groundwater Monitoring Report April, 1999 Sandia National Laboratories/New Mexico - Prepared by IT Corporation (August 1999)

65 Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories, New Mexico - Submitted to the New Mexico Environment Department September 23, 1999

66 Mixed Waste Landfill Design Report

67 Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories, New Mexico - Attachment #A - Preliminary Unsaturated Flow Modeling of the Design of a Closure Cover for the Mixed Waste Landfill dated September 23, 1999

68 Responses to the New Mexico Environment Department Request for Supplemental Information issued June 5, 2000

69 Request for Supplemental Information - Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, September 23, 1999 - Requested by the New Mexico Environment Department, February 16, 2001

70 FY97-99 Vegetation Analysis of ALCD Soil Amended Landfill Cover Plots

71 Construction Overview of Six Landfill Cover Designs

72 Alternative Landfill Cover Demonstration FY2000 Annual Data Report

73 Synopsis of Sandia/DOE Technical Concerns Regarding the Mixed Waste Landfill Report Prepared by Dr. Mark Baskaran, Department of Geology, Wayne State University

74 The Department of Energy and Sandia National Laboratories Response to Dr. Mark Baskaran's Final Report, Mixed Waste Landfill Review

75 Sigma Five Consulting Comments on July 12, 2000 Presentation of Dr. Baskaran by Fritz A. Seiler, August 5, 2000

76 Dr. Baskaran's Response to Seiler's Comments on the Mixed Waste Landfill, August 11, 2000

77 Comments on the Reply to My Review of the Baskaran Evaluation of the Sandia Mixed Waste Landfill Work by Fritz A. Seiler

78 Report on Semiannual Ground-Water Sampling at the Mixed Waste Landfill Sandia National Laboratories/Albuquerque January 1992 - Prepared by IT Corporation May 1992

79 Mixed Waste Landfill Semiannual Groundwater Monitoring Report, April 1998 Sandia National Laboratories - Prepared by IT Corporation July 1998

80 Mixed Waste Landfill Semiannual Groundwater Monitoring Report November 1998/January 1999 Sandia National Laboratories - Prepared by IT Corporation April 1999

81 Mixed Waste Landfill Annual Groundwater Monitoring Report April 1997 Sandia National Laboratories/New Mexico - Prepared by IT Corporation August 1997

82 Semiannual Groundwater Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico October 1995 - Prepared by IT Corporation March 1996

83	Sandia National Laboratories 1979 Environmental Monitoring Report
84	Preliminary Unsaturated Flow Modeling and Related Work in Support of the Design of a Closure Cover for the Mixed Waste Landfill - Prepared by Ross Wolford, GRAM, Inc. November 10, 1998
85	Mixed Waste Landfill Semiannual Groundwater Monitoring Report, April 1996, Sandia National Laboratories, New Mexico - Prepared by IT Corporation July 1996
86	Semiannual Groundwater Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico April 1995 - Prepared by IT Corporation September 1995
87	Report on Semiannual Ground-water Sampling at the Mixed Waste Landfill Sandia National Laboratories/New Mexico April 1993 - Prepared by IT Corporation February 1994
88	Results of 1992 Sandia National Laboratories Hazardous Air Pollutant Baseline Study, November 4, 1992 - Prepared by Radian Corporation
89	New Mexico Environment Department Oversight Bureau - Mixed Waste Landfill Sampling Data Summary provided for WERC Peer Review Panel 3/22-3/23/01
90	Ground Water Sampling Results - Sandia National Laboratories/Albuquerque for Area MW-1
91	Results of Ground Water Sampling at Sandia National Laboratories/Albuquerque Mixed Waste Landfill for Area MW-2
92	Results of Ground Water Sampling at Sandia National Laboratories/Albuquerque for Area MW-3
93	Ground-Water Sampling at the Mixed Waste Landfill - Area MW-4

94 A(n) Water, Non-Filtered Sample Submitted to the State of New Mexico, Department of Health, Scientific Laboratory Division, January 19, 2001 for Area MW-5 and MW-6

95 Results of Ground Water Sampling at Sandia National Laboratories/Albuquerque Mixed Waste Landfill - Area BW-1

96 Results of Non-Aqueous Soil Samples Submitted to American Environmental Network, Inc. on June 4, 1998

97 New Mexico Environment Department Hazardous and Radioactive Materials Bureau Approved Background Concentrations, Sandia National Laboratories/Kirkland Air Force Base, September 1997

98 Well Database Summary Sheet provided to WERC Peer Review Panel March 23, 2001

99 Mixed Waste Landfill (MWL) Data Analysis by Douglas Earp, City of Albuquerque, December 14, 2000

100 Mixed Waste Landfill Data Analysis by Douglas Earp, City of Albuquerque, November 29, 2000 submitted to Dr. Bruce Thomson, Chair, Groundwater Protection Advisory Board

101 Information on Surface Soil Sampling for Tritium and Soil Gas Surveys provided to WERC Peer Review Panel March 23, 2001

102 Cross Section Across Mixed Waste Landfill provided to WERC Peer Review Panel March 23, 2001

103 Monitoring Wells in the Vicinity of the Mixed Waste Landfill provided to WERC Peer Review Panel March 23, 2001

104 Information on Environmental Settling provided to WERC Peer Review Panel March 23, 2001

105 Mixed Waste Landfill Map and Inventory, Attachment 2-1 provided to WERC Peer Review Panel March 23, 2001

106	Modeling the Infiltration of Reactor Coolant Water from Trench D at the Mixed Waste Landfill: Sandia National Laboratories/New Mexico by Ross Wolford, GRAM, Inc., March 27, 1997
107	Documents on Mixed Waste Landfill Background and Facility Investigation provided to WERC Peer Review Panel on March 23, 2001
108	Presentation to WERC Peer Review Panel on March 22, 2001 by Sandia National Laboratories
109	Regulatory Review of the U.S. Department of Energy/Sandia National Laboratories Mixed Waste Landfill RCRA Facility Investigation prepared by William Moats, New Mexico Environment Department
110	Location and Surface Projection of Boreholes 1 through 15 - Tritium Sections
111	Paul Robinson Report: Summary of Data Identifying Organic Compounds in Ground Water Beneath the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, New Mexico, January 2001 from William Moats, New Mexico Environment Department
112	Location and Surface Projection of Boreholes 1 through 15 - Cadmium
113	Comments by Douglas Earp Regarding Sandia's December 14, 2000 Memo
114	Mixed Waste Landfill Corrective Measures Study (Draft) - November 2002
115	Mixed Waste Landfill Corrective Measures Study Workplan - December 19, 2001
116	MWL Corrective Measures Risk Screening Assessment
117	Selecting and Implementing Institutional Controls IN RCRA and CERCLA Response Action at Department of Energy Facilities - August 2000

118	Independent Peer Review of the U.S. Department of Energy Sandia National Laboratories Mixed Waste Landfill - August 31, 2001
119	"Is 'Trust Us, We're the Government' Really A Guarantee? A Review of Financial Assurance Options for Long-Term Stewardship at the Mixed Waste Landfill, Sandia National Laboratories" by W. Paul Robinson - June 18, 2002
120	Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill by Tom Hakonson - February 15, 2002
121	Review of the Risk Screening Assessment for the Mixed Waste Landfill, WMU76 by Marvin Resnikoff - July 2001
122	Summary of information obtained under the Freedom of Information Act
123	Comments by Citizen Action on WERC draft review Sandia Mixed Waste Landfill August 7, 2001
124	Various DOE memorandums on MWL.

Appendix E
Sandia National Laboratories
Inventory of Wastes in the Mixed Waste Landfill

The following inventory by pit and trench was compiled from classified and unclassified disposal records, interviews with current and retired employees, solid waste information sheets, and nuclear material management records. Considerable effort was made to maintain consistency in nomenclature and units. Commonly used acronyms are as follows:
1) MFP – multiple fission products: the nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragment's radioactive decay.
2) DU – depleted uranium
3) activation – the process of making a material radioactive by bombardment with neutron, protons or other nuclear radiation.
4) induced activity – radioactivity that is created when stable substances are bombarded by neutron e.g., the stable isotope Co-59 becomes the radioactive isotope Co-60 under neutron bombardment.

TRENCH A

Differential amplifiers; thermocouples; compressors; MFP- and tritium-contaminated fume hoods, ducting, motors, fans, and plenums; TV cameras, tripods, and telemetry components; MFP-contaminated cooling systems, coils, surge tanks (5 ft diameter X 11 ft long), piping, pumps, couplings, and valves; experimental stainless steel canisters; 17 each 55-gallon drums containing MFP-contaminated demineralizer resin; 2 each 55-gallon drums of MFP-contaminated concrete; empty oxygen cylinders; boxes of fluorescent light bulbs; roll-up door and associated equipment from a TA-5 "KIVA;" shield door from reactor pit; voltage-controlled oscillators, calibrators, and gyros; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; tritium luminary dials; military radium altimeters and gauges; Ni-63 tube; parachute; Sr-90 nuclear cells; flash heating equipment and associated parts; MFP-contaminated L-shaped aluminum chassis; DU in graphite matrix; stainless steel ducting; 61 each spark gap tubes (100 mrem/hr on contact); aluminum sleeve with lead ballast; tritium beds and valves; shock jigs with tubes; 31 each 0.5 Ci Kr-85 tubes and cells; one each 20 ft long X 2 ft diameter heat exchanger, coolant pumps, piping, and valving; air conditioners; tritium targets (10 Ci each) and tubes (100 mCi each); wooden ladder; MFP-, DU-, and tritium-contaminated vacuum cleaners; vacuum pumps and skids; stainless steel sample tubes; irradiated metal samples (5 rem/hr on contact); ion generators; 5-gallons of oil absorbed on vermiculite in sealed A/N can; 128 ft^2 of sheet metal; skid loaded with 300 lbs. of paraffin; 12 each skids of MFP-contaminated concrete blocks, MFP-contaminated lead bricks; 2,600 kg DU.

943 ft^3 of TA-5 routine operational and miscellaneous decontamination waste.

TRENCH B

HEPA filters, fiberglass filters, final and prefilters; MFP-, DU-, and tritium-contaminated vacuum cleaners; cables; ultra-sonic air samplers; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; MFP- and tritium-contaminated fume hoods, ducting, motors, fans, and plenums; boxes of fluorescent light bulbs; sanding disks; neutron generator tubes; backing plates from TA-5 experimental apparatus; packing materials and wooden shipping crates; metal drums from NTS containing DU; alpha-contaminated gas bottles; empty liquid scintillation vials; Ta-182 contaminated platinum-tungsten scrap; heater elements; 10 Ci tritium targets; neutron generator magnets; 14 each empty steel gas cylinders contaminated with DU; 9 each MFP-contaminated ceramic tubes; 1.5-gallons of solvents absorbed on vermiculite in sealed A/N cans; 6 each small storage cabinets; vacuum system components including water circulators, valves, diffusion pumps, fittings, gas analyzers, and vacuum pumps; gas sample bottles from NTS; tritium-contaminated tools; DU metal shavings and cuttings; Victoreen Sr-90 ion chambers; glove box and work bench; demineralizer vessel from reactor; neutron radiograph equipment; thermal reflecting rings; micro scales; Kr-85 light sources; 11 kg deuterium containing 0.25 Ci of tritium; 1-gallon toluene absorbed on vermiculite in sealed A/N can; static meter; Ta-182 pellets; demineralization and radiography tubes.

1326 ft^3 of TA-5 routine operational and miscellaneous decontamination waste.

TRENCH C

Nuclear fuel shipping cask cleanup debris; tritium and C-14 labeled amino acids and tritium labeled uridine; scrap metal contaminated with DU from burn test; 7.1 Ci tritium pellets; uranyl nitrate; "dining car" test hardware; MFP-, DU-, and tritium-contaminated vacuum cleaners; vacuum hose contaminated during cleaning of thorium cloth and thorium cloth debris; concrete crucibles used in reactor safety studies; Kr-85 particle size analyzer; 1,000 lead bricks contaminated with tritium and Na-22; 43 MFP-contaminated lead bricks; 73 each integrated circuits; Ba-133 reactor bolts; flexible glove box ducting; 2 each mechanical vacuum pumps; Sr-90 contaminated carpet; Cs-137 spark gaps; Na-22 cleanup materials, source holders, and shield (1.5 rem/hr on contact); DU-contaminated waste containers; tritium-contaminated vacuum system and power supply; DU billet, hemisphere, and sphere; Pu-238 contaminated hood exhaust hose; Co-60 debris from trailer used to support nuclear fuel shipping cask; MFP-contaminated hot exhaust system prefilters, HEPA filters, and absolute pressure filters; containerized DU residue, turnings, metal workings, and cuttings; surge voltage arrester; tritium-contaminated pump; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; wooden shipping crates; 13 each Po-210 contaminated static eliminators; one each 62 mCi Se-75 source and one each 1.0 mCi Ta-182 source in sealed A/N can; tritium-contaminated fume hood and exhaust plenum; 2.0 kg deuterium absorbed on vermiculite in sealed A/N can; 12 each 55-gallon drums of MFP-contaminated spent demineralizer resin; DU-contaminated Lucite table; 4 each TV cameras; tritium-contaminated ion pump; 1-gallon tritium-contaminated acetone solidified with Safe-T-Set; 24 kg lithium-6 fluoride; 4 each irradiated high speed cameras, lenses, and one telescope; one each 0.1 mCi Ra-226/Be source encapsulated in concrete-filled A/N can; 2 each DU-contaminated glove boxes; 32.1 Ci tritium; 377 kg DU.

Trace Eu-152, Ba-133, I-129, Na-22, Sr-90, Ni-63, Tc-99, Gd-153, Ag-110m, Pm-147, Sr-85, Sb-125, Ta-182, Ge-68, Mn-54, and Fe-55.

1,159 ft^3 of TA-5 routine operational and miscellaneous decontamination waste.

TRENCH D

Compensator and cables from TA-1; tritium-contaminated water and erbium tritide powder; DU-contaminated rocket motors; broken Ra-226 source in plastic holder; corroded and broken 6-ft aluminum step ladder; 13 each 55-gallon drums containing MFP-contaminated spent demineralizer resin; DU residue, turnings, metal workings, and cuttings; MFP-contaminated tape recorders, transmitters, and video cameras; MFP-contaminated compensated ion chamber; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; 4 each aluminum "KIVA" doors from reactor; PEG housing and lid from NTS; MFP-contaminated fuel holsters; ultra filters and ultra filter plenums; MFP-contaminated hot exhaust system prefilters, absolute pressure filters, and plenums; HEPA filters; MFP-contaminated conduit and sheet metal; 2 each sealed Cr-57 sources; TA-1 bldg. 802 construction materials and scrap; MFP-, DU-, and tritium-contaminated vacuum cleaners; TA-5 liquid waste disposal system drain pipes; "Cypress" packaging material from NTS; "Ming Vaso" rad test debris from NTS; "Snap 27" test debris; "Hudson Moon" cleanup and packaging materials from NTS; "Mint Leaf" packaging and cleanup materials from NTS; "Diana Mist" packaging and cleanup materials from NTS; "Thoria" cleanup and packaging materials from NTS; old "KIVA" floor including sheet-rock, wood, and miscellaneous waste from installation of new "KIVA" floor; MFP-contaminated spent demineralizer columns and cartridges; thoria crucibles and tubing; old reactor boiler with associated radiators, piping, and valves; activated reactor stainless steel support tower, cryostat tube and head; empty thorium impact capsules; empty wooden shipping crates for fuel elements; tritium-contaminated power supply, balance, volt meter, ammeter, bridge, vacuum pump, microscope mount, plug-in units, and glass tubes; neutron radiography tube and beam catcher; ultra-sonic bath and power unit; obsolete Bell Labs experimental core tube (10 rem/hr on contact).

2,315 ft^3 of TA-5 routine operational and miscellaneous decontamination waste.

TRENCH E

38 each 55-gallon drums of MFP-contaminated spent demineralizer resin; 7 each 55-gallon drums from Three Mile Island containing MFP-contaminated cables, instruments, and electronic components; 11 each Po-210 contaminated static eliminators; 10-gallons Cs-137 solution solidified with Safe-T-Set in sealed A/N can; oil from lapidary shop solidified with soil in sealed A/N can; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; 6 each irradiated 9 ft 10 in. long X 9 in. dia. stainless steel storage tubes and holding rings; activated top and bottom reactor vessel sections; hydraulic pumps; ion pumps; steel frame and motor assembly from "KIVA" door; burned wood from weapons experiment; 2 each burned empty 55-gallon drums; MFP-contaminated vacuum pumps; obsolete and old test equipment and materials used in reactor fuel tests; DU-contaminated glove box; HEPA filters from hot exhaust plenum; DU-contaminated vacuum and filtering system bracket and assembly; DU-contaminated machine shop cabinets, work tables, filters, and ground cloths; 4 each TV cameras; 45 Ci neutron generator tubes; DU-contaminated crucibles; janitorial barrels; vacuum pumps; file cabinets; 70 lbs. thoria-contaminated soil; tritium-contaminated ion pump; one damaged DU-contaminated shake table or "vibrator" for sieving powdered DU; 10,000 lbs. of decommissioned reactor debris from extensive modifications to the reactor including ventilation ducts, conduit, PVC, nuts and bolts, hot water radiators, metal support parts, concrete, insulation, cable, air blowers, camera equipment, light bulbs, metal stands, electronic equipment, vacuum cleaners, pumps, coveralls, lumber, scaffolding, tables, chairs, gauges, regulators, valves, glove boxes, and stainless steel; 2,500 ft^3 of DU-contaminated soil; plywood ventilation duct; Mettler balance; Sartorius balance; fume hood; Magniwhirl bath; lab furnace; obsolete fire alarm system and associated electrical equipment; scrap wire; 11 each 55-gallon drums numbered 1 through 11: drums 1 through 3 contain 18 nanocuries/gram alpha emitters, drums 4 through 11 contain 8 nanocuries/gram alpha emitters; 2 kg thorium; 8 kg DU; 122 Ci tritium.

Trace amounts of Ce-144, K-40, Zr-95, Nb-95, Sr-85, Eu-152, Eu-155, Ni-63, and Po-210.

Radioactive waste from the Inhalation Toxicology Research Institute (ITRI): ITRI typically disposed of their radioactive waste at the commercial radioactive waste disposal site in Beatty, Nevada. The state of Nevada closed this radioactive disposal site in 1979. SNL, NM accepted a shipment of 119 each 55-gallon drums and 13 plywood boxes of radioactive waste from ITRI in October 1979. A copy of the ITRI radioactive shipment record dated 4/28/80 is attached.

1,093 ft^3 of routine operational waste and miscellaneous decontamination waste.

TRENCH F

Tritium and DU-contaminated glove boxes; ducting; stainless steel; 6 each 55-gallon poly drums containing MFP-contaminated spent demineralizer resin; wooden shipping crates; steel cladding and zirconium insulation; dilute nitric acid neutralized with $CaCO_3$, Na_2CO_3, and $NaHCO_3$ and solidified with yellow powder material; Electro-glo electropolishing agent solution with concentrated phosphoric acid neutralized with Na_2CO_3 and NaOH and solidified with yellow powder material; lab benches; metal table; two each glove boxes; HEPA and prefilters.

There are 5 spent, nuclear fuel-shipping casks of various sizes in Trench F. They include the Hallam cask, the Helicopter cask, the IF-100 cask, the IF-200 cask, and the Yankee cask. These casks were subject to various destructive tests in the mid-1970's to meet Nuclear Waste Policy Act certification requirements for shipping spent nuclear fuel assemblies. These casks, soon to be retired, were removed from active service for destructive testing. The casks were equipped with fuel mock-ups for destructive testing.

The Nuclear Power Facility provided the Hallum cask to Sandia National Laboratories for torch fire tests. The Hallum cask is 19 ft long x 3 ft in diameter and weighs 40 tons. The cask consists of two stainless steel cylinders separated by 8.5 inches of lead shielding in the annulus.

Pratt and Whitney provided the Helicopter cask for drop tests from 2,000 ft above ground surface. The Helicopter cask is a pot-type cask weighing 3 tons. The interior cavity is 4 inches in diameter and 17.5 inches high surrounded by 10 inches of lead.

The Yankee cask and its Atlas railcar were provided by Westinghouse for sled-track impact tests. The Yankee cask is 13 ft long x 5 ft in diameter and weighs 37 tons. The cask consists of two stainless steel cylinders separated by 8.5 inches of lead shielding in the annulus.

The IF-100 and IF-200 casks were provided by General Electric for sled-track impact tests. The IF-100 cask is 13 ft long x 32 inches in diameter and weighs 22 tons. The cask consists of two stainless steel cylinders separated by 8.5 inches of lead shielding in the annulus. The IF-200 cask is 13 ft long x 3 ft in diameter weighing 25 tons. The cask consists of two stainless steel cylinders separated by 8.5 inches of lead shielding in the annulus.

A semi-tractor trailer or "carriage" used for transporting spent, nuclear fuel shipping casks is buried in Trench F. The trailer was contaminated with Cs-137. The trailer was contaminated by a leaking shipping cask that contained a spent, nuclear fuel assembly destined for TA-5. The cask that contained the spent, fuel assembly leaked water during shipment. The cask was decontaminated and returned to Savannah River via another trailer, however, the contaminated trailer was designated non-recoverable and buried. A picture of the trailer buried in Trench F is attached.

792 ft^3 of routine operational and miscellaneous decontamination waste.

TRENCH G

Trench G was the last operational disposal trench. It contained very little waste, as indicated by the geophysics in the MWL Phase 2 RFI Report, when the MWL was closed in December 1988.

Thorium and uranium alloyed aluminum Polaris missile sections; 3 each glove boxes; one Mettler balance and fume hood contaminated with fission products; MFP-contaminated concrete; 2 each 55-gallon poly drums containing MFP-contaminated spent demineralizer resin; fluorescent light bulbs; HEPA and prefilters; MFP-contaminated TV camera; 1,000 cubic yards of dirt from the reactor berm removal.

581 ft^3 of routine operational wastes and miscellaneous decontamination waste.

PIT SP-1

Two each depleted tritium beds; 3-gallons NaOH; 3-gallons acid waste; 1 poly bottle uranium solution; out-dated standard solutions; 30-gallons tritium water; miscellaneous chemicals with beta/gamma contamination; 4 kg enriched lithium; 4 kg Li-6; 408 grams U-235.

PIT SP-2

A plutonium arc tunnel is buried in SP-2. The plutonium arc tunnel was used to simulate ballistic missile re-entry into the earth's atmosphere. Pu-238 microspheres, ranging from 2 to 20 micrometers in diameter, were injected into the arc tunnel under the influence of plasma to determine temperature and pressure effects on nuclear weapon components. The apparatus is 4 ft x 4 ft x 10 ft long with a 2 ft x 2 ft x 5 ft central section. Glove boxes are attached at each end. Approximately 20 microspheres remained in the tunnel when it was buried in 1968.

PIT SP-3

A beryllium catcher is buried in SP-3. The Be-catcher was used to "catch" projectiles fired from various guns and howitzers. Experimental projectiles containing Be and DU were retrieved and studied in tests. The BE-catcher contained fine particles of Be and DU when buried in 1968.

PIT SP-4

Nuclear reactor vessel plates from a decommissioned nuclear reactor are buried in SP-4. The vessel plates came from a nuclear reactor in the San Fernando Valley. The reactor, when decommissioned in 1978, was cut to pieces and shipped to Beatty, Nevada for disposal. Six-foot sections of the outer vessel were salvaged and shipped to Sandia for fission product and Co-60 activation studies. The sections were stored in SP-4 and never tested and remain there to this day. The vessel plates, at the time of burial, measured 2 rem/hour on contact. SP-4 is lined with concrete culvert and concrete bottom-cap making it the only lined pit at the MWL.

PIT SP-5

A 10,000 Ci Co-60 source is buried in SP-5. The 10,000 Ci Co-60 source was manufactured by Oak Ridge National Laboratories in 1960 and delivered to Sandia National Laboratories for deployment in the gamma irradiation facility. The source consists of 12 stainless steel rods, 12 inches long x 0.5 inches in diameter, each containing 8 cobalt metal pellets. Each cobalt pellet is 0.5 inches long. The cobalt metal pellets are located in the center of each rod with 4 inches of lead as shielding filling each end. Each cobalt rod contained approximately 840 Ci in September 1961. The Co-60 source was removed from service and transferred to SP-5 in June 1987. The Co-60 source was buried in a 6.7 ft^3 lead burial cask, which was in turn encased in a 24 yd^3 concrete burial cask. The original 10,000 Ci source will have decayed to 76 Ci as of September 1998, or 6.4 Ci per rod.

PIT 1

DU-contaminated weapons components; mass of DU unknown.

PIT 2

DU-contaminated debris bed; DU-contaminated weapons components; mass of DU unknown.

PIT 3A

DU-contaminated weapons components; 22 kg DU.

PIT 3B

DU-contaminated Mark III missile sections; mass of DU unknown.

PIT 4

DU-contaminated weapons components; mass of DU unknown.

PIT 5

DU-contaminated weapons components; mass of DU unknown.

PIT 6

DU-contaminated weapons components; mass of DU unknown.

PIT 7

DU-contaminated weapons components; 846 kg DU.

PIT 8

DU-contaminated weapons components; mass of DU unknown.

PIT 9

DU-contaminated weapons components; mass of DU unknown.

PIT 10

DU-contaminated weapons components; 178 kg DU.

PIT 11

7 NTS test shapes; 42 kg DU.

PIT 12

Neutron generator tubes; 1 kg thorium; 103 kg DU.

PIT 13

One each 1,800 Ci Co-60 source sealed in a lead and steel burial cask encapsulated in two truckloads of concrete; one each 98 microCi Ra-226 source, one each 1.3 microCi Ra-226 source, two each 5.0 microCi Ra-226 sources, and one each 1.0 microCi Ra-226 source encapsulated in concrete-filled A/N can.

PIT 14

One each sealed 5.0 microCi Po-210 source and source holder; one each sealed 1.0 microCi Po-210 source; miscellaneous uranium and beryllium waste; "Cypress" test debris from NTS; DU-contaminated vacuum cleaner; 3 Ci tritium water; 100 mCi tritium oxide; Pu-238, Po-210, and tritium-contaminated miscellaneous operational and lab waste; tritium-contaminated pumps and valves; Pu-238 contaminated air sampler; neutron generator tubes; a large weapon shell (18 megaton WWII vintage); DU-contaminated weapons components; 178 kg DU.

PIT 15

One each 102.1 microCi Ra-226/Be source and one each 5.5 microCi source in a encapsulated in concrete-filled 55-gallon drum; fume hood filters and filter housings; reactor fuel element ends (5 rem/hr on contact); "Cypress" test debris from NTS; neutron generator tubes and targets; DU-contaminated weapons components; Pershing missile debris; 167 kg DU; 49 grams U-235; 30 Ci tritium.

PIT 16

One each sealed 2.5 Ci Co-60 source encapsulated in a concrete-filled lead cask; two each non-functional 1.5 mCi Ra-226 ionization alphatron gauges encapsulated in a concrete-filled A/N can; nine each Ba-133 reactor bolts; 2 each 52 Ci Co-60 pencils encapsulated in a lead-lined concrete-filled 55-gallon drum; 2 each 10.0 microCi Ra-226/Be sources in lead container encapsulated in a concrete-filled 5-gallon A/N can; one each 1,000 Ci Co-60 source encapsulated in a lead-lined, concrete-filled 55-gallon drum; ionization chambers and current regulators; one each 0.8 mCi Kr-85 source encapsulated in a concrete-filled A/N can; one each 40 mCi Am-241 source encapsulated in a concrete-filled A/N can; one each 18.9 Ci Kr-85 nuclear battery in a steel tube encapsulated in concrete-filled A/N can; SER control rod guides encapsulated in a lead-lined, concrete-filled A/N can (50 rem/hr on contact); thorium metal scrap; one each Sb-124 source projectile (10 rem/hr on contact); 20 each 5.0 microCi Ra-226/Be sources in lead container encapsulated in concrete-filled A/N can; 2 kg thorium oxide; 2,390 kg DU; 75 Ci tritium.

PIT 17

"Casseto" and "Triga" parts from NTS; one each 0.5 mCi Ra-226/Be source, one each 36 Ci Co-60 source, and one each 6.0 Ci Sr-90 source each in a lead container encapsulated in concrete-filled 55-gallon drum; 11 each Kr-85 cells (8.1 mCi total); 2 each uranium carbide nose cones; uranium and zirconium scrap in a 55-gallon drum; 30 Ci tritium lab waste in brass tube; neutron generator tubes; dummy DU reservoir; DU scrap and machine parts; test specimens; brazed to aluminum; fusing and firing assemblies; DU-contaminated weapon components; 3 kg thorium oxide; 457 kg DU.

PIT 18

Pu-238 contaminated paper, gloves, small equipment, components, wire, and sockets; 12 each spark gap tubes; 7 each 10 microCi Ra-226/Be sources in a lead container encapsulated in concrete-filled 55-gallon drum; Pu-238 contaminated vacuum pump; radioactive rock; electrical cables from junction box; reactor fuel element ends (5 rem/hr on contact); neutron generator tubes; Pershing missile test debris; DU-contaminated weapons components; 155 mm gun projectile with a Sb-124 source; 762 kg DU; 45 Ci tritium.

PIT 19

Tritium-contaminated buckets, clothing, swipes, rags, paper, work gloves, vacuum cleaner, and decontamination materials; reactor fuel element ends (5 rem/hr on contact); one each Sb-124 source projectile (10 rem/hr on contact); neutron generator tubes; scrap metal, DU-contaminated muffle furnace; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; one each 3.5 microCi Co-60 source and one each 4.1 microCi Co-60 source in a lead container encapsulated in concrete-filled 55-

gallon drum; Pershing missile test debris; tritium bed; scrap iron; Pu-238/239 contaminated filters; 621 kg DU; 60 Ci tritium.

PIT 21

Two each 3.4 microCi Co-60 sources, one each 31.8 microCi Sr-90 source, one each 100 microCi Co-60 source, one each leaking Sb-124 source, and one each spent Cs-137 source in a lead container encapsulated in concrete-filled 55-gallon drum; NTS irradiated material; DU-contaminated paper, towels, and poly bottles; plutonium oxide-contaminated filters, towels, tape, paper, cleaning and decontamination materials; 4 each irradiated thermal batteries; oil diffusion pump and baffle; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; neutron generator tubes; Pershing missile test debris; DU-contaminated weapons components; 16 kg thorium; 1,731 kg DU; 0.1 grams Pu-238; 30 Ci tritium.

PIT 24

"Hudson Moon" and "Mint Leaf" test debris from NTS; 3 each 500 microCi Ra-226 ionization alphatron gauges encapsulated in a concrete-filled A/N can; one each 45 Ci Co-60 source in a lead shield housing; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; reactor fuel element ends (5 rem/hr on contact); tritium-contaminated General Electric vacuum system, trigger gauge, transducers, hoods, vacuum pump, and panels; Pu-238, Pu-239, U-235, and U-238 contaminated glove box, gamma probe, and stereo microscope; neutron generator tubes; Pershing missile test debris; DU-contaminated weapons debris; 140 kg DU; 60 Ci tritium.

PIT 25

Stainless steel sample cylinders; tritium-contaminated flexible vent; Pu-239 contaminated microscope slide and slide clamps; "Hudson Moon" test debris from NTS; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; one each 3.5 Ci Ir-192 source encapsulated in concrete-filled 5-gallon A/N can; Ta-182 wire, needles, and foil in lead pigs; 4 each 10 microCi Ra-226/Be sources in a lead container encapsulated in concrete-filled 55-gallon drum; one each 30 Ci Ir-192 source encapsulated in concrete-filled 10-gallon A/N can; Ba-133 reactor bolts; DU ballast, machine chips, cuttings, and turnings; head filters and prefilters; DU-contaminated penetration vehicles; one each Pu-238 contaminated stereo microscope, glove box, balance, and manipulator arm; reactor fuel element ends (5 rem/hr on contact); DU-contaminated ceramic base plates and electric furnace; irradiated scrap nickel and reactor material; DU-contaminated sputtering shield, O-rings, and steel wool; 15 each irradiated fission chambers; Be-contaminated glove box and balance; irradiated floor and exhaust hood coverings; tritium-contaminated ion pump; MFP-contaminated transistors, diodes, resistors, circuits, paper, and plastic; one each iridium iriditron, one each 11.6 microCi Ra-226 dew pointer in brass cylinder, one each DU aft simulator; neutron generator tubes; SRAM missile test debris; DU-contaminated weapons components; 1,431 kg DU; 76.5 Ci tritium.

PIT 26

Co-57 contaminated cleanup debris; DU machine chips, turnings, and cuttings; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; 5 each carbon rings; DU-contaminated cloth, towels, and paper; MFP-contaminated machining wastes; 4 each 4.0 Ci Co-60 sources in a lead container encapsulated in concrete-filled 55-gallon drum; 100 microCi Na-22; DU-contaminated Pershing missile debris; DU-contaminated Sierra Army Depot debris; 18 each 1.8 microCi Ra-226 ionization alphatron gauges encapsulated in concrete-filled 32-gallon A/N can; Ta-182 wires in a lead pig; 3 each Victoreen Sr-90 ion chambers; DU-contaminated penetration ballast, noses, and aft simulators; 5 each sealed 389 microCi Ba-133 sources; 5 each sealed 160 microCi Ra-226 sources; 2 each sealed 10 microCi Ra-226 check sources; 2 each sealed 2.2 microCi Cs-137 check sources; 3 each sealed 4.6 microCi Co-60 solution in glass ampules; one each sealed 1.0 microCi Sr-90 solution in a glass ampule; and one each sealed 0.6 microCi Kr-85 gas in a glass ampule; firing and fusing sets; DU-contaminated weapons components; 5,525 kg DU; 88.5 Ci tritium.

PIT 27

One each DU nose ballast; one each tritium-contaminated shipping container; DU plates; 3 each empty steel gas cylinders; tritium targets; 2 each DU penetrators; enriched uranium tensile bars alloyed with Fe-50; 1 kg thorium oxide; neutron generator tubes; 155 mm gun debris; 3,246 kg DU; 81 Ci tritium.

PIT 28

6 each 55-gallon drums containing DU debris; Cs-137 contaminated debris in sealed A/N can; one each 100 microCi Victoreen Sr-90 ion chamber; 10 each irradiated headers; DU-contaminated tapered cantilever and double cantilever; neutron generator tubes.

PIT 30

20 each 0.4 Ci neutron activated aluminum reflector plates encapsulated in concrete; 4 each 187 Ci Co-60 neutron activated stainless steel tubes encapsulated in concrete; activated stainless steel pipe containing reactor instrumentation (1,000 rem/hr on contact); thoria capsules and fragments.

PIT 31

Cs-137 contaminated reactor waste in sealed A/N can; 8 each DU ballast plugs; DU machine chips, turnings, and cuttings; 19 each highly oxidized DU plates; miscellaneous operational and cleanup wastes including towels, paper, packing material, wire, gloves, and tape; one each 10 microCi Ra-226 ionostat; one each 45 mCi Kr-85 ion generator; prefilters from exhaust systems; one each 4 mCi Ra-226/Be source, 4 each DU plates; 3 each uranium/zirconium samples; one each 16 mCi Se-75 source in steel block; 2 each 55-gallon drums contaminated with DU oxide; quartz cloth contaminated with thorium; 1-gallon toluene absorbed on vermiculite in sealed A/N can; neutron generator tubes and targets; DU-contaminated weapons test debris; Pershing missile test debris; 2,460 kg DU; 27.7 Ci tritium.

PIT 32

Two pints deuterium water absorbed on vermiculite in sealed 2-gallon A/N can; one each 150 mCi Ta-182 source in lead pig; 2 each Ta-182 plugs removed from a rain erosion rocket in sealed A/N can; neutron generator tubes and targets; DU-contaminated inner shield assembly; Ra-226, Na-22, Ba-133, Co-60, Co-57, Mo-54, mixed isotopes (1.0 mCi) in lead pig; 6 each 1.0 mCi Se-75 sources in lead pig; 6 kg DU-contaminated lithium tetra-borate; 10 each Po-210 static eliminators; 25 each obsolete 240 mCi Po-210 static eliminators; one each 300 mCi Ba-226 source in sealed A/N can; one each 1.0 microCi Sm-151 source in sealed A/N can; one each 0.1 mCi Pm-147 source in a sealed A/N can; tritium-contaminated glove box; 549 kg DU; 55.6 Ci tritium.

Trace Gd-153, Eu-152, Ce-144, Sr-85, Ba-133, Ag-110m, Tc-199, Ni-63, Na-22, and Pm-147.

PIT 33

One each 24 kg DU sphere; one each 86 Ci Co-60 source in 4,000 lb. lead cask; 15 each 70 mCi Co-60 sources, one each 1.0 mCi Pm-147 source, one each 350 mCi Se-75 source, 15 each 85 mCi Cs-137 sources, and 10 each 25 mCi Ra-226 sources encapsulated in concrete-filled 55-gallon drums; thorium-contaminated quartz cloth; 200 grams uranium hydride; one each 50 Ci

Kr-85 source encapsulated in a concrete-filled A/N can; activated stainless steel roller plate; TA-5 hot cell decontamination debris; one each irradiated balance; fuel element cladding and associated parts from reactor instrumented fuel elements, vacuum system, filters, and tools (2 rem/hr on contact); irradiated, disassembled pressure vessel and crucible; tritium targets and tubes; Three Mile Island radiation detector; 1.6 kg Be; 2,125 kg DU; 822 Ci tritium; 1kg thorium.

PIT 34

One each 110 Ci Co-60 radiography source encapsulated in concrete-filled A/N can; one each ultra-sonic thermometer consisting of a stainless steel tube loaded with copper, cobalt, tantalum, thoria, nickel, and iron (15 rem/hr on contact); activated stainless steel tubing (2 rem/hr on contact); obsolete experimental equipment and parts (3 rem/hr on contact); one each Cs-137 contaminated WESF capsule; neutron generator tubes and targets; 200 grams activated silver; firing sets; uranyl nitrate coatings of foil; trough assembly used in fuel element cleanup; 1,676 kg DU; 328 Ci tritium.

PIT 35

Neutron generator tubes and targets; neutron activated brass; 4 each 55-gallon drums DU from White Sands Missile Range; one each activated stainless steel containment canister; 686 kg DU; 203 Ci tritium.

PIT 36

Neutron generator tubes and targets; one each microcomputer; irradiated diodes, transistors, capacitors, resistors, circuit boards, voltage regulators, and other miscellaneous electrical components; 3 each activated stainless steel containment canisters wrapped in polyethylene sheeting; one each weapon shipping and handling container; thorium-contaminated Polaris missile sections; rings from reactor fuel elements (1.7 rem/hr on contact); 4 each 55-gallon drums containing wastes contaminated with fission products; 673 kg DU; 13.1 kg lithium.

PIT 37

Empty, no contents.

PIT U-1

1,589 kg DU in chips, machine turnings, shavings, cuttings, residue, and scrap.

PIT U-2

5,119 kg DU in chips, machine turnings, shavings, cuttings, residue, and scrap; one each irradiated melt chamber; one each copper crucible containing DU scrap.

PIT U-3

1,114 kg DU in chips, machine turnings, shavings, cuttings, residue, and scrap; 1,000 lbs. of Burn Site DU-contaminated soil and debris; one each DU-contaminated 300 lb. crucible.

Inventory of Inhalation Toxicology Research Institute – Lovelace Biomedical and Environmental Research, Inc. Disposed in Trench E [page 1]

INHALATION TOXICOLOGY RESEARCH INSTITUTE

LOVELACE BIOMEDICAL AND ENVIRONMENTAL RESEARCH INSTITUTE, INC.

RADIOACTIVE SHIPMENT RECORD FORM

From ____________________ Date 4/28/80

Page 1 of 4

Item No.	Rad. Level (mr/hr)		External Contamination Survey (CPM)	Isotope(s)	Container Type	Radioactive Millicuries	Physical State	Contents	Container Cubic Feet
	Surface	at 3 feet							
1	BKG.	BKG.	<100	^{238}Pu ^{239}Pu	55 Gal.Drum	.5	Solid	Plastic,glass,Paper	7.5
2	"	"	"	^{238}Pu ^{144}Ce	"	"	"	"	"
3	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
4	"	"	"	^{238}Pu	"	"	"	"	"
5	"	"	"	^{238}Pu	"	"	"	"	"
6	"	"	"	^{238}Pu	"	"	"	"	"
7	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
8	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
9	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
11	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
12	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
13	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
14	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
15	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
16	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	"
17	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	"
18	50	5	"	^{144}Ce	"	100	"	"	"
19	BKG.	BKG.	"	^{144}Ce ^{238}Pu	"	.5	"	"	"
25	"	"	"	^{134}Cs ^{239}Pu	"	"	"	"	"
26	"	"	"	^{134}Cs ^{239}Pu	"	"	"	"	"
27	"	"	"	^{134}Cs ^{241}Am	"	"	"	"	"
28	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
29	"	"	"	^{134}Cs ^{239}Pu	"	"	"	"	"
30	"	"	"	^{134}Cs ^{241}Am	"	"	"	"	"
31	"	"	"	^{134}Cs ^{239}Pu	"	"	"	"	"
32	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
33	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
34	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
35	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
36	10.	0.4	"	^{238}Pu ^{169}Yb	"	50 (Yb^{169})	"	"	"
37	BKG.	BKG.	"	^{144}Ce ^{238}Pu	"	.5	"	"	"
38	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
39	"	"	"	^{134}Cs ^{239}Pu	"	"	"	"	"
40	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
TOTALS						166			255

All of the waste described above contains no free liquids and no transuranic elements with a radioactivity concentration greater than 10 nanocuries per gram.

J.J. Thompson 4/30/80

Generator Signature Date

Carrier's Signature Date

Inventory of Inhalation Toxicology Research Institute – Lovelace Biomedical and Environmental Research, Inc. Disposed in Trench E [page 2]

INHALATION TOXICOLOGY RESEARCH INSTITUTE
LOVELACE BIOMEDICAL AND ENVIRONMENTAL RESEARCH INSTITUTE, INC.

RADIOACTIVE SHIPMENT RECORD FORM

From ______________________

Date 4/28/80

Page 2 of 4

Item No.	Rad. Level (mr/hr) Surface	Rad. Level (mr/hr) at 3 feet	External Contamination Survey (CPM)	Isotope(s)	Container Type	Radioactive Millicuries	Physical State	Contents	Container Cubic Feet
41	BKG.	BKG.	< 100	^{144}Ce ^{239}Pu	55 Gal.drum	.5	Solid	Glass,paper,plastic	7.5
42	"	"	"	^{147}Pm ^{238}Pu	"	"	"	"	"
44	22	2	"	^{134}Cs ^{144}Ce	"	50	"	"	"
45	190	10	"	^{144}Ce ^{137}Cs	"	500	"	"	"
46	BKG.	BKG.	"	^{144}Ce ^{238}Pu	"	.5	"	"	"
47	15	1	"	^{147}Pm	"	15,000	"	"	"
48	BKG.	BKG.	"	^{144}Ce ^{239}Pu	"	.5	"	"	"
49	"	"	"	^{144}Ce ^{241}Am	"	"	"	"	"
50	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
51	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
54	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
55	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
56	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
57	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
58	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
59	5	.5	"	^{144}Ce ^{238}Pu	"	10(^{144}Ce)	"	"	"
60	BKG.	BKG.	"	^{238}Pu ^{239}Pu	"	.5	"	"	"
61	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
62	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
63	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
64	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
65	"	"	"	^{169}Yb ^{238}Pu	"	"	"	"	"
66	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
67	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
68	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
69	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
70	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
71	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
72	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
73	50	6	"	^{134}Cs ^{144}Ce	"	50	"	"	"
74	60	7	"	^{134}Cs ^{144}Ce	"	50	"	"	"
75	40	5	"	^{134}Cs ^{144}Ce	"	50	"	"	"
76	BKG.	BKG.	"	^{144}Ce	"	.5	"	"	"
77	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	" RI
TOTALS						15724			255

All of the waste described above contains no free liquids and no transuranic elements with a radioactivity concentration greater than 10 nanocuries per gram.

G. J. Newton 4/30/80
Customer's Signature Date

____
Carrier's Signature Date

Inventory of Inhalation Toxicology Research Institute – Lovelace Biomedical and Environmental Research, Inc. Disposed in Trench E [page 3]

INHALATION TOXICOLOGY RESEARCH INSTITUTE

LOVELACE BIOMEDICAL AND ENVIRONMENTAL RESEARCH INSTITUTE, INC.

RADIOACTIVE SHIPMENT RECORD FORM

From ______________________

Date 4/28/80

Page 3 of 4

Item No.	Rad. Level (mr/hr)		External Contamination Survey (CPM)	Isotope(s)	Container Type	Radioactive Millicuries	Physical State	Contents	Container Cubic Feet
	Surface	at 3 feet							
78	BKG.	BKG.	< 100	^{144}Ce ^{238}Pu	55Gal.drum	.5	Solid	Glass,paper,plastic	7.5
79	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	"
81	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
82	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
83	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
84	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
85	"	"	"	^{137}Cs ^{239}Pu	"	"	"	"	"
86	20	.5	"	^{144}Ce ^{238}Pu	"	50(^{144}Ce)	"	"	"
87	BKG.	BKG.	"	^{169}Yb ^{238}Pu	"	.5	"	"	"
88	"	"	"	^{134}Cs ^{238}Pu	"	"	"	"	"
91	"	"	"	^{134}Cs ^{238}Pu	"	"	"	"	"
92	"	"	"	^{134}Cs ^{238}Pu	"	"	"	"	"
93	"	"	"	^{134}Cs ^{238}Pu	"	"	"	"	"
94	40	5	"	^{106}Ru	"	20	"	"	"
95	110	7	"	^{106}Ru	"	60	"	"	"
96	BKG.	BKG.	"	^{238}Pu ^{239}Pu	"	.5	"	"	"
97	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
98	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
99	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
100	"	"	"	^{14}C ^{134}Cs	"	"	"	"	"
101	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
102	25	1	"	^{169}Yb ^{238}Pu	"	50 (^{169}Yb)	"	"	"
103	BKG.	BKG.	"	^{169}Yb ^{238}Pu	"	.5	"	"	"
104	"	"	"	^{169}Yb ^{238}Pu	"	"	"	"	"
107	3	0	"	^{169}Yb ^{238}Pu	"	10 (^{169}Yb)	"	"	"
108	BKG.	BKG.	"	^{144}Ce ^{238}Pu	"	.5	"	"	"
109	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	"
110	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
111	"	"	"	^{106}Ru ^{238}Pu	"	"	"	"	"
112	"	"	"	^{106}Ru ^{238}Pu	"	"	"	"	"
113	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
114	7	1	"	^{134}Cs ^{238}Pu	"	10 (^{134}Cs)	"	"	"
115	BKG.	BKG.	"	^{238}Pu ^{239}Pu	"	.5	"	"	"
117	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
TOTALS						214			255

All of the waste described above contains no free liquids and no transuranic elements with a radioactivity concentration greater than 10 nanocuries per gram.

[signature] 4/30/80

Customer Signature Date

Carrier's Signature Date

Inventory of Inhalation Toxicology Research Institute – Lovelace Biomedical and Environmental Research, Inc. Disposed in Trench E [page 4]

INHALATION TOXICOLOGY RESEARCH INSTITUTE
LOVELACE BIOMEDICAL AND ENVIRONMENTAL RESEARCH INSTITUTE, INC.

RADIOACTIVE SHIPMENT RECORD FORM

From

Date 4/28/80

Page 4 of 4

Item No.	Rad. Level (mr/hr) Surface	Rad. Level (mr/hr) at 3 feet	External Contamination Survey (CPM)	Isotope(s)	Container Type	Radioactive Millicuries	Physical State	Contents	Container Cubic Feet
118	BKG.	BKG.	< 100	^{106}Ru ^{238}Pu	55 Gal.drum	.5	Solid	Glass,plastic,paper	7.5
119	"	"	"	^{106}Ru ^{238}Pu	"	"	"	"	"
120	"	"	"	^{90}Sr ^{144}Ce	"	"	"	"	"
121	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
122	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
123	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
124	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
125	"	"	"	^{169}Yb ^{238}Pu	"	"	"	"	"
128	"	"	"	^{169}Yb ^{238}Pu	"	"	"	"	"
131	"	"	"	^{239}Pu ^{241}Am	"	"	"	"	"
132	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
134	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
135	"	"	"	^{238}Pu ^{239}Pu	"	"	"	"	"
136	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
137	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
242	"	"	"	^{238}Pu ^{241}Am	"	"	"	"	"
247	"	"	"	^{144}Ce ^{239}Pu	"	"	"	"	"
D	BKG.	BKG.	<100	^{137}Cs ^{238}Pu	Plywood Box	.5	Solid	Glass,paper,plastic,	121
G	"	"	"	^{134}Cs ^{144}Ce	"	"	"	metal	91
B	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	154
H	"	"	"	^{90}Sr ^{137}Cs	"	"	"	Manipulatör cell	411
J	"	"	"	^{137}Cs ^{144}Ce	"	"	"	Metal,paper,glass,	121
K	"	"	"	^{137}Cs ^{144}Ce	"	"	"	" plastic	91
M	"	"	"	^{137}Cs ^{144}Ce	"	"	"	"	91
L	"	"	"	^{137}Cs ^{144}Ce	"	"	"	"	121
F	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	91
N	"	"	"	^{137}Cs ^{144}Ce	"	"	"	"	121
A	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	121
E	"	"	"	^{144}Ce ^{238}Pu	"	"	"	"	91
I	"	"	"	^{169}Yb ^{238}Pu	"	5.0	"	Glove Box, paper, glass and plastic	441
TOTALS						19.5			2193.5

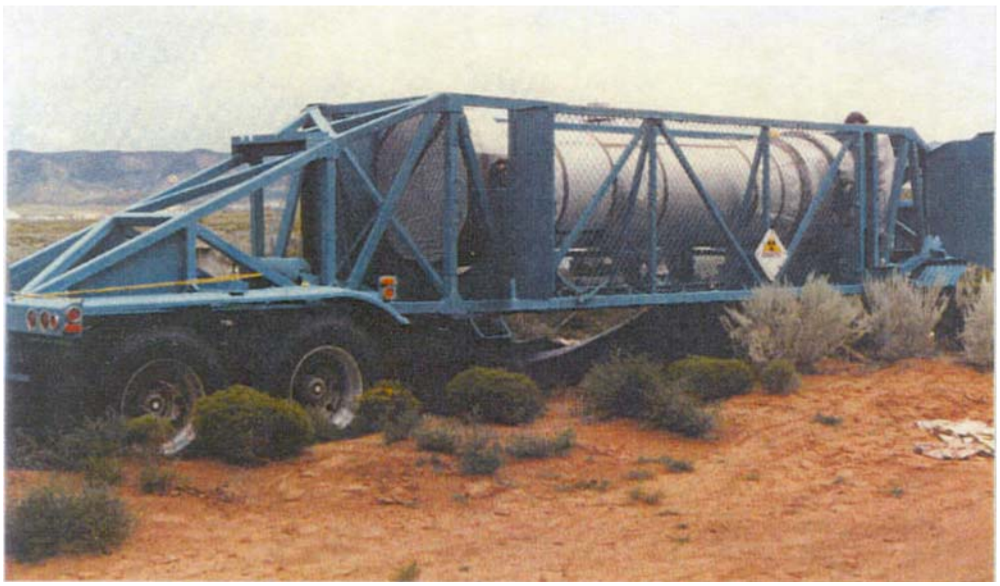
All of the waste described above contains no free liquids and no transuranic elements with a radioactivity concentration greater than 10 nanocuries per gram.

J. J. Thompson 4/30/80

Customer Signature Date

Carrier's Signature Date

[Picture] Cs-137 contaminated shipping cask and semi-tractor trailer. Only the semi-tractor trailer was buried in Trench F.



Appendix F
Editorial Comments on the Draft CMS

The following are editorial comments on the Draft CMS, dated November 2002. These comments were prepared within less than a week after receiving the CMS and as such will necessitate a second review of the study document, depending on the revisions by SNL.

ix – first paragraph – clarify what is meant by 100,000 ft^3

ix – 4th paragraph – document the assumption of IC for 100 years.

x – second paragraph – cite reference or guidance for EPA three general criteria

Section 1.2 – need to add site model with cross-sections showing pits, plumes and groundwater – sketch should also show pathways for exposure and receptors

Page 1.4 is blank – intentional?

Page 1.6 is blank – ditto

Page 1.8 is blank – ditto

Page 1.9 last paragraph – second to last line – no free liquids statement is incorrect.
e.g., 204,00 gallons of water.

Page 1.11 – Section 1.6 addresses item c above it but also needs to address items a and b –they are critical in a closure – c is only regs.

Page 1.12, Section 1.7.2 – show a figure of the tritium migration – is this as liquid or vapor – need to define both.

Page 1.13 Section 1.7.3 second paragraph of section – show a profile from data in cross-section showing VOC to extent of depth and relation to gw – likewise show tritium profile discussed in 3rd paragraph. In the 4th paragraph, explain how the industrial land use situation fits into the real world situation and justify it.

Page 1.13 Section 1.7.4 Show in a couple of figures where the samples were taken from and in a table show the historical trend of the samples since it is indicated that they have been taken since 1990 there are 12 years of history to show trends, or provide adequate references.

Page 2.1 and 2.2 – Number the corrective action objectives.

Page 2.8 – the performance of a soil vegetative cover is indicated as "Good". This performance may vary from poor to fair to good depending on how it is implemented and maintained – more detail is needed here as to the specifics of the cap for proper evaluation. Likewise for page 2.10 – RCRA C Cap.

Page 2.11 – cobbles may actually give only poor performance due to compaction they cause and problems with removal in future excavation.

In the excavation tables pages 2.15-2.19, the problems are overstated – in the future this remedy may be feasible due to changes in technology and strength of source terms over time decreasing.

Page 3.3 Section 3.1.3 – cost is a function of volume of material (and type). With the lesson learned from the Chem Waste LF, is cost in the report being addressed to give the best estimate?

Page 3.6, Section 3.2.1.3 – Table 3-2 should be at the end of the whole section – not on page 3-7 as the other alternatives have not been looked at yet and totals are given in those sections anyway.

Page 3-9 – Cobbles may cause compaction problems – this will limit effectiveness if proven out.

Page 3.10 Section 3.2.4 – need more details here on vegetative cover – the sketchy description does not allow for assessment of the remedy.

Page 3.20 blank?

Page 3.22 ditto

Page 3.26 ditto

Page 3.32 ditto

Page 3.34 ditto

Page 3.38 ditto

Page 3.42 ditto

Page 3.46 ditto

Page 4.13 – 4th paragraph – the type of bio-intrusion barrier is key here – without specific details as to design and engineering it is hard to assess.

Page 5.2, paragraph on CERCLA and RCRA – EPA remedy statement is cited. But the MWL is nowhere close to meeting a RCRA type facility in terms of engineering and design – no clay, no leachate collection, no HDPE liners, etc. How is this lack of engineering being addressed?

Appendix G
Acronyms and Initialisms

Am	americium
A/N	metal cans of various sizes for military ordinance storage
CFC	chlorofluorocarbon
Ci	Curie(s)
CMS	Corrective Measures Study
Co	cobalt
COC	contaminate of concern
Cs	cesium
DOE	U.S. Department of Energy
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ft.	feet or foot
FOIA	Freedom of Information Act
g/cc	grams per cubic centimeter
H-3	tritium
HEPA	high efficiency particulate air (filter)
mg/L	milligrams per liter
Mn	manganese
MWL	Mixed Waste Landfill
Na	sodium
Ni	nickel
Pb	lead
pCi/L	pico curies per liter
PCE	perchloroethene
Pm	promethium
ppb	parts per billion
ppt	parts per trillion
Pu	plutonium
PVC	polyvinyl chloride
Ra	radium
RCRA	Resource Conservation and Recovery Act
Ru	ruthenium
SNL	Sandia National Laboratories
Sr	strontium
SWMU	Solid Waste Management Unit
Tc	technetium
TCA	trichloroethane
TCE	trichloroethene
U	uranium
VOC	volatile organic compound
WERC	a Consortium for Environmental Education & Technology Development
Yb	ytterbium