

# **Independent Evaluation of the Corrective Measures Study, Mixed Waste Landfill, Sandia National Laboratories.**

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## 1.0 Introduction

The Mixed Waste Landfill (MWL) covers 2.6 acres of technical area 3 at Sandia National Laboratories (SNL). It is approximately 5 miles southeast of Albuquerque International Sunport, at the edge of the rapidly developing city of Albuquerque. The region is arid. An aquifer approximately 460 feet below the MWL is the source for Albuquerque's public drinking water. The landfill was operational from March 1959 to December 1988, accepting wastes from both SNL and other sites. The inventory of wastes deposited in the landfill from 1959 to 1964 is still classified by the Department of Energy and is unavailable. The wastes were disposed of in shallow unlined pits and trenches and covered in soil. Some of the pits in the classified area were capped with concrete. The surface area above some of the pits in the classified area currently have very high gamma rates, as reported in the RCRA Facility Investigation Phase 2 Report. These readings cannot be explained by the known inventory compiled by SNL. The known inventory includes at least 6,300 Ci of radioactivity at the time of disposal, as well as many nonradiological hazardous materials including metals and volatile organic contaminants (VOCs). It is suspected by citizen's groups that spent oxide reactor fuels that should be considered high level waste (HLW) are buried in the classified area of the MWL, although this has been so far denied by Sandia/DOE and the NMED.

In September 1996, Sandia/DOE published the Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation. This report included measurements of radionuclides, metals, and VOCs in the soil underneath the landfill and in groundwater. It also included measurements of tritium levels in soil and of tritium flux from the soil. The Phase 2 report concludes that tritium is the primary constituent of concern, although many other hazardous compounds were measured in soils and groundwater. The Phase 2 report was plagued by data analysis problems—many measurements that found unusually high levels of contaminants were discounted due to unidentified laboratory error, although measurements that found low levels were never discounted. The Phase 2 report contains a baseline risk assessment, which was heavily criticized by citizens groups and was eventually retracted by Sandia/DOE.

The Corrective Measures Study (CMS) is based on the information presented in the Phase 2 report and the preceding Phase 1 report, as well as other measurements made at the site, but does not include any new environmental data. The study states, "The purpose of the CMS is to identify and screen, develop, and evaluate potential corrective measures alternatives and recommend the corrective measure(s) action to be taken at the MWL"<sup>1</sup>. The Corrective Action Objectives by which these alternatives were judged 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
- 4) prevent or limit human intrusion into buried waste over the long term.

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<sup>1</sup> CMS, p. 15

The alternatives screened by the CMS included “containment” and “excavation” alternatives. Some potential alternatives were considered unacceptable as they did not meet the Correction Action Objectives. Others were considered acceptable and were considered in more detail, including cost estimates and risk assessments. These alternatives included:

- No Further Action with Institutional Controls (NFA with ICs)
- Bio-Intrusion Barrier
- Vegetative Soil Cover
- Vegetative Soil Cover with Bio-Intrusion Barrier
- RCRA Subtitle C Cap
- RCRA Subtitle C Cap with Bio-Intrusion Barrier
- Complete Excavation with Aboveground Retrievable Storage
- Complete Excavation with Off-Site Disposal
- Partial Excavation with Aboveground Retrievable Storage
- Partial Excavation with Off-Site Disposal
- Future Excavation

The CMS concluded that the alternative that “clearly presents the overall lowest risk to human health and the environment while minimizing costs and meeting MWL corrective action objectives” to be NFA with ICs. Not coincidentally, this was the least expensive of all alternatives considered. However, the final recommendation for the “preferred corrective action” was the Vegetative Soil Cover, as it “offers additional protection against exposure to waste in landfill disposal cells, further minimizes infiltration of water, and mitigates bio- and human intrusion into buried waste without significant added cost”.

In this report, we offer our critique of Sandia/DOE’s choice of preferred corrective actions, as well as of the CMS methodology and its assessment of alternatives, risks, and costs. Since the CMS cites data in previous reports that we consider problematic, we have included a review of those reports when necessary. To prepare this report, we reviewed the CMS and its appendices, the Phase 2 RFI Report for the MWL, independent technical reviews of the MWL by the WERC, a DOE/NMED Oversight Bureau report on HWL at the MWL; independent technical reviews of the MWL conducted by Citizen Action; documents obtained by Citizen Action under the Freedom of Information Act (FOIA); and Sandia/DOE’s responses to these reports, when available.

## **2.0 Importance of Waste Characterization**

In the following report, we will point out several deficiencies of the CMS and associated documents that are impossible to fully correct at the present time because the contents of the classified section of the MWL have not yet been made public despite Freedom of Information Act requests made by Citizen Action. Thus, in the introduction of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia did not provide “information on amounts of hazardous substances disposed,”<sup>2</sup> that is, identify “all

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<sup>2</sup> US Environmental Protection Agency, “Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A),” EPA/540/1-89/002, December 1989, Sect. 4.2.

potential or suspected sources of contamination.”<sup>3</sup> This important purpose of the Phase 2 investigation, “to determine thoroughly the contaminant source,” was not accomplished.

Why is it important to know the full inventory? Because the information allows one to estimate the hazardous life of the landfill, the useful life of containers, the potential radiation dose to future residents and therefore should guide the feasible remediation alternatives. To understand the full present and future potential hazard, Sandia needs to provide the full radiological and toxic chemical inventory of both the landfill’s classified and unclassified sections. This is necessary both to determine what “corrective measure” should be taken to protect the public and environment around the landfill, and to effectively and safely complete that action. The combined inventory for the classified and unclassified sections of the MWL should be listed.

Determining the full radionuclide inventory has been successfully completed at many DOE landfills across the country. For example, the full inventory of the mixed waste storage facility at INEEL has been determined. This waste material was generated at many DOE facilities, but primarily at Rocky Flats. Despite the diversity of sources, DOE-Idaho was able to investigate the generating source and inventory by reviewing generator records, taking gas samples and using non-intrusive means. Lists were provided of the total mass of organic chemicals and metals and the total radioactivity of all radionuclides, as well as the sources of these materials. The need to classify information was never used by DOE/Rocky Flats as an excuse to withhold information about landfill contents. Sandia should provide a similar listing for the MWL.

The Phase II report lists ion exchange resins, activation products and MFP for mixed fission products, without specifying specific radionuclides. The total tritium is listed – 1861 Ci, and the likely locations, while also acknowledging that no information is available for trenches A through D. (Some of this information was later obtained by Citizen Action through FOIA requests, as discussed below.) The Phase II report estimates 200 Ci of Sr-90 and Cs-137, but it is unclear how this information was derived. Many trenches and pits contain mixed fission products, reactor debris and bomb test materials. These wastes contain unevaluated concentrations of Sr-90 and Cs-137, plutonium and activation products. Further, without solidification with a grout, ion exchange resins would contain up to 50% water.<sup>4</sup> But Sandia and the NMED continue to maintain, incorrectly in our opinion, the drummed resins were solid.<sup>5</sup> Radionuclides in wet ion exchange resins would have a greater opportunity to move over time.

Sandia has shown they have the capability to determine the pit and trench contents. In response to a FOIA request for information about the HLW contents of the MWL, Sandia completed an extensive survey of documents pertaining to the disposal and storage of

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<sup>3</sup> *Ibid.*

<sup>4</sup> Oztunali, OI and GW roles, “Update of Part 61, Impacts Analysis Methodology,” NUREG/CR-4370, p. A-19.

<sup>5</sup> Letter from R Kennett, NM Environment Department, to S Dayton, Citizen Action, May 24, 2001.

irradiated reactor fuels at SNL. Their report<sup>6</sup> made public information about past activities at SNL that is no longer sensitive for national security purposes and so was rightly disclosed. Although we do not agree that the evidence cited in this report supports its conclusion that HLW could not have been deposited in the MWL, in our opinion the comprehensive approach to documenting these specific activities and wastes should be extended to the whole landfill.

The information about the specific inventory of the classified section is available, but it is being withheld from the public under claims that it is sensitive for national security. John Gould of DOE has said that the reason the contents are classified is the shape, size, and form of the “materials” buried. He claimed that if information is disclosed, it is possible that a rogue nation may get access to these materials. But it does not seem possible that a “rogue nation” would be able to sneak sophisticated, multi-ton excavation equipment onto the site in order to steal the materials without attracting the attention of security officials. We are requesting information about the radionuclide inventory, not the “shape, size, and form”. There is therefore no reason why an accounting of the specific wastes buried cannot be made public. We do not request blueprints of any technology, only information about what wastes are at the landfill and the full inventory. There is no reason why this information should be classified, and it is the public’s right to know what contaminants have been introduced into their environment.

The NMED did a “very partial review” of the contents of the classified area of the landfill and said it “checked with records” of what SNL said was buried there. But this is not possible based on gamma readings measured at the site. As an example of important missing information, consider the following. Pit 35 has very high direct gamma rates at the surface, 50 millirem per hour (mr/h). What accounts for these high direct gamma readings? Pit 35 contents are listed as 686 kg depleted uranium (DU) and 203 Ci tritium. Neither of these materials account for high gamma readings. Pit 35 also contains neutron generator tubes and targets and neutron activated brass. These materials may have high Co-60 and Nb-94 concentrations that may account for high survey results, but Sandia’s documents have no further information. Nb-94 has a long half-life, 20,000 years. Knowing the source of Pit 35 contents and how the radionuclides were generated, Sandia could develop additional information about pit contents. Similarly, Pit 36 has direct gamma rates of 6 mr/h, but the pit contents were listed as 673 kg DU and 13 kg lithium. The pit also contains neutron generator tubes and targets, rings from reactor fuel elements and 4 55-gallon drums containing fission product contaminated waste. The curie content of these materials is not listed. Pit SP-4 has surface direct gamma readings of 0.5 mr/h. This high gamma dose is likely due to Co-60 and Nb-94 from nuclear reactor vessel plates from a decommissioned nuclear reactor, but the curie content again is not listed. Trench A contains 17 55-gallon drums containing mixed fission products in demineralizer resins. But the exact curie content is not listed. Each trench and pit in the MWL contains similar mysteries. The presence of these fission products, and particularly the presence of activation products and actinides, such as Pu-239, indicates that the MWL

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<sup>6</sup> New Mexico Environment Department, “Nuclear Fuel Assessment Project Summary, Sandia National Laboratories’ Mixed Waste Landfill”, August 2003

will remain hazardous essentially forever. It must be assumed bomb test materials from NTS contain Pu-239.

Many pits (1, 2, 3A and B, and 4 through 11, and Pits U-1 through U-3) and trenches (such as trench C which contains metal turnings), contain depleted uranium, likely in metal form. This includes DU from burn tests and contaminated weapons components. When exposed to air at elevated temperatures, uranium metal will oxidize or burn. In 1979, metal turnings from NMI in Concord, Massachusetts self-ignited en route to the Barnwell low-level radioactive burial ground. FOIA documents reveal a DU fire occurred at the MWL in 1974.

Several pits contain test debris from NTS. This is likely to contain a mixture of plutonium and fission products. Some pits, such as SP-1, and trenches C and D, contain hazardous and unspecified chemicals. As pointed out earlier, hazardous chemical wastes, such as acids, solvents, TCE and carbon tetrachloride, were disposed in the classified section of the MWL in the years 1959-1962.

Some of the wastes buried at the MWL may be properly classified as High Level Waste (HLW). According to the DOE order 435.1, "High-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation."

According to a report by Eric Nuttall that is based on FOIA documents, canisters containing melted spent nuclear fuel residuals were buried at the MWL. Some of the material originated from tests of damaged fuel that were conducted at the Annular Core Research Reactor (ACRR) at Sandia after the accident at Three Mile Island in 1979.<sup>7</sup> Other spent fuel came from the STAR program, which also involved the use of fuel irradiated in the ACRR reactor. A partial collection of documents obtained under the FOIA concerning the disposal of the irradiated reactor nuclear materials (IRNM) was recently released to Citizen Action. The document, "SNL Site Team Report on Assessment of Vulnerabilities of DOE Storage of Irradiated Reactor Fuel and other Reactor Irradiated Nuclear Materials, October 1993" acknowledges the IRNM were disposed of in yard holes in various locations at SNL; however, the actual inventories of these yard holes have not been made available. By law, this material must be excavated and removed to a geologic repository.

Sandia/DOE needs to answer the following questions:

*1) Why is complete waste characterization, which has been accomplished at other sites, not possible at the MWL?*

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<sup>7</sup> Nuttall, Eric, Ph.D., "Sandia Mixed Waste Landfill/Nuclear Spent Fuel Disposal". 2003

*2) How will it be possible for Sandia/DOE to complete a legitimate risk assessment of the site if the complete inventory is not known? Isn't it necessary to incorporate the uncertainty of the inventory into the risk assessment?*

*3) How can the discrepancy between the existing waste inventory and the high gamma readings at Pit 35, Pit SP-4, and Trench A be accounted for?*

*4) Why is the danger of depleted uranium combustion not considered in the CMS risk assessment?*

*5) Isn't it possible, based on the FOIA documents discussed by Eric Nuttall, that there are High Level Wastes in the MWL that must by law be removed to a geological repository?*

### **3.0 Questions Previously Presented to Sandia/DOE**

There have already been several opportunities for communication between Sandia/DOE, concerned citizens, and regulatory bodies. WERC presented an independent review of the draft CMS, which included several recommendations which were not incorporated into the final CMS. The New Mexico Environment Department (NMED) presented a Notice of Deficiency (NOD) on the CMS, which Sandia responded to, including corrections or explanations in some cases.

Paul Robinson, Research Director for Southwest Research and Information Center, Albuquerque, wrote preliminary comments regarding the Draft CMS Work Plan. The NMED returned the comments to Mr. Robinson and requested that Mr. Robinson re-submit the comments during the 60-day public comment period for the draft permit for the MWL. Mr. Robinson's comments concluded that the CMS was incomplete. Sue Dayton of Citizen Action also presented questions on a report completed by Roger Kennett, NMED/DOE Oversight Bureau, regarding potential High Level Waste buried in the MWL, as well as a related report by Dr. Eric Nuttall on Nuclear Spent Fuel Disposal, neither of which has been responded to by SNL or the NMED.

On behalf of Citizen Action, Dr. Marvin Resnikoff presented a report on the draft CMS Workplan<sup>8</sup>. In 2001 the conclusions reached in a report by Dr. Tom Hakonson, who reviewed the ET cap closure plan for the MWL on behalf of Citizen Action, were not responded to by SNL or the NMED. Finally, a summary of information released to Citizen Action in 2000 under the FOIA regarding the MWL inventory was not responded to by SNL and NMED.

#### **3.1 WERC Independent Technical Peer Review<sup>9</sup>**

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<sup>8</sup> Comments on the draft Corrective Measures Study Workplan for the Mixed Waste Landfill, December 19, 2001, prepared by Sandia National Laboratories. Marvin Resnikoff, Ph.D., Radioactive Waste Management Associates, September 20, 2002.

<sup>9</sup> 'Final WERC Report Independent Technical Peer Review of the U.S. Department of Energy Sandia National Laboratories' "Working Draft" Corrective Measures Study', January 31, 2003



The WERC independent peer review of the draft CMS, despite containing faults that were pointed out by Susan Dayton<sup>10</sup>, also contained several excellent suggestions that were not incorporated into the final CMS. The WERC review criticized the CMS for excluding the information that the MWL inventory data from 1958-1964 are still being withheld from the public and are not included in the MWL description.<sup>11</sup> It also criticized the fact that the CMS underreports the amount of liquids that were discharged into the MWL.<sup>12</sup> As noted below, the CMS report only admits that 271,000 gallons of liquids were disposed of, and cites modeling of migration to groundwater in the Phase 2 report based on this number, although in reality at least 19,142,970 gallons were disposed of very near to the MWL, not including earlier liquid wastes and ion exchange resins. There is nothing keeping this water from migrating into the soil under the MWL itself. Although it is true that the CMS is not technically required to include a complete operational history, we concur with WERC that this information ought to have been included, since without it the operational history as presented in the CMS is not only incomplete but misleading. The rest of the report, likewise, should have been informed by the fact that significant amounts of water were dumped in the MWL and that much of the inventory is still classified. *NMED should require Sandia/DOE to explain how the uncertainty in the waste inventory and the nineteen million gallons of extra tritiated water not considered affect the risk assessments for the CMS alternatives, including the possibility for groundwater contamination.*

The WERC report also recommended evaluation of two additional alternatives that were not considered in the CMS. One is temporary cover with future excavation.<sup>13</sup> In our opinion this option has the potential to be an excellent solution for the MWL, combining considerations of cost, short-term safety, and long-term risk. While postponing landfill excavation would allow short-lived radionuclides to decay, saving costs and reducing risks for labor in excavation, a temporary cap would reduce the likelihood that additional releases to the environment could occur in the interim period. In our opinion, it is unfortunate that the CMS did not take WERC's recommendation on this matter into account, and that the CMS does not contain any evaluation of vegetative covers, bio-infiltration barriers, or RCRA subtitle C caps as short-term remedial measures (as opposed to permanent measures). *Sandia/DOE should explain why these options were not considered, and to include them in any future reviews or CMS revisions.*

The other additional alternative suggested by WERC is a combination of storage and disposal options following excavation.<sup>14</sup> In our report below, we will also discuss this alternative, although we prefer slightly different options than the WERC report. The complete excavation alternatives presented in the CMS only present two options for radioactive waste: onsite retrievable storage, or off-site disposal. The WERC report points out that secure retrievable storage would not be necessary for most of the waste at

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<sup>10</sup> "Comments: Interim WERC Independent Technical Peer Review of US/DOE SNL Draft Corrective Measures Study Nov. 2002" By Sue Dayton for Citizen Action

<sup>11</sup> WERC report, p. i-ii

<sup>12</sup> WERC report, p. 33

<sup>13</sup> WERC, p. iv

<sup>14</sup> WERC report, p. iv

the CMS, and that the costs of excavation could be significantly lowered by using a combination of options: secure storage for the most dangerous waste, an onsite RCRA approved landfill for low-level waste, and an onsite conventional landfill for non-hazardous waste. Although we prefer off-site disposal to on-site retrievable storage, we agree with WERC that the costs for excavation options presented in the CMS are unnecessarily high, and that a combination of disposal options is probably the most cost-effective way to excavate the site. *Again, it is extremely unfortunate that this alternative was not evaluated in the CMS, and we recommend that Sandia/DOE seriously consider the WERC combination alternative.*

The WERC report also expressed concern with the finding of volatile organic chemicals in the soil beneath the MWL. Considering the fact that the full landfill contents are unknown, extreme care should be taken that other, more hazardous wastes are not allowed to leak out of the landfill undetected. The panel recommended implementing a vadose zone monitoring system as soon as possible<sup>15</sup> (as is presented in the CMS cost summaries for a few specific alternatives only), instead of never (as the NFA with IC's alternative is presented), or at the start of excavation (as the Future Excavation alternative is presented). In the CMS, vadose zone monitoring is only presented in the cost summaries in Appendix D, but not in the alternative descriptions. We concur with WERC that the vadose zone monitoring system would be an essential component of every alternative save immediate excavation. The alternative descriptions should plainly state that this system will be implemented and utilized. *Sandia/DOE should include vadose zone monitoring in the alternative descriptions, so that it is clearly stated in their permitting that such monitoring must be implemented.*

### 3.2 NMED Notice of Deficiency

The NMED Notice of Deficiency (NOD) noted that the cost for monitoring and institutional controls (IC's) was only calculated for 30 years for all alternatives even though they will be needed indefinitely. Sandia/DOE's only response was that the program they used to calculate cost was only able to forecast a period of 30 years.<sup>16</sup> It made no other attempt to estimate long-term costs of the activities, even though the additional cost would be considerable over the next seventy years (one hundred years is considered to be the longest period for which IC's can be assumed) or the tens of thousands of years for which they may actually be necessary. Sandia/DOE defends itself by pointing out that the differing time periods used are "planning tools", but it does not supply the cost information needed to actually plan for those time periods. *Sandia/DOE should be required to evaluate, or at least estimate, the costs of each alternative over at least a hundred years if not longer. In order for the alternatives to be compared, the time periods for which costs are estimated must be equal for all alternatives.*

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<sup>15</sup> WERC report, p. iv

<sup>16</sup> Sandia National Laboratories, Responses to New Mexico Environment Department Notice of Deficiency for the Mixed Waste Landfill: Corrective Measures Study Report, May 2003. EPA ID# 5890110518, HWB-SNL-01-025. p.2

The NOD also commented “The Department would prefer a remedial alternative that will require as little maintenance as possible”. Although no response was required of Sandia, we would like to point out that any of the non-excavation alternatives will require thousands of years of security, monitoring, and maintenance.<sup>17</sup> *Sandia should explain how it could consider alternatives that will require an infinite maintenance period to “require as little maintenance as possible”.*

The NOD asked Sandia why 8000 cubic yards of soil and debris scraped off the landfill could not be replaced after the waste underneath was excavated, but must be disposed off-site at a cost of \$6.48 million (with an additional cost for replacement soil.) Sandia’s response was that the material will be low-level radioactive waste and must be shipped to an expensive radioactive waste facility.<sup>18</sup> However, replacing the soil after excavation would still be far less dangerous than leaving it, as well as the more dangerous wastes, in place with no excavation. Sandia also never considers an intermediate possibility, such as creating a standard, low-tech, inexpensive landfill on-site for slightly contaminated waste. *Sandia/DOE must justify leaving in place waste of which even the least contaminated fraction is too dangerous to place in a standard landfill, and/or to revise the cost estimates to include an option for leaving less contaminated waste on site.*

The NOD requested further explanation of the CMS assertion that “due to remedial options, the COC’s may vary.” The only explanation provided in the CMS was that except for the NFA with no IC’s alternative and future excavation alternatives, “a potential depth of COC contamination was limited to 0 to 5 feet bgs” (below ground surface). The clarification provided reiterated that only concentrations of contaminants within 5 feet of ground surface were used for screening, but did not explain why.<sup>19</sup> We fail to see how institutional controls will prevent contaminants below 5 feet from becoming concerns (and believe that this was the intent of NMED’s query) , but this was never explained by Sandia. In our opinion, all hazardous compounds present in the MWL should be considered contaminants of concern regardless of whether they have already managed to escape from the MWL. *Sandia/DOE should explain how institutional controls can prevent further contaminant leakage from the MWL both in the near- and long- term future.*

### 3.3 “Comments on the draft Corrective Measures Study Workplan”

This report by Marvin Resnikoff<sup>20</sup> judged the risk assessment of the Phase 2 report on which the CMS is based to be “inadequate”. In their response, Sandia/DOE stated that they intended to withdraw that risk assessment and present a revised version in the CMS.

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<sup>17</sup> Responses to NMED NOD, p.4

<sup>18</sup> Responses to NMED NOD, p. 20-21

<sup>19</sup> Responses to NMED NOD, p. 21

<sup>20</sup> Comments on the draft Corrective Measures Study Workplan for the Mixed Waste Landfill, December 19, 2001, prepared by Sandia National Laboratories. Marvin Resnikoff, Ph.D., Radioactive Waste Management Associates, September 20, 2002.

In the response to Dr. Resnikoff's report, Sandia stated "Short-term and long-term risk will be evaluated in the CMS for each remedial alternative". However, since the risk assessments did not include all the contaminants that might eventually leak out of the landfill, nor did it evaluate risk past the point when institutional controls might be dissolved, it cannot be said to adequately evaluate long term risk. *Sandia should explain why long-term risk still has not been evaluated for the landfill.*

Dr. Resnikoff also raised the concern that there was no risk assessment for a future residential use scenario, to which Sandia replied that this would be completed in the CMS. However, the risk assessment presented in the CMS does not include all contaminants, nor does it assess risks involved with digging or drilling that might occur during residential use of the site. If there is depleted uranium present at the MWL, it might ignite from drilling, causing an explosion or releasing extremely hazardous fumes from burning waste. *Sandia must explain why there is no residential risk assessment that assesses all contaminants and dangers, or it must provide such an assessment.*

### 3.4 "Review of 'Sandia National Laboratories, New Mexico Mixed Waste Landfill Corrective Measure Study Draft Work Plan of December 19,2001'"<sup>21</sup>

In this report, Paul Robinson questioned Sandia's use of a streamlined CMS methodology, since the MWL is not necessarily a "low risk facility", as emphasized by the NMED's determination that "past handling, storage, treatment, or disposal of any solid waste or any hazardous waste at SNL may present an imminent and substantial endangerment to health or the environment"<sup>22</sup>. Sandia/DOE replied that the streamlined approach is appropriate because releases to the environment thus far have been minimal, and thus "the CMS needs to focus only on source control/elimination, and related issues."<sup>23</sup> However, since the CMS risk assessment considers only releases to the environment and not sources, it essentially ignores the issue of source control. *Why did Sandia/DOE ignore the contaminant sources even though it specifically stated they should be the main focus of the CMS report?*

### 3.5 "Questions regarding the Kennett report" by Sue Dayton, Citizen Action

Sue Dayton had several important points on the Kennett report on Spent Nuclear Fuel disposal at SNL that have not been addressed by Sandia/DOE. Some of these include:

1) Dr. Eric Nuttall's research concludes that high level waste (HLW) generated from oxide reactor fuel experiments at Sandia are buried in the MWL. The Kennett report

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<sup>21</sup> Paul Robinson, "Review of 'Sandia National Laboratories, New Mexico Mixed Waste Landfill Corrective Measure Study Draft Work Plan of December 19,2001'" Submitted on behalf of Citizen Action.

<sup>22</sup> NMED, "Notice of Intent to Issue a Draft Order to Sandia National Laboratories, EPA 5890110518, 9/2/2002

<sup>23</sup> NMED, "Response to Citizen Action's Comments on Sandia National Laboratories' Mixed Waste Landfill Corrective Measures Study Work Plan", EPA 5890000518-1, p. 21.

failed to review and address Dr. Nuttall's paper. *We request that this paper be reviewed and responded to.*

2) The Kennett report claims that the waste generated from the oxide reactor fuels experiments cannot be classified as HWL as the "short duration of the irradiation in the ACRR did not change the U/Pu inventory in either spent or fresh fuels". *We would like Sandia/DOE to provide more information about the previous history of the fuels that were sent to SNL, such as the temperatures they were exposed to.* This information is necessary to justify the assumption in the Kennett report that the fuels are not HLW.

3) One of the FOIA documents<sup>24</sup> states that, in addition to the 4 canisters the Kennett report mentions, "additional cans were disposed of at the landfill....all the spent cans were hastily disposed of....there are no doubt additional cans in the landfill, but their location is unknown." *We would like this to be taken into account by Sandia/DOE. Since this document is strong evidence that there is HLW buried in the MWL, we would like the CMS modified so that it complies with federal regulations to have HLW removed and stored in a secure repository.*

#### **4.0 Deficiencies of CMS and Risk Assessment**

As discussed above, many of the deficiencies of the CMS and its Risk Assessment cannot be redressed without full disclosure of the contents of the classified section of the MWL. The uncertainty in the landfill inventory is a severe handicap on any attempt to assess the risk it presents, forcing the authors of the CMS to rely on assumptions and guesses of how dangerous the contents might be to human health and the environment. The uncertainty about the current situation at the MWL is increased by problems with how environmental data at the MWL have been collected and interpreted.

The other major faults in the CMS and Risk Assessment are caused by a failure to consider sufficiently long-term scenarios. The report simply does not extend its consideration of possible dangers over the lifetime of the waste. The longer hazardous substances will take to decay, the greater the possibility that one of the several potential exposure pathways described below will lead to human harm. It is primarily because of this fact that we have found the CMS to be insufficiently thorough in its evaluation of risks to human health and the environment.

Over these time periods it is also increasingly likely that regulatory climates will change, and institutional controls may not be maintained or may be enforced less stringently. Specifically, it is impossible to ensure that people will be prevented from moving onto the site and living there, particularly considering its proximity to a major urban center. Therefore the CMS should fully consider a residential scenario in all risk assessments, including evaluation of all contaminants present.

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<sup>24</sup> FOIA document #22, Feb. 20, 1997. Memo from Jerry Peace/MS-1148 to Mark Jackson, MS-0184 DOE/KAO and John Gould, MS-0184 DOE/KAO. Subject: MWL Classified Area Pit Contents.

There are also technical faults in the Risk Assessment of the CMS, primarily involving improper use of the RESRAD computer code in evaluating potential doses to workers and the public. Although the RESRAD program is a powerful tool for estimating risk from residual radioactive contamination, its use is limited to specific, residential exposure scenarios, and the inputs and parameters must be set correctly for its results to be useful.

#### 4.1 Inappropriate Use of Streamlined CMS Methods

The Mixed Waste Landfill Corrective Measures Study (CMS) put forward by Sandia National Laboratories and the Department of Energy is based on a misguided approach to radioactive waste management and contains conclusions that are misleading and/or incorrect. It is our opinion that the streamlined Corrective Measures approach is not an appropriate way to deal with the Mixed Waste Landfill, which is in fact closed and should be required to comply with closure regulations and not merely the interim groundwater standards required for Corrective Measures. But even within the Corrective Measures framework, this CMS is faulty. It fails to accurately assess the long-term implications of the landfill in terms of both cost and risk. By choosing a solution that only reduces risks in the short term, and provides a barrier to excavation, this alternative may make long-term solutions more difficult and costly. By following the CMS recommendations, we may waste a substantial amount of public money and put public health and lives at risk:

“ ‘Low-risk’ facilities where environmental problems are relatively small, and where releases present minimal exposure concerns

High-quality remedies proposed by the Permittee that are highly protective and consistent with remedial objectives

Facilities with straightforward remedial solutions that have proven effective in similar situations

Phased remedies where the nature of the environmental problem dictates development of a remedy in phases with follow-up studies as appropriate to deal with remaining remedial needs at the facility.<sup>25</sup> ”

It is our opinion that the first condition does not apply to the Mixed Waste Landfill (MWL). Although releases of radioactivity to the environment may be minimal at the present time, the extremely long hazardous lives of these materials make it unlikely that releases will never occur. It is impossible to assure that these releases, when they do occur, will present “minimal exposure concerns”. The expense of cleaning an aquifer once material escapes is prohibitive. If significant levels of contamination were to reach groundwater the populace relying on it would be left without a safe water source in an arid area with growing water shortages. This would be a severe blow to the economy of the surrounding region.

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<sup>25</sup> CMS study, p. 16

The MWL is on the southern edge of Albuquerque, a growing city. Figure 1 shows the City of Albuquerque Chamber of Commerce's projections for city development. The MWL is directly south of an area designated "semi-urban" and east of a "major transit center" and a "proposed major activity center". It is 5 miles away from the Albuquerque International Sunport (airport) and approximately two miles from the Journal Ampitheater, a 20,000 seat concert venue. Levels of radioactivity at certain areas of the landfill are high enough to cause significant harm to an individual even if the exposure time were short. If the waste were to be disturbed by digging, erosion, or geologic instability, this harm would be even greater. There would also be a risk that the waste would migrate off of the site and expose nearby residents to radiation.

Presently the Department of Energy oversees the site and prevents residents from accessing it, but it is impossible to predict whether effective administrative control will continue for the thousands of years for which the waste will continue to be hazardous. It is also impossible to predict how well administrative control will be able to protect the site from accidents: a wayward plane landing, misguided digging, inquisitive children, etc. The area also may not remain geologically stable, which we will discuss below. Over the thousands of years that must be considered, the probability of an accident or natural disaster is high. If the public were to be exposed to the waste at the landfill, the consequences could be high. Therefore the facility should not be considered "low-risk", or that release of this waste to the environment present "minimal exposure concerns."

In addition to not being a "low-risk facility", the MWL does not present any of the other situations for which a streamlined CMS is appropriate. The remedies presented by the Permittee (in this case, the US Department of Energy) are not "high-quality" or "highly protective" considering the nature of the waste. The only alternatives that may meet these conditions, those that require excavation of the waste, were not favored by the CMS. The solution to the waste problem at the MWL is not "straightforward" as SNL states in the CMS, nor have any of the proposed remedies "proven effective in similar situations". It would be impossible to claim that any radioactive waste disposal has proven effective, as such proof would require thousands of years of study. To the contrary, all radioactive waste management practices are highly unproven and inherently risky. There is no "proven" method for disposing of this waste that has no chance of harm to workers or the public. Finally, there is no reason for a "phased remedy" of the MWL. To the contrary, any temporary measures that are enacted to cover over the waste may make a future excavation more difficult, costly, and risky. Although the radioactivity of the waste will decrease over time, the overall danger will likely not disappear during our lifetimes and the best use of public resources would be to implement the final remedy as soon as possible to avoid prolonging risk and escalating expense.

*Sandia/DOE should address these issues, and either explain how the facility can be considered "low-risk" with a "straightforward", "proven" solution in a long-term scenario despite the concerns presented above, or assess the site in a more detailed way than is provided for in the streamlined CMS methodology.*

#### 4.2 Data Sampling and Interpretation Problems

We are concerned with the methodology that was used in the Phase 2 report for soil sampling. (Most of the COC contaminant concentrations given in the CMS seem to have come from reports preceding the Phase 2 RFI, however, the CMS primarily describes the Phase 2 RFI as the source of data on soil contamination.) The samples taken do not adequately characterize the soil underneath the MWL. The samples were taken from boreholes drilled outside the MWL at an angle sloping underneath the waste disposal pits. However, the boreholes would not have reached the ground underneath the nearest pit until a depth below ground surface of about 40 feet. They would have been considerably deeper before they reached the center of the MWL. The waste buried in the landfill was not uniform, and there is no reason to assume that samples taken at its edge represent the levels of contamination in the middle. Thus it is particularly problematic that soil samples were used to determine COC's instead of the landfill inventory. In addition to the fact that additional contaminants could leak from the landfill at any time, significant levels of hazardous chemicals could have already leaked from the center of the landfill without having been detected.

Further, we are concerned that there has been no extensive vegetation sampling program in the CMS vicinity that we are aware of, nor has there been any sampling program to determine the extent of biological transport of contaminants through plants and soil fauna. (See section 4.4b for details on the potential dangers of biological transport.) A report by Tom Hakonson, a specialist in Radioecology, concluded "It is my opinion that the soil sampling done by SNL/NM in 1990 as a part of the Phase 2RFI provides little information that can be used to answer questions about the effects of biointrusion in transporting MWL contaminants to the soil surface."<sup>26</sup>

Many of the conclusions in the CMS are supported by data that has been selectively altered in order to make the contamination problem seem less dire. The Phase 2 RFI report dismisses as laboratory mistakes several soil measurements that show high concentrations of radioactivity, the measurements showing extremely low concentrations were not similarly dismissed.<sup>27</sup> (This was also an issue with the groundwater testing in the same report as discussed above.) The report claims that the laboratories performing the radioactivity analysis were new to the laboratory protocols and did not produce accurate results. In several cases, samples showing high levels of radionuclides were retested and showed lower levels, although the samples initially showing low levels generally were not checked to see if retesting would show higher levels. In our opinion, it is inappropriate to selectively discard data points because of claims of laboratory error. If these measurements were a result of laboratory error, then all of the laboratory radiological testing is called into doubt. It is irresponsible to present a risk assessment based on unreliable data. If the DOE believed that their soil testing methods were unreliable, they should not have claimed to be able to evaluate risk until they retested the soil.

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<sup>26</sup> Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill by Tom Hakonson, Ph.D., Environmental Evaluation Services, LLC. p.9

<sup>27</sup> Phase 2 RFI report, p. 4-144



In addition, although the CMS study assumes that no radiological contamination has reached the aquifer, this assumption is debatable. Sandia data showed that ten organic compounds and three organic analytes were measured above background in groundwater.<sup>28</sup> Prof. Mark Baskaran, a geologist who reviewed Sandia's measurements, has convincingly shown that uranium with isotopic proportions unlike those of natural uranium has reached groundwater.<sup>29</sup> SNL's own data in the Phase 2 report show above-background concentrations of uranium, strontium-90, thorium-228, Th-230, and Th-232, and tritium.<sup>30</sup> Each time high levels of radionuclides were found, the report labeled them as "suspect", "questionable", or "anomalous". In some of these cases it may be true that there were laboratory errors, but is nonetheless irresponsible to selectively delete data points for this reason. It is also unclear whether the samples tested were filtered or unfiltered—filtered samples could have excluded contaminants present as suspended particulates.

Even if the concentrations in groundwater are still within safe drinking water levels, radionuclide concentrations elevated above background could indicate that further infiltration into the aquifer is likely. The CMS completely denies the possibility that radionuclides from the MWL could reach groundwater, and it does not analyze the risk this might present.

*In our opinion the soil and groundwater sampling that has been completed at the MWL is not adequate for assessment of contaminant release to the environment. Sandia/DOE should complete more rigorous testing with reliable laboratory analysis. The risk assessment must also account for the possibility of environmental releases that cannot be detected by borehole and groundwater sampling as well as the possibility of future environmental releases from the landfill.*

#### 4.3 Lack of Long-Term Assessments

The CMS is intended to determine the final actions that must be taken at the MWL before a post-closure permit can be issued. The DOE intends to present a Post-Closure Care Plan in 2004.<sup>31</sup> The CMS thus must allow a post-closure plan to be implemented—i.e., it must allow long-term environmental protection to occur. Short-term solutions should not prevent long-term solutions from being implemented. According to the Code of Federal Regulations, corrective actions "must be initiated and completed within a reasonable

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<sup>28</sup> Sandia National Laboratories, *Environmental Restoration Project DOE/SNL/NM Responses to NMED October 30 1998, NOD for "Report of Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, NM, US Department of Energy, Attachment 9, June 10, 1999 (update)*, p. 21.

<sup>29</sup> Baskaran, M., *Mixed Waste Landfill Review*, Department of Geology, Wayne State University, Detroit, MI 48202, July 5, 2000. Sandia dismisses these measurements as false positives.

<sup>30</sup> Sandia National Laboratories, *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation*. September, 1996., p. 5.55-56

<sup>31</sup> CMS study, p. 16

period of time considering the extent of contamination” (40 CFR 264.100e3). Another requirement is that the Corrective Action Plan “minimize the need for further maintenance” (40 CFR 265.111a). In order for these requirements to be met, the CMS needs to consider the environmental implications of the MWL over a time span of thousands or tens of thousands of years. In some cases an interim or phased solution may be necessary, but the role of these short term measures must be considered in a long-term context, and such measures should not hinder a long-term solution

However, the methodology of this CMS made long-term analysis difficult. Its risk assessment is based on present-day conditions only, denying the possibility that the leakage of waste that has occurred since 1959 might continue over the next several thousand years. The risk assessment was based on soil measurements presented in other documents, including the 1996 Phase 2 RFI. Except for tritium, which was measured onsite by an outside consultant, the COCs were determined by drilling several boreholes and testing soil for radiological and non-radiological contaminants. All of the boreholes were located around the perimeter of the landfill, sloping underground towards the soil under the buried waste.<sup>32</sup> The results found in the Phase 2 study are referenced as the source of the contaminant soil concentrations given in the CMS. Since Sandia/DOE alleges that no radiological contaminants other than tritium were measured in these boreholes, the concentrations of radiological contaminants measured in surface soil during facility closure were used for plutonium and uranium isotopes.<sup>33</sup>

It is unscientific to claim that further releases from the MWL are impossible, without additional and convincing analysis. The fact that some of the buried radioactivity has already leaked into the soil, despite the fact that only a very small proportion of the waste’s hazardous lifespan has passed, is proof that significant additional releases may occur in the future. Wastes in the MWL were buried in a variety of forms—some in metal containers, polyethylene bags, fiberboard drums, wooden crates, and cardboard boxes.<sup>34</sup> Obviously these containers will continue to degrade and additional radionuclides may be released into the soil. Considering the very long-lived nature of the radioactive contamination, it is likely that most of it will outlive the containers it was buried in and will eventually make its way into soil.

The Phase 2 report and the CMS make no attempt to predict what might leak out of the landfill in the future, despite the fact that many of the contents of the disposal pits are known. Nor do the reports attempt to assess what risk these future releases would present to the environment and the public. The CMS admits that its risk assessment “does not consider risk posed by organic, inorganic, or radiological constituents present in the MWL inventory that have not been released into the environment”.<sup>35</sup>

In effect, the risk assessment only analyzes the risk presented by the soil lying under the landfill today, not by the landfill itself. It completely ignores the enormous pile of

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<sup>32</sup> Phase 2 RFI Report p. 4-87

<sup>33</sup> CMS, p. I-11

<sup>34</sup> CMS, p. 18

<sup>35</sup> CMS, p. I-11

leaking radioactive waste, poorly characterized, buried in unlined pits, which lies above the soil that was tested. This is despite the fact that, according to data presented in the Phase 2 RFI report, plumes of tritium and volatile organic compounds around the landfill are spreading.<sup>36</sup> It is our opinion that this issue alone is sufficient to declare the CMS deficient. Since the risk assessment in the Phase 2 RFI has been withdrawn, there is no baseline risk assessment of the site as well as no risk assessment of the various corrective measures alternatives. ***It is essential that Sandia/DOE redo the risk assessment with the inclusion of all radionuclides known to be present at the site and a conservative estimate of their concentrations in the landfill itself.*** Otherwise there is no way to judge what risk is currently posed by the site or how much that risk may be remediated by corrective actions.

#### **4.4 Neglected Pathways and Dangers**

In addition to ignoring the majority of contaminants present at the MWL, the CMS neglects several potential pathways through which the public could be exposed to these contaminants. The list of pathways that must be considered depends on the hazardous lifetimes of the specific contaminants in the landfill. Since a complete inventory of the classified area is still missing, some of these contaminants may still be unidentified.

##### 4.4a Groundwater

We agree with Sandia/DOE's assessment that tritium contamination of the aquifer is not a serious concern, because even if the landfill's tritiated water were to slowly percolate into the groundwater, by the time it were to reach the aquifer in significant quantities it would no longer be highly radioactive. However, a greater concern is that percolating water, organic compounds, or other liquids will carry with them more hazardous and long-lived radionuclides that have the potential to render the aquifer unusable.

According to the CMS, "because depth to groundwater at the MWL makes groundwater an unlikely pathway for contaminant transport in the future, groundwater data are not evaluated in this risk assessment."<sup>37</sup> It is not the purpose of a risk assessment to tell us a pathway is "unlikely" and neglect it—the risk assessment should determine how likely or unlikely harm through this pathway is, and the extent of public health damage that is theoretically possible were the pathway to be an issue. The determination that groundwater does not need to be considered seems to be based on calculations in the Phase 2 report, which are purported to show that, under current climatic conditions, the contaminants in the MWL will never reach groundwater.

However, the modeling in the Phase 2 report is less than conclusive. For one, there is essentially no modeling of tritium. Two models are presented, one of which predicts that the EPA Drinking Water Standard will be exceeded in 2024, and one which predicts that levels could be even higher. Since both of these models would also predict present-day

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<sup>36</sup> Phase 2 RFI report figures 4.4-2 and 4.4-3 and pp. 4.58

<sup>37</sup> CMS, p. I-3

concentrations thousands of times higher than those measured, the models are discounted, but no alternatives are presented.

The models also do not seem to consider the effect that chemical form and contaminant mixing in soil might have on contaminant transport rates. The presence of both VOC's and water will influence how deep each will migrate in the aqueous phase, but they seem to have been modeled as if they were inhabiting different blocks of soil. The influence that VOC's would have on the solubility of radionuclides was not discussed. The differences in solubility of various radionuclides, depending on their chemical form and the chemical environment of surrounding soil, was also not discussed. Based on the fact that the report states that radionuclides are not expected to migrate far based on their "low initial activity and low mobility", we assume that less soluble radionuclides were modeled. Since there is no complete inventory of the MWL, and no way to predict how chemical mixing within pits might affect radionuclide mobility, it would be more appropriate to model the most soluble radionuclide forms.

However, the greatest problem with the modeling is that the Phase 2 RFI is misleading about the disposal of liquids at the landfill and the extent to which contamination has reached groundwater. It states: "Disposal of free liquids was not allowed at the MWL",<sup>38</sup> although it admits that in 1967 271,000 gallons of reactor coolant water were dumped in Trench D in 1967. In fact, the prohibition against free liquid disposal was not put into effect until 1975, fifteen years after the landfill opened.<sup>39</sup> A Sandia memo obtained through a FOIA (Freedom of Information Act) request by Citizen Action revealed that 12,556,970 gallons and 6,586,000 gallons of reactor cooling water were released in Technical Areas 3 and 5, respectively, in the time period 1963-1971. These waters contained a total activity of 35 curies.<sup>40</sup> The Mixed Waste Landfill is within Technical Area 3, which also contains the Chemical Waste Landfill, about 1.5 km from the MWL. Technical Area 5 covers a very small area at the northeast corner of Technical Area 5; its edge is only about 800 feet from the edge of the MWL. In addition to this large water volume, other FOIA documents recently received by Citizen Action reveal that it was not until 1975 that SNL required liquid wastes to be solidified before being placed in the MWL.<sup>41</sup>

The models used in the Phase 2 RFI are based on the disposal of 271,000 gallons of liquids, not 19,142,970 gallons. Therefore it is impossible to say from these models that contaminants will not reach groundwater.

It is our opinion that potential groundwater contamination is still a concern. Radionuclides from other dry landfill sites have reached aquifers deep beneath. Tritium at the Beatty, Nevada landfill, with a hydrologic setting similar to the MWL, has reached the aquifer, 357 feet below the surface, and has also moved off-site, within a 35-year

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<sup>38</sup> Mixed Waste Landfill Corrective Measures Study, p. 18

<sup>39</sup> ER Program/Site Health and Safety Plan, 1992 (FOIA 115, 116).

<sup>40</sup> Memo from M Goodrich to A Parsons, Sept 13, 1989. FOIA document #114

<sup>41</sup> SNL Project Document Plan 92-24, Site Health and Safety Plan Form.

period<sup>42</sup>. While some water was buried with the radioactive waste (700,000 gallons), by far the greatest amount (37 million gallons of rainfall) infiltrated the site from precipitation. This is despite the fact that this site receives only 6 inches of precipitation annually, compared with 9.3 inches annual precipitation in the Albuquerque area.<sup>43</sup> The finding of contamination in the groundwater surprised USGS scientists, who had predicted, based on scientific models, that contamination would not occur. Scientist Dr. Howard Wilshire, who worked for the USGS before being fired for publicly doubting the modeling, explained that “preferential pathways” within the unsaturated layer allow water to flow down specific channels much faster than it would percolate through the surface as a whole.<sup>44</sup> The Beatty example shows that we simply cannot assume that contamination at the MWL will not reach groundwater.

In addition to the Beatty example, there is clear evidence of groundwater contamination at other SNL locations not far from the MWL. These are disturbing both because they further prove that groundwater contamination should be considered a concern for the MWL, and because the plumes emanating from these sites might effect contaminant transport in the vadose zone below the MWL. TCE contamination in groundwater has been found at the Chemical Waste Landfill, within Technical Area 3, about 1.5 km from the MWL.<sup>45</sup> TCE contamination has also been found at Technical Area 5, about 800 feet from the MWL, as 3-4 times the MCL. It is believed that the TCE migrated to groundwater in the aqueous phase.<sup>46</sup> In the Sandia North area, covering Technical Areas 1 and 2, TCE and nitrate contamination has been measured in both deep and shallow wells. The deep wells, measuring the main aquifer (lying above another shallow aquifer in this location,) correspond to a depth of about 500 feet. TCE in one of these wells has been found to be 5 times the Maximum Concentration Limit (MCL) of 5 g/L.<sup>47</sup> The near edge of this area is 4.7 km from the MWL. Thus groundwater at the MWL, and therefore the vadose zone above it, are surrounded by plumes of TCE contamination on all sides. It is not known how these plumes might interact with possible present-day or future plumes of radioactive contamination below the MWL. TCE is a solvent and might accelerate contaminant migration into groundwater. In any case, it is clear that even the arid Albuquerque region is not immune to groundwater contamination.

The CMS states “Contaminants are unlikely to reach groundwater due to negligible recharge, high evapotranspiration, and an extensive vadose zone composed of alluvial soils with low hydraulic conductivities.”<sup>48</sup> All of these factors were equal or similar at the areas described above, yet groundwater contamination did occur there. Preferential flow pathways may account for the contamination described above. Another explanation could be the effect of torrential rainstorms. It is possible that groundwater recharge is not

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42 Contamination at the Beatty, Nevada, Radioactive Waste Disposal Facility. Committee to Bridge the Gap, Los Angeles, CA, 1996, p.5

43 [www.city-data.com](http://www.city-data.com)

44 Committee to Bridge the Gap.

45 *ibid*, p. 4-36

46 *ibid*

47 Final SNL/NM Site-Wide Environmental Impact Statement, Volume 1, October, 1999. DOE/EIS-0281. p.4-34

48 CMS, p. 29

negligible, but only seems so from the low average precipitation rates that mask the effect of fierce, all-at-once rainstorms. The 1999 SNL Site-Wide Environmental Impact Statement points out that “local groundwater recharge is associated primarily with infiltration of arroyo water during short-term storm events.”<sup>49</sup> In addition, considering only annual average precipitation rates is particularly inappropriate considering that winter precipitation in the form of snow will infiltrate the soil all at once during thaws. At this time, remaining snow cover and cool temperatures will greatly limit evapotranspiration, and so the snowmelt will infiltrate far into the soil. According to [www.city-data.com](http://www.city-data.com), Albuquerque receives an average of 11 inches of snowfall a year. The effects of rainstorms and snow on infiltration of precipitation into the vadose zone is totally ignored by the modeling done in the Phase 2 RFI.

*Sandia/DOE should carefully consider the Beatty experience, the possibility of preferential flow pathways, the potential effect of storm events, and the 19 million gallons of water dumped at or near the MWL and re-evaluate the risk to human health through the groundwater pathway.*

#### 4.4b Other Neglected Pathways

The risk assessment only considers contaminants present in the upper five feet of soil as presenting a risk to the public. Non-radiological contaminants measured at the site at lower depths are excluded from the analysis. Because most of the corrective measures alternatives presented involve adding soil to the landfill, even some of the contaminants which are currently present in the upper five feet of soil are excluded from every risk assessment except NFA with no IC's. Essentially, the CMS denies the possibility that, at any time over the next thousand years, erosion could occur that would expose the contaminants. Also, although the CMS discusses the role of capillary action in arid soil causing upward migration of contaminants away from groundwater,<sup>50</sup> it does not discuss the possibility that this effect could cause soluble contaminants to move upward into the upper soil layers or to the surface. However, it is clear from the tritium flux at the landfill that significant evaporation of the landfill's contents is occurring.<sup>51</sup> High levels of evaporation at the surface may pull tiny columns of water up through the sandy soil, and any contaminants dissolved in this water will also move upwards. Over the course of such a long time period this could cause significant surface contamination, yet the pathway was not even considered in the CMS.

The risk assessment also does not consider any risk posed by biological factors, including the activities of soil organisms and micro-organisms. Although it does contain an ecological assessment, this assessment only considers **risk to** two species, the deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*). It does not consider risks to human health **posed by** animals and ecological processes. It specifically

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<sup>49</sup> Site-Wide EIS, p. 4-36

<sup>50</sup> CMS study p. I-25

<sup>51</sup> Phase 2 RFI report, p. 4.36-37

does not consider the potential impacts of insect or vertebrate soil fauna, which could transport wastes off-site or up to the soil from the surface. Although there is very little known about the effects of soil fauna on radionuclide transport, recent research indicates that they may be the dominant form of contaminant migration in certain situations.<sup>52</sup> Although the soil at Sandia MWL may be arid and unlikely to support earthworms, it undoubtedly contains native soil fauna that may ingest radionuclide-contaminated soil or other micro-organisms that absorb the contaminants from soils. Although there may not be enough research to accurately predict the effect this may have on contaminant transport at the MWL, it is irresponsible of Sandia/DOE to completely neglect the danger. Considering the long life of the radionuclides, even a slow rate of upward transport by soil fauna could bring contamination to the surface regardless of the volume of soil piled on the landfill. The CMS study also claims that institutional control will prevent access of larger animals to the wastes, although it does not specify how this is to be accomplished. The intrusion of burrowing animals will be impossible to prevent if a soil cover is the only barrier, and even a plastic or gravel layer may not be adequate if the wastes can still be reached from below or from the side.

These issues were explored more fully in a report by Tom Hakonson, Ph.D.<sup>53</sup> According to his report, "The fact that tritium currently emanates from the surface of the Mixed Waste Landfill is most certainly related in large degree to the presence of burrowing animals and vegetation present on the landfill surface and the effects these organisms have on soil moisture status and soil porosity." He also explains that even grass may send roots several meters down into soil. These roots can then absorb radionuclides, metals, and organic contaminants and transport them into the plant body above ground. When the plant dies or the leaves senesce, the contaminants will then be present on the soil surface. In fact, FOIA documents show that elevated levels of tritium have been found in vegetation up to 5 km away from the MWL.<sup>54</sup> As far as we know this fact has never been addressed by SNL/DOE.

A final, and serious, exclusion of the CMS is the lack of discussion of potential geologic instability in the area. Any claim of even relative safety of the MWL is based on the assumption that the area is stable, and that, barring human intrusion, the waste will never be disturbed. However, there is significant cause for concern that the entire Albuquerque area is vulnerable to subsidence, a gradual or sudden ground sinking caused by the draining of the underlying aquifer.<sup>55</sup> This has already presented problems in the similar arid region of Southwestern Arizona. Uneven land sinking creates fissures in the land that can become large through subsequent erosion. In other areas, these fissures have

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<sup>52</sup> Bunnenberg and Taeshner, 2000. Soil Fauna Transport Versus Radionuclide Migration. *Radiation Protection Dosimetry*. Vol. 92(1-3): pp. 35-38

<sup>53</sup> Hakonson, 2002. Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill. Available on the Citizen Action website at <http://www.radfreenm.org/pages/indie-review.htm>, accessed March 2004

<sup>54</sup> FOIA document 112, Interview with Donna Hartzel to "G.L., 1989. As cited on Citizen Action website at <http://www.radfreenm.org/pages/whatwhen.htm>, accessed March 2004.

<sup>55</sup> Sean D. Connell, "Geology, Groundwater, and Geologic Hazards in the Albuquerque Basin, New Mexico. American Geological Institute Publications. Accessed online at [www.agiweb.org/environment/publications/mapping/graphics/newmexico.pdf](http://www.agiweb.org/environment/publications/mapping/graphics/newmexico.pdf), February 2004.

damaged “buildings, roads and highways, railroads, flood-control structures, and sewer lines”.<sup>56</sup> The possibility that one of these fissures could develop at the MWL exposing the waste to the air is real and should have been discussed in the CMS. Again, considering the long life-span of the waste, and assuming that current water-use patterns continue, it is unrealistic to assume that the geologic stability of the area will not be greatly affected by aquifer drainage.

The possibility of major earthquakes in the Albuquerque area is also far from remote. The Tijeras, Coyote, Hubbell Springs, Manzano, Sandia, and West Sandia faults run through Kaufmann Air Force Base, where the SNL technical areas are located.<sup>57</sup> The USGS considers that the Albuquerque area is a relatively high-risk earthquake zone, with a 10% chance of having a major earthquake, powerful enough to damage buildings, in the next 50 years.<sup>58</sup> (See Figure 2.) Minor damage to Albuquerque buildings from earthquakes occurred in 1931, 1954, 1970, and 1971.<sup>59</sup> It is impossible to know if the next “big one” will be in ten thousand years or this year. Even a relatively minor earthquake could alter groundwater and surface water flow, changing the rate of contaminant migration. It could also damage the containers that hold wastes in the landfill, causing a sudden release of large quantities of radiation. If highly dangerous wastes are stored on site, storage warehouses could be damaged in a quake. In a worst-case scenario, an earthquake might expose wastes to the air, where dusts could be stirred up by the wind and cause harm to local residents. In any case, an earthquake of any size could disturb the wastes and increase the rate of transport through water and/or soil.

The likelihood that any of these omitted pathways and possibilities will lead to serious public health effects may be slight when they are considered individually and over the short term. However, when they are considered together, and when the long lifespan of the waste is taken into account, it begins to be apparent that these gaps in the CMS risk assessment may be significant. Although there is no guarantee that one of these pathways would prove to be important, there is also no guarantee that they would not. A risk assessment should be a tool for the protection of public health, and as such should be as conservative as possible. It is our opinion that the risk assessment of the CMS is too incomplete to be considered a valid analysis of the potential harm posed by the MWL and is also not a reasonable basis for consideration of alternatives. *Sandia/DOE should include these neglected pathways in an expanded risk assessment and re-evaluate the uncertainty associated with each of the CMS alternatives.*

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<sup>56</sup> United States Geological Survey, United States Department of the Interior. “Land Subsidence in the United States”. Circular number 1182. Devin Galloway et al., editors. 1999.

<sup>57</sup> Site-Wide EIS, figure 4.5-5

<sup>58</sup> United States Geological Survey, Probabilistic Hazard Lookup by Zipcode, 1996.  
<http://eqint.cr.usgs.gov/eq/cgi-bin/zipcode.cgi>. Zipcode 87101

<sup>59</sup> USGS Earthquake Hazards Program, Earthquake History of New Mexico,  
[http://neic.usgs.gov/neis/states/new\\_mexico/new\\_mexico\\_history.html](http://neic.usgs.gov/neis/states/new_mexico/new_mexico_history.html), accessed March 2004



## **4.5 Risk Assessment Technical Issues**

### **4.5a Risk Assessments for Non-Excavation Alternatives**

In addition to the misguided approach and inappropriate exclusions of the risk assessment, there are several technical problems with the existing assessment and the sections of the Phase 2 RFI report that it is based on.

The risk assessments for all non-excavation alternatives omit contaminants that have not been detected in high levels in the upper five feet of soil. The risk assessment also ignores sources of high gamma readings. Sandia/DOE has failed to explain this omission despite the fact that it was noted in the NMED Notice of Deficiency. While the exclusion of contaminants that have not yet been measured in the environment, as discussed above, is already negligent, the additional exclusion of contaminants below five feet is simply scientifically indefensible. Excluded non-radiological contaminants include 2-Butanone, 2-Hexanone, 4-Methyl-2-pentanone, Benzoic acid, Chromium VI, n-Nitrosodiphenylamine, Phenol, Pyrene, Tetrachloroethene, Trichloroethene, and Xylenes.<sup>60</sup> A full list of radiological contaminants is listed in Appendix A; only uranium, plutonium, and tritium were evaluated in the risk assessment. In ignoring these contaminants, as well as the pits with high gamma readings in its risk assessment, Sandia/DOE is essentially not modeling the no further action alternative, or a site that presently exists.

There is a potential problem with the use of the computer program RESRAD for the risk evaluation. The CMS does not present the inputs used for this program, as is generally accepted practice for a professional report. Therefore it is completely impossible to fully evaluate the results reached using the program. The most important issue is that it is unclear what soil concentrations were used for the program. It would be inappropriate to use the concentrations measured in soil at the MWL because of the continual leaking of wastes from the landfill into this soil. Although RESRAD is designed to have soil radionuclide concentrations given as inputs, in this the majority of the contamination originates in the landfill, not in the soil below it. For proper, conservative use of the RESRAD program, the initial radionuclide concentrations **in the landfill itself** must be used, not the concentrations detected in soil. This would provide an extremely conservative, worst-case scenario, as RESRAD is not designed to model contaminant migration out of leaky containers, which would be slower than migration through soil. However, any other use of RESRAD would simply ignore the majority of the contamination. This is particularly true for the pits with high gamma readings. These are excluded in the risk assessment. That is, Sandia/DOE is modeling a burial ground that does not exist, unless Sandia provides a plan for removing these high gamma producing materials. It is obvious that the CMS did not use RESRAD properly, however, since any reasonable accounting of the radionuclide concentrations in the landfill would have led to

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<sup>60</sup> CMS, p. I.13-I.20

much higher potential doses than the CMS reports. The CMS appears to have again neglected the possibility of additional leakage in this section of the risk assessment, and so has severely underestimated the risks posed by the landfill.

The risk assessments for all non-excavation alternatives assume that there is very low uncertainty involved in these Corrective Actions.<sup>61</sup> In our opinion, this is a severe underestimate. In several cases we have considered, institutional controls have been lost in a short time period and waste facilities have been breached; unauthorized individuals have gained access to radioactive sites. Unless the “institutional controls” involved are equivalent to those of a high-security prison, we cannot be completely sure that unauthorized individuals, such as inquisitive children, will not be exposed to radioactivity at the site. With the increased risk of terrorism in our current political climate, it is particularly important to take into consideration the security of the site and the potential for the waste underneath the soil to be disturbed. Although the likelihood of this may be extremely low, the consequences would be so devastating that the insecurity of the site should certainly be taken into account in the risk assessment. There is also the possibility that institutional controls may be removed or weakened. There is no way to ensure that, one hundred years from now, politicians will understand the hazardous waste problem enough to ensure that such waste sites are adequately funded. Given a recession, war, or change in political climate, funding for environmental protection could be weakened such that the adequacy of institutional controls at the site is threatened. As a recent example, DOE’s Inspector General reported on March 16 of this year that nuclear weapons plant have eliminated or reduced training for guards responsible for repelling terrorist attacks, according to the AP.<sup>62</sup> As we move further away from cold war days when the production of nuclear weapons was so important, the impetus for funding burial ground oversight will further decline.

Although these scenarios may seem much less likely than potential accidents in other remediation alternatives, such as exhuming the waste, one must take into account the extremely long time period involved. Although the CMS only accounted for the next one hundred years of site management (and only used 30 years for cost estimates), the actual radioactive lifetime of much of this waste is several hundreds of years. Thus, the possibility for accident or oversight happening at least once over this time period is significant. This is particularly true for a residential scenario, which must be considered given the impossibility of ensuring that institutional controls will outlast the waste. A particularly dangerous possibility under a residential scenario would be drilling a well—if there is depleted uranium present at the MWL, it might ignite from drilling, releasing extremely hazardous fumes from burning waste. *Given these concerns, in our opinion the uncertainty of all non-excavation alternatives should be considered “medium” or “high” and the risk assessments altered accordingly. The exclusion of COC’s and the improper use of the RESRAD program also must be corrected in the CMS risk assessment.*

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<sup>61</sup> CMS, p. I-49

<sup>62</sup> “Training for nuclear plant guards reduced,” Associated Press, March 16, 2004.

#### 4.5b Risk Assessment for Excavation Alternatives

The CMS used RESRAD to evaluate risk to workers during excavation. This is an inappropriate use of the RESRAD program, which was developed to evaluate risk to future residents of a contaminated site and not evaluate risk to workers during excavation. Risk assessment details are only presented for the Complete Excavation with Off-Site Disposal Alternative. Since the details presented for this alternative in appendix J-2 of the CMS are consistent with the summary risk assessment description for Future Excavation in appendix I<sup>63</sup>, we assume that a similar methodology was used for both alternatives.

The risk assessment presented has little to do with a realistic excavation scenario. It is actually an assessment of risk to a resident who has moved onto the site after all cover has been removed from the disposal pits and trenches and all shielding material (containers, casks) have been stripped from the waste. It is based on an inventory of about 5,800 Ci of waste, which, based on the claim on pg. 9 of the CMS that the total inventory was 6,300 Ci at the time of disposal, probably represents Sandia's estimate of the total amount of radioactivity currently present at the MWL. The risk assessment does not take into account the fact that the potential for worker exposure would be reduced using machinery, protective clothing and masks, and special remediation technology. It does not consider that the pits and trenches would not be uncovered all at once. Again, this is a risk assessment for an individual living on top of the uncovered waste, not for a worker. This is exactly the type of risk assessment that should have been included, but was not, for "containment" scenarios, because of the possibility of IC loss and cover erosion. It is a farce to claim that this is a reasonable risk assessment for worker exposures. Because of the sophistication of contemporary remediation technology, actual risks to workers would be much lower. This type of waste is routinely handled at other sites, such as the Barnwell LLW site, without exposure of workers to high doses of radiation.

*Sandia/DOE must provide a realistic risk assessment for the excavation alternatives, taking into account the methodology and equipment that would most likely be used for each alternative.*

#### 4.6 Cost Analysis

The CMS cost evaluations are biased toward low cost alternatives. They contain some major omissions that have resulted in an artificially low cost. E.g., they only evaluate cost for 30 years of monitoring, although the report claims that IC's can be maintained for 100 years (and would be necessary for much longer than that). The CMS claimed that costs could not be evaluated for longer than that based on the limitations of the RACER program they used to calculate escalation factors. However, the escalation factors they give for the years 2007-2040 fit well to a simple logarithmic model ( $y = 54.898 \ln(x) -$

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<sup>63</sup> CMS study, p. I-34

416.33;  $R^2 = 1$ )<sup>64</sup> which can roughly predict escalation factors for the long-term future. Based on this model, Sandia could have at least estimated the cost of maintaining the monitoring program until 2107. In our opinion, the cost estimates are biased, overestimating the costs of excavation alternatives while underestimating the long-term costs of non-excavation alternatives.

#### 4.6a Non-Excavation Alternatives

For the NFA with IC's alternative, the cost of implementing a vadose zone monitoring system in 2007 should have been included, as was included in the Vegetative Soil Cover alternative (\$158,922). The higher yearly monitoring cost for this alternative should have been used as well (\$42,079/yr instead of \$31,137/yr). We believe there is no way to justify including a less stringent monitoring system with a less protective remedial alternative. Also completely omitted from the NFA with IC's alternative cost assessment was the average yearly "operations and maintenance" cost, which was given as \$10,500 for the Vegetative Soil Cover. The NFA alternative may require even more maintenance because without a protective vegetation layer, the soil will quickly erode due to the effects of both wind and water and more will need to be added.

There are also severe problems with the cost estimate for the RCRA Subtitle C Cap. The direct cost of this alternative, as listed in Appendix D of the CMS report, is \$5,259,906. The total phase element cost as listed in Appendix C is \$1,634,340. The direct cost given in Table 3-2 is \$2,850,872. The extremely high cost as listed in Appendix D is likely due to the high yearly maintenance costs (\$40,563/yr-\$187,289/yr), while the low cost in Appendix C is due to the fact that only twelve months of monitoring and maintenance are included. It is not clear why the yearly maintenance is considered to be so much higher than for the vegetation cover or the bio-intrusion layer (yearly maintenance of \$10,500/yr and \$21,441/yr respectively), since the activities described are exactly the same for all alternatives: seeding, mulching, grading, erosion control, signage, and fencing. However, the monitoring and maintenance costs for this alternative, as for the NFA alternative, would continue indefinitely.

If public health is to be indefinitely protected from the waste at MWL, monitoring and maintenance for each of the "containment" alternatives will have to continue for thousands of years, not only for one hundred years. In addition, the costs for all of the non-excavation scenarios also exclude the costs of indefinite institutional controls themselves. The supervision of the site, including managing all monitoring/surveillance activities and the associated paperwork and administration, will add to the expenses of Sandia/DOE or whatever governmental body assumes responsibility for the site. The loss of revenue that could be gained from selling or leasing remediated property on the edge of a growing city should also be taken into account when comparing "containment" to excavation with off-site disposal options. The real costs of each of these alternatives are many times higher than those presented by the CMS. *We would like Sandia/DOE to correct the mistakes and exclusions in the cost assessments as described above.*

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<sup>64</sup> Microsoft Excel 2000 software

#### 4.6b Excavation Alternatives

The cost evaluation for the future excavation alternative is unreasonably high, as it includes excavation and on-site retrievable storage activities that will probably be unnecessary. It is not clear why various partial excavation alternatives are only assessed for an immediate excavation scenario, and not for a future excavation scenario. It makes no sense to dig up waste after it has already decayed into a harmless state.

Total cost for this alternative given in the final report (after responses to the NMED notice of deficiency) was about \$236 million. This includes \$169 million in transportation and disposal costs, including \$158 million in costs for shipping and disposing of 23,486 cubic yards of mixed waste at \$6,739 per cubic yard (as well as a \$5 million cost for shipping boxes which is mistakenly repeated in excavation costs discussed below). These costs can be compared to the costs listed for a partial excavation with off-site disposal scenario: about \$22 million for shipping and disposal of 32,147 cubic yards of low-level waste and \$18 million for 2,626 cubic yards of mixed waste. We fail to see how, under a future excavation scenario, more waste will require off-site disposal than under an immediate excavation scenario. It is unnecessary to dispose of all wastes off-site; only the most dangerous and long-lived wastes will require off-site disposal. Even if less hazardous wastes are disposed of off-site, as is shown for the partial excavation scenario, costs for their transportation and disposal are much lower. Thus, we think the shipping and disposal costs of the future excavation alternative will be closer to \$30 million than \$158 million, and the total transportation and disposal costs will be around \$36 million rather than \$169 million.

The \$236 million total cost for future excavation also includes \$48 million for excavation and characterization as shown in Appendix C, as well as about \$5 million for shipping boxes and \$5 million for loading the wastes into the shipping boxes. It also includes \$24,059,274 for a classified soil storage warehouse and a classified waste storage warehouse totaling 64,585 square yards. We are not sure why Sandia thinks it will be necessary to store so much waste in warehouses in addition to the large volume of waste being shipped offsite. Unless soil contamination is much more extensive than we have been led to believe, storage of such a large volume of soil (the soil storage warehouse is planned to be 53,100 yd<sup>2</sup> in area) would not be necessary. Storage of so much waste at once should also not be necessary: the landfill will be excavated in stages, and shipments offsite and replacement of less hazardous wastes into an onsite standard landfill should proceed continuously. As there are only approximately 11,000 **cubic** yards of waste in the MWL (although this does not include contaminated soils<sup>65</sup>), it is ridiculous to have 64,585 **square** yards of storage space.

Costs given for all immediate excavation alternatives are completely unreasonable. Most of the excess cost can be accounted for by the fact that waste characterization costs are given as \$1000/yd<sup>3</sup> for soils and \$10,000/yd<sup>3</sup> for debris, ten times as high as the costs for the future excavation alternative. Recent advances in on-site waste characterization

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<sup>65</sup> CMS, p. 9

technology may even reduce these costs below those cited for the future excavation alternative.<sup>66</sup> The off-site disposal alternative cost assessment also includes costs for warehouses capable of storing huge amounts of wastes, although only small storage areas would be needed to hold wastes before shipment. These alternatives also include the costs for off-site disposal of large amounts of wastes, although in all likelihood only a small proportion of the waste would require off-site disposal and the rest could be simply replaced or put in a conventional or RCRA-approved landfill onsite.

*Sandia/DOE should provide a reasonable estimate of the costs of excavation, including revised excavation methodology that would reduce costs.*

## **5.0 Assessment of CMS Alternatives**

The major problem with most of the alternatives presented in the CMS has already been noted: a failure to consider the long-term risks and costs and a failure to take into account the site as it exists today. Except for the alternatives involving excavation and off-site disposal of long-lived wastes, each “corrective measure” requires that monitoring and maintenance activities continue for thousands of years. In the cost estimations, only 30 years of monitoring and maintenance are included. Thus the majority of the costs of every alternative not requiring excavation has been essentially omitted, and the costs of the alternatives cannot be compared. Although the CMS makes it appear that the various excavation alternatives would be about one hundred to five hundred times more expensive than the alternatives without excavation, this is misleading. Any alternative that would have the longest-lived waste placed in a geological repository will allow society to avoid the costs of thousands of years of maintenance and monitoring. In addition, there are several unexplained omissions and assumptions in the cost estimations. We have taken cost and the mistakes in the CMS cost estimations into account in reviewing the alternatives presented in the CMS.

In our opinion, the preferred alternatives for the MWL are Future Excavation or the immediate removal of high-level or long-lived waste with the use of a containment cell for the remainder. The Future Excavation alternative limits the dangers of contaminant leakage to a finite period of time, after which the shorter-lived material will have decayed and the longer-lived material can be more safely and cheaply excavated. The most dangerous material should be disposed off-site in a geological repository, as is required by law for high-level waste. Unless significant leakage of this material occurs within the next fifty years, the remainder of the soil and waste at the landfill could be safely left on site. Fifty years from now, a portion of the waste will no longer be a threat to human health, as some of the radiological and non-radiological contaminants will have decayed (although some will remain hazardous indefinitely).

If Future Excavation is planned, then temporary measures should ensure that exposures and contaminant migration do not occur in the meantime. A temporary non-excavation

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<sup>66</sup> Kalb et al., Accelerated Site Technology Deployment Cost and Performance Report: Comparability of ISOCS Instrument In Radionuclide Characterization at Brookhaven National Laboratory. March, 2001. see particularly Table 6-4.

alternative not considered in the CMS would be constructing a temporary roof or building over the entire site. This would be an effective way to limit water infiltration onto the site over the short term. It would also prove less difficult for future excavation than the other “temporary” alternatives. Any addition of soil or materials onto the landfill, particularly a cap or bio-intrusion barrier, would only make it more difficult to reach the landfill’s contents when the time for excavation comes. In addition, covering the landfill will make it more difficult to determine the locations of the pits and trenches. If instead a structure were erected over the site, then it could be simply removed, revealing the site for excavation. Erecting a structure would also limit the temptation for regulators in the future to rescind promises for excavation by claiming that the site has been dealt with, as there is no way to claim that such a structure could be a permanent solution.

For our preferred version of the future excavation alternative, a vadose zone monitoring system should be implemented immediately with monitoring that would continue through 2039 or somewhat longer. In 2039, the landfill areas that are known or suspected to contain highly radioactive, long-lived waste would be excavated. This would require the full disclosure of the landfill contents as described above. The high-level waste would be transported to a geologic repository, and the remainder would be left on site.

Another preferred alternative is removal of high-level and long-lived waste model and on-site storage of low-level wastes is the Corrective Action Management Unit containment cell at place at the SNL chemical waste landfill.<sup>67</sup> The containment cell is lined to prevent water infiltration, and will be covered when the cell is filled. It has underlying access tubes five feet below the liner that allow real-time monitoring of potential leakage with a neutron probe. It also has vadose zone monitoring systems in place at 5 and 15 feet below the liner. Boreholes have been drilled up-gradient from the containment cell to monitor soil gases and moisture that might infiltrate the soil under the cell. The life-cycle cost of the entire CAMU, including facilities for storing bulk soils and containerized wastes and soil treatment facilities in addition to the containment cell, is projected to be approximately \$14 million. The containment cell is designed to hold 37,000 cubic yards of treated waste. Its cost can be compared to the \$24 million **initial** cost (not including future maintenance and monitoring costs) for classified waste storage warehouses given in the CMS (for 35,000 cubic yards of soil and waste). With lower waste storage construction costs and less waste transported offsite, our version of future excavation would be considerably cheaper than the future excavation alternative as presented in CMS.

The CMS concluded that its preferred alternative was a Vegetation Layer. However, in our opinion this is an inadequate permanent solution. There are many faults in how this alternative and all other non-excavation alternatives were assessed in the CMS. In our opinion, none of these alternatives is adequately protective of human health and the environment in the long term.

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<sup>67</sup> Michael J. Irwin and Lee A. Brouillard, “Real-Time Monitoring for Performance Assessment, Corrective Action Management Unit Containment Cell, Sandia National Laboratories, New Mexico”.

All of the “containment” alternatives rely on the maintenance of Institutional Controls (ICs). The CMS makes several claims for the effectiveness of ICs that are not substantiated in the text. There is an assumption made that the institutional controls will be 100% effective at preventing access to the site. However, there are no details given for the extent of security measures planned: number of long-term security personnel, type and extent of fencing, etc. The CMS also claims that ICs will prevent burrowing mammals from accessing the site, but does not explain how this is to be done. If animals have access to the site, then radioactive materials could make their way into the food chain, which would have major implications for the local ecology that are not discussed in the study. ICs are also not able to prevent further contaminant seepage into soil, as discussed earlier in this report.

The CMS found the No Further Action (NFA) with Institutional Controls (ICs) alternative to be the corrective measures alternative that “presents the overall lowest risk to human health and the environment while minimizing costs and meeting MWL corrective action objectives”. However, the Vegetative Soil Cover alternative, was determined to be the preferred alternative because it “offers additional protection against exposure to waste in landfill disposal cells, further minimizes infiltration of waters, and mitigates bio- and human- intrusion into buried waste without significant added cost in construction and long-term monitoring, surveillance and maintenance, and access controls.”

It is our opinion that, since institutional controls cannot be guaranteed to last as long as the waste, NFA with IC’s is not a viable alternative. It consists mainly of mounding dirt over the waste and monitoring groundwater. As soon as IC’s are removed—if the property is sold, the surveillance and maintenance become lax, or a future government cuts spending on environmental protection—the soil will simply erode away and expose the waste. In addition, even if IC’s were to be maintained, the cost of maintenance, surveillance, and monitoring over thousands of years would be astronomical. Vadose zone monitoring, which was included in the costs of the vegetative soil cover alternative but not of this alternative, would be necessary as well. By the time groundwater monitoring found contamination it would already be too late to do anything about it. Even if no one drank the water before it became contaminated, the aquifer would be spoiled and unavailable for use by future generations. By monitoring the zone above the groundwater, it would be possible to detect dangerous spillage or seepage before it reaches the groundwater when a remedy would still be possible. Vadose zone monitoring was suggested by the WERC Peer Review of the CMS.<sup>68</sup> This would add significantly to the cost of this alternative since the vadose zone monitoring would also need to be in place for thousands of years.

As the CMS concluded, the Vegetative Soil Cover alternative would be preferable to NFA with IC’s because it would better prevent erosion of the protective layer of soil over the waste. However, growth of a substantial vegetative cover in the arid environment of New Mexico might require irrigation and fertilization. Irrigation may promote seepage

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<sup>68</sup> Final WERC Report: Independent Peer Review of the U.S. Department of Energy Sandia National Laboratories’ “Working Draft” Corrective Measures Study. January 31, 2003, p. 26



of contaminants into the groundwater. Fertilizer contains chelating agents that mobilize nutrients but also increase contaminant solubility, which also puts groundwater at risk. This alternative would also require the increased costs of thousands of years of groundwater and vadose zone monitoring, as well as maintenance to ensure that the vegetative cover remains intact and healthy. These costs are not honestly presented in the CMS.

A preferable corrective measure, although it would also be only temporarily effective, would be a Vegetative Soil Cover with Bio-Intrusion Barrier. This alternative adds a layer of gravel and cobbles below the vegetative soil cover. These would decrease the amount of water that percolates into the landfill. It would also prevent burrowing animals from accessing the waste, and provide a detriment to future human intrusion into the waste. However, this alternative is still not a permanent solution and would also require monitoring of the groundwater and vadose zone as well as maintenance, and the associated additional long-term costs that were not included in the CMS.

The RCRA Subtitle C Cap alternative was excluded from detailed assessment in the CMS. It was determined that the long-term effectiveness of the cap was too uncertain, although none of the non-excavation alternative measures presented are adequate protection of the public in the long term. However, this is the standard cap used at landfills, and it is our opinion that it will effectively prevent water infiltration and not leak as suggested by the CMS. A more effective alternative would be to combine the Subtitle C Cap with a Bio-Intrusion Layer. This would further protect the landfill from wind erosion and water infiltration.

None of the alternatives above can be regarded as completely permanent solutions. Long after thirty or even one hundred years, the waste will still remain. If, after one of these alternatives is implemented, the monitoring system does detect that contaminants are leaking further towards the groundwater, the remedial actions will have to be judged a failure and excavation or further protective activities will be necessary. It seems likely that, in the future, environmental groups will be increasingly concerned about the dangers of radioactive waste and will press to have the material removed. As discussed above, it is also not unlikely that an accident or geological event, such as land subsidence, could render any of these alternatives ineffective and put public health in danger.

## **6.0 Conclusions**

The CMS report is misleading—while it includes hundreds of pages of description, cost analysis, and risk assessment for several alternative “corrective measures”, it is regardless incomplete. Although it evaluated several excavation alternatives, it did not consider those that we think are most promising. It included risk assessments for all alternatives, but not including the actual contaminants and concentrations present at the landfill, or extended over the actual hazardous life of the waste. It provided hundreds of pages of cost estimates, but did not project these costs over the correct time period. Both the risk

assessments and the cost estimates contained exclusions and exaggerations that biased the report toward alternatives less protective of human health and the environment. In our professional opinion, the preferred alternative determined by the CMS is not adequate to carry out the CMS objectives over the long term. These deficiencies in the CMS cannot be corrected without complete disclosure of the MWL contents, additional determination of environmental releases, and competent completion of risk assessments that consider a long-term, residential scenario as well as short-term risk to workers. In our opinion the CMS should be declared invalid and Sandia's application for permitting changes should be denied until a revised, non-streamlined CMS can be completed.

The most important issues that must be addressed by Sandia/DOE are:

Declassification of the MWL inventory and full disclosure of its contents. Sandia/DOE should complete a thorough investigation to ensure that all wastes have been accounted for, and then complete a risk assessment based on known levels of contamination and not on guesses and assumptions. The FOIA documents that suggest that High Level Waste is buried at the site should be given careful consideration. There is no reason why the MWL inventory, declared classified during the cold war, must remain classified today.

Completion of a long-term, residential-scenario risk assessment. This should include the possibilities of drilling into combustible depleted uranium, of accelerated erosion caused by land subsidence, of upward contamination by plants, capillary action, and soil fauna, and of accelerated migration to groundwater through preferential flow pathways. It should also account for the high level of uncertainty inherent in very long time periods. The risk assessment should be based on estimated contaminant concentrations within the landfill itself, and should consider the actual amount of liquid wastes deposited at or near the MWL.

Accurate, unbiased measurement of contaminant levels in soil and groundwater.

Completion of excavation scenario risk assessments that take into account contemporary waste management practices and technologies that are commonly used at other radioactive waste sites.

Realistic assessment of the costs of a future excavation scenario, including off-site disposal of more hazardous radioactive wastes and on-site disposal of less-hazardous and non-radioactive wastes.

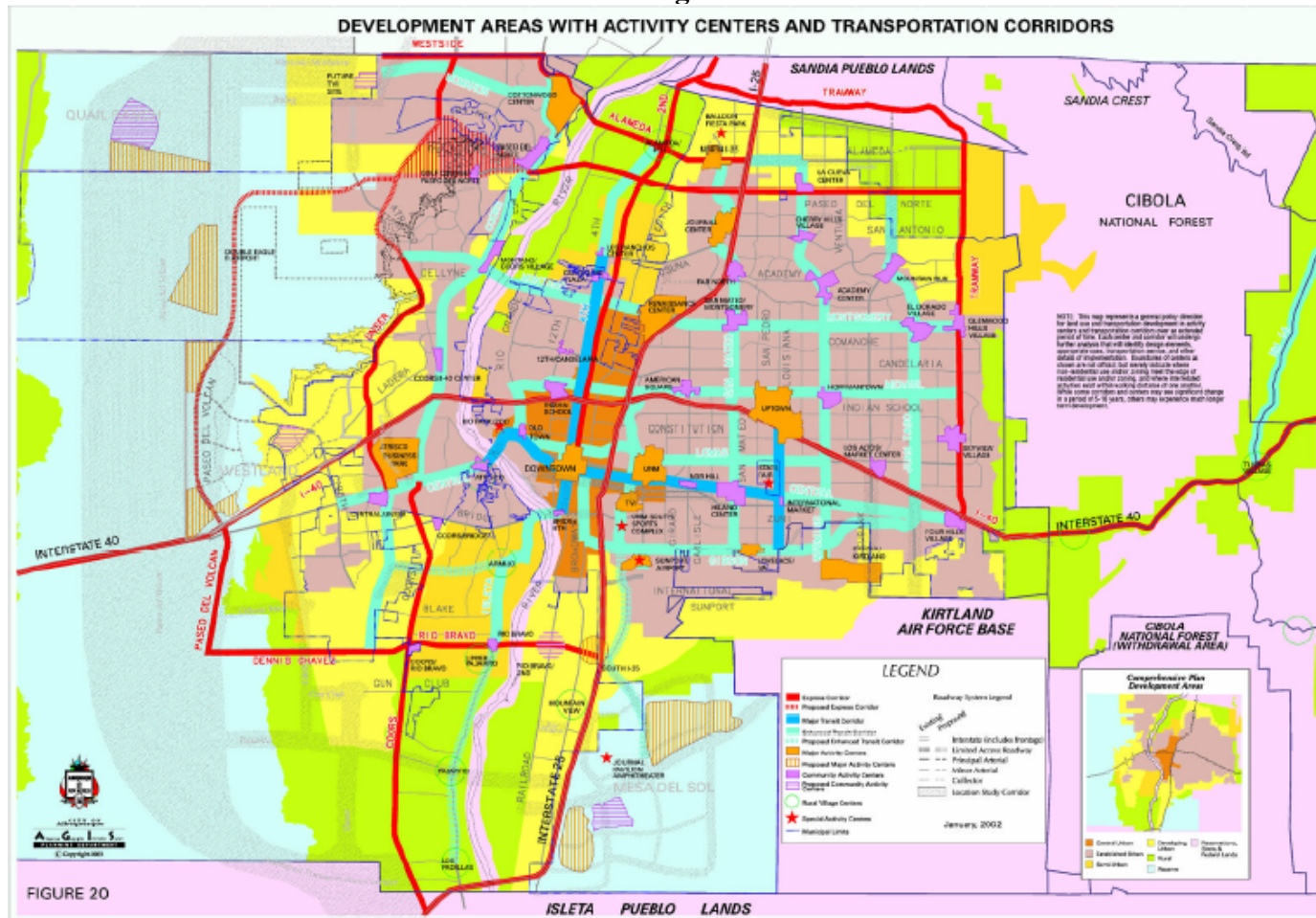
Assessment of costs of non-excavation alternatives over extremely long time periods, including the costs of all monitoring and maintenance as well as of institutional controls.

Re-evaluation of the preferred corrective action alternative based on estimation, based on long time periods, of the actual risks and costs of each alternative.

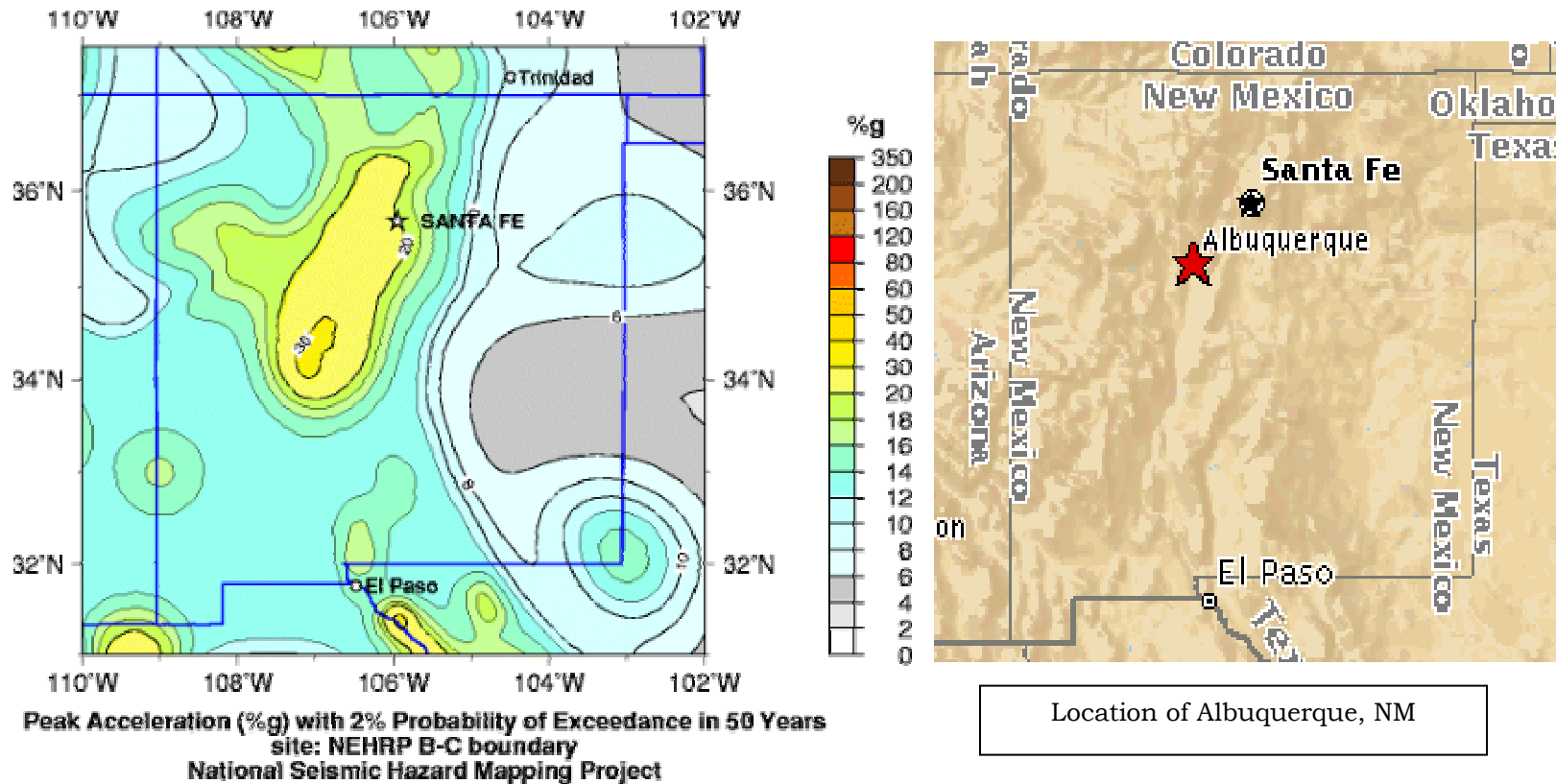
The management of the Sandia MWL will serve as a precedent for other radioactive waste landfills across New Mexico and across the country. The choice of action to be taken today will also influence the health and prosperity of the growing Albuquerque region for many generations to come. Utmost care should be taken that the risk posed by

this site is assessed as accurately as possible, and that the choices for site management are made with consideration of all the facts that can possibly be obtained.

## 7.0 Figures



**Figure 1. Planned Development of the city of Albuquerque.** The MWL is within the Kirtland Air Force Base at the lower right of the map, within the left-hand column of the legend. Figure from City of Albuquerque Planning Department, Albuquerque/Bernadillo County Comprehensive Plan, as amended January 2002.



**Figure 2. Locations of Earthquake Hazard Zones and Location of Albuquerque.** The 10% g value is used to estimate the minimum peak acceleration at which building damage can occur. On the average, it “corresponds to Modified Mercalli Intensities VI to VII, levels of threshold damage, in California, for ground motions within 25 km of the earthquake epicenter.”

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