CLEAN-UP PROGRESS AT THE SNL/NM CLASSIFIED WASTE LANDFILL

Paula J. Slavin
GRAM, Inc.

Bob Galloway
Sandia National Laboratories
Albuquerque, New Mexico

ABSTRACT

The Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration Project is currently excavating the Classified Waste Landfill in Technical Area II, a disposal area for weapon components for approximately 40 years until it closed in 1987. Many different types of classified parts were disposed of in unlined trenches and pits throughout the course of the landfill's history. A percentage of the parts contain explosives and/or radioactive components or contamination.

Excavation commenced in March 1998, and approximately 90 percent of the site (as defined by geophysical anomalies) has been completed as of January 2000. The excavation has progressed backward chronologically from the last trenches filled through to the earlier pits. The material excavated consists primarily of classified weapon assemblies and related components, so disposition must include demilitarization and sanitization. This has resulted in substantial waste minimization and cost avoidance for the project, because nearly 90 percent of the classified materials are being demilitarized and recycled.

The project is using field screening and lab analysis in conjunction with preliminary and in-process risk assessments to characterize soil and make waste determinations in as timely a fashion as possible. Challenges in waste management have prompted the adoption of innovative solutions.

The excavation is scheduled to be completed in July 2000, with follow-on verification sampling, demilitarization, and waste management activities to conclude in February 2001.

INTRODUCTION

Sandia National Laboratories, New Mexico (SNL/NM) is a Department of Energy (DOE) contractor located within the boundaries of Kirtland Air Force Base (KAFB) to the south of Albuquerque, New Mexico. The SNL/NM Environmental Restoration (ER) Project is currently remediating the Technical Area II (TA-II, Figure 1) Classified Waste Landfill (CWLF) as a Voluntary Corrective Measure (VCM).

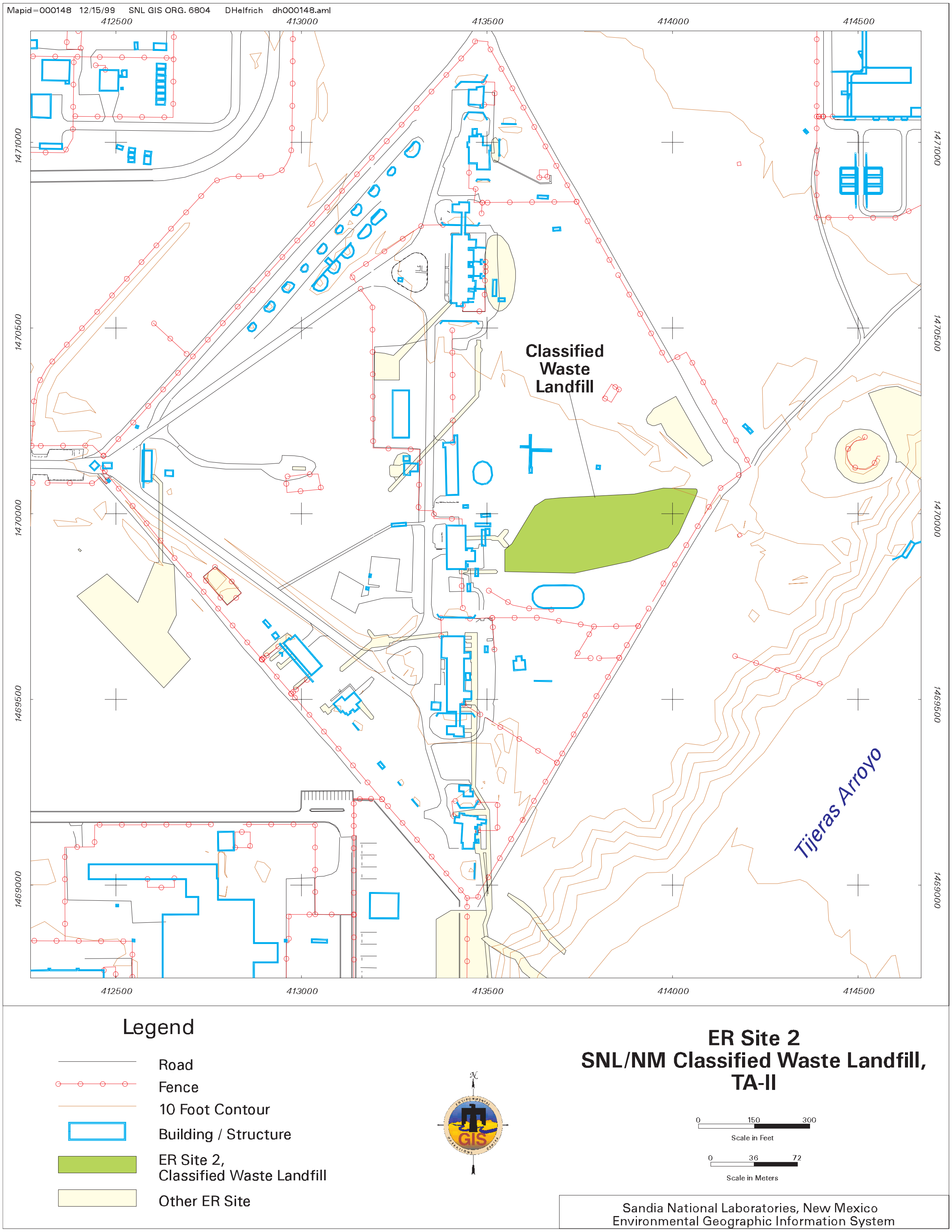

Figure 1. Location of Site 2 (Classified Waste Landfill) within Technical Area II at Sandia National Laboratories in Albuquerque, New Mexico.

Site Location and History

The CWLF is located in the eastern portion of TA-II (Figure 1). The landfill proper covers approximately 1.5 acres, but is included in a suspect area that encompasses approximately 3.5 acres. The CWLF consists of a series of disposal trenches and pits that were used for disposal of classified weapons components (1).

Classified waste was buried at the CWLF from the early 1950s through 1987, with some disposals possibly as early as 1947. The majority of classified waste in the CWLF is composed of metal, plastic, and paper. A percentage of the waste contains explosive, hazardous, and/or radioactive components.

Until 1958, no records were maintained for material disposed of in the CWLF (2,3). An inventory of the classified material buried prior to June 1972 was destroyed during a DOE paperwork reduction initiative. The remaining available information (from 1972-1987) was compiled from interview notes, Delivery to Reclamation records (4), a Burial Log Book (5), and the Nuclear Materials Management and Safeguard System database (6). However, little information was available on explosive, chemical, or radiological hazards associated with material in the landfill.

The waste-disposal method typically used by Sandia personnel was to bury the waste by excavating trenches to depths of 8 to 15 feet and emplacing materials collected from throughout SNL/NM for disposal, then backfilling each trench section to bring it to grade (7). In some cases, deep pits (approximately 18 feet) were dug with a clamshell excavator. Upon finishing a waste emplacement, personnel would set a marker with the location designation at the approximate midpoint of the cell.

Project Objectives and Justification

The landfill is being simultaneously characterized and excavated to mitigate its potential to pose hazards to human health and the environment. The following factors were used as the basis for excavating the landfill:

- There is the potential for the site to have contributed to groundwater contamination known to exist beneath TA-II. The New Mexico Environment Department and DOE Citizens Advisory Board have ranked this site high on their list of concerns.

- The site contains hazardous and radioactive materials that pose a threat of release.

- Intrusive activities (e.g., drilling prior to removal of the materials) would have been likely to expose personnel to unnecessary hazards.

- Because of the landfill subsidence and shallow burial, classified materials were already visible at the surface and had the potential to be removed by unauthorized personnel.

- SNL/NM has planned construction in the area.

- Because of the discrete nature of the waste (i.e., as debris within individual pits in trenches), traditional assessment approaches, such as surface sampling or sampling from boreholes, would not fully characterize the nature and extent of contamination and would be likely to puncture containers, thereby potentially releasing contaminants to the workers and/or environment.

- Significant long-term cost savings could be realized by conducting the cleanup voluntarily and on an accelerated schedule.

Background Investigations

Prior to initiating the landfill excavation, project personnel conducted background investigations to determine the types of materials and hazards they would encounter in the landfill. These investigations included personnel interviews, archival searches, and aerial photograph review and analysis.

Field investigations included soil-vapor and radiation surveys across the landfill and borehole sampling on the landfill perimeter. In addition, a series of geophysical surveys was conducted to delineate the extent of the burials. The surveys included electromagnetic and magnetometer surveys. The results confirmed the presence of eight trenches with discrete burials as well as a few outlying pits, for a total of 84 anomalies (Figure 2). The geophysical surveys were used to guide the excavation process and have been used as a means for tracking completion to date.

The archival searches and the aerial photograph analysis, combined with the geophysical surveys, proved to be the most useful of the preliminary investigations. Finding the Delivery to Reclamation records allowed us to identify particular hazards associated with particular pits in the landfill (for at least the more recent pits), while the aerial photographs were useful in determining the timing of the disposals. The geophysical surveys identified all the burials in the area, and allowed some guesswork at depth and extent of burials.

Materials and Contaminants

Based on the review of archived information and interviews, a list was compiled of items potentially disposed of in the landfill and the probable contaminants associated with them. The following is a partial list of items assumed at the beginning of the project to have been buried in the landfill:

- Weapon cases, shells, and related components,
- Thermal batteries (some unfired),
- Lasers and radar equipment,
- Expended tritium tubes,
- Beryllium disks,
- Neutron generators,
- Electronic equipment and switches,
- Items potentially containing high explosives, and
- Potentially classified documents, film, and microfiche.

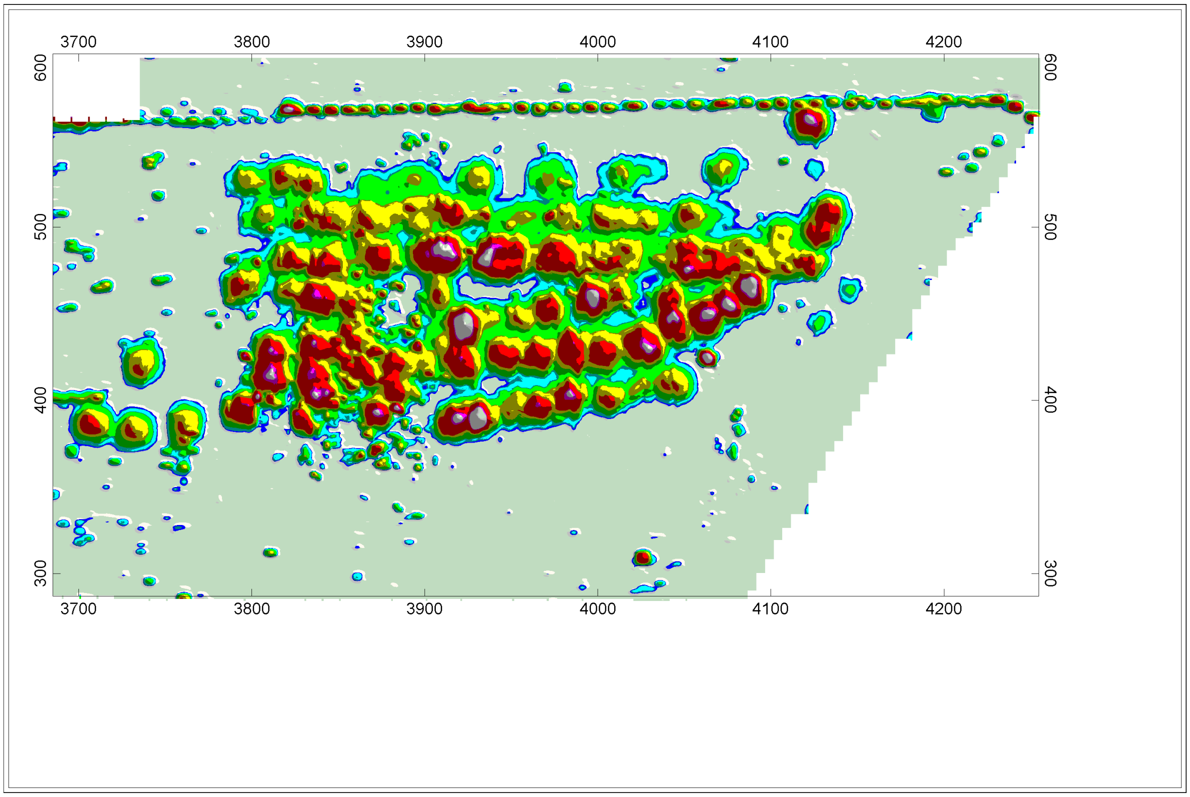

Figure 2. Electromagnetic Signature of Classified Waste Landfill, Sandia National Laboratories, New Mexico. North conventional (at top of map). NM State Plane coordinates (in feet) provide axes bounding survey.

Potential constituents of concern (COCs) associated with these items included the following:

- Radioactive strontium, nickel, tritium, thorium, plutonium, and uranium isotopes,
- Metals, including lead, beryllium, barium, cadmium, chromium, mercury, and nickel,
- High explosive (HE) compounds,
- Polychlorinated biphenyls (PCBs), and
- Volatile organic compounds (VOCs).

As the excavation has progressed, some of these COCs have been ruled out as contaminants. But the list of materials has grown considerably with each new pit uncovered. This has, in some cases, proven challenging for the waste-management team.

EXCAVATION

With the information provided by the geophysical surveys and historical documentation, an excavation plan was developed. The excavation has progressed from the pits and trenches for which the most documentation exists (i.e., the youngest) backward through time to those for which little or no documentation is extant. The excavation plan was developed in this manner to serve two main purposes: 1) the pits with the greatest amount of information would be excavated first to allow the field crew to hone their process skills on known materials and 2) the more recent materials were reported to be free of radioactive and hazardous contamination. The latter aspect facilitated the previous one (i.e., it was better to get "practice" on processes without having to deal with contamination issues).

Excavation began in early March 1998 and nearly 90% of the landfill has been completed as of January 2000. A discussion of the excavation and characterization processes follows.

Initial Excavation Procedures

Because of the great variability in expected contents (potential radiological, chemical, explosive, and other component types), a careful and methodical multi-phase approach is being taken. A trackhoe excavator is first used to remove the overburden, which varies in thickness from 1.5 to 6 feet. The overburden is segregated from the underlying material because it is expected to contain little or no contamination. It is screened and sampled for chemical and radiological hazards and content, then set aside for use as backfill at the end of the project. No contaminated overburden or sloping material has been found to date.

Material Identification and Characterization

The excavation then proceeds to the emplaced materials with the excavator operator looking for compressed gas cylinders, unexploded ordnance, or other hazards that could be immediately harmful to the field crew. At this point, a more thorough examination and screening of the material is conducted. Excavated materials are removed and spread on the ground to an approximate depth of 6 inches. Radiological and explosives experts survey the material for any items that pose an immediate hazard to personnel. Hazards are safed and/or isolated, then the larger components are removed and placed in bins for further surveying at a sorting/segregation area.

After this initial screening, the remaining material (soil, gravel, cobble, smaller items, and debris) is placed in a screen plant equipped with three screens (6 inch [in.]; 2 in.; and 1 in.) to segregate soil from debris. Additional hand sorting is performed to remove debris from the cobbles that are segregated by the screen plant. The debris processed by the screen plant is then sent to the sorting/segregation area.

Historical records (when available) have been used to identify the contents of the pits and to enhance hazard identification and mitigation. Once materials are identified, classified databases are searched and subject experts are contacted to assist with determining proper hazard mitigation procedures and current level of security classification, and to review options for the ultimate disposition of components and materials. Because the current classified weapons component databases do not specifically identify all the hazards associated with a particular item, project personnel are compiling information gained from the material characterization effort to increase the usability of such databases. At this point in the project, the crew has the greatest knowledge base for the materials encountered and is relied on to distinguish materials in the field and to know their particular hazards. The option is readily available, however, to consult with more knowledgeable experts about a particular item and its associated hazards.

Material Sorting and Segregation

At the sorting/segregation area, items are sorted by hand and checked a second time for radiological components or loose contamination and other hazards. They are separated into process streams based on their type (thermal batteries, firing sets, neutron generators, capacitors, trainers, and so forth) and level of classification. The items are then submitted to a radiological survey area to be checked a third time for loose contamination or radiation prior to release as non-radioactive material. If present, removable radioactive components are separated from the main component, sent through for disposal as radioactive waste, and the remainder of the component (if non-radioactive) is slated for recycling. Those items that have been confirmed to be free of radiological contamination then are sorted further for demilitarization, recycling, or disposal. Items that cannot be released as non-radioactive or effectively decontaminated are segregated for disposal as radioactive waste.

MATERIAL DISPOSITION

To minimize the amount of time that will be spent at the end of the project dealing with waste disposal, and to minimize the amount of space required for classified storage, material disposition is performed concurrently with excavation and site characterization to the extent possible. After items have been checked for hazardous or radioactive contamination or internal components, they are separated based on their ability to be reused or recycled. Some items have been slated for display at the National Atomic Museum, for use by the KAFB at their nuclear weapons training school, or by SNL and Los Alamos National Laboratories groups that train personnel for nuclear, explosive, or radiological incident response. The vast majority of the remaining items can be recycled for recovery of common metals (e.g., steel, copper, lead, iron, aluminum, magnesium) and precious metals (gold, silver, palladium, platinum). Prior to recycling or waste disposal, however, items must be rendered non-classified and unusable (i.e., demilitarized). This is accomplished by first removing any radiological sources and hazardous materials (e.g., batteries, capacitors, beryllium), then shredding, chopping, or crushing the material into an unusable, unrecognizable form. This step is required to protect national security interests.

Waste Characterization and Management

The types of materials being removed from the landfill have presented waste management personnel with some unique challenges. First, because the cost to dispose of classified waste is 8-10 times that for unclassified waste, cost-effective waste minimization is of paramount importance. The sheer volume of items removed to date (more than 600 tons representing more than 2 million individual pieces) would have proven prohibitively costly to dispose of as classified waste, had another option not been available. The main thrust of waste management, then, is to render unclassified, or demilitarize, as much of the material as possible. This has allowed disposition to include recycling, rather than simply transferring to another landfill. This aspect of the project is more fully explored in the paper entitled "Demilitarization of Classified Waste as a Waste Minimization Technique," presented in Session 25 of WM00.

The second aspect of waste management hinges on "free-releasing" items, that is, characterizing them for radiological contamination, and certifying that they are free of radioactivity such that, once demilitarized, the pieces may be released to the general public. This requirement has led to the multiple radiological checks in the process. Again, cost avoidance drives much of this since materials that are otherwise nonregulated are significantly cheaper to dispose. Similarly, for those materials that are hazardous (e.g., thermal batteries), the ability to demonstrate that they are not also radioactive avoids disposing of them as mixed waste, a much costlier waste stream. Demilitarizing again plays a significant role in this arena, for there is currently no disposal option for classified mixed waste.

Items that are found to have fixed radioactive contamination or that contain radioactive sources that cannot be separated from the component (to date, much less than 0.01% of all items removed) must be characterized for disposal as radioactive waste. This has again presented formidable challenges and has led to the development of unique characterization techniques. This aspect of the project is discussed in the paper entitled "Multi-Method Characterization of Low-Level Radioactive Waste at Two Sandia National Laboratories Environmental Restoration Sites," presented in Session 21 of WM00. The ability of staff to meet the challenges presented to them has enabled the project to move forward in this area, rather than stagnate and lose momentum.

SITE CHARACTERIZATION

Concurrent with the excavation and sorting/segregation activities, soil that has been processed through the screen plant is characterized for chemical and radiological constituents. A combination of on-site field screening and off-site laboratory analysis is used to characterize and segregate the excavated soil. Aliquots of soil, collected from every 50 cubic yards of soil excavated, are checked for metals content by on-site X-ray fluorescence (XRF), for volatile organic content by photoionization detectors (PIDs), and for radiological activity by gamma spectroscopy. These field data are used immediately to segregate "clean" from "dirty" soil. The results are then confirmed by periodically submitting splits for analysis by off-site laboratories. A total of approximately 45,000 cubic yards has been processed to date. Careful segregation of contaminated soil has limited the volume of soil to be disposed as waste to approximately 50 cubic yards.

Radiological Characterization

Another example of the project's adaptation to changing conditions has come in the area of soil characterization. It was assumed at the beginning of the project that radioactively-contaminated soil would be encountered in much of the CWLF. This was based on its proximity to the SNL/NM Radioactive Waste Landfill (RWL) and the fact that, during the 1996 excavation of the RWL, a large amount of plutonium-contaminated soil was encountered. To enhance the ability to quickly detect and segregate radioactive soil, a Large Area Gamma Spectroscopy (LAGS) system was set up at the site.

The LAGS consisted of the following features: two 30-ft x 30-ft concrete pads within a large temporary structure, and a gamma spectrometer attached to a boom to allow it to swing alternately between the pads. Soil was placed in 10-cubic yard lots on each pad, and the gamma spectrometer collected readings for 30 minutes. The system was connected to a computer so that results could be generated quickly to make real-time determinations on soil disposition. As the project progressed, however, little radioactive contamination was encountered, so use of the LAGS system was discontinued. Radiological characterization is now accomplished by collecting grab samples for fixed-lab gamma spectroscopy. The use of grab samples is more consistent with sampling protocols in the rest of the SNL/NM ER Project and takes advantage of the homogeneity produced by the screen plant and soil movement activities. The structure used for soil radiological characterization was subsequently dedicated to the sorting and segregation of artifacts.

Although the LAGS system proved to be overkill for the CWLF project, its utility is not to be underestimated. In contrast to other radiological characterization systems, the LAGS allows real-time processing of soil for gamma emitters concurrently with excavation, which enhances the ability to characterize soil quickly and segregate it for waste minimization purposes. Because the system is based on gamma spectroscopy, it allows the simultaneous characterization of more than 70 radioisotopes at one time, rather than only one. This eliminates the necessity to run soil with multiple radiological contaminants through a system multiple times for characterization and separation. Limitations of the system arise, however, for characterizing pure alpha- or beta-emitters (e.g., tritium) – these must be analyzed for separately.

Risk Assessment

To expedite the decision process for segregating clean from potentially contaminated soil, a preliminary risk assessment was performed and preliminary remediation goals (PRGs) for naturally-occurring and anthropogenic constituents were developed before excavation began. PRGs for both metal and radiochemical species were calculated based on cumulative risk from the COCs. A set of values for metals concentrations and radioisotope activities was formulated to allow real-time "go/no-go" decisions in the field.

For metal species, the risk assessment was based on an industrial land-use scenario, and the guidance promulgated by EPA (8,9) for use at Superfund sites was used. In order to be site-specific for the New Mexico habitat, negotiations with the NMED resulted in modification of some of the default parameters (inhalation and ingestion rates, etc.) used in the risk assessment. For radionuclides, the development of the PRGs was based on analyses using the RESRAD code (10) to comply with DOE Order 5400.5 (11). Recreational/industrial land-use scenarios were utilized for the calculations. If necessary, further "worst-case" calculations can be conducted under the residential scenario, based on the assumption that institutional controls might be lost at some time in the future (i.e., the land reverts to private ownership). The risk assessment for human health was based on both the hazard index and excess cancer risk, with the more conservative result being used for the PRG.

Because the final risk assessment will be based on cumulative risk of individual constituents, and there are more than five COCs, each field screening value used is set at 10 percent of its calculated PRG. Thus, conservatism is injected early in the process in case more than one COC is found that exceeds its background concentration (as has sometimes been the case). An example comparison of metal PRGs for human health versus ecorisk is provided in Table I. The use of PRGs allows project personnel to quickly determine which soil piles should be segregated and sampled further as potential waste and which ones can be set aside for use as backfill.

For those samples in which concentrations exceed their respective PRGs, a screening risk assessment is conducted to determine whether the soil lots can still pass for final backfill or should be separated for waste disposal. Soil lots that exceed their PRGs but still pass a risk assessment are set aside to be placed at the bottom of the excavation during backfilling. The final 5 feet of material of backfill will be clean fill to ensure compliance with ecorisk (ecological risk for burrowing animals is assumed to be negligible below a depth of 5 feet).

At the conclusion of the project, geophysical surveys will be performed across the bottom of the excavation to confirm removal of all buried materials. Soil samples will then be collected from the excavation bottom and walls for verification analysis. A final risk assessment will be conducted for the site using the maximum observed values of these verification data and the characterization data for the soils removed from the excavation; acceptable results will optimize the return of as much soil as possible to the excavation.

Table I
Preliminary Remediation Goals for Metals
SNL/NM Classified Waste Landfill

COC	Deer Mouse PRG	Burrowing Owl PRG	Final Ecorisk PRG	Human Health PRG (Industrial Land-Use)	Final Site 2 PRG	10% PRG Level	Background Level
Arsenic	2.03E+01	5.09E+03	2.03E+01	1.90E+00	1.90E+00	0.19	4.4
Barium	5.09E+02	1.84E+04	5.09E+02	6.60E+04	5.09E+02	51	200
Beryllium	2.06E+02	NA	2.06E+02	1.90E+03	2.06E+02	21	0.8
Cadmium	2.09E+02	8.54E+03	2.09E+02	5.10E+02	2.09E+02	21	0.9
Chromium	1.91E+03	1.59E+03	1.59E+03	3.80E+03	1.59E+03	160	12.8
Lead	1.22E+04	1.71E+04	1.22E+04	2.00E+03	2.00E+03	200	11.2
Mercury	8.87E+02	9.96E+00	9.96E+00	3.10E+02	9.96E+00	1.0	<0.1
Nickel	3.57E+03	3.80E+04	3.57E+03	2.00E+04	3.57E+03	360	25.4
Selenium	5.89E+00	5.60E+01	5.89E+00	5.10E+03	5.89E+00	0.60	<1
Silver	1.55E+03	NA	1.55E+03	5.10E+03	1.55E+03	155	<1
Uranium (metal)	1.02E+02	4.40E+04	1.02E+02	3.00E+03	1.02E+02	10	2.3

NOTE: All values in mg/kg (ppm).
PRG – Preliminary remediation goal.
NA – Information not available

CONCLUSION

The CWLF remediation project was planned to optimize concurrent excavation, material disposition, waste management, and site characterization. To date (January 2000), nearly 90% of the landfill has been excavated to a depth of 15-16 ft, and more than 2 million individual items (over 600 tons) have been removed and characterized. Fewer than 10% of the items removed have been radioactive or disposed as waste – approximately 90% of the materials have been slated for recycling.

In addition, less than 0.1% of the excavated soil will require disposal as waste. Very little of the soil has been radioactively contaminated, and much of the soil that contains metals above background levels will be returned to the excavation. The vast majority of soil removed to date will be used for backfill.

ACKNOWLEDGMENTS

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

REFERENCES

1. Sandia National Laboratories, 1997, "Voluntary Corrective Measures Plan, Environmental Restoration Project, Site 2, Classified Waste Landfill", Sandia National Laboratories, Albuquerque, NM.

2. Sandia National Laboratories, 1992, Environmental Operations Records Center, Interviews Conducted for the Environmental Restoration Program, Environmental Impact and Restoration Division 7723.

3. Sandia National Laboratories, 1991, Environmental Operations Records Center, Interviews Conducted for the Environmental Restoration Program, Environmental Impact and Restoration Division 7723, by Martha E. Haines, Org. 4312, Robert P. Kelly, Org. 3430, and John R. Cochran, Org. 7723.

4. Sandia National Laboratories, 1997, Environmental Operations Records Center, Delivery to Reclamation (DTR) Forms, Batches 18 through 40, dated January 1976 through October 1987.

5. Sandia National Laboratories, 1991, Burial Log Book.

6. Oak Ridge National Laboratories (ORNL), 1995, Nuclear Materials Management and Safeguard System (NMMSS), CRD (Confidential Restricted Data), database maintained by the Oak Ridge National Laboratory Computing and Technical Services.

7. Jerome, D. E., 1989, SNL/NM Dept. 3432, "Approval for SNLA Classified Material Burial Grounds Security Plan", memorandum to A. R. Chernoff, DOE/AL/MSD, dated April 21, 1989.

8. United States Environmental Protection Agency (USEPA), 1989, "Risk Assessment Guide for Superfund," Volume I – Human Health Evaluation Manual, Part A – Human Health Evaluation Manual, December 1989.

9. United States Environmental Protection Agency (USEPA), 1991, "Risk Assessment Guide for Superfund," Volume I – Human Health Evaluation Manual, Part B – Development of Preliminary Risk-Based Remediation Goals, December 1991.

10. Yu, C., A.J. Zielen, J.-J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, 1993, "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD", Version 5.0. Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

11. United States Department of Energy (DOE), 1993, "Radiation Protection of the Public and the Environment," DOE Order 5400.5, U.S. Department of Energy, Washington, DC.