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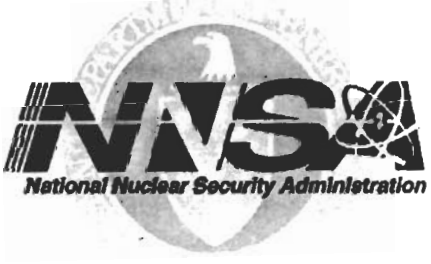
Sandia National Laboratories/New Mexico

CHEMICAL WASTE LANDFILL
LANDFILL EXCAVATION
VOLUNTARY CORRECTIVE MEASURE
FINAL REPORT
ENVIRONMENTAL RESTORATION PROJECT
SANDIA NATIONAL LABORATORIES/
NEW MEXICO

April 2003

Environmental
Restoration
Project



National Nuclear Security Administration
Sandia Site Office

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ACRONYMS AND ABBREVIATIONS

ACM	asbestos-containing material
AOC	area of contamination
bgs	below ground surface
CA	corrective action
CAMU	Corrective Action Management Unit
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
COC	constituent(s) of concern
COPEC	contaminants of potential environmental concern
CS	chlorobenzylidene malonitrile
CWL	Chemical Waste Landfill
cy	cubic yard(s)
DIH	Division of Industrial Hygiene
DOE	U.S. Department of Energy
DQO	Data Quality Objectives
EK	Electrokinetic Extraction System
EOD	explosives ordnance disposal
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
EZ	exclusion zone
°F	degrees Fahrenheit
g	gram(s)
HASP	Health and Safety Plan
HCN	hydrogen cyanide
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HWMF	Hazardous Waste Management Facility
ICN	Interim Change Notice
IRIS	Integrated Risk Information System
KAFB	Kirtland Air Force Base
kg	kilogram(s)
L	liter(s)
lb	pound(s)
LE	Landfill Excavation
LOAEL	lowest-observed adverse-effect level
MDA	minimum detectable activity
MDL	method detection limit
µg	microgram(s)
mg	milligram(s)
mrem	millirem
NFA	No Further Action
NMED	New Mexico Environment Department
NOAEL	no-observed adverse-effect level
OSHA	Occupational Safety and Health Administration
OSML	On-site Mobile Laboratory
PCB	polychlorinated biphenyl

ACRONYMS AND ABBREVIATIONS (Concluded)

PCE	tetrachloroethene
pCi	picocurie(s)
PVC	polyvinyl chloride
ppb	parts per billion
ppm	parts per million
PPE	personal protective equipment
QA	quality assurance
QAPP	QA Program Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RBCA	Risk-Based Corrective Action
RCRA	Resource Conservation and Recovery Act
RME	Reasonable Maximum Exposure
RMWMF	Radioactive and Mixed Waste Management Facility
SAP	Sampling and Analysis Plan
SNL/NM	Sandia National Laboratories/New Mexico
SOB	site operational boundary
SOW	statement of work
SVOC	semi-volatile organic compound
TA	Technical Area
TCE	trichloroethene
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TEDE	total effective dose equivalent
TEVES	Thermally Enhanced Vapor Extraction System
THA	task hazard analysis
TSCA	Toxic Substance Control Act
UCAP	Unlined Chromic Acid Pit
UCL	upper confidence limit
URS	United Research Services, Inc.
UXO	unexploded ordnance
VCM	Voluntary Corrective Measure
VE	Vapor Extraction
VOC	volatile organic compound
WMP	Waste Management Plan

EXECUTIVE SUMMARY

The Chemical Waste Landfill (CWL) at Sandia National Laboratories/New Mexico (SNL/NM) was a 1.9-acre landfill located approximately 6 miles southeast of Albuquerque, New Mexico. The CWL was used for disposal of chemical and solid waste between the years of 1962 and 1985, and as a storage facility for hazardous waste drums between 1981 and 1989. Liquid and solid waste disposal was discontinued in 1981 and 1985, respectively. Closure of the CWL was formally initiated in 1988.

This document addresses the cleanup activities and risk assessment conducted as part of the Landfill Excavation (LE) Voluntary Corrective Measure (VCM). The LE VCM was an integral part of the expedited Corrective Action Program defined in the New Mexico Environment Department (NMED) approved CWL Closure Plan (SNL/NM December 1992). Previous investigations, characterization studies, and historical records were used to plan the LE VCM. Complete excavation of the CWL was performed from September 1998 through February 2002. Backfilling to 40 percent has been completed as of August 2002 and 100 percent completion to former grade is expected by October 2003. Final waste management and backfilling activities are ongoing and will be detailed in subsequent reports or addendums to this report.

The LE VCM final risk screening assessment addresses the excavation both with and without backfill materials placed to grade. Preliminary risk screening assessments were discussed informally with the NMED in May 2002 in conjunction with authorization to begin backfilling, as stipulated in the Backfill and Compaction Plan (SNL/NM July 2002). NMED requested additional information on the preliminary risk screening assessments prior to issuing a decision, and requested the final verification analytical results and a final risk screening assessment (Bearzi June 2002). In response to this NMED request for additional information, SNL/NM proposed to submit the final verification analytical results and risk screening assessment in the LE VCM Report (Zamorski August 2002). The main purpose of the final risk screening assessment is to verify excavation completion and obtain NMED approval for backfilling. NMED approval of this information is requested to resolve the only remaining issues associated with the "Approval with Conditions: Class 1 Modification: Backfill and Compaction Plan, Addendum C to Appendix S, Chemical Waste Landfill Closure Plan, April 2002" (Bearzi June 2002).

The LE VCM consisted of excavation and removal of over 52,000 cubic yards of contaminated soil and debris, along with verification sampling, waste segregation and management, and final waste disposal. Approximately 89 percent of the excavated soil has been moved to the adjacent Corrective Action Management Unit for final treatment and/or disposition. Approximately 11 percent of the excavated soil has been returned to the excavation as backfill material. Less than 1 percent of the total volume of material excavated, including all debris, will be disposed of at one or more permitted off-site facilities.

The primary objective of the LE VCM was to remove the buried waste and associated contaminated soil from the former disposal areas. Secondary objectives included preventing further impacts to groundwater quality, risk mitigation, and acceleration of final site closure. To meet these objectives, designated areas of the site were excavated to a minimum of 12 feet below ground surface (bgs) to remove all debris and soil. Additional excavation was performed to remove debris buried deeper than 12 feet bgs and to remove soil contaminated at levels that exceeded the CWL risk-based criteria (SNL/NM August 2000). The maximum depth of excavation was 30 feet bgs.

All final verification analytical results for the excavation and backfill materials sampled to date are included in the risk screening assessment. Excluding duplicates, 236 samples were analyzed for metals, volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls, and radionuclides. A small subset of samples was also analyzed for dioxins and furans. Excavation verification soil samples were collected from the nodes of a 25-foot grid superimposed over the excavation. Judgmental samples were also collected in smaller areas not covered by the verification grid based upon soil staining or other criteria. All backfill materials were screened and sampled according to the LE VCM Sampling and Analysis Plan (SNL/NM November 1998a) and associated relevant Interim Change Notices (SNL/NM March 1999a, December 2000, July 2001, and December 2001).

The human health risk screening assessment used conservative assumptions, a reasonable maximum exposure approach, and incorporated all final verification results. Calculations for nonradiological constituents of concern (COCs) for an industrial land use scenario not considering backfill materials show the hazard index is 0.25 and the calculated excess cancer risk is 8E-6. Both are below the acceptable risk criteria approved by the NMED (Bearzi January 2001). Incremental total effective dose equivalent (TEDE) and corresponding estimated cancer risk from radiological COCs is 3.9 millirems (mrem)/year and 5.7E-5, respectively, for an industrial land use scenario. These values are much less than the U.S. Environmental Protection Agency guidance (EPA 1997c). Furthermore, for radiological COCs not taking into account the backfill material, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is only 11.7 mrem/year with an associated excess cancer risk of 1.5E-4. The guideline for this scenario is 75 mrem/year (SNL/NM February 1998). Therefore, the site is eligible for unrestricted radiological release.

The risk was also calculated incorporating the backfill material for nonradiological COCs that were determined to be the main risk drivers. These calculations show that for both the industrial and residential land use scenarios the hazard index is 0.00, significantly lower than the accepted numerical guidance from the U.S. Environmental Protection Agency. The associated calculations show the excess cancer risk is 3.1E-8 for the industrial land use scenario and 5.2E-8 for the residential land use scenario, both below the acceptable risk value provided by NMED (Bearzi January 2001). The results of this assessment are within the acceptable ranges for both the industrial and residential land use scenarios compared to established numerical guidance for human health.

Based upon the ecological risk screening assessment for radiological and nonradiological COCs, ecological risks associated with the CWL are expected to be low for both scenarios (with or without backfill materials).

The results of the excavation, final verification soil sampling, and final risk screening assessment presented in this report demonstrate that the primary and secondary objectives of the LE VCM have been achieved.

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is a U.S. Department of Energy (DOE) facility located on Kirtland Air Force Base (KAFB), immediately southeast of the City of Albuquerque, New Mexico. SNL/NM consists of five Technical Areas (TAs) that occupy 2,820 acres within KAFB and includes several remote test areas that span 17,740 acres of KAFB (Figure 1-1). SNL/NM's primary mission is developing technologies to promote national security, with an emphasis on nuclear weapons development, engineering, testing, and stockpile stewardship. As a result of these activities, certain sites have been contaminated with hazardous and/or radioactive constituents.

The Chemical Waste Landfill (CWL) was a 1.9-acre disposal site located in the southeastern corner of TA-III at SNL/NM (Figure 1-1). The CWL was used for the disposal of chemical, radioactive, and solid waste generated by SNL/NM research activities from 1962 until 1985, and as a storage facility for hazardous waste drums from 1981 to 1989. Closure of the CWL is the responsibility of the SNL/NM Environmental Restoration (ER) Project.

As part of the closure process, the CWL was excavated from September 1998 through February 2002. The purpose of this report is to document the Landfill Excavation (LE) Voluntary Corrective Measure (VCM). The primary objective of the LE VCM was to remove the buried waste and associated contaminated soil from the former disposal areas. The secondary objectives of the LE VCM included groundwater protection, risk mitigation, and expediting final closure. Backfilling of the excavation, waste management, and closure of the site operational boundary (SOB) are ongoing activities that will be covered in subsequent CWL reports or addendums to this report.

As part of the LE VCM, more than 52,000 cubic yards (cy) of contaminated soil and debris were removed, segregated, and managed prior to final treatment and/or disposal. Approximately 89 percent of the excavated soil has been moved to the adjacent Corrective Action Management Unit (CAMU) for final disposition. Approximately 11 percent of the excavated soil has been returned to the excavation as backfill material. Off-site disposal is ongoing, and will involve less than 1 percent of the total volume of material excavated.

This report provides a brief summary of previous investigations leading up to the LE VCM (Chapter 2.0) and documents the LE VCM as follows:

- Excavation approach (Chapter 3.0)
- Excavation results, including waste volume estimates tracked according to the defined disposal areas within the landfill (Chapter 4.0)
- Waste management activities through September 2002 (Chapter 4.0)
- Final verification sampling results for the excavation (floor and sidewalls) and backfill materials (Chapter 5.0)
- Final risk screening assessment (Chapter 6.0) incorporating 236 off-site laboratory final verification analytical soil sample results that characterize the site with the excavation backfilled to grade

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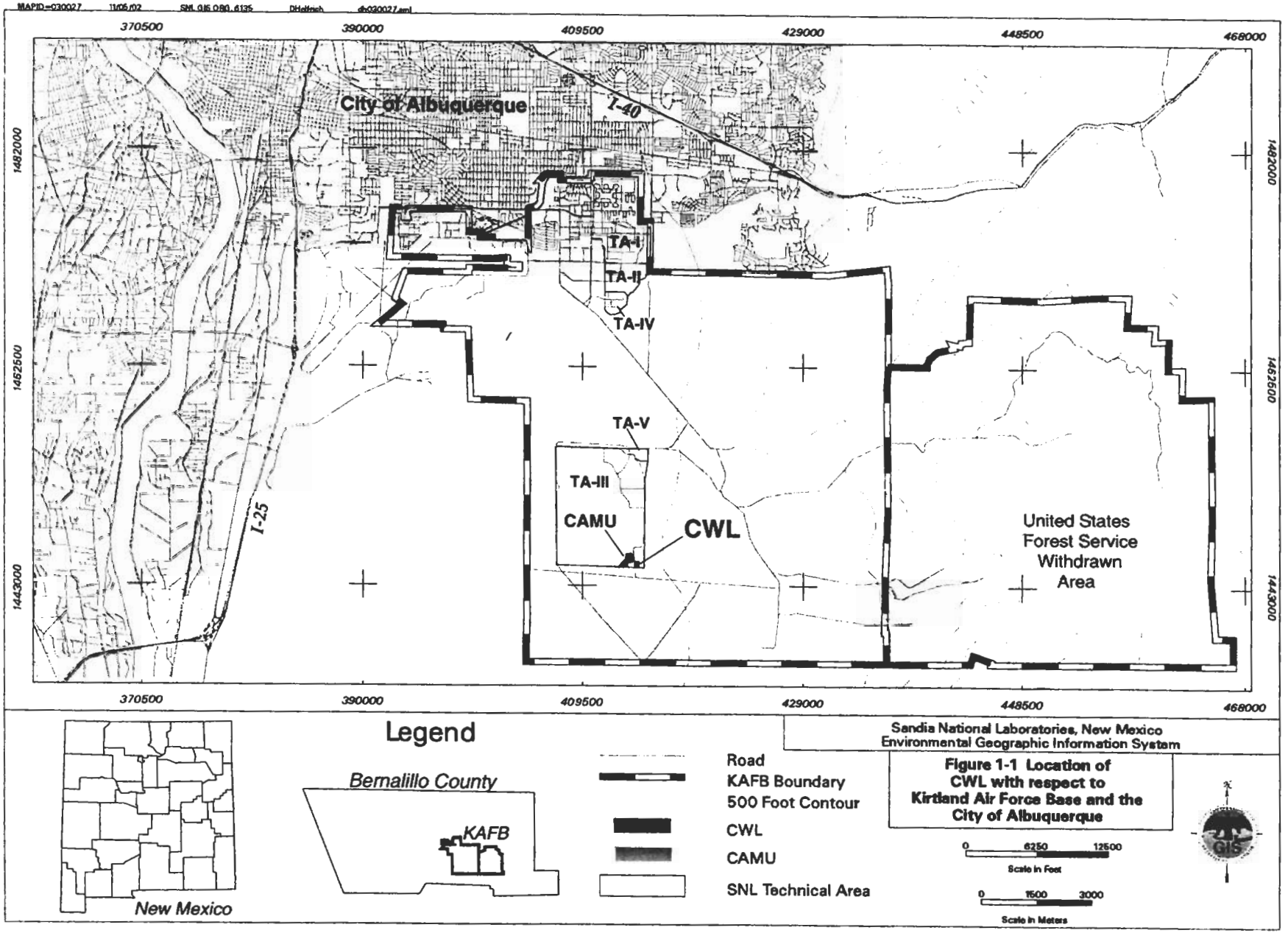
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City of Albuquerque
I-40
I-25
TA-I
TA-II
TA-IV
TA-V
TA-III
CAMU
CWL
United States Forest Service Withdrawn Area
Legend
Bernalillo County
KAFB
New Mexico
Road
KAFB Boundary
500 Foot Contour
CWL
CAMU
SNL Technical Area
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
Figure 1-1 Location of CWL with respect to Kirtland Air Force Base and the City of Albuquerque
0 6250 12500
Scale in Feet
0 1500 3000
Scale in Meters
GIS

- Project conclusions and recommendations relative to the ongoing CWL Corrective Measures Study (CMS) and final closure (Chapter 7.0)

The risk screening assessment presented in Chapter 6.0 and Annex A is being used as the starting point for the CMS that will define the final corrective action(s) for the site.

The remainder of this chapter presents the following background information to provide a context for the LE VCM project and results.

- Regulatory Background (Section 1.1)
- CWL Closure Plan History (Section 1.2)
- Expedited Corrective Action (CA) Program (Section 1.2.1)
- LE VCM Scope and Objectives (Section 1.3)
- LE VCM Project Evolution (1.3.1)
- Permits and Public Involvement (Section 1.3.2)
- Current Status of the LE VCM and CWL (Section 1.4)

1.1 Regulatory Background

SNL/NM disposed of wastes into unlined pits at the CWL from 1962 until 1985. In 1981, all liquid waste disposal was discontinued; however, solid waste disposal continued until 1985. The CWL was operated as a storage facility for hazardous waste drums from 1981 to 1989. All CWL disposal and storage operations were discontinued completely in 1989, and all pits were covered with soil. More detailed information regarding the history of disposal and disposal practices is presented in Section 2.1.

Because the CWL was operational when Resource Conservation and Recovery Act (RCRA) regulations were promulgated in 1976, the CWL qualified for interim status. Interim status allowed facilities to continue operation while RCRA authorities implemented a staged approach to permitting, establishing dates for the submittal of permit applications. During this period, the DOE and SNL/NM decided to close the CWL.

The closure process was then subject to RCRA interim status requirements, defined in 20.4.1.600 New Mexico Administrative Code incorporating Title 40 Code of Federal Regulations (CFR) 265, Subpart G. As part of this process, groundwater monitoring began at the CWL in 1985.

1.2 Closure Plan History

To implement the Subpart G closure provisions, the DOE, SNL/NM, and the New Mexico Environment Department (NMED) began negotiation of a Closure Plan in May 1988. In 1990, groundwater monitoring results confirmed the presence of trichloroethene (TCE) at concentrations exceeding the regulatory limit of 5 parts per billion (ppb). This finding led to the development and incorporation of a CA program into the Closure Plan in October 1991, which also addressed the closure performance standards required of Subpart G. In February 1993, the Final Closure Plan and Postclosure Permit Application (SNL/NM December 1992) were conditionally approved by the NMED (NMED February 1993). The Closure Plan is an enforceable document that details the approved closure process. The Postclosure Plan portion

of the Closure Plan was not approved by the NMED due to substantial uncertainty regarding actual closure requirements.

1.2.1 Expedited CA Program

In 1996, an expedited approach to the CA program was proposed in an effort to accelerate risk reduction through source removal, mitigate groundwater impacts, and reduce the complexity, schedule, and cost of final closure. Several factors that led to development of the expedited approach are summarized as follows:

- TCE concentrations in groundwater continued to exceed regulatory limits.
- Additional site characterization work had been completed by 1995 (CWL Groundwater Assessment Report [SNL/NM October 1995]).
- New U.S. Environmental Protection Agency (EPA) cleanup initiatives (area of contamination [AOC] policy [Shapiro March 1996] and CAMU regulations [EPA February 1993]) made it feasible to manage and treat excavated hazardous wastes on site, significantly reducing the cost to excavate source terms at sites like the CWL.
- The DOE and the SNL/NM ER Project were aggressively pursuing a programmatic strategy to reduce costs and expedite the closure schedule.

The expedited strategy included two interrelated VCMs, vapor extraction (VE) and LE. The VE VCM was performed first to prevent further impacts to groundwater quality by partially removing and gaining control of the volatile organic compound (VOC) vapor plume in the vadose zone. Based upon the site characterization work performed between 1992 and 1995, the VOC vapor plume was determined to be the source of the elevated levels of TCE in the groundwater (SNL/NM October 1995). Immediately following the active phase of the VE VCM, the LE VCM was performed to remove the source of the VOC vapor plume, which emanated from the waste materials and contaminated soil still present in the former disposal area. The long-term objectives for both VCMs were as follows:

- Significantly reduce or eliminate source areas associated with the CWL, including both the VOC vapor plume (source of groundwater contamination) and the original waste (source of the organic vapor plume and other potentially hazardous and radioactive constituents).
- Prevent further degradation of groundwater quality.
- Improve groundwater quality over time.

The desired overall effect of both VCMs was to reduce TCE concentrations in groundwater to below the regulatory limit and protect groundwater and other environmental pathways from potential contamination sources within the former disposal area.

The two VCMs were incorporated as Appendix S to the Closure Plan in May 1996 as a Class I Permit Modification request requiring prior approval (Lasker November 1996). The NMED approved the Class I Permit Modification with conditions on March 7, 1997 (Kelley March 1997).

LE: Landfill excavation
VCM: Voluntary Corrective measure

The VE VCM was implemented in May 1997 and consisted of an active and a passive phase. The active extraction phase of the VE VCM was started in May 1997 and completed in July 1998. During this period, more than 4,000 pounds (lb) of VOCs were removed from the vadose zone beneath the former disposal areas (SNL/NM May 2000). The VE system was then modified to allow for a passive phase of extraction and monitoring while the LE VCM took place, and remains in place and operational at this time. The primary goal of the VE VCM was to significantly reduce the vapor-phase VOC contamination in the vadose zone. This was achieved with two significant results: 1) the impact to groundwater was mitigated such that TCE concentrations no longer exceed regulatory limits, and 2) the site was prepared for successful implementation of the LE VCM. The VE VCM report (SNL/NM May 2000) describes the VE system and its performance during the two-year operating period from May 1997 to July 1999 (active and passive phases). The CWL quarterly reports have documented all groundwater monitoring results associated with the CWL.

Excavation of the CWL began in September 1998 and was completed in February 2002 as part of the LE VCM. The scope and objectives of the LE VCM are presented in the following section.

1.3 LE VCM Scope and Objectives

The overall scope of the LE VCM was to completely excavate areas of the landfill where disposal had occurred. Excavation was planned in a sequential, area-by-area manner based upon a comprehensive review of existing information and investigation data. In each defined disposal area within the CWL, the excavation was to proceed to a depth sufficient to remove all landfill contents and associated contaminated soil, up to a maximum depth of 20 feet below ground surface (bgs) (SNL/NM November 1998a). The main objective of the LE VCM was to remove the source for the VOC vapor plume, as well as other potential contamination sources, in order to eliminate contaminants from the vadose zone and groundwater, to mitigate the risk associated with the contamination, and to prepare the site for closure. Additional objectives included backfilling the excavation to grade, final disposal of all excavated and project-generated waste, and closure of the SOB. These ongoing efforts are summarized in Section 1.4.

Due to the inherent nature of the LE VCM, worker safety was a critical operational objective stressed throughout the project. This included ensuring the safety of site workers performing the LE VCM as well as SNL/NM and contractor personnel at nearby facilities. A rigorous health and safety program was implemented (SNL/NM November 1998b) and communication with nearby facilities was a priority throughout the excavation phase of the LE VCM project.

The LE VCM was conducted under two regulatory regimes: RCRA for the hazardous constituents and the Toxic Substances Control Act (TSCA) for polychlorinated biphenyls (PCBs). TSCA requirements are the purview of the EPA. To satisfy the TSCA requirements of 40 CFR 761, notification of the planned excavation was sent to EPA Region VI in December 1998 (Zamorski December 1998).

1.3.1 LE VCM Project Evolution

For context, it is important to understand that the LE VCM was initiated with a substantial degree of uncertainty. The most significant factor was the lack of detailed disposal records. Disposal records for the first 13 years of the 23-year disposal history were unavailable,

incomplete, inaccurate, and/or contained vague waste descriptions resulting in unknown waste types and volumes. In addition, direct investigation methods to characterize the landfill contents, such as drilling and sampling, were very limited due to the dangerous nature of some of the buried waste (gas cylinders, potential unexploded ordnance [UXO], etc.).

For these reasons, the LE VCM excavation, waste management, and worker health and safety approaches evolved and changed significantly as more accurate information was gained through direct experience. The many challenges associated with excavation of the CWL were met by applying a philosophy of continuous process improvement based upon actual experience and feedback from the site workers and project staff. The key to documenting and executing new approaches during the project (i.e., implementing the changes in a timely manner) was the close working relationship established among the staff at the DOE, the SNL/NM ER Project, and the NMED. Without this team approach and the active support of the NMED, expeditious implementation of key changes would not have been possible. Process changes and the associated documentation are discussed in Chapter 3.0.

In addition to process/procedural changes, another major change was the implementation of the risk-based approach (SNL/NM August 2000), developed in early 2000 and approved by the NMED in October 2000 (Lewis October 2000). The risk-based approach changed cleanup goals from background concentrations to risk-based criteria, consistent with the NMED-approved approach for other SNL/NM ER Project sites. Risk-based criteria were also developed to allow excavated soil to be returned to the excavation as backfill ("replaceable soil"), based upon soil sample analytical results. Section 3.4.1 provides more detailed information regarding the risk-based approach.

1.3.2 Permits and Public Involvement

Permits and licenses for daily activities associated with the LE VCM were required by SNL/NM and city, state, and county agencies. Table 1-1 lists the applicable permits and licenses, associated guidelines, and activity limits established for LE VCM operations.

The public, stakeholders, and regulatory agencies were kept informed during the planning and implementation stages of the LE VCM as required in the NMED conditions for approval of Appendix S of the Closure Plan (NMED February 1993).

The following activities have been performed and are ongoing:

- Quarterly reports of VCM activities are submitted to the NMED and EPA (quarterly reporting began in 1993 after approval of the Closure Plan).
- Technical meetings with the NMED and stakeholders are held on an as-needed basis, no less frequently than two times per year.
- The public has been kept informed of significant events through the DOE-SNL/NM public information process (e.g., Citizen Advisory Board Meetings, quarterly meetings, and mailings).
- During the LE VCM, many tours were conducted.

Table 1-1
Required Permits and Licenses for the LE VCM

Permit/License	Issuing Agency	Relevant Activities	Specific Applicable Requirements	Facility Activity Limits
Certificate of Registration for Air Pollutant Source in Bernalillo County No. NM/001/00540	Albuquerque Environmental Health Department	Material excavation—130,000 cubic yards	20 NMAC 11.20.II.1 20 NMAC 11.40.I.6 20 NMAC 11.90.II.1.5,1.6	N/A
		Material handling (PM)		PM emissions not to exceed 10 lb/hr or 25 tons per year (listed as 5.96 lb/hr, 3.10 tons/year)
		Wind erosion (PM)		PM emissions not to exceed 10 lb/hr or 25 tons per year (listed as 1.05 lb/hr, 0.55 tons/year)
		Soil off-gassing (VOC)		VOC emissions not to exceed 10 lb/hr or 25 tons/year (listed as 4.61 lb/hr, 2.40 tons/year)
SNL/NM Dig/Penetration Permits	SNL/NM	Excavation activities deeper than 18-inches below ground surface. Note: Numerous dig permits issued for the LE VCM project	SNL/NM Environment, Safety, and Health Manual	N/A
Surface Disturbance/ Demolition Permit—Particulate Matter Control Plan	Albuquerque Environmental Health Department- Air Pollution Control Division	Earth moving and fill hauling	20 NMAC 11.20 20 NMAC 11.20.1.7.6 20 NMAC 11.20.11.8	Total disturbed area—310,000 ft^2
Storm Water Best Management Practices	SNL/NM	Excavation and waste management activities (SNL/NM September 1999)	N/A	N/A
National Emission Standards for Hazardous Air Pollutants	EPA	Chemical Waste Landfill—Remediation activities that may be potential sources of radiological air emissions.	40 CFR 61 Subpart H	Radiological air emissions > 0.1 mrem/yr
Land Use Permit PERM/0-KI-99-0003	U.S. Air Force	Access to a 1-acre area of land on KAFB. The easement for access is to provide the additional room necessary for workers to access their work locations around the south end of the landfill.	N/A	No contamination from the CWL would be brought onto or transported over the easement area.

Refer to footnotes at end of table.

Table 1-1 (Concluded)
Required Permits and Licenses for the LE VCM

Permit/License	Issuing Agency	Relevant Activities	Specific Applicable Requirements	Facility Activity Limits
Radiological Work Permits—RWP0315, 0730, 1120, 1414 and 1726	SNL/NM	Excavation of the CWL, segregating landfill debris, performing chemical and radiological analyses, and managing the waste for shipment and or treatment at the CAMU.	10 CFR 835 DOE Order 5400.1 DOE N 441.1 SNL/NM Environment, Safety, and Health Manual	Radiation Exposure Levels: General area ≤ 0.1 mrem/hr On contact ≤ 0.1 mrem/hr
Radiological Work Permits – RWP0360, 0795, 0938, 1288, and 1577	SNL/NM	CWL On-Site Mobile Laboratory Trailers—Perform sample preparation and analysis of environmental samples		Radiation Exposure Levels: General area ≤ 0.1 mrem/hr On Contact ≤ 0.1 mrem/hr
Radiological Work Permits – RWP0746 and 1749 Radiological Work License—RWL 6000-011	SNL/NM	Operation of 2 X-ray fluorescence devices for soil and waste sample analysis (metals) RGD 0084 (Spectrace 6000 XRF Unit) RGD 00410 (Jordan Valley XRF unit)		N/A
Radiological Work Permit – RWP0748	SNL/NM	Electron Capture Device for PCB soil analyses		N/A
Radiological Work Permit – RWP1704	SNL/NM	Operation of MC-3 Density/Moisture Probe for backfilling field measurements		N/A
Hot Work Permit No. 97-1502	SNL/NM	General welding and cutting activities	N/A	N/A

CAMU = Corrective Action Management Unit.
CFR = Code of Federal Regulations.
CWL = Chemical Waste Landfill.
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.
ft^2 = Square feet.
hr = Hour.
KAFB = Kirtland Air Force Base.
lb = Pound(s).
LE = Landfill Excavation.
mrem = Millirem(s).
N/A = Not applicable.
NMAC = New Mexico Administrative Code.
PCB = Polychlorinated biphenyl.
PM = Particulate matter.
RGD = Radiation-generating device.
RWL = Radiological Work License.
RWP = Radiological Work Permit.
SNL/NM = Sandia National Laboratories/New Mexico.
VCM = Voluntary Corrective Measure.
VOC = Volatile organic compound.
XRF = X-ray fluorescence.

SOB: Site operational boundary

Quarterly reporting and technical meetings are ongoing and will continue until final closure of the CWL is approved.

1.4 Current Status

Excavation of the CWL began on September 30, 1998 and was completed on February 12, 2002. Most of the excavated soil (approximately 89 percent) has been treated and/or disposed of at the adjacent CAMU, which was set up and permitted specifically to handle the CWL excavated waste.

Backfilling efforts are underway and are approximately 40 percent complete. The CWL Backfill and Compaction Plan, submitted to the NMED in April 2002, was conditionally approved in June 2002 (Bearzi June 2002). The plan was revised to satisfy the NMED conditions and resubmitted to the NMED (SNL/NM July 2002). Backfilling was initiated in June 2002 with the placement of approximately 1,250 cy of rock and 35 cy of concrete directly on the excavation floor as a marker layer. Approximately 11 percent of the excavated soil (about 5,670 cy) was returned to the base of the excavation and placed on top of the rock layer as replaceable soil fill consistent with the risk-based approach (SNL/NM August 2000). Subsequently, clean fill was used to backfill the excavation. In August 2002, 40 percent of the excavation had been backfilled, and activities were temporarily suspended while soil treatment at the CAMU began. CAMU operations are ongoing and scheduled to be completed by June 2003. Backfilling activities are planned to resume in June 2003 and are expected to be completed by October 2003.

Preliminary risk screening assessments were discussed informally with the NMED in May 2002 in conjunction with authorization to begin backfilling, as stipulated in the Backfill and Compaction Plan (SNL/NM July 2002). The NMED requested additional information on the preliminary risk screening assessments prior to issuing a decision that included the final verification analytical results and a final risk screening assessment (Bearzi June 2002). In response to this NMED request for additional information, SNL/NM proposed to submit the final verification analytical results and risk screening assessment in the LE VCM Report (Zamorski August 2002). The final verification analytical results are provided in Volume 2 of this report and are discussed in Chapter 5.0. The final risk screening assessment is provided in Annex A and discussed in Chapter 6.0. NMED approval of this information is requested to resolve the only remaining issues associated with the "Approval with Conditions: Class 1 Modification: Backfill and Compaction Plan, Addendum C to Appendix S, Chemical Waste Landfill Closure Plan, April 2002" (Bearzi June 2002).

Final characterization and off-site disposal of soil that does not meet the CAMU waste acceptance criteria (less than 200 cy) and debris (excavated and project-generated) are ongoing. After completion of this work, planned for 2005, a Waste Management Addendum to this LE VCM Report will be issued to document final disposition of all project waste.

Efforts are ongoing to clear the SOB (area around the landfill used for equipment and waste staging, waste segregation and management, etc.), which includes scraping approximately 2 inches of soil from the entire SOB, removing berms associated with current surface-water control features, and performing the general site grading necessary as part of final site restoration. The SOB was scraped and the loose soil has been managed and sampled in 1,000-cy piles. This soil will be used as clean fill. The SOB will be sampled using the approved 50-foot sampling grid (SNL/NM March 1999a). The SOB 50-foot grid samples will be analyzed

for the typical CWL analytical suite, including metals (RCRA metals plus hexavalent chromium, beryllium, copper, nickel), VOCs, semivolatile organic compounds (SVOCs), PCBs, and radionuclides. The results will be evaluated against the risk-based criteria to determine appropriate final disposition and whether additional scraping is required to achieve risk-based closure of the SOB. All of this information will be documented in an SOB Closure Addendum to this LE VCM Report.

2.0 SITE DESCRIPTION

The CWL, shown in Figure 2-1, is located in the southeast corner of SNL/NM TA-III and encompasses an area of approximately 1.9 acres (Figure 2-2). The topography is generally flat with a gentle slope toward the west. A fence surrounded the landfill prior to the LE VCM. No major arroyo channels occur in the area and most surface-water flow is along road ditches. The CWL is approximately 4 miles south of the nearest well that supplies drinking water and is at least 3 miles from any natural groundwater discharge point.

The region's semi-arid climate averages approximately 8 inches of annual precipitation resulting primarily from thunderstorms during late summer to early autumn and snowfall in the winter. Daytime summer temperatures average approximately 90 degrees Fahrenheit (°F), and daytime winter temperatures average approximately 50°F.

SNL/NM is near the east-central edge of the Albuquerque Basin, which is a north-south–trending basin located within the Rio Grande Rift Zone. The uplifted fault blocks of the Sandia, Manzanito, and Manzano Mountains comprise the eastern basin boundary. The Nacimiento Uplift, the Lucero Uplift, and the Ladron Mountains bound the western side of the basin. There is little physiographic relief on the northwest side of the basin (SNL/NM October 1995).

The surficial geology at the site is characterized by a thin veneer of aeolian sediments underlain by alluvial fan deposits known as the Santa Fe Group, a heterogeneous sequence of unconsolidated to semiconsolidated cobbles, gravels, sands, silts, and clays of alluvial to fluvial origin. These sediments are locally cemented by caliche (SNL/NM October 1995).

SNL/NM lies within the Albuquerque Basin hydrologic regime. The basin is approximately 100 miles long and ranges from 20 to 40 miles wide. The Rio Grande, flowing north to south, is the main drainage in the basin. The major aquifer in the Albuquerque Basin is contained within the Santa Fe Group sediments. Groundwater in the basin occurs under generally unconfined conditions; however, confined or semi-confined conditions exist locally. At the CWL, the water table is approximately 485 feet bgs. The general groundwater flow direction is to the northwest and does not exhibit significant seasonal change, based upon quarterly monitoring that began in 1990. Local heterogeneity northwest of the site suggests a more northerly direction of groundwater flow in this area. The regional hydrologic system is described in more detail in the SNL/NM "CWL Ground Water Assessment Report" (SNL/NM October 1995).

2.1 Site Operational History and Characterization

SNL/NM involvement in research and development for the Department of Defense began in the 1940s. Most of the information presented in this section is summarized from the following two early CWL reports:

- "Characterization of the SNL Chemical Waste Disposal Site" (Weston November 1984)
- "RCRA Interim Status Groundwater Monitoring Plan" (IT December 1985)

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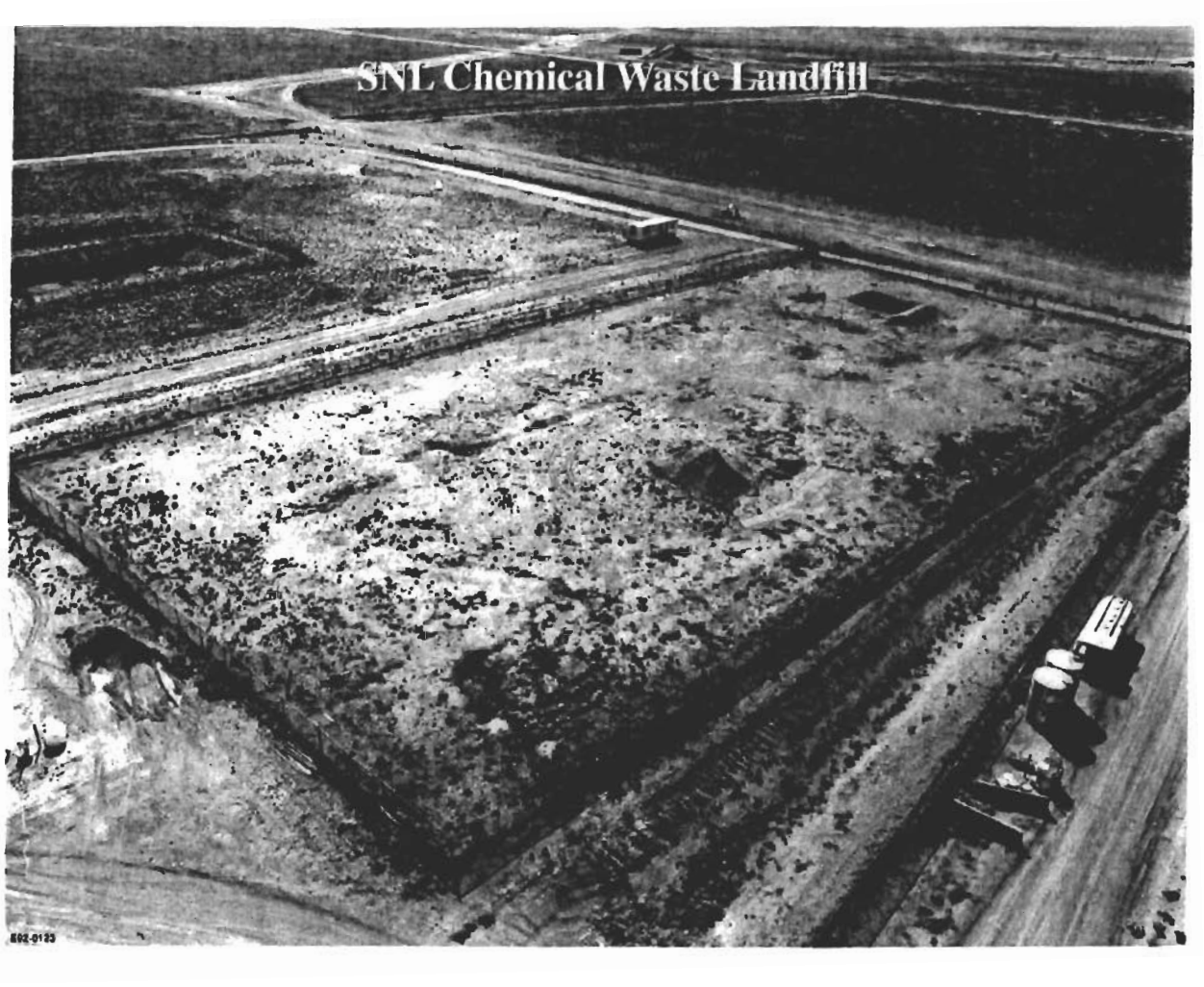
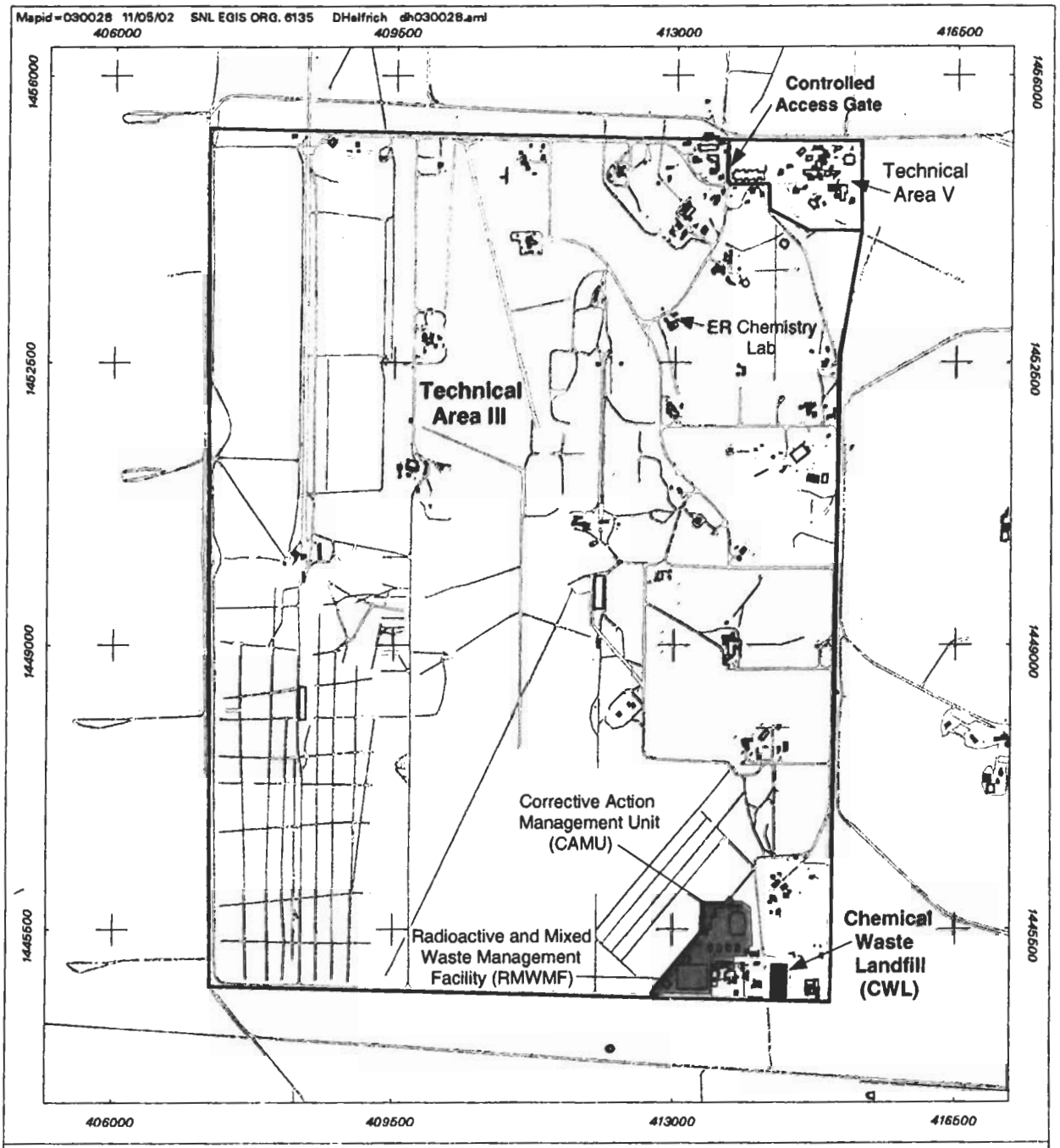


Figure 2-1
Chemical Waste Landfill in 1992 (View to the Southeast)



Legend

- Building / Structure
- Paved & Unpaved Road
- SNL Technical Areas III/V
- CAMU
- CWL

Figure 2-2
Location of the CWL and CAMU within Technical Area III

0 1000 2000
Scale in Feet

0 240 480
Scale in Meters

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These reports were also used as the basis for early CWL closure planning documented in the CWL Closure Plan (SNL/NM December 1992). No records of disposal are available for the period between 1962 and 1975, resulting in a high degree of uncertainty concerning the actual waste types, waste volumes, and disposal locations within the CWL during this 13-year period. However, from reconnaissance studies (Weston November 1984 and IT December 1985), it was inferred that the waste pits were, for the most part, uniformly distributed. Figure 2-3 shows a schematic interpretation of the disposal pit locations as of 1984, based upon the Roy F. Weston Inc. study of historical records and available site data (Weston November 1984).

Disposal of waste into unlined pits at the CWL began in 1962. Separate pits were reported to have been used for the disposal of acids, oxidizers, reducers, organic and reactive compounds, bulky materials, metal, neutral compounds, and salts. Waste was to be separated by type and placed in the appropriate pits. However, this procedure was not strictly followed while the landfill was in operation. In addition to pits, an unlined surface impoundment that measured approximately 23 by 6 by 7 feet deep was used for disposal of chromic acid waste from the early 1970s to 1978 (labeled "Chromic Acid Trench" in Figure 2-3). A lined surface impoundment approximately 15 by 15 by 5 feet deep was used between 1979 and 1982 for the disposal of both liquid chromic acid waste and ferric chloride waste (labeled "Surface Impoundment Chromic Acid" in Figure 2-3).

The original waste pits were excavated 8 to 12 feet deep by at least 2 feet wide using a backhoe. After a pit had been filled with waste, a new one was excavated and numbered the same as the original pit. The number assigned to each waste pit corresponded to a specific chemical type, as shown in Table 2-1. Markers that were historically used for identifying pit locations, as shown in Figures 2-4 and 2-5, were subsequently destroyed or buried during grading activities.

Table 2-1
Summary of Waste Pit Identification Numbers

Pit Designation	Waste Type
1 or 1B	Reactive compounds, aluminum hydrides
2A	Oxidizers
2B	Reducers
3	Organic compounds
4	Acids, mineral acids
5	Metals, neutral salts, bulky material, unknowns

After 1975, records were available documenting SNL/NM's Division of Industrial Hygiene (DIH) waste collection services. DIH employees completed chemical disposal tickets to show the location of the waste pickup, the type of waste material, the contact personnel, the special instructions, and the designated disposal area.

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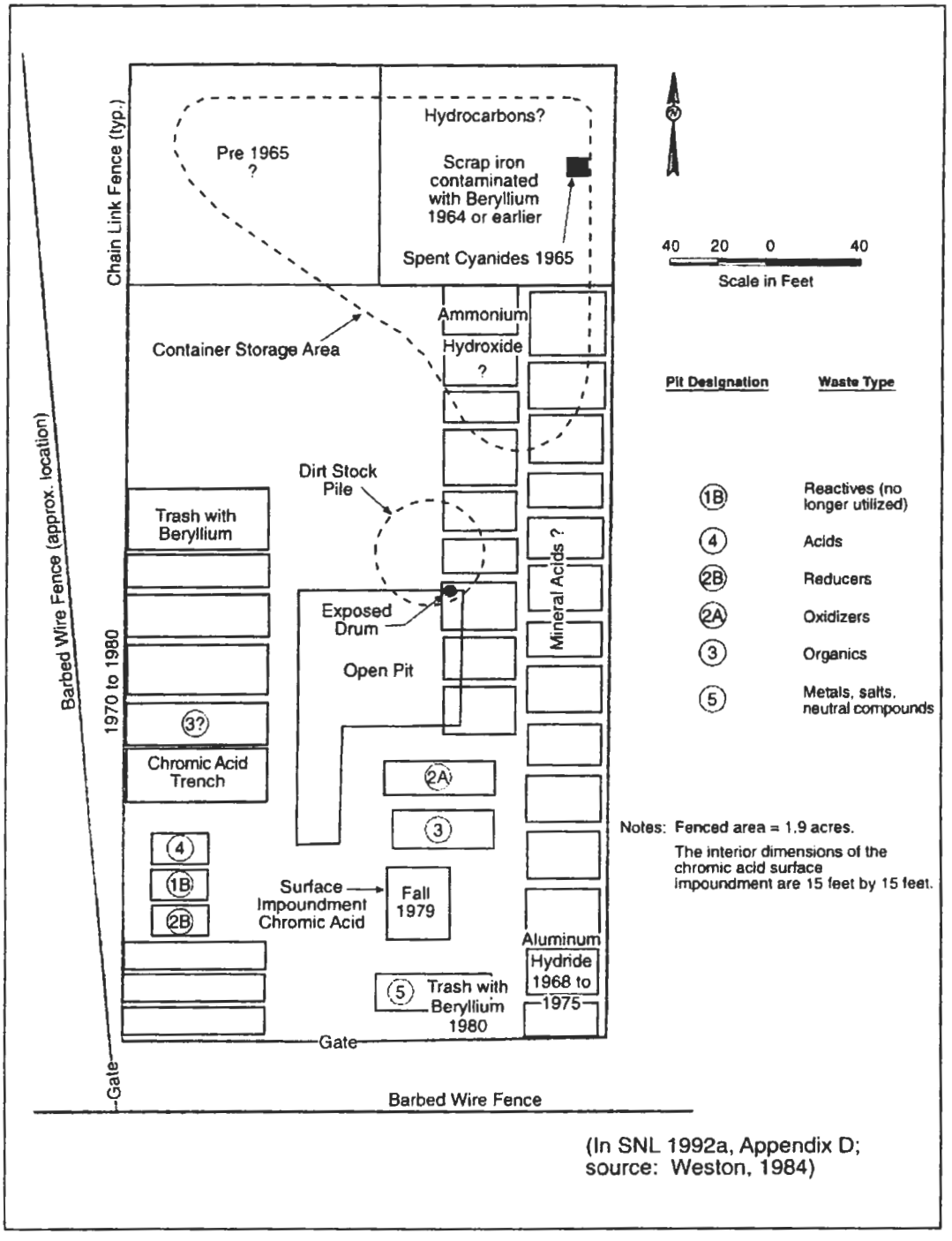

(In SNL 1992a, Appendix D; source: Weston, 1984)

Figure 2-3
Interpretation of Disposal Pit Locations and Contents as of 1984

Figure 2-4
Historic Photograph Showing Markers Used for Pit Identification

Figure 2-5
Historic Photograph Showing a Disposal Pit and Associated Marker

The rate at which the waste pits were filled varied depending upon the types of waste. Waste pits designated to contain organic contaminants were filled most quickly. When filled to capacity, the pits were covered with fill material and allowed to settle over time. As the material settled, new fill material was added. Heavy-equipment traffic on the CWL surface resulted in compaction of the material.

In 1981, all liquid waste disposal into unlined pits ceased; however, solid waste disposal continued until 1985. Liquid waste was stored next to the appropriate pit and later packaged into 55-gallon drums. Chemically similar wastes, such as oils and solvents, were consolidated and disposed of off site at an approved disposal facility by a hazardous waste management contractor.

From 1985 to 1989, the CWL operated under RCRA interim status as a storage facility with a capacity for 300 hazardous waste drums. Waste drums were staged on the ground surface in segregated areas according to waste type. In 1989, operations at the CWL were discontinued completely, all waste drums were removed from the surface of the landfill, and all pits were covered with soil backfill. The lined chromic acid surface impoundment remained uncovered until April 1991, when the impoundment was covered with a sheet of plastic and approximately 2 inches of soil to minimize wind dispersal of chromium-contaminated dust.

2.1.1 Preliminary Site Characterization Studies and Existing Data

Site characterization activities were performed between 1971 and the start of the LE VCM in September 1998. Site characterization activities for the period from 1981 to 1998 are depicted in Figure 2-6. Both nonsampling (geophysical surveys and trenching) and sampling (surface and subsurface soil, soil-vapor, and groundwater) activities were performed at the CWL and are summarized in Table 2-2, which includes a brief description of each site investigation and the findings. The main conclusions from previous site investigations are briefly summarized as follows:

- Elevated chromium concentrations (relative to background concentrations) associated with the unlined chromic acid surface impoundment were documented in the soil as deep as 75 feet bgs.
- A VOC vapor plume was delineated in the vadose zone beneath the disposal area and appeared to extend all the way to groundwater at approximately 500 feet bgs.
- VOC soil contamination appeared to be restricted to the main disposal areas and immediately surrounding vicinity. Widespread soil contamination away from the disposal areas was not encountered, unlike the VOC vapor-plume contamination.

Data from geophysical surveys, soil sampling, soil coring, monitoring wells, and vapor extraction wells were used to develop a conceptual model of the site (discussed in Section 2.2) and to plan the expedited, two-phase VCM strategy. Planning for the LE VCM focused on the known waste materials from disposal records and sampling data, and the locations of disposal pits based primarily upon historical records (where available), trenching, and geophysical survey data. This information is summarized in Section 2.1.2.

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Table 2-2
Summary of Previous Investigations at the CWL

Year	Investigation Type	Constituents Evaluated	Results
1971	Soil boreholes (5)	Beryllium, chromium, cadmium, mercury, cyanide, phenols	Boreholes next to trenches, no contamination noted
1978	Batch adsorption	Cesium, strontium, chromium, lead, mercury, nickel, cadmium	Based upon mobility, chromium only contaminant of concern; recharge rate estimated at 89E-6 to 6E-5 ft/day
1981	Soil boreholes	Chromium	Chromium migration to a depth of 45 ft
1983	Soil boreholes (4)	Chromium	Chromium migration 50 ft vertically, 13 ft laterally
1984	Geophysical survey	EM, GPR, and VFM surveys	Map contaminant plume, buried material detected, disposal pit boundaries estimated
1985	Soil boreholes (17), trenches (10)	Metals, VOCs, SVOCs, TOC, and cyanide	Complete landfill coverage, broad range of inorganic- and organic-contaminated soil, metal and glass debris noted
1985	Monitoring wells (5)	Metals, VOCs	Low VOCs in MW-1, MW-3, and BW-1; TCE in soil samples
1987	Soil boreholes (7)	Chromium	Chromium migration 75 ft vertically, 65 to 70 ft laterally
1990	Monitoring well (MW-4)	Metals, VOCs	No contamination noted
1991-1992	Geophysical survey	Towed array magnetometer and GPR surveys	Buried material and waste pit boundaries determined
1992	TEVES vapor extraction wells (2)	Metals, VOCs, PCBs, PAHs	TCE, PCE, acetone, PAHs, PCBs, chromium detected in soil samples
1992	UCAP boreholes (3)	Chromium	Volume of chromium-contaminated soil estimated at 8,000 cubic yards
1992	Unsaturated zone investigation (21 boreholes and soil-gas sampling)	VOCs, SVOCs, pesticides, dioxin/furans, PCBs, metals	Elevated levels of TCE, TCA, and PCE (indicating presence of NAPL); PCBs detected in soil
1993	Slant boreholes (2)	Chromium	Chromium detected in soil 26.4 ft bgs near 1960s pit area
1995	Soil boreholes	VOCs, SVOCs, PCBs, metals	VOCs, metals, SVOCs in soil; PCBs in ppb range
1996-97	EK Extraction System soil boreholes	VOCs, SVOCs, PCBs, metals	VOCs including acetone, chromium, PCB (Aroclor-1260) in soil samples
1996-97	Vapor extraction well soil boreholes	VOCs, SVOCs, PCBs, metals	With exception of acetone, low VOC levels in soil
1998	Geophysical survey	Magnetometer, metal detector and conductivity surveys	Buried material and waste pit boundaries determined

Ref: SNL/NM November 1998a.
bgs = Below ground surface.
BW = Background well.
CWL = Chemical Waste Landfill.
EK = Electrokinetic.
EM = Electromagnetic.
ft = Foot (feet).
GPR = Ground Penetrating Radar.
MW = Monitoring well.
NAPL = Nonaqueous Phase Liquid.
PAH = Polyaromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
PCE = Tetrachloroethene.
ppb = Parts per billion.
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
TCA = 1,1,1-trichloroethane.
TCE = Trichloroethene.
TEVES = Thermally Enhanced Vapor Extraction System.
TOC = Total organic carbon.
UCAP = Unlined Chromic Acid Pit.
VFM = Vertical Field Magnetometer.
VOC = Volatile organic compound.

2.1.2 Potential Waste Types and Constituents

Facility operations at SNL/NM generated a variety of solid and liquid wastes, including hazardous, radioactive, mixed, and nonradioactive/nonhazardous wastes. Based upon site characterization data and historical records of disposal, various constituents of concern (COCs), including VOCs, SVOCs, inorganic compounds (metals including RCRA metals plus hexavalent chromium, beryllium, copper, and nickel), oily wastes, PCBs, and contaminated debris were expected at the site. Other waste streams were also suspected of containing radioactive waste, mixed waste, asbestos, and DOE-classified waste.

Intensive LE VCM planning efforts focused on evaluating all existing data and creating large-scale maps showing the location of all available and relevant information. Of special importance were:

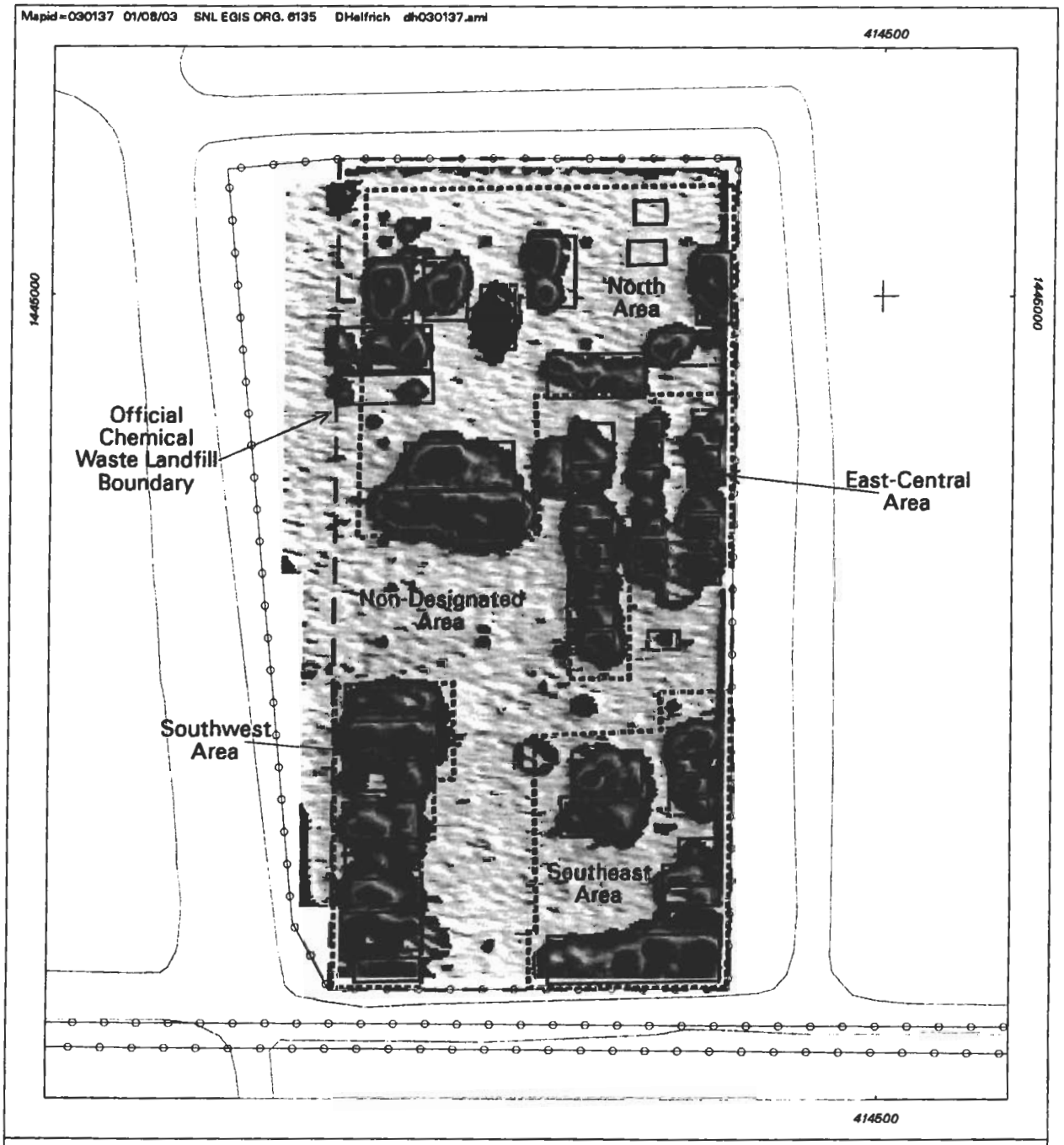
- Historical information and disposal trench land survey data from 1984 (Weston November 1984)
- Exploratory trenching and soil sampling conducted in 1985 (IT December 1985)
- Geophysical survey conducted in 1998 (Hyndman August 1998)

The 1998 geophysical survey was particularly important in confirming the former disposal pits and trenches and is included in Annex B. Results of the 1998 geophysical survey are presented in Figure 2-7. Based upon this detailed evaluation, the CWL was subdivided into four designated excavation areas and one "Non-Designated Area" for the LE VCM (Figures 2-7 and 2-8). The four designated excavation areas were the East-Central Area (0.22 acres), the Southeast Area (0.28 acres), the Southwest Area (0.19 acres), and the North Area (0.52 acres). Each of these designated excavation areas contains numerous former disposal pits and trenches. The remaining area within the boundary of the CWL that was not initially determined to have been impacted by past waste disposal, based upon available data, was referred to as the Non-Designated Area and encompassed approximately 0.69 acres. A brief summary of each designated excavation area and the anticipated contamination/waste types, based upon this historical data set, is presented in the following sections.

2.1.2.1 East-Central Area

The East-Central Area consisted of disposal pits used from the early 1960s to the early 1970s for the disposal of both organic and inorganic wastes. The area had commonly been referred to as the "60s pits." Historical records indicate that the 60s pits were grouped into three areas within the East-Central Area: acid waste in Area I, inorganic waste in Area II, and organic waste in Area III. In addition to these three areas, a pit located directly north of Area III received waste that did not conveniently fit into the pits (e.g., drums and tanks).

During the previous site investigations, analysis of soil-gas and soil samples from this area indicated a host of organic constituents as well as elevated levels of chromium. A list of contaminants found in soil samples taken from the East-Central Area during previous site investigations is provided in Table 2-3.



Legend

- Paved & Unpaved Road
- CWL Boundary
- Fence
- Excavation Area Boundary
- Interpreted Disposal Pit and Trench Location

EM-61 Difference Response

- 750 mV
- 300 mV
- 60 mV
- 20 mV
- 5 mV

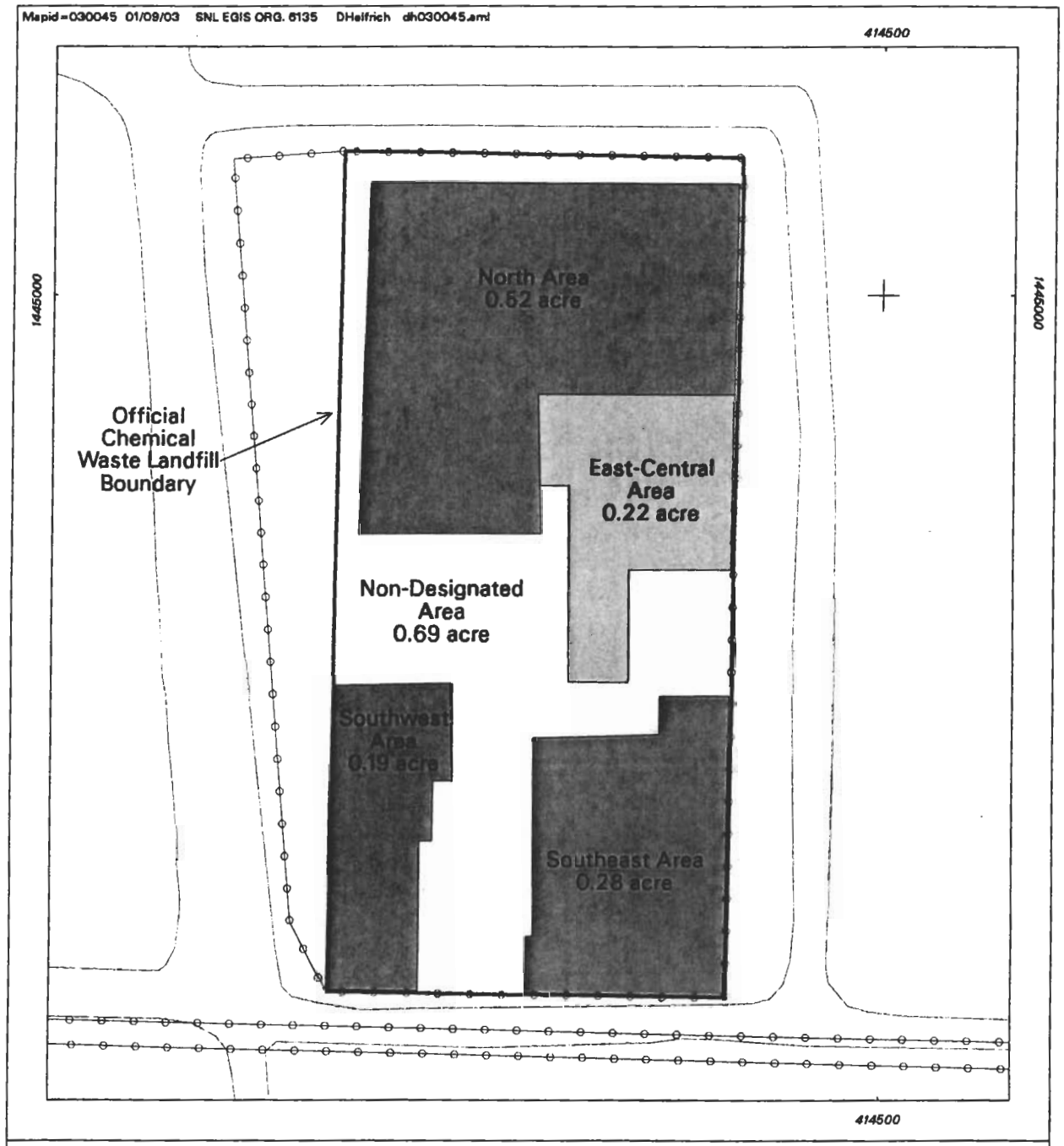
mV = millivolts

Figure 2-7
Interpreted Disposal Locations based on 1998 Geophysical Survey Chemical Waste Landfill

0 40 80
Scale in Feet

0 9.6 19.2
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

- Paved & Unpaved Road
- CWL Boundary
- Fence
- Southeast Area
- East-Central Area
- North Area
- Southwest Area

Figure 2-8
Designated Excavation Areas and the Non-Designated Area Chemical Waste Landfill

0 40 80
Scale in Feet

0 9.6 19.2
Scale in Meters

N

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 2-3
Potential Contaminants in the Soil of the East-Central Area

VOCs			
1,1,2-trichloroethane	Benzene	Cis-1,2-dichloropropylene	Tetrachloroethene
1,1-dichloroethane	Bromoform	Cyclohexane	Toluene
1,1-dichloroethylene	Carbon tetrachloride	Dichlorobromomethane	Trans-1,2-dichloroethylene
1,2-dichloropropane	Chlorobenzene	Dimethoxymethane	Trans-1,2-dichloropropylene
1,1,1-trichloroethane	Chlorodibromomethane	Ethyl benzene	Trichloroethene
Freon 113	Chloroform	Freon 11	Xylene
2-nitropropane	2-butanone	Methylene	
Acetone	Cis-1,2-dichloroethylene	Styrene	
SVOCs			
1,2,4-trichlorobenzene	4-nitrophenol	Diethyl phthalate	Phenanthrene
1,4-dichlorobenzene	Acenaphthene	Hexachlorobenzene	Phenol
2,4-dinitrotoluene	Benzoic acid	N-nitroso-di-n-propylamine	Pyrene
2-chlorophenol	Bis(2-ethylhexyl) phthalate	N-nitrosodiphenyl-amine	
4-Chloro-3-methylphenol	Chrysene	Pentachlorophenol	
Metals		**PCBs**	
Arsenic		Aroclor-1242	
Chromium		Aroclor-1254	

LE = Landfill excavation.
PCB = Polychlorinated biphenyl.
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
VCM = Voluntary Corrective Measure.
VOC = Volatile organic compound.
Reference: LE VCM Waste Management Plan (SNL/NM November 1998c).

Trenching activities conducted in 1985 along the eastern, southeastern, and western boundaries of the East-Central Area uncovered buried metallic and glass debris, including intact 55-gallon drums (some filled with liquids of various viscosities, colors, and densities), cans, bottles, plastic bags of powders, laboratory glassware, metal turnings, grindings, and a beryllium-contaminated metal plate wrapped in plastic (IT December 1985). A pressurized gas cylinder was also unearthed during the excavation of a pit in the western portion of the East-Central Area. All waste items were encountered at approximately 2 to 4 feet bgs. All trenches and excavation pits were backfilled following the completion of activities.

2.1.2.2 Southeast Area

Historical records suggested oxidizers, organic compounds, and aluminum hydrides were disposed of in the Southeast Area. Based upon waste inventory records from 1975 to 1982, the following volumes of waste were disposed of in pits within the area: 15 to 20 lb of beryllium-contaminated waste, 3,000 to 3,500 lb of lead-contaminated waste, 70 to 80 lb of mercury-contaminated waste, two 3,000-lb steel tanks, and 1,000 gallons of chromic acid waste. Historical records also indicated that 15 bottles of uranyl nitrate and 0.5 liter (L) of uranium were mistakenly placed in this area of the landfill during the 1970s.

Both organic and inorganic contamination was detected in soil samples taken from the Southeast Area. The primary contaminants were benzene, ethylbenzene, toluene, and xylene compounds, acetone, and various metals. A list of all contaminants detected in soil samples taken from the Southeast Area during previous site investigations is included in Table 2-4.

Table 2-4
Potential Contaminants in the Soil of the Southeast Area

VOCs			
1,1-dichloroethylene	Benzene	Freon 113	Xylene
1,1,1-trichloroethane	Chloroform	Methylene chloride	
2-butanone	Ethylbenzene	Tetrachloroethene	
2-hexanone	Freon 111	Toluene	
Acetone		Trichloroethene	
SVOCs			
Acenaphthene	Benzo(b)fluoranthene	Diethyl phthalate	Phenol
Anthracene	Benzo(k)fluoranthene	Fluoranthene	Pyrene
Benzo(a)anthracene	Bis(2-ethylhexyl) phthalate	Fluorene	
Benzo(a)pyrene	Chrysene	N-nitrosodiphenyl-almine	
Di-n-butylphthalate	Dibenzofuran	Phenanthrene	
Metals		**PCBs**	
Mercury		Aroclor-1260	
Beryllium		Aroclor-1016	
Chromium			
Lead			

LE = Landfill excavation.
PCB = Polychlorinated biphenyl.
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
VCM = Voluntary Corrective Measure.
VOC = Volatile organic compound.
Reference: LE VCM Waste Management Plan (SNL/NM November 1998c).

During trenching activities conducted in 1985 within the northeastern, central, and eastern portions of the Southeast Area, crushed drums, 5-gallon cans, plastic bottles, plastic bags, and miscellaneous laboratory glassware were unearthed at approximately 3 to 5 feet bgs. Some of the containers were intact (IT December 1985).

2.1.2.3 Southwest Area

The Southwest Area of the CWL received acids, reactive compounds, reducers, organic compounds, and chromium waste during the 1970s and 1980s. Disposal records indicate that the following volumes of waste were disposed of in this area: approximately 2,800 gallons of acetone, 400 gallons of freon, 90 gallons of laser dye, 7,000 gallons of solvent waste, 1,025 gallons of TCE, 240 gallons of toluene, 765 gallons of creosote oil, and 5,500 gallons of waste oil. Radioactive waste (0.2 lb of thorium oxide) was inadvertently disposed of in this area of the landfill in 1981. The northernmost disposal pit in the Southwest Area reportedly contained trash with beryllium waste. Waste inventory records indicated that approximately 2,500 gallons of chromic acid waste were dumped into the unlined chromic acid pit from 1975 to 1981. During the same period, the southern portion of the Southwest Area received 330 gallons of acetone and 700 lb of lithium waste (mainly lithium batteries).

Soil in the area was contaminated primarily by VOCs (mainly TCE, 1,1,1-trichloroethane, and tetrachloroethene [PCE]) and chromium waste originating from an unlined chromic acid pit. Previous soil sampling in this area had confirmed organic (including PCBs) and inorganic contaminants. Soil and soil-gas sampling, conducted as part of the Thermally Enhanced Vapor Extraction System (TEVES) demonstration project (SNL/NM August 1997), revealed elevated

levels of VOCs, SVOCs, and PCBs. Table 2-5 includes a list of contaminants detected in soil samples taken from the Southwest Area during previous site investigations.

Table 2-5
Potential Contaminants in the Soil of the Southwest Area

VOCs			
1,1,2,2-tetrachloroethane	4-ethyl toluene	Decane	Styrene
Freon 113	4-methyl-2-pentanone	Ethyl benzene	Toluene
1,1,1-trichlorethane	Acetone	Freon 12	Tetrachloroethene
1,1,2-trichloroethane	Benzene	Hexane	Trichloroethene
1,3,5-trimethylbenzene	Carbon disulfide	Methylene	Freon 11
1,2-dibromoethane	Carbon tetrachloride	Methylene chloride	Vinyl chloride
1,1-dichloroethane	Chlorobenzene	n-Heptane	Xylene
1,2-dichloroethane	Chlorodifluoro-methane	n-Nonane	
1,2-dichloropropane	Chloroform	n-Octane	
2-butanone	Cyclohexane	n-Pentane	
SVOCs			
1,2-dichlorobenzene	Benzo(a)anthracene	Carbazole	Methyl napthalene
1,4-dichlorobenzene	Benzo(a)pyrene	Chrysene	Naphthalene
2-methylnapthalene	Benzo(b)fluoranthene	Dibenzofuran	N-nitrosodiphenylamine
2,4-dimethyl phenol	Benzoic acid	Diethyl Phthalate	Phenanthrene
4-methyl phenol	Benzo(g,h,i)perylene	Di-n-butylphthalate	Phenol
4-methyl-2-pentanone	Benzo(k)fluoranthene	Fluoranthene	Pyrene
Acenaphthene	Bis(2-ethylhexyl) phthalate	Fluorene	
Anthracene	Butyl benzyl phthalate	Ideno(1,2,3-cd)pyrene	
Metals		PCBs	
Barium		Aroclor-1016	
Beryllium		Aroclor-1242	
Chromium		Aroclor-1260	
Lead			

LE = Landfill excavation.
PCB = Polychlorinated biphenyl.
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
VCM = Voluntary Corrective Measure.
VOC = Volatile organic compound.
Reference: LE VCM Waste Management Plan (SNL/NM November 1998c).

Drums, metal cans, glass bottles, plastic bags, and laboratory glassware were also discovered approximately 2 feet bgs during trenching activities near the southern boundary of the Southwest Area (IT December 1985).

2.1.2.4 North Area

The North Area was the largest of the four designated areas (Figure 2-8) and involved the greatest uncertainty concerning disposal pit locations, excavation-generated waste streams, and excavation waste volumes. Historical records and geophysical data indicated the majority of waste was buried debris. In addition to buried debris, previous soil sampling revealed elevated levels of organic and inorganic contaminants in soil throughout the area. Elevated levels of lead and chromium were detected in soil samples from the north-central portion of the North Area, and elevated levels of PCBs were documented in the northeastern portion. Table 2-6 lists known contaminants in the North Area from previous soil sampling events.

Table 2-6
Potential Contaminants in the Soil of the North Area

VOCs			
1,1-dichloroethane	4-methyl-2-pentanone	Cis-1,2-dichloroethylene	Methylene chloride
1,1,1-trichloroethane	Acetone	Cis-1,3-dichloropropylene	Styrene
1,1,2-trichloroethane	Benzene	Dichlorobromomethane	Tetrachloroethene
1,2-dichloropropane	Bromoform	Dimethoxymethane	Toluene
1,2-dichloroethane	Carbon tetrachloride	Ethylbenzene	Trans-1,2-dichloroethylene
2-butanone (MEK)	Chlorodibromo-methane	Freon 11	Trichloroethene
4-methyl-1-pentanone	Chloroform	Hexane	Xylenes (total)
SVOCs			
Acenaphthene	Benzo(g,h,I)perylene	di-n-Butyl phthalate	Phenanthrene
Anthracene	Benzo(k)fluoranthene	di-n-Octyl phthalate	Phenol
Benzo(a) anthracene	Benzyl alcohol	Fluoranthene	Pyrene
Benzo(a)pyrene	bis(2-ethylhexyl) phthalate	Fluorene	Tyrosine
Benzo(b) fluoranthene	Dibenzofuran	Ideno(1,2,3-cde)pyrene	
Metals		**PCBs**	
Arsenic		Aroclor-1016	
Barium		Aroclor-1242	
Chromium		Aroclor-1260	
Lead			

LE = Landfill excavation.
PCB = Polychlorinated biphenyl.
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
VCM = Voluntary Corrective Measure.
VOC = Volatile organic compound.
Reference: LE VCM Waste Management Plan (SNL/NM November 1998c).

Exploratory trenches, excavated approximately 18 inches bgs along the western edge and within the northern and central portion of the North Area, revealed various cans and bottles, some containing liquids or powders, 55-gallon drums, corroded steel equipment, and bags of metal turnings and grindings.

2.2 Pre-LE VCM Conceptual Model

The nature and extent of contamination at the CWL prior to the LE VCM was based upon the characterization studies and field investigations that are summarized in Table 2-2 and Section 2.1. The pre-LE VCM conceptual model summarized in this section is also presented in the CWL LE VCM Sampling and Analysis Plan (SAP) (SNL/NM November 1998a). Conceptual models of waste disposal and migration that represent the CWL are presented in Figures 2-9 and 2-10. These diagrams illustrate the principal waste types and interpreted contaminant migration from disposal areas based upon previous studies. Although many combinations of waste constituents are possible, the figures are simplified representations of the major waste constituents that were expected based upon disposal records and previous studies. A detailed summary of historic disposal practices at the CWL is provided in the CWL LE VCM Waste Management Plan (WMP) (SNL/NM November 1998c).

Figure 2-9 (a) presents a conceptual model of a solvent waste pit and near-field contaminant migration. Based upon drilling and soil-sampling data, solvent migration (laterally and vertically) away from the original waste pits is very limited, as shown in Figure 2-9. Far-field impacts are

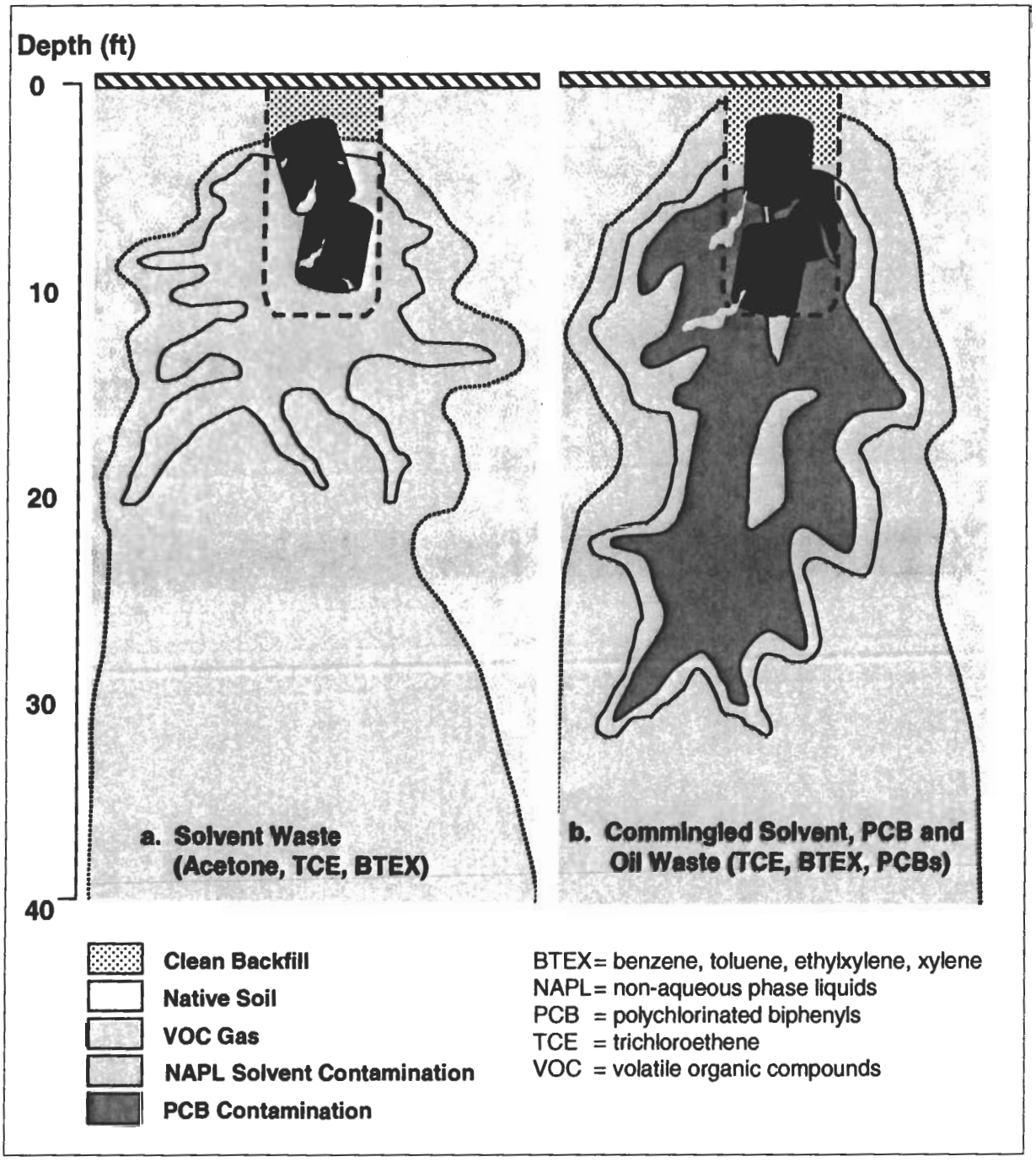


Figure 2-9
Pre-LE VCM Conceptual Model of Disposal Pits Containing Leaking Containers with Solvent and Commingled Solvent/PCB Waste

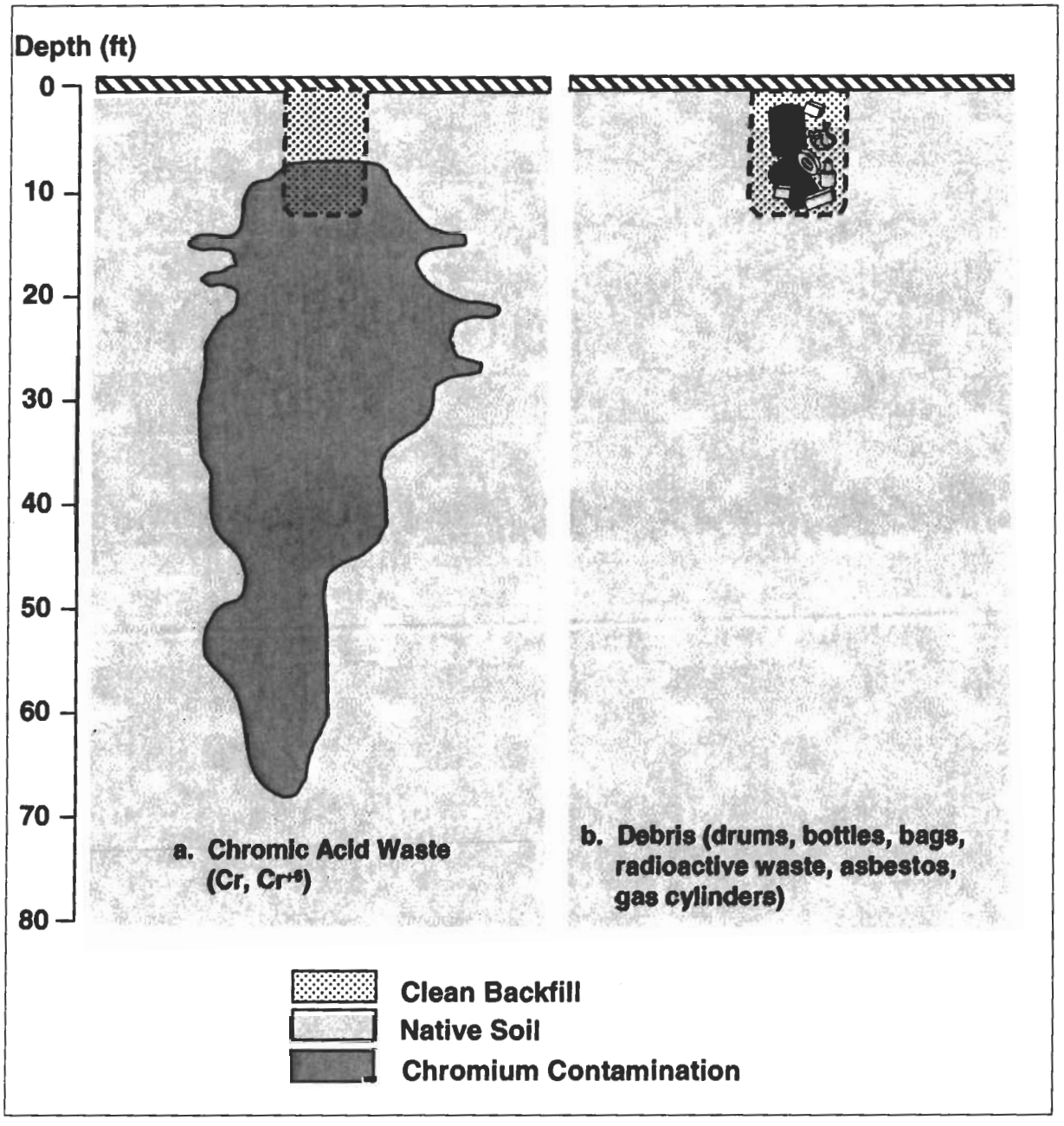


Figure 2-10
Pre-LE VCM Conceptual Model of Disposal Pits Containing
Chromic Acid Waste or Debris

not shown, but could involve soil vapor, sediment, and pore-water impact by volatilized VOCs. Figure 2-9 (b) shows a conceptual model of a commingled solvent/waste oil pit. Of particular concern with nonvolatile organic constituents is the presence of PCBs. Because PCBs are often associated with oil-like waste material, the waste oil is indicated by the "PCB contamination."

A disposal pit with chromic acid waste is shown in Figure 2-10 (a). In this case, the chromium associated with the spent chromic acid is shown to have migrated to approximately 65 feet bgs. Figure 2-10 (b) presents a solid waste (e.g., debris, asbestos, and possibly medical, classified, and/or containerized radioactive waste) disposal scenario. No contaminant migration is expected under this scenario.

In one area of the CWL, near the southwestern corner of the Southwest Excavation Area, a partitioning interwell tracer test performed in December 1995 indicated the presence of residual nonaqueous phase liquid to a maximum depth of approximately 30 feet bgs (INTERA 1995). Excavation and sampling conducted during the LE VCM confirms the results of this tracer test and is discussed further in Section 6.3, in which the LE VCM results are used to update this conceptual model.

Results from drilling and sampling conducted in 1995 show that lateral dispersion around many of the pits is not significant within the upper 15 feet bgs. However, this is not the case in the Unlined Chromic Acid Pit (UCAP) and 60s pits chromic acid disposal areas where constituents appear to have dispersed laterally under capillary forces. Excavation and sampling results from these two areas confirm the lateral dispersion, but show that it was not extensive (less than 15 feet).

The extent of the VOC vapor plume underlying the CWL, prior to the startup of the VE VCM in May of 1997, was estimated to cover approximately 25 acres and extend 490 feet in depth, as indicated from field data and transport modeling. This VOC vapor plume was approximately centered on the CWL and included all soil-vapor containing VOCs at greater than 1 part per million (ppm). Twenty-six VOCs have been identified as representing the bulk of the VOC mass within the soil-vapor plume. These include chlorinated aliphatics, aromatic hydrocarbons, ketones, and chloro-fluorocarbons. The most significant VOC was TCE due to its persistence, ubiquitous nature in the plume, and perceived risk to human health. Other relatively important constituents were acetone and the freons. The active extraction phase of the VE VCM, completed in July 1998, removed more than 4,000 lb of total VOCs from the vadose zone.

The VOC vapor plume migrated to the water table where it touched the capillary fringe. Partitioning from the gas phase to the aqueous phase occurred, resulting in groundwater contamination. Evidence showed that the groundwater plume was shallow in vertical extent (i.e., less than 2 feet thick), was 6 or fewer acres in horizontal extent, and had a maximum groundwater concentration of approximately 30 ppb for VOCs. Since completion of the active extraction phase of the VE VCM, concentrations of TCE in groundwater beneath the CWL have been consistently below the regulatory limit of 5 ppb, as presented in the CWL quarterly reports.

As part of the LE VCM, additional data concerning the magnitude and extent of lateral and vertical migration of soil contamination were obtained through direct excavation, pre-verification sampling and analysis, and final verification sampling and analysis. This information confirms the conceptual model that is discussed in more detail in Section 6.3 as part of the final risk screening assessment.

MEAT HERE → SECTION 3

CONTACT M³ FOR OTHER WEEDS ICNs etc.

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3.0 EXCAVATION APPROACH AND OPERATIONS

The excavation approach involved planning efforts and field operations associated with excavation, sampling, and waste management. Planning consisted of the production and incorporation of both regulatory and internal technical documents. Table 3-1 lists documents governing the excavation process that were submitted to the NMED and EPA Region VI. Internal project documents are summarized in Table 3-2. Initial planning documents included the Health and Safety Plan (HASP) (SNL/NM September 1998), SAP (SNL/NM November 1998a), Operational Work Plan (SNL/NM November 1998b), WMP (SNL/NM November 1998c), Security Plan (SNL/NM August 1998), and On-Site Mobile Laboratory (OSML) Quality Assurance Plan (SNL/NM March 1999b). Subsequent changes to the excavation approach were required based upon logistical and safety considerations, simplification of waste characterization procedures, discovery of unexpected waste types or volumes, and changing laboratory capabilities. These changes resulted in modifications, which are documented in Table 3-1, to the planning documents (Interim Change Notices [ICNs]), to the CWL Closure Plan (Class 1 and 2 modifications), and to the regulatory approvals.

Excavation was initiated in the East-Central Area (Figure 2-5) because this area had more complete characterization information and was suspected to contain insignificant concentrations of PCBs. Since new TSCA regulations were promulgated in June 1998, the management of TSCA wastes was not well-established. Therefore, excavation of the Southwest and Southeast Areas (Figure 2-5), known to contain PCBs, was planned to follow the East-Central Area excavation. Excavation of the North Area (Figure 2-5) was scheduled last because, as the oldest disposal site, the possible contents of disposal pits in this area were not well-documented.

Initially, the top 12 feet were excavated in each area. Excavation of deeper intervals was performed as needed. The initial excavation depth was chosen primarily because of equipment limitation considerations. The majority of debris in the landfill was expected to occur in the top 8 to 12 feet bgs, the range of a typical backhoe such as those used to create the original disposal trenches. Therefore, a trackhoe with a 12-foot reach was selected for excavation operations. In addition, possible contact with chemical and physical hazards was most likely to occur in the top 12 feet where buried debris was present. Keeping equipment operators at the ground surface minimized operator exposure to these chemical and physical hazards. Following excavation to 12 feet bgs, excavation to 20 feet bgs would proceed at locations where additional debris was expected to occur or where soil-sampling analytical results indicated the need for further excavation.

Individual burial pits or trenches were indistinguishable during excavation. Therefore, a plan for tracking excavated soil and numbering the associated samples was developed based upon excavation blocks within each designated area. This plan is included in Annex C, and Figure 3-1 depicts the locations of each excavation block. Table 3-3 includes the dates of excavation for each block and brief descriptions of the materials removed.

Verification of excavation to 12 feet bgs was accomplished using a metered rod and string line that was secured at the original ground surface and stretched across the excavation area. Pre-verification sampling was performed if contamination at or below 12 feet bgs was likely or suspected. When survey or analytical results indicated the need, deeper excavation proceeded, followed by additional sampling. Table 3-4 provides final sampling dates. This process was repeated until all analytical results indicated that remaining soils were below risk-based levels.

Table 3-1
Summary of Documents Submitted to NMED and EPA

Document	Completed Date	Approval Date	Description of Document
Class 1[a] Modification to Closure Plan adding Appendix S to the CWL Closure Plan[b]	11/96	03/07/97 [Approval with conditions][c]	Incorporated the VE and LE VCM Projects into the Closure Process for the CWL. Provided overall scope, objectives, and technical approach of the VCMs as Appendix S to the Closure Plan.
SAP[d]	11/09/98	07/09/99	Original SAP for the LE VCM. Defined original approach to excavation sampling and analytical protocol. Approved by NMED with five conditions.
WMP[e]	11/09/98	07/09/99	Original WMP for excavation of CWL. Defined original planning assumptions and approach to waste segregation, characterization, and management. Approved by NMED with five conditions.
TSCA Cleanup Notification and Certification[f]	12/17/98	No response – automatic approval	DOE provided EPA with cleanup notification and certification, as required under 40 CFR 761.61 (a) of the planned remediation at the CWL. The following information was provided: 1) CWL VCM Plan (Appendix S of the Closure Plan for the CWL); 2) SAP for the CWL Excavation; 3) WMP for the CWL Excavation; 4) matrix and supporting information, directing readers to PCB-specific information in the above documents; and 5) a written certification.
ICN #1 for the SAP[g]	05/22/99 [prepared in March 1999] 10/05/99 [response to RSI]	07/09/99 [Approval with conditions, and RSI]	The most significant changes described in this ICN were the discontinuation of field screening as a method used to segregate waste into piles and the increase of the staged soil pile size to an operationally-efficient size. Redundancy between on- and off-site sampling was also reduced. Designated excavation areas were also incorporated into this ICN.
ICN #1 for the WMP[h]	05/22/99 [prepared in March 1999] 10/05/99 [response to RSI]	07/09/99 [Approval with conditions, and RSI]	This ICN reorganized several sections of the original WMP. The changes were based upon actual waste materials encountered during excavation rather than those anticipated in the original WMP. It expanded the excavation, segregation, and management planning sections of the document. In addition to these changes, project personnel information was updated. Additional changes were made to ensure consistency with changes proposed to the SAP and to incorporate changes reflected in newly promulgated regulations. Changes related to streamlining the excavation process to increase worker health and safety included the use of EPA's AOC policy, the use of a mechanical screening device rather than a site-built sorting table as a primary means for waste segregation, and the elimination of field screening of soils for waste minimization.
Class 2 Modification adding Addendum B to Appendix S of the CWL Closure Plan[i]	07/29/99	07/30/99 (temporary authorization for 180 days) 02/02/00 (temporary authorization for 180 days) 04/28/00 (Approved)	This addendum defined changes in the operational processes at the CWL, including: 1) the use of a commercially available mechanical screening device as the primary means for waste segregation; 2) a brief description of the technical approach to the CWL excavation; 3) the clarification of the SOB, including designation of a waste segregation tent that was to be constructed for radiological screening and segregation of the debris as well as temporary storage of specific waste matrices; and 4) a description of the new, dedicated corridor for the transportation of waste, soils, and supplies between the CWL and the CAMU.

Refer to footnotes at end of table.

Table 3-1 (Continued)
Summary of Documents Submitted to NMED and EPA

Document	Completed Date	Approval Date	Description of Document
TSCA Request for Storage of PCB Soils[j]	02/29/00	04/28/00	DOE requested approval under 40 CFR 761.61(c) for: a) approval of a 180-day extension for storage of regulated PCB materials at the CWL, allowing storage until September 4, 2000; and b) Approval of risk-based storage under 40 CFR 761.61(c), beginning September 5, 2000, and effective for a period of two years following the completion of the CWL excavation and backfilling. EPA granted approval for storage through September 4, 2001, on April 28, 2000.
TSCA Request for Extended Storage of Regulated PCB Soils[k]	09/05/00 04/10/01 Additional Information Provided	12/04/00 Temporary Authorization 05/22/01 Conditional Approval	This request was for approval of extended storage of bulk PCB-contaminated soils. On November 15, 2000, EPA responded that additional justification was needed. On December 4, 2000, EPA granted a temporary extension until September 4, 2001. On April 10, 2001, DOE provided additional justification for continued storage of bulk soils at the CAMU and PCB soils at the CWL. On May 22, 2001, EPA granted a conditional approval for extended storage, the period determined by an EPA decision on a risk-based request (40 CFR 761.61[c]) for management of regulated PCB materials.
Risk-Based Approach for Excavation and Backfilling of the CWL[l]	09/08/00	10/11/00	This guidance document provided the risk-based criteria that were used to determine the completion of excavation and to determine which excavated soils could be returned to the excavation as backfill material. The changes described in this document were intended to bring the CWL excavation project into alignment with risk-based strategies at other SNL/NM ER sites and to avoid volume problems at the CAMU waste cell. NMED approved this approach by letter[m], and it was published in the November 29, 2000, CWL Quarterly Report for August through October 2000.
Class 1[a] Modification of Addendum B to Appendix S of the CWL Closure Plan, for SOB Extension[n]	09/14/00	09/29/00 (NMED approval) 10/13/00 (EPA approval)	DOE requested the approval of a minor extension of the SOB during the landfill excavation to store excavated soils. This was approved by NMED on September 29, 2000, subject to the conditions that the CAMU portion of the SOB be utilized only upon receipt of approval from EPA. EPA approved the CAMU boundary change on October 13, 2000.
ICN #2 for the SAP[o]	12/21/00	01/25/01	This defined the verification sampling strategy for replaceable soils and for clean backfill. It also defined the process used for the final risk determination for the CWL, including the use of off-site laboratory data.
Class 1[a] Modification of Addendum B to Appendix S of the CWL Closure Plan[p]	07/19/01	07/31/01	This modification to Addendum B, Appendix S, replaced the wet decontamination procedure for rocks with a dry method using the mechanical screening device.
ICN #2 for the WMP[q]	07/24/01	07/31/01	The WMP and ICN #1 for the WPM called for a representative number of debris items to be sampled by chipping, cutting, snipping, or otherwise obtaining a sample of the debris material. The approach described in this ICN allowed a mechanized process (shredding), cutting tools, and/or other appropriate technologies by which to obtain those chip, cut, or snip samples of soft debris, metal, wood, and concrete. The sampling and analysis frequency and the analytical program were not changed by this ICN.

Refer to footnotes at end of table.

Table 3-1 (Concluded)
Summary of Documents Submitted to NMED and EPA

Document	Completed Date	Approval Date	Description of Document
ICN #3 to the SAP[r]	07/24/01	07/31/01	This ICN eliminated the pre-verification sampling step in areas that were actually less contaminated than expected during excavation (North Area). It also allowed for the use of off-site laboratories when on-site capabilities were not available.
Request for Contained-In Determinations[s]	08/01/01	01/24/02 [Approval with conditions]	This request established criteria for making contained-in determinations for contaminated soil, debris, and storm water associated with the CWL and CAMU.
Risk-Based Approach Request for TSCA[t]	10/30/01	06/21/02	DOE requested EPA approval for implementing the risk-based approach developed for RCRA constituents, for management of TSCA-regulated constituents (PCBs). Request included all original planning documents (and associated ICNs), the risk-based approach (SNL/NM August 2000), and Appendix S to the Closure Plan (and associated modifications). Storage of PCB regulated material approved through September 20, 2003
ICN #4 to the SAP[u]	02/25/02	06/21/02	This is an addition to the SAP for investigation of PCB contamination in the southern part of the Southwest Area of the CWL.
Class 1[a] Modification adding Addendum C to Appendix S of the CWL Closure Plan[v]	04/29/02	06/26/02 [Approval with conditions]	This modification defines the approval process for backfilling the excavation and identifies necessary actions prior to, during, and after backfilling, until the CMS process is complete.
ICN #5 to the SAP and ICN #3 to the WMP[w]	12/20/02	Awaiting approval	These changes will formalize the contained-in determination implementation process for debris and will identify related text changes in the SAP and WMP.

[a]Requires prior approval.
[b]SNL/NM November 1996.
[c]Kelley March 1997.
[d]SNL/NM November 1998a.
[e]SNL/NM November 1998c.
[f]Zamorski December 1998.
[g]SNL/NM March 1999a.
[h]SNL/NM March 1999c.
[i]SNL/NM July 1999.
[j]Cooke April 2000.
[k]Zamorski September 2000a.
[l]SNL/NM August 2000.
[m]Lewis October 2000.
[n]Zamorski September 2000b.
[o]SNL/NM December 2000.
[p]SNL/NM July 2001a.
[q]SNL/NM July 2001c.
[r]SNL/NM July 2001b.
[s]Zamorski August 2001.
[t]Zamorski October 2001 and SNL/NM October 2001a, b.
[u]SNL/NM December 2001.
[v]SNL/NM July 2002.
[w]SNL/NM December 2002a and 2002b.

AOC = Area of Contamination.
CAMU = Corrective Action Management Unit.
CFR = Code of Federal Regulations.
CMS = Corrective Measures Study.
CWL = Chemical Waste Landfill.
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ICN = Interim Change Notice.
LE = Landfill Excavation.
NMED = New Mexico Environment Department.
PCB = Polychlorinated biphenyl.
RCRA = Resource Conservation and Recovery Act.
RSI = Request for Supplemental Information.
SAP = Sampling and Analysis Plan.
SNL/NM = Sandia National Laboratories/New Mexico.
SOB = Site operational boundary.
TSCA = Toxic Substances Control Act.
WMP = Waste Management Plan.
VCM = Voluntary Corrective Measure.
VE = Vapor Extraction.

Table 3-2
Summary of SNL/NM Internal Planning Documents for the LE VCM

Document	Completion Date	Description of Document
Operations Plan[a]	9/98	Original operations plan for excavation of the CWL.
HASP[b]	9/98	Original HASP for excavation of CWL (Revision 1–9/98). Revision 2–8/99, Revision 3–3/01, Revision 4–draft is in progress.
Quality Assurance Project Plan for the OSML[h]	3/99	This plan presents OSML data quality objectives and operating procedures associated with on-site analysis of soil samples. Revision 1–January 2001.
Sample Identification Plan for Excavated Soil and Verification Samples[i]	1/00	This plan provides an index explaining the sample numbering scheme for the LE VCM project. Two revisions have been made to the plan: Revision 1–January 2002 and Revision 2–January 2003.
CWL Excavation Restart – Post-CS Incident[g]	2/00	This plan presented a summary of the CS incident and the revised plan to restart excavation activities. The CS incident involved the release of an irritant powder (chlorobenzylidene malonitrile) encountered during excavation in the Southwest Area.
Tritium in Excavated Soil Assessment Plan[j]	2/00	Memorandum from Mark Miller to David Miller, "Tritium in Soil Assessment for CWL," Feb 9, 2000. Soil pile segregation and resampling plan for excavated soil with elevated tritium activity. Four excavated soil piles affected (23-07, 23-08, 15-29, and 34-01). Results of sub-pile sampling presented in CWL Quarterly Progress Reports (November 22, 2001 and February 22, 2002).
Operating Guideline for General Radiological Procedures[c]	7/00	This document was attached to the Radiological Work Permit for the CWL and addressed procedures for radiological screening of CWL waste.
Operating Guideline for Hydration/Break Station[d]	7/00	This document was attached to the Radiological Work Permit for the CWL and addressed procedures for site workers taking work/hydration breaks during a work shift.
TA-III Security Plan[e]	10/00	This plan addresses the unique security requirements for test facilities in TA-III.
Chronic Beryllium Disease Prevention Program for the CWL[f]	1/02	This plan was developed for the CWL to meet the requirements of 10 CFR Part 850 and the *Chronic Beryllium Disease Prevention Program* established by the DOE and SNL/NM *Industrial Hygiene Program*. The intent of this plan is to limit the potential for CWL personnel to be exposed to beryllium and ensure early detection of beryllium-related disease through personnel medical surveillance.

[a]SNL/NM November 1998b.
[b]SNL/NM September 1998.
[c]SNL/NM July 2000a.
[d]SNL/NM July 2000b.
[e]SNL/NM October 2000.
[f]SNL/NM January 2002.
[g]Kwiecinski February 2000.
[h]SNL/NM March 1999b.
[i]SNL/NM January 2003.
[j]Miller February 2000.
CFR = Code of Federal Regulations.
CS = Chlorobenzylidene malonitrile.
CWL = Chemical Waste Landfill.
DOE = U.S. Department of Energy.
HASP = Health and Safety Plan.
LE = Landfill Excavation.
OSML = On-Site Mobile Laboratory.
SNL/NM = Sandia National Laboratories/New Mexico.
TA = Technical Area.
VCM = Voluntary Corrective Measure.

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Table 3-3
Excavation Block Index

Block #	Date	Area	Depth	Comments
1	09/30/98–11/16/98	EC	0'–12'	Soil from the EC Area
2	11/17/98–11/30/98	EC	0'–12'	Soil from the EC Area
3	12/01/98–12/14/98	EC	0'–12'	Soil from the EC Area
4	12/15/98–01/07/99	EC	0'–12'	Soil from the EC Area
5	01/08/99–01/11/99	EC	0'–12'	Soil from the EC Area
6	01/12/99–01/20/99	EC	0'–12'	Soil from the EC Area
7	01/25/99–02/08/99	EC	0'–12'	Soil from the EC Area
8	02/09/99–02/24/99	EC	0'–12'	Soil from the EC Area
9	02/25/99–04/29/99	EC	0'–12'	Soil from the EC Area
10	05/03/99–07/02/99	EC	0'–12'	Soil from the EC Area
11	07/15/99–07/30/99	SE	0'–12'	Soil from the SE Area
12	08/13/99–09/02/99	SE	0'–12'	Soil from the SE Area
13	09/09/99–11/04/99	SE	0'–12'	Soil from the SE Area
14	11/08/99–11/30/99	SE	0'–12'	Soil from the SE Area
15	12/02/99–01/15/00	SE	0'–12'	Soil from the SE Area
16	12/15/99–12/18/99	EC	12'	Soil from bottom of EC Area at 12'
17	01/25/00	SE	12'	Soil from bottom of SE Area at 12'
18	02/11/00–03/17/00	SW	0'–12'	Soil from the SW Area
19	03/23/00–04/08/00	SW	0'–12'	Soil from the SW Area
20	04/20/00–05/22/00	SW	0'–12'	Soil from the SW Area
21	06/01/00–06/13/00	SW	0'–12'	Soil from the SW Area
22	06/13/00–07/07/00	SW	0'–12'	Soil from the SW Area
23	07/07/00–07/21/00	SW	0'–12'	Soil from bottom of SW Area at 12'
24	08/24/00–09/15/00	NO	0'–12'	Soil from the NO Area
25	09/22/00–10/05/00	NO	0'–12'	Soil from the NO Area
26	10/05/00–11/03/00	NO	0'–12'	Soil from the NO Area
27	11/06/00–12/06/00	NO	0'–12'	Soil from the NO Area
28	12/11/00–12/12/00	NO	0'–12'	Soil from the NO Area
29	12/15/00–01/12/01	NO	0'–12'	Soil from the NO Area
30	01/12/01–01/19/01	NO	0'–12'	Soil from the NO Area
31	01/20/01–01/31/01	NO	0'–12'	Soil from the NO Area
32	02/01/01–02/09/01	NO	0'–12'	Soil from the NO Area
33	02/13/01–03/28/01	SW	12'–18'	UCAP area in SW Area
34	02/16/01–03/09/01	NO	0'–12'	Soil from the NO Area
35	02/22/01–02/23/01	SE	12'–16'	South end of SE Area
36	03/13/01–03/22/01	NO	0'–12'	Soil from the NO Area
37	03/23/01–04/05/01	NO	0'–12'	Soil from the NO Area
38	03/26/01–03/27/01	SW	18'	UCAP area in SW Area
39	04/11/01–04/20/01	NO	0'–12'	Soil from the NO Area
40	04/23/01–05/17/01	NO	0'–12'	Soil from the NO Area
41	05/22/01–06/06/01	NO	0'–12'	Soil from the NO Area
42	06/19/01–07/09/01	NO	0'–12'	Soil from bottom of NO Area at 12'
43	07/20/01–09/05/01	SW	12'–20'	Soil from Sampling Point #J9 and the west half of the SW Area from 12' to 20'
44	7/27/01	SE	-	Soil from equipment ramp into SE Area
45	09/07/01–10/08/01	SE	12'–14'	Soil from the SE Area Sample Locations #5 and #14
46	9/18/01	SE	12'–14'	Soil where geophysical anomalies were removed from the SE Area (Near Sample Locations #3 and #13 of the SE Area)
47	10/30/01–11/01/01	SW	12'–20'	Soil from the east half of the SW Area from 12' to 20'
48	11/06/01–11/07/01	SW	20'	Soil from additional sloping needed in SW Area in preparation for Geoprobe®
49	12/4/01	SW	20'	Soil from additional sloping along west bank of the SW Area in order to excavate for PCBs

Refer to footnotes at end of table.

Table 3-3 (Concluded)
Excavation Block Index

Block #	Date	Area	Depth	Comments
50	12/05/00–12/05/01	SW	20'	Soil from additional sloping along south bank of SW Area in order to excavate for PCBs
51	02/07/02–02/22/02	SW	20'–30'	Soil from three areas in the SW Area from 20' to 30'
ND-X1[a]	12/15/99–08/21/00	ND	--	ND Area
ND-X2	1/11/01	ND	--	Soil from road between SE and SW Areas
ND-X3[b]	12/15/00–01/11/01	ND	--	Radioactive soils generated from the NO Area
ND-X4[c]	08/03/01–08/17/01	ND	--	ND Area along northern boundary of the NO Area

[a]ND-X1 represented soil excavated throughout the ND Area; therefore, it is not represented in Figure 3-1.
[b]ND-X3 represented soil excavated from the NO Area, which was contaminated with radiological constituents. This soil was not assigned to a pit designation; therefore, it is not represented in Figure 3-1.
[c]ND-X4 represented soil excavated from the benched area at the northern boundary of the NO Area. This soil was not assigned to a pit designation; therefore, it is not represented in Figure 3-1.
EC = East-Central.
ND = Non-Designated.
NO = North.
PCB = Polychlorinated biphenyl.
SE = Southeast.
SW = Southwest.
UCAP = Unlined Chromic Acid Pit.
-- = Not applicable.

Table 3-4
Dates of Verification Sampling and Metal Detector, Geophysical, and Radiation Verification Surveys

Final Verification Sampling/Surveys	Excavation Areas				
	East-Central	Southeast	Southwest	North	Non-Designated
Sample Collection	3/16/01 6/5/01 6/7/01 9/27/01 10/2/01	6/21/01 6/25/01 9/13/01 9/19/01 9/20/01 9/25/01 11/19/01 11/29/01	6/11/01 6/12/01 6/14/01 6/25/01 8/24/01 9/19/01 11/19/01 11/29/01 12/6/01 2/5/02 2/8/02	6/27/01 7/19/01 7/31/01 8/1/01 8/2/01 8/7/01 8/13/01 8/16/01 8/17/01 8/18/01 8/20/01 9/10/01	7/23/01 7/26/01 9/25/01 11/29/01
Metal Detector Surveys	8/7/01 8/8/01	6/25/01 6/26/01 7/2/01	6/21/01 6/25/01	8/8/01 8/21/01 8/27/01	--
Geophysical Surveys	8/30/01	7/3/01	6/28/01	8/30/01	--
Radiation Surveys	7/01	3/01	3/01	7/01	--

-- = Not applicable.

Following the completion of excavation in each area, metal detector, geophysical, and radiation surveys were performed (Table 3-4). When these surveying methods identified anomalies, further excavation was performed to ensure complete removal of anomalies. Hydraulic conductivity samples were collected from each area (see Annex D), and a certified land survey was performed to comply with regulatory requirements under 40 CFR 265.116. This was followed by backfilling, which began with a layer of excavated rock and pieces of concrete obtained from excavated well bollards and pads (see Section 4.7). Replaceable soil was placed in the first and second soil lifts over the rock layer, and clean fill material was then used to backfill the excavation to approximately 40 percent volume (see Section 4.7). Complete compaction was ensured through collecting standard Proctor samples (see Annex D), adding water during placement, using a sheep's foot roller, and taking neutron moisture measurements of each lift after placement and compaction.

3.1 Planning

The detailed planning of the excavation began with the contracting process. A statement of work (SOW) was drafted in November 1997 that summarized existing characterization studies, most of which focused on the identification of potential COCs for groundwater contamination, the primary reason for performing the LE VCM. The SOW delineated the landfill into four areas of excavation (Figure 2-5) and presented a general approach to characterizing and managing the excavated soil. Over the following year, this general approach was further developed into detailed SAPs and WMPs.

In April 1998, placement of the contract with the remediation contractor, United Research Services, Inc. (URS) initiated the preparation of the main CWL guidance documents (see Tables 3-1 and 3-2). At the same time, URS began drafting the HASP and the site Operational Work Plan, based upon information provided in the SOW. The approach at first envisioned performing the entire excavation using Level C personal protective equipment (PPE) to protect site workers from chromium and solvent contamination, which had been identified as the primary COCs during extensive site characterization studies (Figure 2-3).

In June 1998, URS obtained a copy of the 1984 CWL characterization report appendices that contained a detailed listing of disposal tickets for the years 1975 to 1985 (Weston November 1984). This information, which resulted in a modification of the excavation approach, identified the wastes as including compressed gas cylinders, pyrophoric materials, munitions debris, radioactive materials, and sodium cyanide powder with liquid acids. A UXO technician was added to the project field crew, and the excavation process was modified to include predominantly Level B (supplied air respirator) PPE.

In July 1998, field equipment, administrative office trailers, and OSML trailers and equipment were assembled at the site. Figure 3-2 represents the configuration of the administrative, laboratory, and field operation areas in 2001. Laboratory equipment and analysts were mobilized, and laboratory procedures were developed. Details regarding the instruments, analytical methods, and procedures are available in the OSML Quality Assurance Project Plan (QAPP) (SNL/NM March 1999b), the SAP (SNL/NM November 1998a), and the WMP (SNL/NM November 1998c) (see Tables 3-1 and 3-2).

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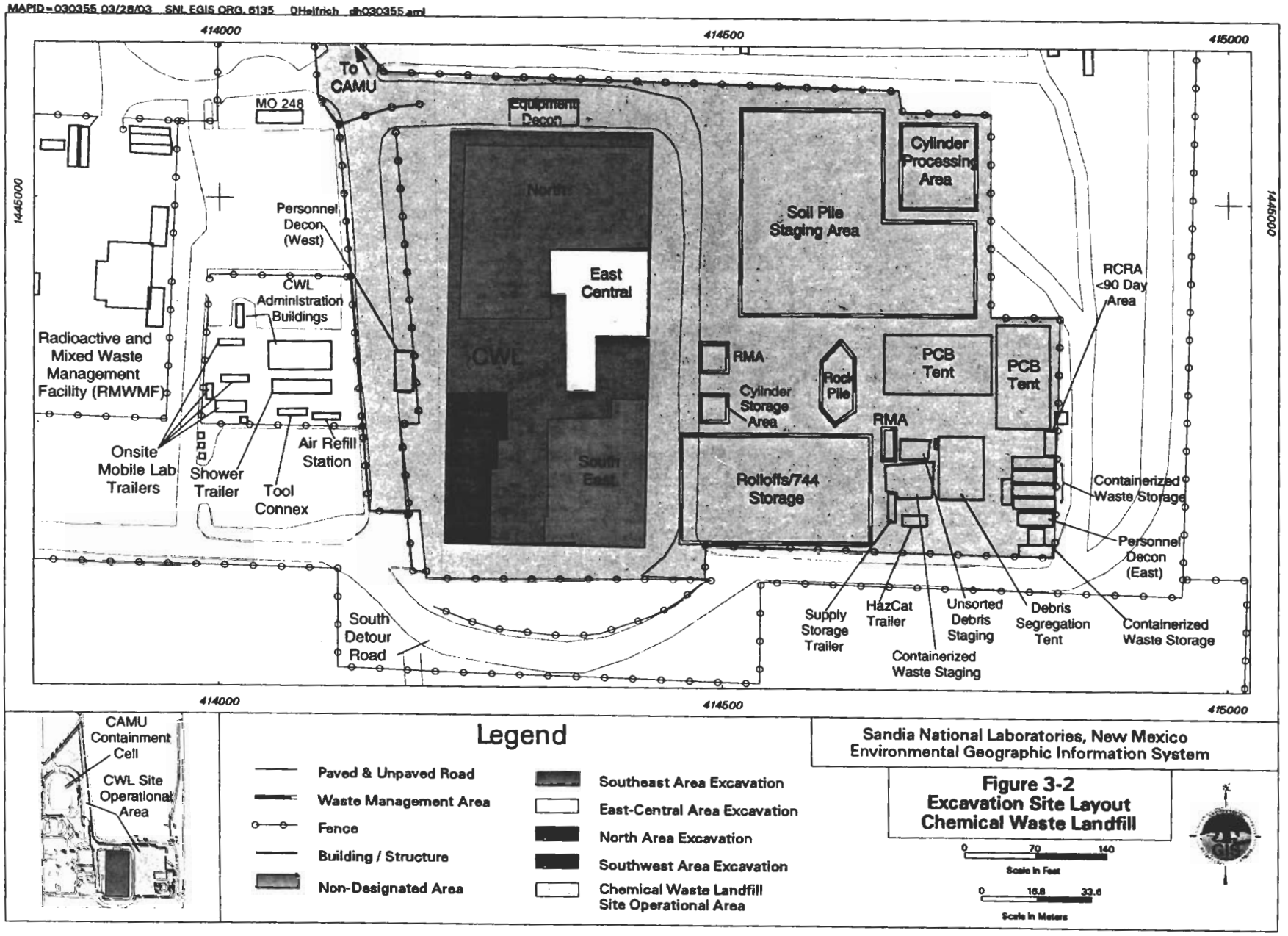
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414000
414500
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To CAMU
MO 248
Equipment Decon
North
East Central
CWL
South East
Soil Pile Staging Area
Cylinder Processing Area
RCRA <90 Day Area
Personnel Decon (West)
CWL Administration Buildings
Radioactive and Mixed Waste Management Facility (RMWMF)
RMA
Cylinder Storage Area
Rock Pile
PCB Tent
PCB Tent
RMA
Rolloffs/744 Storage
Containerized Waste Storage
Personnel Decon (East)
Onsite Mobile Lab Trailers
Shower Trailer
Tool Connex
Air Refill Station
South Detour Road
Supply Storage Trailer
HazCat Trailer
Unsorted Debris Staging
Containerized Waste Staging
Debris Segregation Tent
Containerized Waste Storage
CAMU Containment Cell
CWL Site Operational Area
Legend
Paved & Unpaved Road
Waste Management Area
Fence
Building / Structure
Non-Designated Area
Southeast Area Excavation
East-Central Area Excavation
North Area Excavation
Southwest Area Excavation
Chemical Waste Landfill Site Operational Area
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
Figure 3-2
Excavation Site Layout
Chemical Waste Landfill
0 70 140
Scale in Feet
0 16.8 33.6
Scale in Meters

In August 1998, several boreholes inside the CWL were plugged and abandoned, as summarized in the CWL VE VCM report (SNL/NM May 2000). These boreholes that had been cased and capped at the surface were no longer needed, and the casings were removed with excavated soil to a maximum depth of 20 feet bgs. The grout plugs prevent them from becoming hydrologic conduits. During this time, the majority of excavation field personnel arrived on site to begin extensive training in safety procedures, site protocol, and operational procedures. A site walk-through inspection revealed the presence of a buried drum in one area of the CWL that had not been designated for excavation. A plan for the excavation of the Non-Designated Area within the CWL boundaries was developed in ICN #1 for the SAP (SNL/NM March 1999a) in response to visual confirmation of buried waste in the Non-Designated Area. In addition, one location within the Non-Designated Area exhibited a marked subsidence shortly after excavation began. The site inspection was followed by a geophysical survey that was performed for the purpose of guiding excavation operations (Figure 2-4).

Site preparations completed within this timeframe included the following:

- Fabrication of blast-resistant Lexan shielding for personnel
- Set up of the supplied-air tank exchange area that was expanded in January 1999 to include a Grade D breathing air compressor for on-site refill of self-contained breathing apparatus tanks
- Installation of breathing air tanks and Lexan shielding on the excavator
- Construction of site fencing around the contamination reduction zone, the personnel decontamination areas, and the exclusion zone (EZ)
- Creation of the RCRA less-than-90-day accumulation area(s)
- Fabrication of freestanding signs designating the required treatment of excavated soil piles
- Construction of an above-grade, fully contained equipment decontamination bay in the North Area of the excavation, later relocated north of the landfill surface (Figure 3-2)
- Fabrication of 2-inch mesh screen-topped stands for separating soil from debris
- Set up of a video monitoring station
- Mobilization of a foam fire extinguishing unit

The site preparation phase was extended for several weeks during emergency preparedness planning to address the concern of controlling off-site releases, necessary because of the potential severity of toxic gases. Based upon the CWL inventory records and a plausible worst-case scenario, an air dispersion model was developed. This document, "Chemical Waste Landfill, Emergency Planning Exercise, Release of Hydrogen Cyanide at Pit 5," included as Appendix A of the original HASP (SNL/NM September 1998), resulted in significant changes to the excavation approach, including restrictions based upon wind speed and direction. A meteorological station was installed to monitor wind conditions, and excavation ceased when

wind directions were between 41 and 171 degrees and wind speeds were greater than 2 miles per hour, or too high to control fugitive dust emissions from the site.

3.2 Excavation

Excavation began in the East-Central Area in September 1998 (Figure 3-3). A total of 25 buckets of soil were placed onto a stationary screen designed to allow soil to fall through the mesh into a waiting dump truck and rocks and debris to roll off the inclined surface of the screen onto the ground behind the truck. However, in practice, very little soil fell through these "truck screens" because of a high degree of cohesion resulting from grass roots and compaction. Over the ensuing three weeks, the "truck screen" was altered to include hinges and a handle so that the trackhoe operator could lift and drop the top to promote soil movement through the screen (Figure 3-4). In addition, dust-control modifications were made to the truck screen, including attaching plastic sheeting to the screen, installing water sprayers, and wrapping the unit's legs with plastic. This method of separating soil from debris was used until the end of October 1998, while excavating overburden material before buried waste was encountered.

Excavation operations slowed down while a table screen was fabricated on which soil could be spread by the trackhoe. The screen allowed the soil to pass through so that site workers could manually remove excavated debris from the screen surface (Figure 3-5).

Planning documents were updated to reflect these process changes. For the HASP, corporate procedures were in place whereby a Task Hazard Analysis (THA) card was generated every time HASP activities changed. THA cards were collected for incorporation into subsequent HASP revisions.

Excavation operations using the table screen began in November 1998. Site workers wore Level C or B PPE in the EZ depending upon job function and proximity to the excavation. The Site Safety Officer and UXO expert, who wore Level B protection, observed the trackhoe operators remove buried material. The trackhoe lowered the bucket to the 12-foot depth and pulled up along the excavation face, removing material in a vertical swath extending from 12 feet bgs to the surface. Site workers removed excavated debris from the top of the screen when one or more trackhoe buckets of material (depending upon the amount of debris) had been deposited onto the screen.

The trackhoe stopped excavating activities while the site workers came from behind explosion-resistant blast shielding to remove the debris from the screen-topped table. All items were surveyed for elevated radiation using a sodium iodine detector and/or a Geiger-Mueller counter. Like materials were placed into bags, buckets, tubs, or other containers, put onto a cart, and removed to a waste management area within the confines of the CWL site boundary. The waste was placed by matrix onto containment pallets, debris items were swiped for removable surface radiation, and the contents of any leaking containers were transferred to intact containers.

Figure 3-3
Trackhoe Begins Excavation

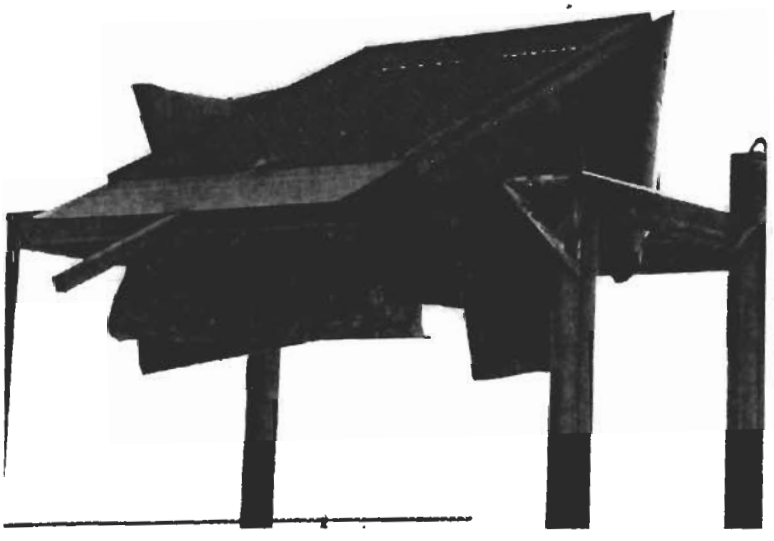

Figure 3-4
"Truck Screen" with Hinges and Handle

Figure 3-5
Trackhoe in Operation Using a Table Screen

When approximately 5 cy of soil had accumulated under the table screen, a harness was attached to the screen so that the trackhoe could move the screen out of the way. The loader would then gather the soil under the screen, stopping to allow sample technicians to take photoionization detector and radiation readings and collect a sample/aliquot of soil for laboratory analysis. Each bucket of soil was loaded into a dump truck and placed into a pile on the landfill surface.

This process was vastly more successful than the use of the truck screens and averaged 155 cy per 50-hour work week. However, several safety issues had to be addressed. First, many bottles, bags, and containers of chemical products, both liquids and solids, ruptured during the excavation process. Acids that came into contact with the alkaline soil underwent neutralization reactions, and water used for dust control caused reactions of chemical products on the table screen, exposing site workers to the chemicals. Although the addition of various vibrating devices to the table screen improved the tendency of soil to fall through the screen, this did not address the ergonomics concern.

In February 1999, the excavation contractor addressed these safety concerns with a proposal to re-engineer the excavation process by replacing the table screen with a commercially available, motorized screen (called a Screen-All®) designed for use in LE. While excavation operations continued using the table screen approach, this in-process change was planned carefully to ensure that additional hazards were not introduced.

During this planning process, it was apparent that it would be physically impossible to excavate the landfill while storing all excavated materials at the site. Delays in characterizing the excavated soil caused by the complexity of analytical requirements and the volume of samples, coupled with the decision to delay the acceptance of soil at the CAMU until January 1999, created a situation that limited the operational area. Once the CAMU began accepting soil, the immediate space problem was alleviated. However, the operational area decreased as the excavation progressed, eventually impacting the ability to excavate. The lined chromic acid pit was leveled to create more space. In addition, the use of the AOC concept to establish the SOB was discussed with NMED personnel to address this condition.

In July 1999, a modification to the Closure Plan was submitted to NMED (Table 3-1). It described the use of the Screen-All®; created the SOB, using the AOC concept to include just under 5 acres of operational area surrounding the CWL; and eliminated spray-washing requirements for equipment traveling between the CWL and the adjacent CAMU by constructing a dedicated haul route. Improvements implemented in the Closure Plan Modification included the installation of a debris-sorting tent, which allowed debris segregation to occur even in inclement weather; and the use of a motorized conveyor belt with a site-built hopper, which eliminated the need to manually handle each excavated rock.

The Closure Plan Modification, submitted in July 1999, as well as corresponding changes to the SAP (Table 3-1), were approved by the end of July 1999. Excavation temporarily halted while these changes were implemented. Between July and November 1999, the new site boundary for access control was fenced. Berms and silt fencing were installed to prevent storm water run-on and runoff. Beginning in August 1999, personnel were trained in the use of the Screen-All®. A waste management and two PCB storage tents were erected in September and October 1999. Also during this time, the air line and conveyor systems were installed and a detour road directing traffic around the south end of the CWL onto KAFB was built. In addition, the dedicated haul corridor road to the CAMU was constructed.

Upon completion of the excavation in the East-Central Area, the excavation activities proceeded to the Southeast Area (Table 3-3). Soil that contained PCBs at levels greater than 50 ppm were first encountered in the Southeast Area on August 31, 1999. Although the required regulatory notification under the self-implementing TSCA cleanup option had been submitted in December 1998 (Zamorski December 1998), it was evident that the excavated PCB soil would have to remain on site for longer than six months, which exceeded the allowable storage time under the regulations (40 CFR 761.61[a]). Negotiations with the EPA resulted in approval on April 28, 2000 (Cooke April 2000) to store PCB soil longer than six months at the CWL (this same approval reclassifies the CWL-remediation as a risk-based cleanup under 40 CFR 761.61[c]). This allowed for storage of PCB soil piles on both bermed plastic sheeting with an impermeable cover and inside a tent structure. On June 26, 2002, EPA approved the risk-based TSCA cleanup application (Cooke June 2002), covering all aspects of PCB management activities.

As a result of the Closure Plan Modification approved in July 1999, excavation and debris segregation were now separate processes (Figures 3-6 and 3-7), although crew size and safety concerns prevented the two operations from occurring simultaneously. Because of its success, this approach was not significantly altered during the remainder of the excavation. Site-worker safety had significantly improved, and the increased production efficiency of excavation corresponded to an improvement in the trackhoe's cycle time for removing material from the excavation and depositing it onto the Screen-All®. The average excavation rate increased from 155 to 374 cy per 50-hour work week.

The rate at which debris could be sorted on the conveyor system lagged behind the rate of excavation due to the increase in efficiency resulting from the use of the Screen-All®. This led to a significant backlog of debris that had been separated from the soil, which was temporarily stored in a debris staging area next to the waste management tent. Debris from both the Southeast and the Southwest Excavation Areas were combined into this large debris pile, making it difficult to determine accurate debris volumes for each of these areas. Hay bales that had been used to create a low wall surrounding the debris were soon replaced with concrete barriers.

After the new process had been in effect for approximately two months, a chemical fire occurred in the waste management tent, resulting in evacuation of the site while emergency response procedures were initiated. A metal container with slightly elevated field radiation levels, consistent with the presence of potassium compounds, had been removed from the conveyor belt. Crystalline material filling a crack in the container had been disturbed in the collection of a sample for characterization. The material began to smoke then burst into flame, expelling burning fragments within a 15-foot radius. This container and a second identical intact container were determined to contain a sodium-potassium alloy.

The contents of these containers were neutralized with water in the floor of the excavation, and the material was destroyed on site.

This event caused several changes to the operational process. Because of the potential hazards presented by the excavation and on-site waste management, workers at a neighboring facility adopted a 4-day workweek. The CWL workers increased from a five- to a six-day workweek to allow unrestricted excavation activities on Fridays and Saturdays. In addition, all of the debris from the Southwest Area was sorted before excavation in the North Area began.

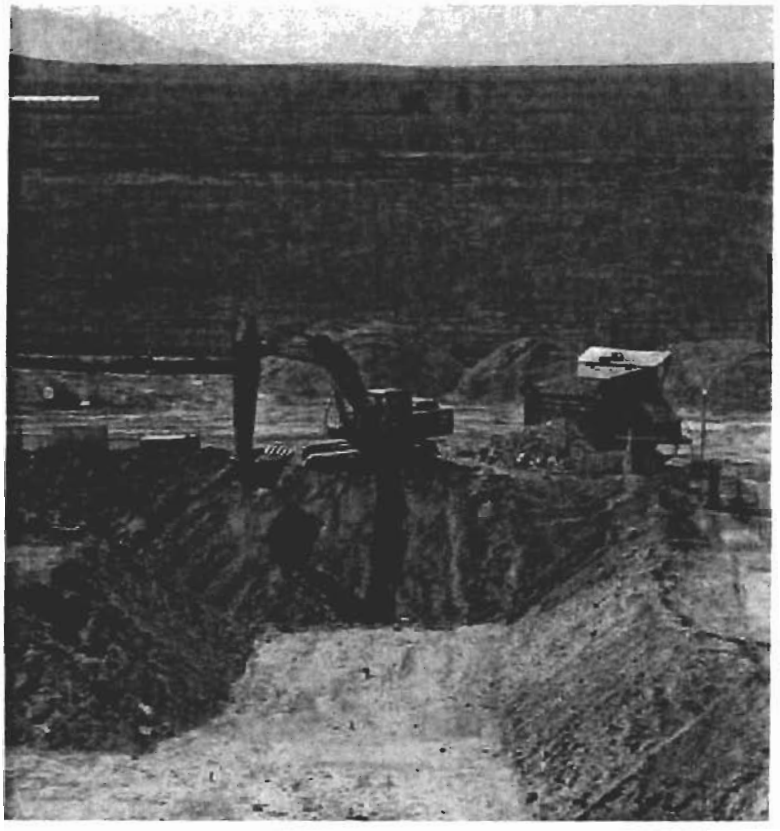

Figure 3-6
Screen-All® in Operation

Figure 3-7
Debris Sorting on the Conveyor Belt in the
Waste Management Tent Using Airline Respirators

The 12-foot excavation in the Southeast Area was completed on January 15, 2000. Although debris was seen protruding from the excavation floor in the southern edge of this area, the decision was made to complete the excavation of all areas of the landfill to 12 feet bgs before performing deeper excavation. This meant that the debris would be left where it was, and excavation would proceed to the Southwest Area. This was due, in part, to the large volumes of sticky foam that were emitted into the excavation when the trackhoe had disturbed the protruding debris. The removal of a large number of compressed gas cylinders above this remaining debris, including other cylinders of sticky foam, indicated that additional compressed gas cylinders would likely be present below 12 feet bgs. For safety reasons, the disturbance of these cylinders was postponed.

After excavation to 12 feet bgs was completed in the Southeast Area, excavation of Trenches 3 through 6 in the Non-Designated Area was performed. Operational challenges had been encountered when Trench 2 was installed after excavation of the surrounding material to 12 feet bgs. In order for the trackhoe to operate on a continuous surface during excavation of the Southwest Area, the trenches were installed, sampled, and then backfilled with the removed material.

Excavation of the top 12 feet of the Southwest Area began on February 11, 2000, and continued until July 21, 2000. In addition, the excavation approach was modified primarily due to two events that occurred during excavation of this area. The first event was the excavation of an irritant powder, which became aerosolized and caused some site workers to experience skin irritation. Truck drivers hauling soil from the Screen-All® to the soil staging area were wearing negative pressure respirators; however, due to an ill-fitting respirator, one driver experienced symptoms of coughing and respiratory irritation. All site workers were then required to wear supplied air during excavation procedures. The irritant powder was later determined to be chlorobenzylidene malonitrile (CS).

In the second event, a hand-held hydrogen cyanide (HCN) meter showed a detection of 18 ppm HCN during excavation on a Saturday in March 2000. Weekly air monitoring reports identified this event, but because the reading was not sustained, excavation continued until safety oversight personnel reviewed the information. HCN had been identified as a worst-case scenario; thus, excavation operation was halted while the meter reading was investigated and a restart plan developed. Although daily calibration of the instrument was routinely performed, it was determined that the factory calibration certification for the meter instrument had expired, which caused the validity of the reading to be questioned.

The restart plan incorporated new restrictions and implemented changes to the excavation approach. Unrestricted excavation was allowed only on Fridays and Saturdays when no neighboring facility personnel were present. Although excavation was allowed to proceed Monday through Thursday, during both excavation and debris sorting operations, CWL personnel now controlled vehicular traffic on the detour road that ran along the south side of the SOB. Vehicles were momentarily detained on approach to the SOB, and excavation or sorting paused while the vehicles passed. Once the vehicles had passed, excavation and sorting procedures resumed.

The first round of pre-verification sampling occurred in the East-Central and Southeast Areas in March 2000 during excavation of the Southwest Area. The NMED requested the sampling event and identified a total of eight judgmental locations to sample, four in each of the areas. A sampling grid was arranged on the floor of the excavation using a fiberglass measuring tape. This grid was shifted to the south, relative to the planned grid, because the North Area had not

yet been excavated. Sloping began at the boundary of the East-Central and North Areas at ground surface and extended approximately 18 horizontal feet southward where the sloped material joined the East-Central Area excavation floor at 12 feet bgs.

Debris visible in the floor of the excavation in the Southwest Area consisted of polyvinyl chloride (PVC) tubes, wiring, and electrodes associated with the Electrokinetic Extraction System (EK) experiment. Most of the test debris had been removed during the 0- to 12-foot excavation; however, reports indicated that the placement of electrodes extended to only 16 feet. Therefore, removal of the test debris from 12 to 16 feet was planned.

Excavation of the Southwest Area to 12 feet was completed in July 2000. The Southwest Area excavation stopped short of the northern boundary when no buried debris was encountered and original geomorphic features, such as grading and bedding planes, were observed in the soil. This field evidence indicated that the soil had not been disturbed during burial operations. A depth survey was performed in August 2000 to verify that 12 feet had been excavated. Once the Southwest Area was excavated to 12 feet, the area surrounding and including Trench 5 was removed during installation of an access road from the Southeast to the Southwest Areas.

Prior to beginning excavation in the North Area, the equipment decontamination pad was moved from the landfill site, where it had originally been constructed. Excavation of the North Area began on August 24, 2000. Buried debris was much less dense in this area than in the other three areas and included mostly solid debris rather than liquid chemicals. However, because disposal operations in this area were not as well-documented as in the other areas, and because it was the closest area to continuously occupied offices, a plausible worst-case scenario was developed for the excavation of explosives (SNL/NM March 2001). The planning exercise, "Chemical Waste Landfill Excavation Project Emergency Planning Hypothetical Exercise for the North Excavation Area: Detonation of Energetic Material," resulted in modifications to both the excavation process and several internal processes. These improvements resulted in increased blast shielding protection for site workers. The greatest impacts would be sustained if an explosion occurred on top of the Screen-All®; therefore, the Screen-All® could not be set up within 200 feet of the nearest office building. Since this was not operationally efficient, excavation in the proximity of this calculated blast radius occurred only on Fridays and Saturdays, when the office buildings were not occupied.

As excavation progressed, it was evident that the original estimates for excavated soil volumes would be greatly exceeded. The CAMU containment cell, which was designed according to the original estimates, would exceed capacity if excavation proceeded to 20 feet bgs in all areas. A risk-based approach, similar to the standard procedure used at other SNL ER sites, was developed for the CWL (SNL/NM August 2000). This approach allowed the excavation to cease when the levels of residual contaminants in the floor and sidewalls of the excavation reached risk-based, rather than background levels. In addition, soil below these same levels could be returned to the excavation as backfill. For operational efficiency, each 100-cy soil pile that had passed the risk-based criteria could be combined to create 1,000-cy piles for final verification sampling.

With the approval of this approach in October 2000 (Lewis October 2000), the need for additional soil storage space at the CWL became critical. To ensure that the CAMU received the most highly contaminated soil prior to using excavated soil as backfill, potentially replaceable soil was staged at the CWL until excavation was completed, at which time a comparison of CAMU cell capacity relative to the excavated soil was made. Metals treatment at the CAMU added an estimated 15 percent (cement and additives) to the volume of soil requiring

the treatment. As such, in order to calculate the volume of replaceable soil that would fit into the CAMU cell, it was necessary to determine the final volume of soil requiring stabilization. A modification to the Closure Plan (modification of Addendum B to Appendix S) was approved in late September 2000 (Table 3-1) that permitted the expansion of the SOB northward onto property that had previously been included in the CAMU boundary (Figure 3-2).

Visible debris had been observed in the far Northwest corner in the Non-Designated Area during a pre-excavation walk through in 1998, prompting the creation of the Non-Designated Area excavation strategy in ICN #1 for the SAP. More debris was encountered than was visible on the ground surface, but burial depth was shallow (less than 6 feet). No evidence of burial outside of the landfill boundary was observed. In the Northwest corner, excavation was restricted to two days a week and the volume to be excavated in this area had increased; therefore, the excavation rate was low in this corner. This slowdown in operations was offset by the very high excavation rate in the rest of the area, in which buried debris was generally sparse and consisted mostly of solid items, including a glovebox and thorium-containing slag.

Excavation of the EK-experiment debris from 12 to 18 feet in the Southwest Area, corresponding to Excavation Block 33 (Figure 3-1), occurred when about half of the North Area was excavated to 12 feet bgs. The decision to interrupt excavation of the North Area was made to address cost and schedule uncertainties associated with unknown wastes below 12 feet. Excavation began on February 22, 2001. At approximately 14 feet, an extremely hard, black-colored layer of soil created by the EK experiment was encountered. A sample of this material was collected (see Section 4.4.1), and the expectation of high chromium and copper concentrations was verified. This material was removed from the excavation; however, it was observed to extend into the excavation sidewall outside of the landfill boundary. Excavation laterally outside of the landfill boundary was beyond the scope of the project, and excavation was halted while management was consulted on the appropriate actions necessary to proceed.

While awaiting approval, excavation of the North Area above 12 feet and the Southeast Area below 12 feet continued to remove the debris in the south end of the Southeast Area. The buried debris was removed within two days. The soil generated from this effort corresponds to Excavation Block 35 (Figure 3-1), which extended to 17 feet bgs. Excavation in the North Area continued while approval to remove the remaining hardened EK-experiment material from the Southwest Area was pending.

On March 26, 2001, excavation of the remaining hardened soil was approved. After resloping of the sidewall in this area to accommodate the increased excavation size was completed, the hardened soil was removed. Excavation outside of the landfill boundary was necessary for only several feet to remove all of the material. Green staining of the soil on the floor and on the sidewalls of the excavation was observed after the hard material had been removed. As set forth in the SAP, six judgmental samples were taken in the area of the staining to determine whether deeper excavation was necessary. Preliminary risk results, based upon the initial chromic content of these stained areas, indicated that these locations passed the risk-based criteria. Even though visibly discolored, deeper excavation was not necessary in this location.

Excavation of the North Area to 12 feet bgs was completed on July 9, 2001. The soil excavated in the North Area between 0 and 12 feet bgs was generally below risk-based levels. Therefore, pre-verification sampling was eliminated in the North Area.

Pre-verification sample results from the East-Central, Southeast, and Southwest Areas indicated that two areas existed in each of the Southeast and the Southwest Areas (see

Sections 4.3 and 4.4, respectively) that contained PCBs greater than 50 ppm. Two additional locations in the Southeast Area, corresponding to two excavation blocks, both numbered as 46 (Figure 3-1), contained geophysical anomalies and were excavated to a total depth of 14 feet bgs to remove the buried debris. Sample locations centered in the two excavation blocks of the Southeast Area, both numbered as 45 (Figure 3-1), were excavated to 14 feet bgs. Subsequent resampling at 14 feet bgs in the Southeast Area indicated that PCBs were below acceptable levels. Sample Location J009, located in the Southwest Area in excavation block 43 (Figure 3-1), failed the risk-based criteria due to the presence of aniline at 12 feet bgs. This prompted the removal of a 2-foot lift surrounding the location. After resampling at 14 feet bgs at the J009 location, OSML results indicated that aniline was below risk-based levels and no further excavation was required.

Two adjacent sample locations in the Southwest Area required additional excavation to achieve desired PCB concentrations. A Geoprobe® was used to collect subsurface soil samples in this vicinity. Excavation from 12 feet to the final depth was performed in several stages, based upon the detection of PCBs in successive samples above concentration limits. A separate sampling plan (ICN #4 for the SAP) to proceed with the investigation and excavation of PCBs in this area was drafted and implemented after verbal approval from the EPA and NMED. Written approval of this approach from both regulatory agencies came in June 2002 after the sampling and subsequent excavation were complete (Table 3-1).

The TSCA risk-based approach approved by the EPA included a graded approach to site controls based upon residual concentrations. In order to achieve the lowest level of required site controls, SNL/NM and DOE chose to continue cleanup beyond the original maximum depth of 20 feet bgs, as defined in the SAP (SNL/NM November 1998a). The approval included authorization to perform TSCA decontamination of equipment by high-pressure spray washing, granted after results of spray washing a dump truck, followed by TSCA-specified grid and swiping procedures, indicated that PCBs had been adequately removed. In addition, the EPA allowed rocks to be replaced into the excavation after a total PCB and rock absorption study indicated that the excavated limestone had not absorbed measurable quantities of PCB compounds (Appendix E, SNL/NM October 2001a, b).

Backfilling of the landfill began with dry decontamination and placement of excavated rocks and concrete into the contiguous North, East-Central, and Southeast Areas of the excavation. No rocks were placed in the Southwest Area, and concrete was placed only in two discrete locations in the Southeast Area (see Section 4.7). Dry decontamination procedures consisted of running the materials through the Screen-All® a second time to remove excess soil adhering to the materials. This procedure, approved in a modification to the Closure Plan (Table 3-1), was successful in removing approximately 900 cy of soil from the rocks and concrete and producing visibly cleaner fill material. The placement of the rock material serves as a marker layer identifying the extent of excavation in the North, East-Central and Southeast Areas should future characterization activities take place. However, there was not enough material to cover the entire extent of the excavation for this layer (Figure 3-8).

Soil meeting the risk-based replaceable soil criteria was placed into the excavation in the first two successive lifts over the rock layer (see Section 4.7). Too little fill material was available to complete the second lift across the Southeast Area. Backfilling continued with fill material obtained from native soil removed during construction of the CAMU cell. This fill material, referred to as the "CAMU Spoils Pile," was sampled to determine standard proctor parameters

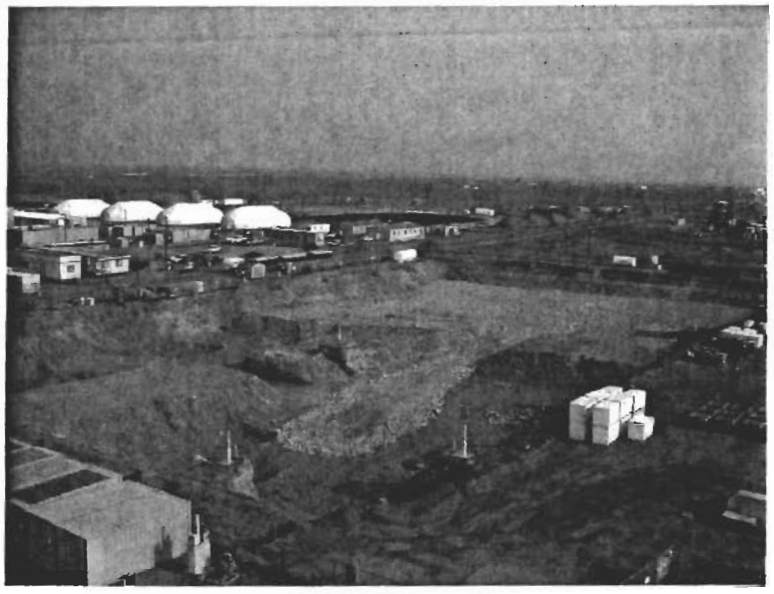

Figure 3-8
View to the Northwest of Rock Placement in the CWL

(Annex D) and screened to 4 inches according to specifications in Addendum C to Appendix S of the Closure Plan (Backfill and Compaction Plan) (Table 3-1). Neutron moisture measurements were performed after every lift to ensure adequate compaction.

Backfilling operations ceased when the excavation was filled to 40 percent capacity. The Southwest Area was not backfilled with any material. Backfilling activities are currently scheduled to resume in June 2003 when CAMU treatment operations are completed. Completion of CWL backfilling to grade is projected for September 2003. Section 4.7 presents a detailed description of the backfill status of the landfill.

A verification geophysical survey may be performed, on request, after backfilling to grade has been completed. This final survey is expected to confirm the surveys already performed in the excavation prior to backfilling. Known test materials, sampling equipment, and other features that are expected to be identified in this final survey include:

- A Geoprobe® rod in the North Area
- TEVES wells remaining at depth in the Southwest Area
- Plugged and abandoned boreholes throughout the site

These items were previously identified and do not represent original waste material.

3.3 Sampling, Analysis, and Waste Management

Information regarding the OSML capabilities and specific procedures used are available in the SAP (Table 3-1) and the Laboratory QAPP (Table 3-2). A full-service laboratory was established on site using equipment typical of fixed-base production grade commercial laboratories. Very detailed plans for segregation of soil and waste materials were developed in the SAP and WMP. Field implementation of the characterization flow diagrams proved to be difficult. Waste disposal practices were defined based upon the data requirements of SNL/NM's Hazardous Waste Management Facility (HWMF), Solid Waste Management Facility, and Radioactive and Mixed Waste Management Facility (RMWMF), thus eliminating unnecessary waste characterization. In addition, the Request for Contained-In Determinations (Zamorski August 2001), approved in January 2002, allowed some of the project-generated wastes to be disposed of as solid waste (Table 3-1).

Sampling of soil began on a very small scale. Samples were collected on the basis of excavator and loader buckets per 10-cy truck and per 50-cy pile. Many of the analyses performed at these various frequencies were redundant. When it was evident that the truck screens were not logistically feasible and the subsequent use of a table screen began, samples were collected from the loader bucket instead of the trackhoe bucket. This was not considered to be a quality-affecting change to the SAP or to the WMP.

Similar to the THA/HASP revision process used for safety-related changes, the SAP and the WMP indicated that deviations from procedure not affecting quality, such as these, were to be documented in site records while the project continued. Thus, an ICN was drafted to describe changes to the SAP and WMP associated with the new approach of using a table screen rather than a truck screen. It was expected that these changes would be documented and collected until a revision, based upon more significant changes to the requirements of the SAP and WMP, was issued.

Concurrent with planning for use of the Screen-All®, negotiations were underway with regulatory, radiation protection, and waste management personnel to simplify the SAP and WMP requirements. The original effort to minimize mixing of waste between each bucket and/or truckload of excavated soil was found to be an ineffective technique because the character of the excavated soil did not change substantially between each bucket or truckload. A proposal to sample for nonradioactive constituents for each 100-cy pile of excavated soil was met with success. However, radiological characterization was required to continue at a 50-cy frequency for both gamma spectroscopy and tritium. Gross alpha/beta analyses were discontinued due to the continual absence of activities above background.

Instead of issuing a revision to the SAP and WMP, all interim changes were compiled into a single document that was approved in July 1999 as ICN #1 to both the SAP and WMP (Table 3-1). Table 3-5 compares the original sampling frequencies to the revised frequencies. No additional changes to either the SAP or the WMP were required until December 2000.

Table 3-5
Soil Analytical Frequencies

Analysis		Initial Excavation Process (frequency volume [cy] per sample)	Revised Excavation Process (frequency volume [cy] per sample)
Radiological	Field Radiological Meter	2–3 1/3	3 1/3
	Tritium	50	50
	Gamma Spectroscopy	50	50
	Gross Alpha/Beta	50	--
Metals	XRF	10	--
	ICP	50	100
	Mercury	50	100
VOCs	VOC Screen	2–3 1/3	--
	EPA Method SW846 8260[a]	10	100
PCBs	PCB Screen	10	--
	EPA Method SW846 8082[a]	--	100
SVOCs	EPA Method SW846 8270[a]	50	100

[a]EPA November 1986.
cy = Cubic yards.
EPA = U.S. Environmental Protection Agency.
ICP = Inductively coupled plasma.
PCB = Polychlorinated biphenyl.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.
XRF = X-ray fluorescence.
-- = Not applicable.

During excavation in the Southwest and North Areas, four 100-cy soil piles were generated that contained tritium activities exceeding the background concentration (less than 20,000 picocuries [pCi]/L) for acceptance at the CAMU. A plan to segregate typical 100-cy soil piles into eight smaller sub-piles (approximately 12.5 cy in size) for additional tritium sampling had been developed in February 2000 to address this potential situation (Miller February 2000). The purpose of the plan was to minimize the volume of soil that could not be placed at the CAMU by attempting to isolate the soil exceeding the 20,000 pCi/L limit. The four excavated soil piles

that were affected included three from the Southwest Area (Block 23, Piles #07 and #08, and Block 15, Pile #29) and one from the North Area (Block 34, Pile #01). Results of these tritium sub-pile resampling efforts are presented in CWL Quarterly Closure Progress Reports (SNL/NM November 2001, SNL/NM February 2002).

As stated earlier, the risk-based approach, approved in October 2000, allowed for the creation of 1,000-cy piles of potentially replaceable soil. In order to confirm the status of the soil as replaceable, a single sample representative of the entire volume was collected, and off-site analysis was performed to achieve the very low detection limits required for confirmatory risk calculations.

During the excavation process, debris was sorted into similar matrices. Chemical product identification was conducted in the field using Hazcat kit methods and was followed by on-site laboratory analysis, when necessary, to confirm the identity of the product. However, this process did not keep pace with the excavation of containers. Therefore, a large inventory of excavated chemical containers with unknown contents accumulated. When a chemical was identified that was particularly reactive or presented specific safety concerns, it was disposed of off site through SNL/NM's HWMF or RMWMF. A list of containers that were disposed of off site as of December 2002 is presented in Annex E. Once excavation operations were completed, the remaining inventory of unknown chemical containers was categorized for storage compatibility and subsequently sampled to meet off-site disposal requirements.

Some excavated debris was disposed of off site during the excavation process because of the limited operational space available at the beginning of the project. Disposal was completed for debris that was processed to the point of being acceptable for disposal. A list of these items is presented in Annex E and includes pieces of beryllium, liquid mercury switches and vials, and some chemical batteries. On-going disposal of unsoiled PPE and CWL wastewater occurred. However, most waste streams were allowed to accumulate until the end of the excavation, so that only a single characterization and disposal effort was necessary. In August 2001, a specialty contractor processed intact compressed gas cylinders and conducted treatment of a container of elemental mercury that had been excavated.

PCB contamination was typically associated with used oil that contaminated items it contacted after disposal. Generally, analyses for the presence of PCBs was conducted only if an oily sheen or liquid oil was present. Waste that contained PCBs was segregated for further sampling and characterization. Swipe samples were collected and analyzed for tritium and gross alpha/beta. If the results indicated that the material was not radioactive, it was analyzed by the OSML for PCBs.

As previously mentioned, debris that had been sorted into similar waste matrices during the excavation process were accumulating. Soiled PPE, used respirator cartridges, plastic sheeting, and other project-generated waste streams had also been allowed to accumulate. ICN #1 for the WMP included very detailed flow charts for sample collection frequencies and for analysis requirements. In practice, however, a representative sample was difficult to obtain because of the mangled and corroded condition of the debris. To allow the collection of more representative samples, a hydraulic shredder, included in ICN #2 for the WMP, was installed at the site (Table 3-1).

Even with the debris shredded, sampling requirements were difficult to meet and were excessive when compared to the characterization required by off-site disposal facilities. Much of the debris, especially project-generated material, was not visibly soiled; however, all materials

leaving the SOB as waste were regulated as listed hazardous wastes. A petition was submitted to NMED in August 2001 (Zamorski August 2001) to remove the listing on debris where appropriate. Two methods of making a Contained-In Determination resulted from the January 2002 approval:

- Visual method
- Sampling method

A walk-through by NMED personnel took place in March 2002 and resulted in a determination that most of the project-generated debris no longer contained hazardous waste and could be disposed of as solid waste (SNL/NM May 2002). In addition, ICN #5 for the SAP and ICN #3 for the WMP were submitted as a joint document in December 2002 (SNL/NM December 2002a and 2002b) and included details of how the Contained-In approval would be implemented at the site for debris subject to the Contained-In determination via the sampling method. Detailed information on wastes disposed of off site will be provided in future submittals.

During the pre-verification sampling of the Southwest Area, it was found that the northern row of planned verification locations fell on the sidewall slope because excavation of the Southwest Area had terminated before the entire area had been excavated. This was due to encountering undisturbed, native soils while still in the Southwest Area. To adjust for this early termination of excavation and to maintain the planned sample density, samples collected from locations numbered 1 to 3, as described in ICN #1 for the SAP, were collected as J007 to J009 (see Section 4.4).

According to the schedule presented in Table 3-4, final verification samples were collected from each excavation area, and the associated analytical results, presented in Chapter 5.0, were used for the final risk assessment (Chapter 6.0 and Annex A). No pre-verification samples were collected from the North Area based upon the absence of significant contamination in the overlying soil.

The SOB will be sampled according to ICN #2 for the SAP. The top 2 inches of soil, which will be scraped during restorative site grading, will be sampled and used for backfill material. Sample results will be presented in future submittals.

4.0 EXCAVATION RESULTS

This chapter provides both summary and detailed information that documents the LE VCM results. Excavated materials are summarized for the entire project (Section 4.1), and then by area (Sections 4.2 through 4.6). Sections 4.2 through 4.6 also present the pre-verification sampling results. A complete summary of the final disposition of waste is not possible at this time because final waste characterization, off-site disposal, SOB closure, and backfilling are ongoing activities (see Section 1.4). Backfilling operations are being conducted according to the CWL Backfill and Compaction Plan, Addendum C to Appendix S of the Closure Plan (SNL/NM July 2002). Completion of these activities will be documented in Addendums to this LE VCM report that will be submitted to the NMED. A final engineering report detailing backfilling operations will also be submitted to the NMED after completion of final corrective alternative(s) at the site, as described in the amended Chapter 12 of the Closure Plan (SNL/NM February 2003).

Excavation of the CWL began in September 1998 and was completed in February 2002. This landmark project involved the excavation and removal of more than 52,000 cy of soil and solid, hazardous, and mixed waste from the original disposal area of the CWL. Perhaps the greatest achievement of the LE VCM was the successful implementation of a comprehensive health and safety program that resulted in the excavation being completed within a 3.25-year period (estimated 500,000 man-hours worked) without a serious (life-threatening) injury. Only four Occupational Safety and Health Administration (OSHA) recordable, two OSHA restricted-time, and two OSHA lost-time injuries have occurred during the project through December 2002. All of these injuries were related to general site work and not actual excavation and waste segregation activities. Possibly the most significant factor was the rigorous, top-to-bottom implementation of the health and safety program, including countless man-hours of task- and project-specific training as well as safety incentives. Another key to this success was the re-engineering of the excavation process as the project progressed, which incorporated motorized equipment and better ergonomic designs. By working together with the NMED and EPA, critical process changes were made and appropriately documented while work continued following safer and more efficient procedures and practices (see Chapter 3.0).

Figure 4-1 shows the cumulative volume of excavated soil through time along with the estimated average excavation rates and amounts of soil excavated from each area of the CWL. The excavation production rate by month is shown in Figure 4-2 as a histogram chart with information explaining significant delays or production slowdowns. Color coding is used in Figure 4-2 to conceptually show the areas excavated over time. Figure 4-3 depicts the CWL after excavation was completed in February 2002, with colors representing the various depths of excavation.

In early June 2001, the excavation was completed to 12 feet bgs. Confirmatory geophysical surveys were performed from June to August 2001 in the excavation areas. By September 18, 2001, the last significant buried debris based upon confirmatory geophysical surveys was excavated. Additional excavation below 12 feet bgs, based upon pre-verification soil sample results (Annex F), was completed in the Southeast and Southwest Areas by February 2002.

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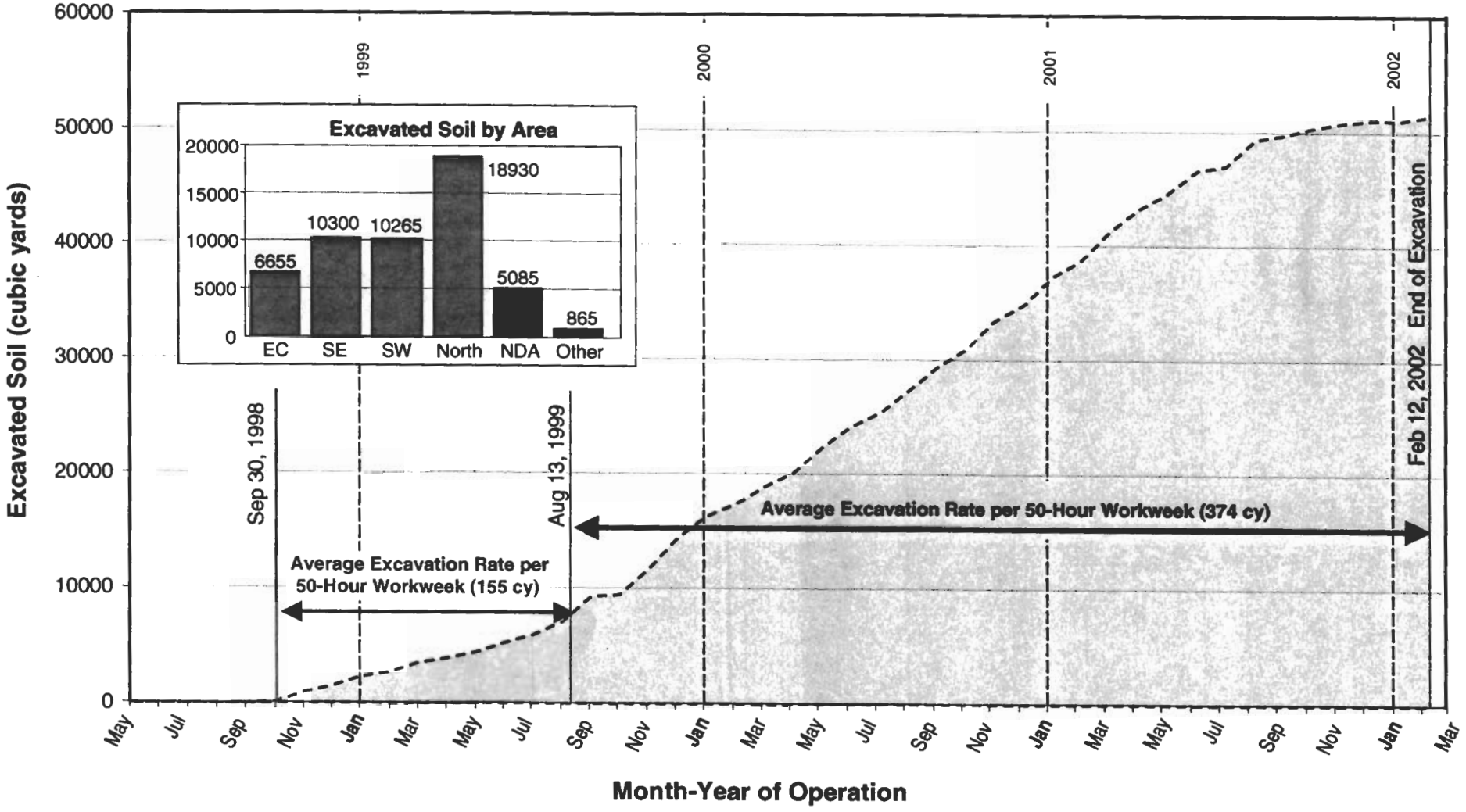
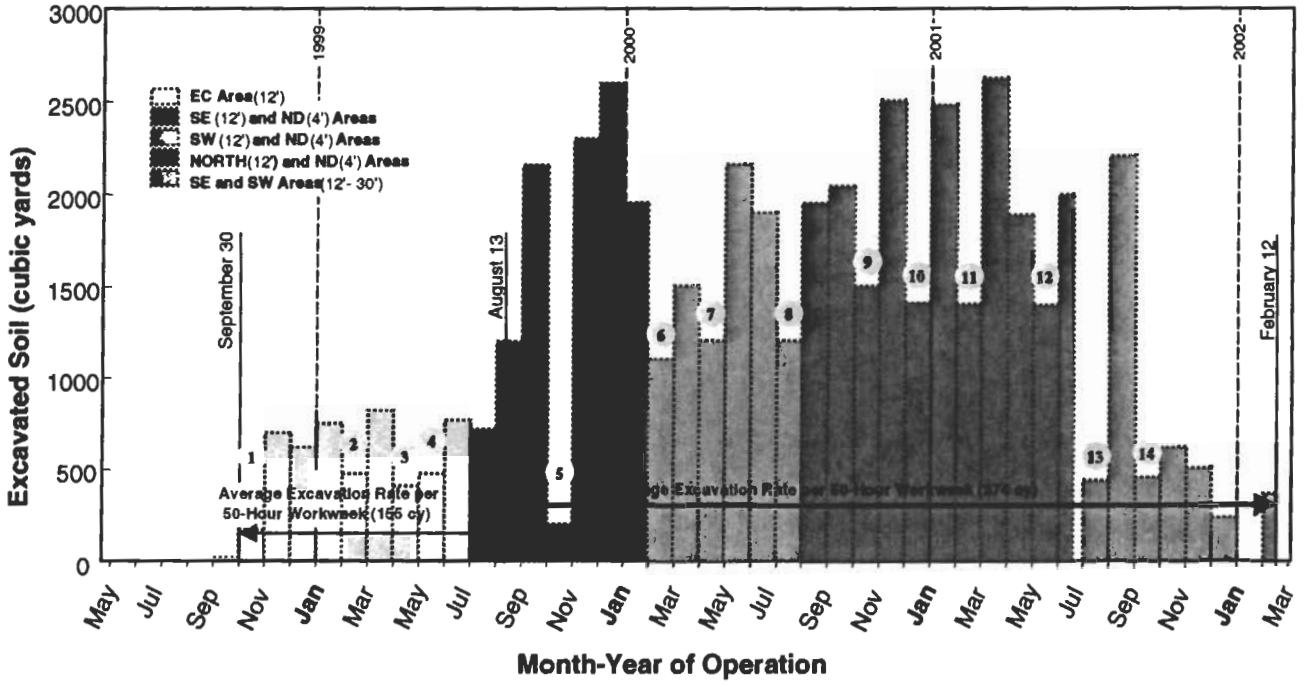


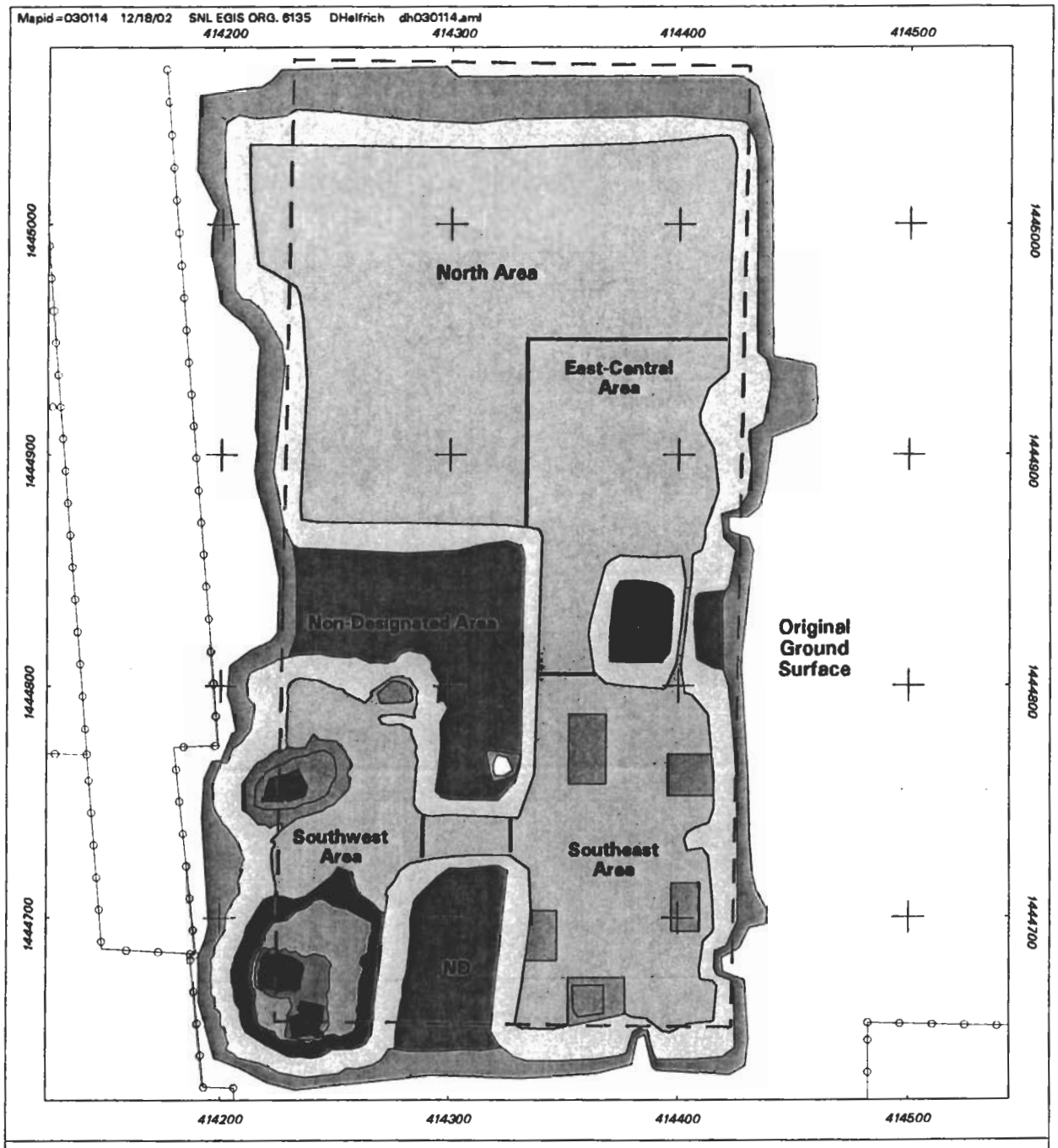
Figure 4-1
Cumulative Volume of Excavated Soil



Explanation of delays or slowdowns:

1. Changing from truck screen to table screen.
2. Space limitations within the CWL.
3. Space limitations within the CWL.
4. No UXO technician and high winds.
5. New SOB areas constructed, including set up of waste management tent and PCB tents.
6. Debris segregation prioritized to eliminate stockpiled debris in waste management area. Encountered irritant powder (chlorobenzylidene malonitrile) which required restart plan.
7. Repaired PCB tents and assisted with installation of new CAMU dome tent at Bay #3.
8. Completed segregating all debris from SW Area before starting at North Area.
9. New SOB areas set up (northeast corner of CWL and North Annex Area) while waiting for risk-based approach approval from NMED.
10. Consolidated soil piles to create more space for continued soil pile storage.
11. Encountered radiologically-contaminated debris. Other SNL/NM contractors working in area to perform test (not related to CWL). Return to the Southwest Area for additional excavation at EK area (west-central portion of Southwest Area).
12. No room for staging excavated soils, pre-verification sampling conducted.
13. Verification sampling conducted.
14. Verification sampling conducted.

Figure 4-2
Monthly Volume of Excavated Soil



Legend

- Excavation Area Boundary
- Fence
- CWL Boundary

Depth of Excavation (ND = Non-Designated Area)

0' No Excavation		
0 - 4'	12 - 14'	20'
4' ND Floor	14 - 16'	25'
4 - 12'	16 - 18'	30'
12' Floor	12-20'	

Figure 4-3
Final Excavation Extent
Prior to Backfilling
Chemical Waste Landfill

0 35 70
Scale in Feet

0 8.4 16.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

4.1 Summary of Volumes and Disposition of Excavated Soil and Debris

The estimated volumes of excavated soil and bulk debris items are presented by area in Sections 4.2 through 4.6. Estimates for excavated soil were generated in the field by tracking the number of loader buckets and dump truck loads. After excavated soil and debris were processed through the table or power screen, a front loader with a 3-cy bucket was used to load 10-cy dump trucks. Dump trucks then transported the soil to the staging area in the SOB where 50- to 100-cy soil piles were created and managed. Typically the loader buckets were heaped and held an estimated 3 1/3 cy. Three loader buckets typically filled the dump truck bed, and 10 dump truck loads would make a 100-cy soil pile. Although the excavation process and soil volume tracking evolved during the project, the vast majority of soil was tracked and estimated using this method. Therefore, the volume estimates include expansion that occurred after excavation (cut yards), and are not based upon in situ calculations (bank yards). This expansion factor is estimated to be approximately 30 percent for typical CWL soil material based upon experience at the CWL and CAMU.

Debris volumes are more difficult to estimate because of the nature of the material (i.e., internal void space, such as the air space inside an empty metal tank, and external void space between items when consolidated in a container or pile). For the LE VCM project, volumes have been estimated for excavated bulk debris including metal, wood, soft debris (plastics, paper, cardboard, etc.), and resins. The volume estimates for these debris types are based upon the container volumes in which the debris was staged after excavation. Concrete was removed from the shallow subsurface during excavation, but the vast majority was associated with monitoring well bollards and fence posts that were removed.

The volume of excavated rock was estimated based upon the number of dump truck loads it took to transport the rock back into the excavation as part of the backfilling effort. Excavated rock also was not tracked to the excavation areas for the same reason as bulk debris. Specific waste forms, which include compressed gas cylinders, intact chemical containers, partially expended munitions items, thermal batteries, and chemical batteries, are tracked by either the number or the weight of items. The size and shape of these items varies considerably making realistic volume estimates difficult. Unique items also tracked separately as specific waste streams include large metal objects (glove box, tanks, etc.), radioactively contaminated debris, asbestos-containing material (ACM) (tiles and blocks), and biohazardous waste. These specific waste forms are not included in volume estimates for debris, but are described and listed in this section.

Ongoing Waste Management and SOB Work

Final characterization and off-site disposal of debris are ongoing activities. After completion of this work, currently scheduled for 2005, a Waste Management Addendum to this report will be prepared to document the final disposition of all project waste. In this addendum, debris volumes and number-of-items (specific waste forms) estimates will be revisited and updated. Final disposition of any remaining soil waste (mixed, hazardous, radioactive, solid) will also be addressed in the Waste Management Addendum.

Efforts to clear the SOB, which are ongoing, include scraping/sampling approximately 2 inches of soil from the entire SOB and removing berms currently used for surface-water control. A source of fill material for the CWL is the SOB soil that has been scraped, stockpiled in 1,000 cy piles, and sampled as clean fill (see Section 4.7 and 5.6.4). Additional scraped SOB

soil will be characterized and, if acceptable, used as clean fill material at either the CAMU or CWL, depending upon CAMU operational needs. The SOB will then be sampled using the approved 50-foot sampling grid described in ICN #1 to the SAP (SNL/NM March 1999a). The additional scraped SOB soil pile samples and the 50-foot grid samples will be analyzed for the typical CWL analytical suite, and the results will be evaluated against the risk-based criteria to determine both appropriate final disposition and whether or not additional scraping is required to achieve risk-based closure of the SOB. All of this information will be documented in an SOB Closure Addendum to this report.

4.1.1 Summary of Excavated Soil

Table 4-1 provides a comprehensive summary of the excavated soil volume estimates including excavated volumes from each area, as well as the current or planned final disposition of the soil (CAMU, excavation backfill [replaceable soil], or off-site disposal). Soil sent to the CAMU is classified according to the various treatment groups or categories based upon soil pile analytical results. All excavated soil is attributed to a specific excavation area except for the 865 cy of soil resulting from the decontamination of excavated rocks, which were run through the power screen a second time in accordance with the Class I Modification to Addendum B to Appendix S of the Closure Plan (SNL/NM July 2001a). This soil was sampled and sent to the CAMU for stabilization treatment. In addition to the soil volumes summarized in Table 4-1, approximately 240 cy of soil, scraped from the northeastern part of the SOB to clear an area for the gas cylinder contractor to set up operations, was sampled and stockpiled with the replaceable soil that was returned to the excavation as part of the ongoing backfilling effort.

A full breakdown of soil volumes sent to the CAMU for treatment and/or disposal is shown in the lower portion of Table 4-1, along with excavated and scraped soil that will not be sent to the CAMU. The 240 cy of soil scraped from the SOB (not excavated from the CWL) are included in the 5,670 cy returned to the excavation, and thus are accounted for in the grand total at the bottom of the table. During the earlier phase of excavation (prior to approval of the risk-based approach in October 2000) when all nonradioactively contaminated soil was automatically sent to the CAMU, soil pile volumes that were below 50 cy were rounded up during reporting (e.g., 47 would be rounded to 50 cy). This rounding accounts for the 292-cy discrepancy between the two grand totals in Table 4-1, after subtracting the 240 cy of scraped SOB soil not included in the excavation area grand total.

Figure 4-4 graphically shows the percentage of soil excavated in each area of the CWL, and Figure 4-5 presents the anticipated final disposition of the excavated soil. The vast majority of the excavated soil (89 percent) is currently at the CAMU. Approximately 11 percent has already been placed into the bottom of the excavation as replaceable soil backfill. Only 70 cy, or less than 1 percent of the excavated soil, will require disposal at a permitted off-site facility as mixed or radioactive waste.

Replaceable Soil

The three potential options for final disposition of the excavated CWL soil include: 1) CAMU treatment, 2) replacement in the excavation as backfill material, or 3) off-site disposal. Placing soil that meets risk-based criteria back into the excavation was approved in the risk-based approach (SNL/NM August 2000) (Table 3-1). At this time, the soil stockpiling and staging

Table 4-1
Summary of Excavated Soil
CWL LE VCM

Excavated Soil Volumes by Area			
		Volume (cy)	Excavation Area
		6,655	East-Central Area
		10,300	Southeast Area
		10,265	Southwest Area
		18,930	North Area
		5,085	Non-Designated Area
		865	Soil from Screening the Rock Pile (865 cy)
		52,100	**Grand Total – Excavated Soil**
	Final Disposition	Volume (cy)	Material Description
Soil Sent to the CAMU	CAMU[a]	2,780	Organic constituents at/above CAMU Treatment Levels
	CAMU[a]	15,522	Metals at/above CAMU Treatment Levels
	CAMU[a]	6,170	Metals and organic constituents at/above CAMU Treatment Levels
	CAMU[a]	5,315	TSCA-regulated PCB soil (>50 mg/kg) with tritium levels below CAMU WAC
	CAMU[a]	17,105	No-Treat Soil and Soil that Passed the Risk-Based Criteria
		46,892	***Total Volume of Soil Sent to CAMU***
Soil Not Sent to the CAMU	Excavation	5,670	Passed Risk-Based Criteria as "Replaceable"
	Off-site[b]	50	Does not meet the CAMU WAC, potential mixed waste
	Off-site[b]	20	TSCA-regulated PCB soil with Tritium > CAMU WAC, potential mixed waste (also above CAMU Treatment Levels for metals)
		5,740	***Total Volume of Soil that did not go to the CAMU***
		52,632[c]	**Grand Total – Excavated and Scraped Soil**

[a]Analytical reports for all soil sent to the CAMU have been included in the CWL Quarterly Closure Reports.
[b]Final characterization and off-site disposal are ongoing. Off-site disposal will be documented in the Waste Management Addendum to this report.
[c]Estimate is biased slightly high due to rounding soil pile volumes for CAMU reporting. This total also includes 240 cy of scraped soil not included in the excavation area grand total. See Section 4.1.1 for a detailed explanation.
CAMU = Corrective Action Management Unit.
CWL = Chemical Waste Landfill.
cy = Cubic yard(s).
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
PCB = Polychlorinated biphenyl.
TSCA = Toxic Substances Control Act.
VCM = Voluntary Corrective Measure.
WAC = Waste Acceptance Criteria.

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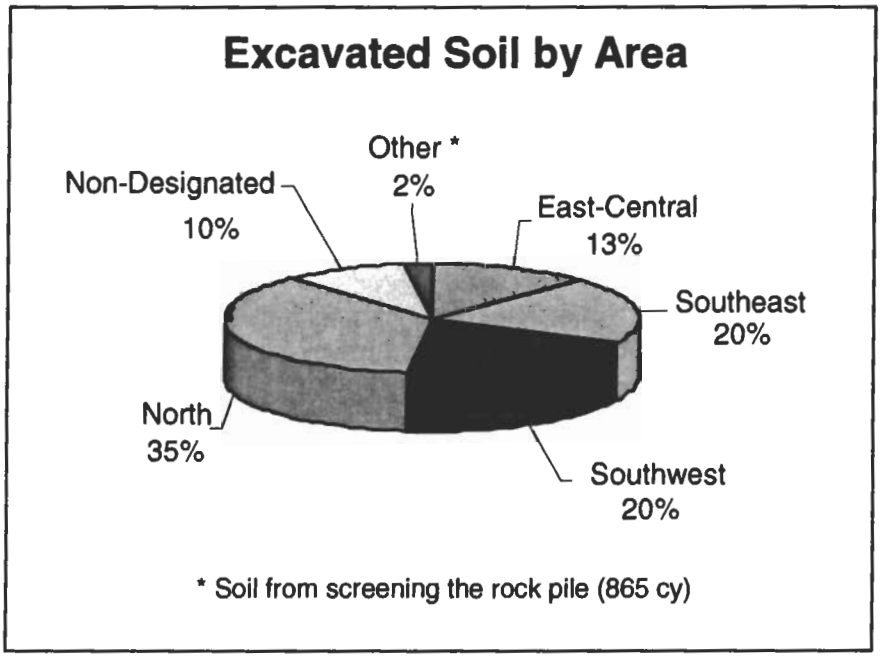


Figure 4-4
Excavated Soil Volumes by Area

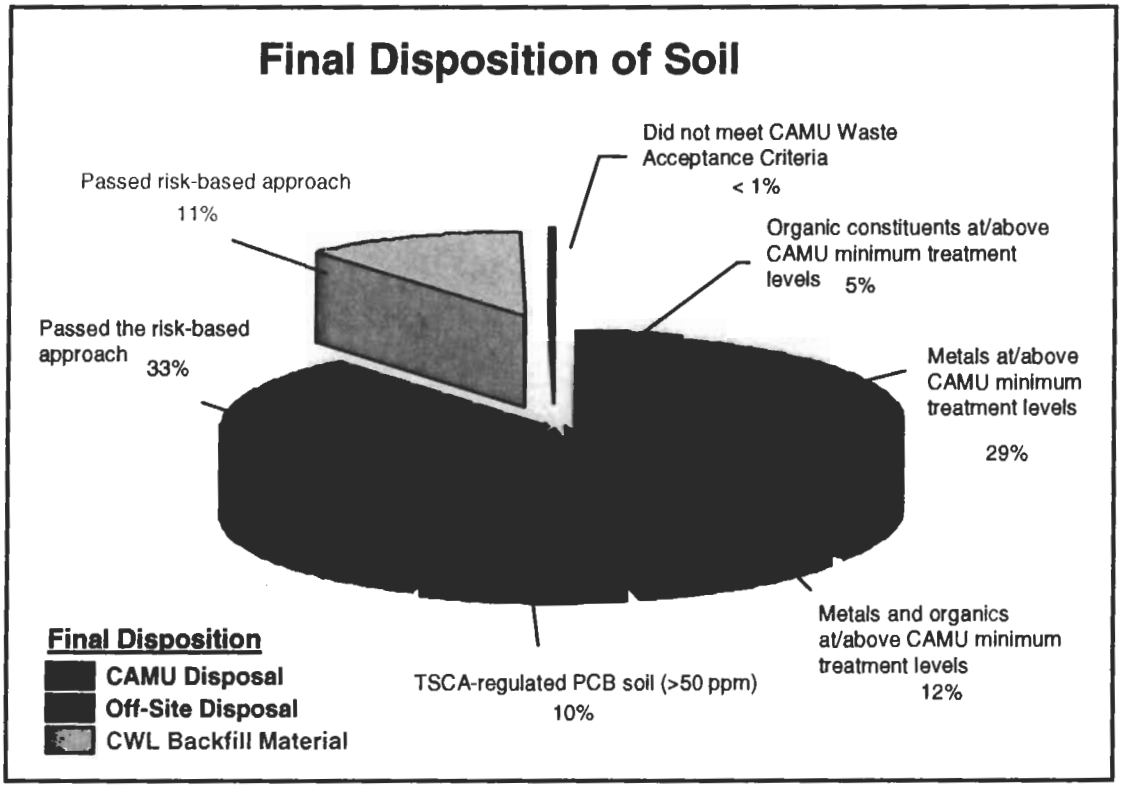


Figure 4-5
Final Disposition of Soil

process has been changed from 50-cy to 100-cy piles. The piles were sampled and if the on-site analytical results passed the risk-screening criteria, up to ten 100-cy piles could be combined to form a 1,000-cy replaceable soil pile. As the 1,000-cy piles were formed, a final confirmatory sample was collected and sent to an off-site laboratory for analysis. The off-site data for all potentially replaceable soil piles (1,000 cy or less) was then combined with the excavation verification analytical data set (sidewalls and floor final verification sample off-site analytical results discussed in Chapter 5.0) and evaluated in the final risk screening assessment presented in Chapter 6.0. A total of 10,640 cy of soil in 1,000-cy or less soil piles were evaluated and passed the preliminary risk screening assessment conducted prior to the start of backfilling in June 2002. As indicated in Table 4-1 and Figure 4-5, approximately 5,670 cy of this replaceable soil was returned to the bottom of the excavation. The preliminary 100-cy soil pile risk screening documentation for all excavated soil replaced in the excavation, including the on-site analytical results, are presented in Annex G. The remainder of the replaceable soil that passed the preliminary risk screening (4,970 cy) was sent to the CAMU to meet the volume requirements needed to fill the disposal cell. These data are presented and discussed in Chapter 5.0. The final risk screening assessment, provided in Annex A, is discussed in Chapter 6.0 and includes analytical results for all fill materials and excavation verification samples (sidewall and floor samples).

4.1.2 Summary of Excavated Debris

Table 4-2 provides a comprehensive summary of bulk debris types and some of the specific waste forms excavated from the CWL. Bulk debris materials that were recovered from the excavated soil include wood, metal, soft debris (i.e., paper, plastic, cardboard, cloth, etc.), and resins. For these debris types, volume estimates are provided based upon recent container inventories. Most of the 60 cy of wood appears to be pieces of broken pallets that were disposed of in the landfill. Of the 150 cy of metals recovered from the landfill, approximately 4 cy were nonferrous materials consisting of dewar flasks, copper tubing, aluminum parts, stainless steel containers, etc. The excavated ferrous metals (approximately 145 cy) were generally highly corroded due to the ubiquitous presence of acid wastes in the disposal pits. Many corroded 55-gallon drum pieces were removed, but most of the steel was from unidentifiable scrap materials, and approximately 15 cy contained an oily residue. Excavated soft debris was placed into 55-gallon bags that filled three 40-cy roll-off bins. All concrete recovered was associated with the removal of monitoring well bollards and fence posts that were within the landfill boundary or at the perimeter of the landfill.

Specific waste forms, tracked individually by weight or by number of items, are listed in the excavation area waste summaries presented in Sections 4.2 through 4.6. Some of the specific waste forms summarized in Table 4-2 include large metal items, intact chemical containers, gas cylinders, radioactive waste, thermal and chemical batteries, partially expended munitions items, and inactivated polio virus in glass vials.

Large, intact metal items (such as large vessels, glove boxes, and tanks) are managed separately as individual items and will be resized using cutting torches or other standard methods prior to final disposal, if necessary. They are not included in the metal volume estimates. A number of components and assemblies, such as vacuum system control panels and small motors were also recovered and managed separately from bulk metal debris. Approximately 2,000 chemical containers with unknown contents were recovered intact (Figure 4-6). To date, approximately one-third of these have been characterized and include

Table 4-2
Summary of Excavated Debris
CWL LE VCM

Debris Type	Estimated Volume[a] (cy)	Comments
Soft Debris	120	Includes only excavated soft debris. Does not include project-generated soft debris (tarps, liners, PPE, etc.). All of this excavated debris has been shredded. Final characterization and off-site disposal are ongoing activities.
Metal	150	Includes 5 cy of nonferrous metal and 15 cy of ferrous metal with oily residue that is segregated from the other metal. Final characterization and off-site disposal are ongoing activities.
Wood	60	All excavated wood has been shredded except for 1 cy with oily residue. Final characterization and off-site disposal are ongoing activities.
Oversize Metal	40	Large items that may require sizing prior to disposal. Volume is approximate and will be revised after resizing debris. Final characterization and off-site disposal, as necessary, are ongoing activities.
Resins	60	50 cy were disposed of off site through the HWMF. Ten cy contain oily residue. Final characterization and off-site disposal are ongoing activities.
Rocks (> 2-inches)	1,250	All rocks have been placed on the floor of the excavation in the North, East-Central, and Southeast Areas prior to backfilling.
Concrete	35	All concrete was associated with well bollards and fence posts within or at the CWL boundary. All concrete has been placed in the Southeast Area of the excavation.
Specific Waste Forms (Not Included in Volume Estimate Totals)		
Intact chemical containers	~2,000 containers	Containers are 100 mL to partial 55-gallon drums. Final characterization and off-site disposal are ongoing activities.
Radioactive, Potential Mixed Waste, and NORM	300+ containers	Includes various containers (5 mL to 55 gallon) and debris types, including thorium slag, media contaminated with depleted uranium, potassium salts, etc. Final characterization and off-site disposal are ongoing activities.
Thermal batteries	1,050 items/batteries	Includes 360 breached batteries and parts plus 520 batteries already disposed of off site. One hundred seventy remain to be x-rayed as part of final characterization prior to off-site disposal.
Chemical batteries	2,740 pounds	Includes lead-acid, rechargeable nickel-cadmium, lithium, alkaline, mercury, and others. Batteries were recovered both in packs and separately, making an accurate item count very difficult. Final characterization and off-site disposal are ongoing activities.
Partially Expended Munitions Items	30	Includes items such as flash tubes and smoke grenades. All items disposed of by KAFB EOD.
Gas Cylinders	357	All gas cylinder contents have been treated on site and rendered inert. Empty cylinders are being treated as scrap metal.

[a]All volumes are estimates and numbers are rounded except for gas cylinders (see Section 4.1 for explanation).
CWL = Chemical Waste Landfill.
cy = Cubic yard(s).
EOD = Explosive Ordnance Disposal.
HWMF = Hazardous Waste Management Facility.
KAFB = Kirtland Air Force Base.
LE = Landfill Excavation.
mL = Milliliter(s).
NORM = Naturally occurring radioactive materials.
PPE = Personal protective equipment.
VCM = Voluntary Corrective Measure.

Figure 4-6
Various Debris Items Excavated From the CWL

acids, solvents, oxidizers, carcinogens, water-reactive materials, pyrophoric materials, inert salts, plasticizers, darkroom chemicals, epoxies, oils, paints, and other industrial products. A list of chemicals and debris disposed of at permitted off-site disposal facilities through December 2002 is presented in Annex E. The remainder of these chemicals were categorized for material compatibility to allow for proper storage until final identifications could be completed. Final waste characterization and disposal information will be presented in a Waste Management Addendum to this report.

In addition to chemical disposal, 357 compressed gas cylinders that appeared to be intact were excavated from the CWL (Figure 4-6). A gas cylinder specialty company (Integrated Environmental Services) began processing the cylinders and characterizing the contents of the cylinders at the CWL on August 20, 2001. Various combinations of five methods were used to process the cylinders and included:

- Carbon adsorption
- Devalving of the containers with or without the use of liquid nitrogen
- Neutralization of the cylinder contents using sulfuric acid or sodium hydroxide
- Recontainerization of solids and liquids from the cylinders for disposal through the SNL/NM HWMF
- Venting of the gases through a carbon scrubber

Of the 357 cylinders, 233 were empty. The cylinder contents were categorized into solids and liquids, atmospheric gases, process gases, and other gases based upon definitions/categories used by the industrial gas manufacturing industry. Table 4-3 defines the different cylinder contents that were placed into these categories. Of the 124 cylinders with contents, 19 contained solids and/or liquids, 54 contained atmospheric gases (i.e., air, nitrogen, oxygen, argon, and/or neon), 6 contained process gases (i.e., carbon dioxide, carbon monoxide, and/or hydrogen), and 45 contained other gases.

A total 2,740 lb of various chemical batteries were excavated as well as approximately 1,050 thermal batteries/parts. The 1,050 thermal battery items were excavated and stored safely in a special cage until testing and characterization (Figure 4-6). This total includes 360 breached batteries and parts, plus 520 batteries that have been tested and disposed of off site. All batteries and parts were checked to ensure that they were previously discharged. Approximately 170 thermal batteries remain to be x-rayed as part of final characterization prior to off-site disposal (discharge must be verified using this method). The chemical batteries included lead-acid, rechargeable nickel-cadmium, lithium, alkaline, mercury, and others of various sizes and shapes. An accurate count is very difficult because many were excavated as battery packs that included multiple individual batteries. Final characterization and off-site disposal are ongoing activities.

Approximately 30 pieces of partially expended munitions debris were excavated from the landfill. After identification by the site UXO specialist, the items were protectively managed in a designated area until SNL/NM or KAFB Explosive Ordnance Disposal (EOD) personnel could arrive on site and remove the items for appropriate disposal. The munitions debris included partially expended intact smoke grenades, intact primers for M67 artillery round flash tubes, and blasting caps. All munitions items were disposed of by KAFB EOD.

Table 4-3
Contents of Cylinders Processed at the CWL

Atmospheric Gases	Air
	Air, Trace Freon
	N_2, O_2, Ar
	N_2, Air
	N_2, O_2
	N_2, O_2, Ar, Liquid
	N_2, Trace O_2
	Nitrogen
Process Gases	Carbon Dioxide
	Carbon Monoxide
	Hydrogen
Solids and Liquids	Ammonia/Chlorine Solution
	Hydrogen Bromide
	Liquid
	Nickel Plating Solution/Ammonia
	Solid Media
	Solid Media/Metal Chips
	Sticky Foam
Other Gases	Ammonia
	Ammonia/Phosphine
	Carbon Disulfide
	Carbon Monoxide
	Chlorine
	Chlorine, Hydrogen Chloride
	D_2, N_2, O_2, Trace SF_6
	Dichlorosilane
	Dichlorosilane/HCl
	Ethane, Trace O_2, CO_2
	Fluorinated Hydrocarbon
	Hexafluoroethane
	Hydrogen Chloride
	Hydrogen Fluoride
	Hydrogen Sulfide
	Methane
	Molybdenum Hexafluoride
	Nitric Oxide
	Nitric Oxide/Nitrogen Dioxide
	Nitric Oxide/Nitrous Dioxide
	Nitrogen Trioxide
	Nitrous Dioxide
	Nitrous Oxide
	Phosphine
	Propylene
	Silicon Tetrafluoride
	Trimethylaluminum
	Tungsten Hexafluoride
	Tungsten Hexafluoride, HF

Ar = Argon.
CO_2 = Carbon dioxide.
CWL = Chemical Waste Landfill.
D_2 = Deuterium.
HCl = Hydrogen chloride.
HF = Hydrogen fluoride.
N_2 = Nitrogen.
O_2 = Oxygen.
SF_6 = Sulfur hexafluoride.

Three vials were excavated together that were labeled "Polio." The original laboratory notebooks describing the history of these vials were located and they indicated the vials were inactivated by autoclaving prior to disposal in the CWL. The three vials of inactivated polio virus were turned over to SNL/NM Medical and disposed of through the SNL/NM HWMF.

Annex E summarizes the excavated chemicals and debris items that were disposed of at permitted off-site disposal facilities through December 2002. Approximately 70 cy of soil and most debris items are still in the process of final characterization and off-site disposal. A Waste Management Addendum to this report will be completed to document these activities and update the information provided in this report after SOB closure and final waste characterization and disposal are completed.

Sections 4.2 through 4.6 present the results of the LE VCM activities by excavation area. A summary of the following information is provided for each area:

- Excavation and waste summary (soil bulk debris and specific waste forms)
- Excavation to 12 feet bgs activity summary
- Pre-verification sampling results and additional excavation, if performed, below 12 feet bgs

In each of the designated excavation areas, the subsurface boundaries of the original disposal pits were obscure, making accurate differentiation of individual pits during the digging process impossible.

Section 4.7 provides a detailed summary of the backfilling activities completed as of August 2002.

4.2 East-Central Area

The East-Central Area is approximately 0.22 acre. The depth of buried materials and associated contaminated soil was estimated to extend from 12 to 20 feet bgs in this area. The volume of buried materials and potentially contaminated soil in this area was estimated to be 5,659 cy (SNL/NM November 1998c).

Excavation in this area was completed to a maximum depth of 12 feet bgs, including the removal of Excavation Blocks 1 through 10 and 16 (Figure 3-1). The average excavation rate was approximately 155 cy a week. Debris items excavated from the East-Central Area generally contained a mixture of deteriorated materials, broken and intact small containers, and porous and nonporous debris (i.e., wood and scrap metal). Table 4-4 summarizes the excavated soil and bulk debris from the East-Central Area.

Table 4-4
East-Central Area Excavated Waste Volumes
CWL LE VCM

Excavated Materials	Estimated Volumes (cy)
Soil	6,655
Rocks (> 2 inches)	102
Soft Debris	15
Metal	35
Wood	25
Resins	0

cy = Cubic yard(s).
CWL = Chemical Waste Landfill.
LE = Landfill Excavation.
VCM = Voluntary Corrective Measure.

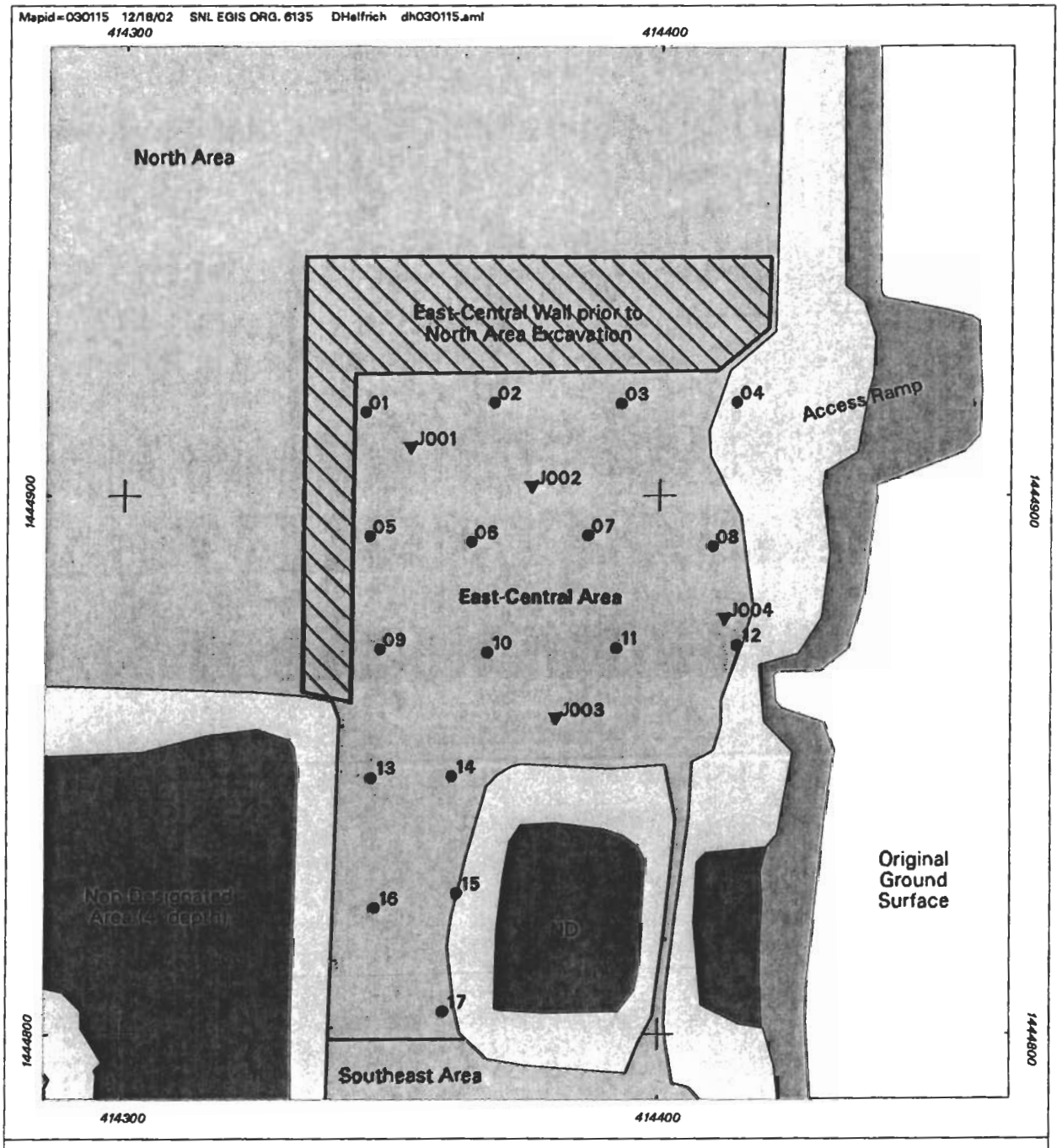
4.2.1 Excavation to 12 Feet bgs (East-Central Area)

Excavation of buried materials began in the northeast corner of the East-Central Area on September 30, 1998, and proceeded along the eastern side, moving south. The excavation along the eastern boundary showed the location and extent of suspected disposal pits within the area and was consistent with original planning assumptions. Excavation along this side of the East-Central Area also showed that the lateral extent of buried debris did not extend outside the eastern CWL boundary fence. Soil staining observed at the 12-foot-bgs depth in several areas may have been associated with the rupturing of plastic bags containing non-RCRA-regulated yellow-powdered dye excavated in this area.

4.2.2 Pre-Verification Sampling Results (East-Central Area)

Pre-verification samples were collected from the floor of the East-Central Area during April 2000. In addition to the pre-verification grid samples, four judgmental samples (J001, J002, J003, and J004) were collected from the East-Central Area during March 2000. The judgmental samples were taken from NMED-identified, non-grid locations in areas of stained soil or other criteria. NMED personnel were present during the collection of the judgmental samples to observe the collection process and to receive split samples for separate laboratory analysis. The analytical results for the SNL/NM split samples were submitted to the NMED on August 28, 2000 (Young August 2000).

Analytical results for the pre-verification samples collected from the East-Central Area were screened against the risk-based criteria (SNL/NM August 2000). No further excavation of the floor was necessary based upon the risk screening results for the pre-verification samples. Results for the NMED split samples did not include risk-based criteria. Figure 4-7 shows all the pre-verification sampling grid and judgmental locations for the East-Central Area. Table 4-5 shows the verification grid and judgmental locations that were sampled, the depth, and the risk screening results. Risk screening cover sheets and analytical results are provided in Annex F.



Legend

- Verification Grid Sample
- Judgmental Sample
- East-Central Area Boundary

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- East-Central Wall prior to North Area Excavation
- 4 - 12'
- 12' Floor

Figure 4-7
East-Central Area Verification Grid and Judgmental Sample Locations
Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 4-5
East-Central Area Pre-Verification Sample Risk Screening Results
CWL LE VCM

Sample Date	Sample Location[a]	Sample ID[a]	Sample Depth (ft)	Preliminary Risk Screening Analysis (Pass/Fail)
4/11/00	Floor	74-EC-D012-V001	12	PASS
4/11/00	Floor	74-EC-D012-V002	12	PASS
4/11/00	Floor	74-EC-D012-V003	12	PASS
4/11/00	Floor	74-EC-D012-V004	12	PASS
4/11/00	Floor	74-EC-D012-V005	12	PASS
4/11/00	Floor	74-EC-D012-V006	12	PASS
4/11/00	Floor	74-EC-D012-V007	12	PASS
4/11/00	Floor	74-EC-D012-V008	12	PASS
4/18/00	Floor	74-EC-D012-V009	12	PASS
4/18/00	Floor	74-EC-D012-V010	12	PASS
4/18/00	Floor	74-EC-D012-V011	12	PASS
4/18/00	Floor	74-EC-D012-V012	12	PASS
4/18/00	Floor	74-EC-D012-V013	12	PASS
4/18/00	Floor	74-EC-D012-V014	12	PASS
4/18/00	Floor	74-EC-D012-V015	12	PASS
4/18/00	Floor	74-EC-D012-V016	12	PASS
4/18/00	Floor	74-EC-D012-V017	12	PASS
3/20/00	Floor	74-EC-D012-J001	12	PASS
3/20/00	Floor	74-EC-D012-J002	12	PASS
3/20/00	Floor	74-EC-D012-J002 Duplicate	12	PASS
3/20/00	Floor	74-EC-D012-J003	12	PASS
3/20/00	Floor	74-EC-D012-J004	12	PASS

[a]See Figure 4-7 for the location of the samples listed.
CWL = Chemical Waste Landfill.
EC = East-Central Area sample.
ft = Foot (feet).
ID = Identification.
LE = Landfill Excavation.
VCM = Voluntary Corrective Measure.

4.3 Southeast Excavation Area

The Southeast Area is approximately 0.28 acres in size. The depth of buried materials and associated contaminated soil was estimated to extend to 15 to 20 feet bgs in this area. The estimated volume of buried materials and potentially contaminated soil in this area was estimated to be 5,362 cy (SNL/NM November 1998c).

Excavation in this area was completed to a maximum depth of 16 feet bgs, including the removal of Excavation Blocks 11 through 15, 17, 35, and 44 through 46 (Figure 3-1). Excavation below 12 feet bgs was performed in three locations because of more deeply buried debris (Excavation Blocks 35 and 46), and in two locations based upon pre-verification sample results (Excavation Block 45). The average excavation rate for the Southeast Area was 420 cy per week. The increase in the excavation rate relative to the East-Central Area was associated with a power screen implemented in August 1999 (see Chapter 3.0) used to segregate soil from debris. Excavated waste from the Southeast Area included soft debris, metal, wood, resins, rocks, sticky foam, gas cylinders, thermal batteries, and chemical containers. Table 4-6 summarizes the excavated soil and bulk debris.

Table 4-6
Southeast Area Excavated Waste Volumes
CWL LE VCM

Excavated Material	Estimated Volumes (cy)
Soil	10,300
Rocks (> 2 inches)	180
Soft Debris	35
Metal	25
Wood	10
Resins	15

cy = Cubic yard(s).
CWL = Chemical Waste Landfill.
LE = Landfill Excavation.
VCM = Voluntary Corrective Measure.

4.3.1 Excavation to 12 Feet bgs (Southeast Area)

Excavation of buried materials began on July 19, 1999, in the northern portion of the Southeast Area and proceeded southward. Excavation of soil and debris to 12 feet bgs was completed on January 16, 2000; however, some debris still existed at a depth greater than 12 feet bgs in the southwest part of the area along the southern boundary. This deeper area of debris burial extended over an estimated 15- by 25-foot area. Additional soil was removed on January 25, 2000, across the base of the excavation to achieve a consistent 12-foot-bgs depth.

Excavation Below 12 Feet bgs

During the week of February 26, 2001, excavation occurred in the southwestern part of the area to a depth of 16 feet bgs to remove the debris remaining below 12 feet bgs. Soil, rocks, and debris, including more than 100 gas cylinders, were removed from this area. Additional

geophysical surveys were performed with hand-held magnetometers to confirm the removal of all debris in this area (Excavation Block 35 in Figure 3-1), which includes Grid Point 19 and extends to the south sidewall (Figure 4-8).

On July 3, 2001, the confirmatory geophysical survey was performed in the Southeast Area. Based upon the survey results, two areas approximately 10 by 10 by 2 feet bgs were excavated to remove small metal items and scrap. (The size and shape of these areas appears larger in Figure 4-8 due to minor sloping for equipment access.) These two areas roughly correspond to verification Grid Locations 03 and 13 (see Figure 4-8) and represent Excavation Block 46 (Figure 3-1). Additional excavation below 12 feet bgs at two more locations based upon pre-verification sampling results is described in Section 4.3.2.

4.3.2 Pre-Verification Sampling Results (Southeast Area)

In March 2000, four judgmental samples (J001, J002, J003, and J004) were collected from NMED-identified, non-grid locations in the Southeast Area at the same time judgmental samples were collected from the East-Central Area. NMED personnel were present during the collection of the judgmental samples to observe the collection process and to receive split samples for separate laboratory analysis. The analytical results for the SNL/NM split samples were submitted to the NMED on August 28, 2000 (Young August 2000). Pre-verification grid samples were collected from the floor of the Southeast Area during late April and early May 2001. The pre-verification sample for Grid Point 13 was not collected because additional digging was anticipated in that part of the area to remove buried debris. Only a final verification (off-site laboratory) sample was collected from this location (see Section 5.2 for analytical results).

Analytical results for the pre-verification samples collected from the Southeast Area were screened against the risk-based criteria (SNL/NM August 2000). Risk screening results indicated the sample from Grid Location 05, located in the northeastern part of the excavation area, exceeded the PCB threshold value of 100 milligrams (mg)/kilogram (kg) at a concentration of 234.4 mg/kg (see Figure 4-8). Grid Sample 14, located in the southwestern part of the excavation area, passed preliminary risk analysis; however, at 81.45 mg/kg, PCB concentrations in the soil were close to the PCB threshold concentration of 100 mg/kg. These locations were both excavated to a depth of 14 feet bgs. The excavated area extends approximately 12.5 feet east to west and 12.5 feet north to south from the center of the grid sample location to form a 25-foot square centered on the grid point. Approximately 180 cy of PCB-contaminated soil and rock were excavated from these two locations, which were identified as Excavation Block 45 (Figure 3-1).

Table 4-7 shows the verification grid locations that were sampled, the depth, and the preliminary risk screening results. After excavation to 14 feet bgs, both grid locations (05 and 14) and four additional judgmental locations (J007 and J009 associated with Grid Node 05, and J006 and J008 associated with Grid Node 14) were collected to verify removal of PCB-contaminated soil. All sample results reported nondetections for total PCBs (less than 0.5 mg/kg). In the area excavated to 16 feet bgs because of buried debris along the southern boundary, judgmental sample J005 was collected and analyzed on site for the standard CWL analytical suite. Risk screening of the J005 sample analytical results indicated that excavation beyond the 16-foot-bgs depth was not required. Risk screening cover sheets and analytical results are provided in Annex F.

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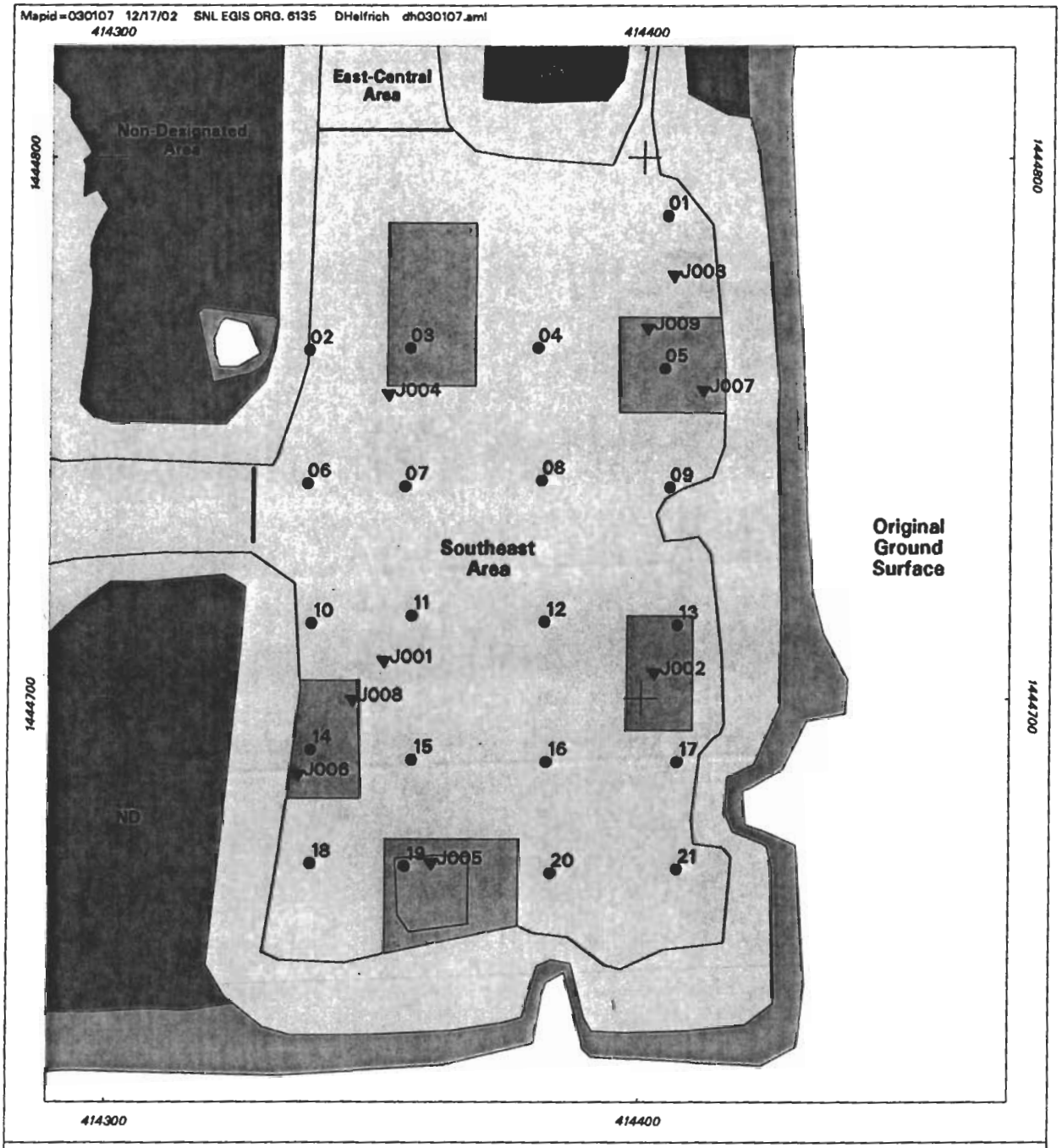

Legend

- Verification Grid Sample
- Judgmental Sample
- Southeast Area Boundary

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor
- 12 - 14'
- 14 - 16'

Figure 4-8
Southeast Area Verification Grid and Judgmental Sample Locations Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 4-7
Southeast Area Pre-Verification Sample Risk Screening Results
CWL LE VCM

Sample Date	Sample Location[a]	Sample ID[a]	Sample Depth (ft)	Preliminary Risk Screening Analysis (Pass/Fail)
4/30/01	Floor	74-SE-D012-V001	12	PASS
4/30/01	Floor	74-SE-D012-V002	12	PASS
4/30/01	Floor	74-SE-D012-V003	12	PASS
4/30/01	Floor	74-SE-D012-V004	12	PASS
4/30/01	Floor	74-SE-D012-V005	12	FAIL (PCB >100 mg/kg)
9/07/01	Floor	74-SE-D014-V005	14	PASS (PCBs <100 mg/kg)
4/30/01	Floor	74-SE-D012-V006	12	PASS
4/30/01	Floor	74-SE-D012-V007	12	PASS
5/01/01	Floor	74-SE-D012-V008	12	PASS
5/01/01	Floor	74-SE-D012-V009	12	PASS
5/01/01	Floor	74-SE-D012-V010	12	PASS
5/08/01	Floor	74-SE-D012-V011	12	PASS
5/08/01	Floor	74-SE-D012-V012	12	PASS
5/08/01	Floor	74-SE-D012-V014	12	PASS[b]
9/07/01	Floor	74-SE-D014-V014	14	PASS (PCBs < 100 mg/kg)
5/08/01	Floor	74-SE-D012-V015	12	PASS
5/08/01	Floor	74-SE-D012-V016	12	PASS
5/08/01	Floor	74-SE-D012-V017	12	PASS
4/24/01	Floor	74-SE-D012-V018	12	PASS
4/24/01	Floor	74-SE-D017-V019	16	PASS
4/24/01	Floor	74-SE-D012-V020	12	PASS
5/08/01	Floor	74-SE-D012-V021	12	PASS
3/20/00	Floor	74-SE-D012-J001	12	PASS[c]
3/20/00	Floor	74-SE-D012-J002	12	PASS[c]
3/20/00	Floor	74-SE-D012-J003	12	PASS[c]
3/20/00	Floor	74-SE-D012-J004	12	PASS[c]
5/08/01	Floor	74-SE-D017-J005	16	PASS
9/07/01	Floor	74-SE-D014-J006	14	PASS (PCBs <100 mg/kg)
9/07/01	Floor	74-SE-D014-J007	14	PASS (PCBs <100 mg/kg)
9/07/01	Floor	74-SE-D014-J008	14	PASS (PCBs <100 mg/kg)
9/07/01	Floor	74-SE-D014-J009	14	PASS (PCBs <100 mg/kg)

[a]See Figure 4-8 for the location of the samples listed.
[b]Because the total PCB result was close to the threshold value of 100 mg/kg, the area around this grid point was excavated.
[c]NMED split-sample location.
CWL = Chemical Waste Landfill.
ft = Foot (feet).
ID = Identification.
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
NMED = New Mexico Environment Department.
PCB = Polychlorinated biphenyl.
SE = Southeast.
VCM = Voluntary Corrective Measure.

4.4 Southwest Excavation Area

The Southwest Area is approximately 0.19 acres. The depth of buried materials and associated contaminated soil was estimated to extend from 12 to 20 feet bgs in this area. The estimated volume of buried materials and potentially contaminated soil was 5,744 cy (SNL/NM November 1998c).

Excavation of the Southwest Area began in February 2000 and was completed to a depth of 12 feet bgs in July 2000. Excavation in this area was completed to a maximum depth of 30 feet bgs in February 2002 after an extended, phased investigation of the southern part of the Southwest Area. Excavation to 12 feet bgs included the removal of Excavation Blocks 18 through 23. Deeper excavation described in Sections 4.4.1 and 4.4.2 involved the removal of Excavation Blocks 33 (18 feet bgs), 43 (to 20 feet bgs), 47 (20 feet bgs) 48 through 50 (sidewall sloping to 20 feet bgs), and 51 (25 and 30 feet bgs) (Figure 3-1).

The weekly excavation rate for the Southwest Area averaged approximately 370 cy per week. During the week of February 21, 2000, excavation was temporarily suspended due to the release of the irritant powder CS. The excavation and waste segregation progress slowed again during the weeks of June 25 to July 25, 2000, because of the quantity of radioactive material and debris that was encountered during the excavation of the northern part of the Southwest Area. In addition, two soil piles from this area, each 100 cy in size, contained elevated activities of tritium that resulted in additional soil segregation and sampling activities.

Debris excavated from this area included chemical containers, bulk debris, gas cylinders, thermal batteries, chemical batteries, sulfur compounds, CS (irritant powder), and radioactively contaminated material. Debris associated with the TEVES demonstration project and the EK experiment was also removed. Table 4-8 summarizes the excavated soil and bulk debris.

Table 4-8
Southwest Area Excavated Waste Volumes
CWL LE VCM

Excavated Materials	Estimated Volumes (cy)
Soil	10,265
Rocks (> 2 inches)	440
Soft Debris	30
Metal	15
Wood	10
Resins	15

CWL = Chemical Waste Landfill.
cy = Cubic yard(s).
LE = Landfill Excavation.
VCM = Voluntary Corrective Measure.

4.4.1 Excavation to 12 Feet bgs (Southwest Area)

Excavation of the Southwest Area began on February 11, 2000, and was completed on July 21, 2000, to a depth of 12 feet bgs.

Excavation Below 12 Feet bgs

After the excavation of the Southwest Area to 12 feet bgs, debris associated with the EK experiment was visible on the excavation floor in the middle-western portion of the Southwest Area. During excavation of this debris, a hardened, black layer of soil was encountered directly beneath the debris at approximately 16 to 17 feet bgs. This black layer, as well as approximately 330 cy of soil and debris, was removed from the excavation floor on February 13 and 15, 2001 (Excavation Block 33 in Figure 3-1). The black layer in the sidewall was not fully excavated in February 2001 because it extended outside the original landfill boundary and contract scope. The excavated debris between 12 and 16 feet bgs included copper electrodes and PVC and ceramic tubing with wires protruding from the ends. The debris was associated with two SNL/NM experimental in-situ remediation systems that were installed in this area where an unlined chromic acid disposal trench had been used from the early 1970s to 1978 (labeled "Chromic Acid Trench" in Figure 2-3). These two small experimental remediation systems, the TEVES (SNL/NM August 1997) and EK (SNL/NM 1998), were operated during 1992 and 1996 to 1997, respectively (see Table 2-2).

On February 26, 2001, six judgmental samples (J001, J002, J003, J004, J005, J006) were collected (Figure 4-9) to determine whether additional excavation would be necessary. These soil samples were analyzed for the typical CWL analytical suite (VOCs, SVOCs, RCRA metals plus nickel, copper, beryllium, and hexavalent chromium, PCBs, tritium, and gamma spectroscopy). As shown in Figure 4-10, two samples were collected from the bottom of the excavation at 18 feet bgs (J001 and J002), two samples were collected from the hardened, black soil in the western slope at approximately 16 feet bgs (J004 and J006), and two samples were collected from the green-stained soil in the western slope directly below the hardened, black soil at approximately 17 feet bgs (J003 and J005). Samples J004 and J006 exceeded risk-based criteria (SNL/NM August 2000) due to high chromium concentrations. All other sample results passed the risk screening analysis. Chromium results for the six samples are shown in Table 4-9.

Table 4-9
Chromium Results for J001 through J006
CWL LE VCM

Sample Date	Sample Location	Sample Depth (ft)	Chromium Results (mg/kg)
2/26/01	74-SW-D018-J001	18	650
2/26/01	74-SW-D018-J002	18	360
2/26/01	74-SW-D018-J003	17	150
2/26/01	74-SW-D018-J004	16	7,200
2/26/01	74-SW-D018-J005	17	140
2/26/01	74-SW-D018-J006	16	9,000

CWL = Chemical Waste Landfill.
ft = Foot (feet).
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
VCM = Voluntary Corrective Measure.

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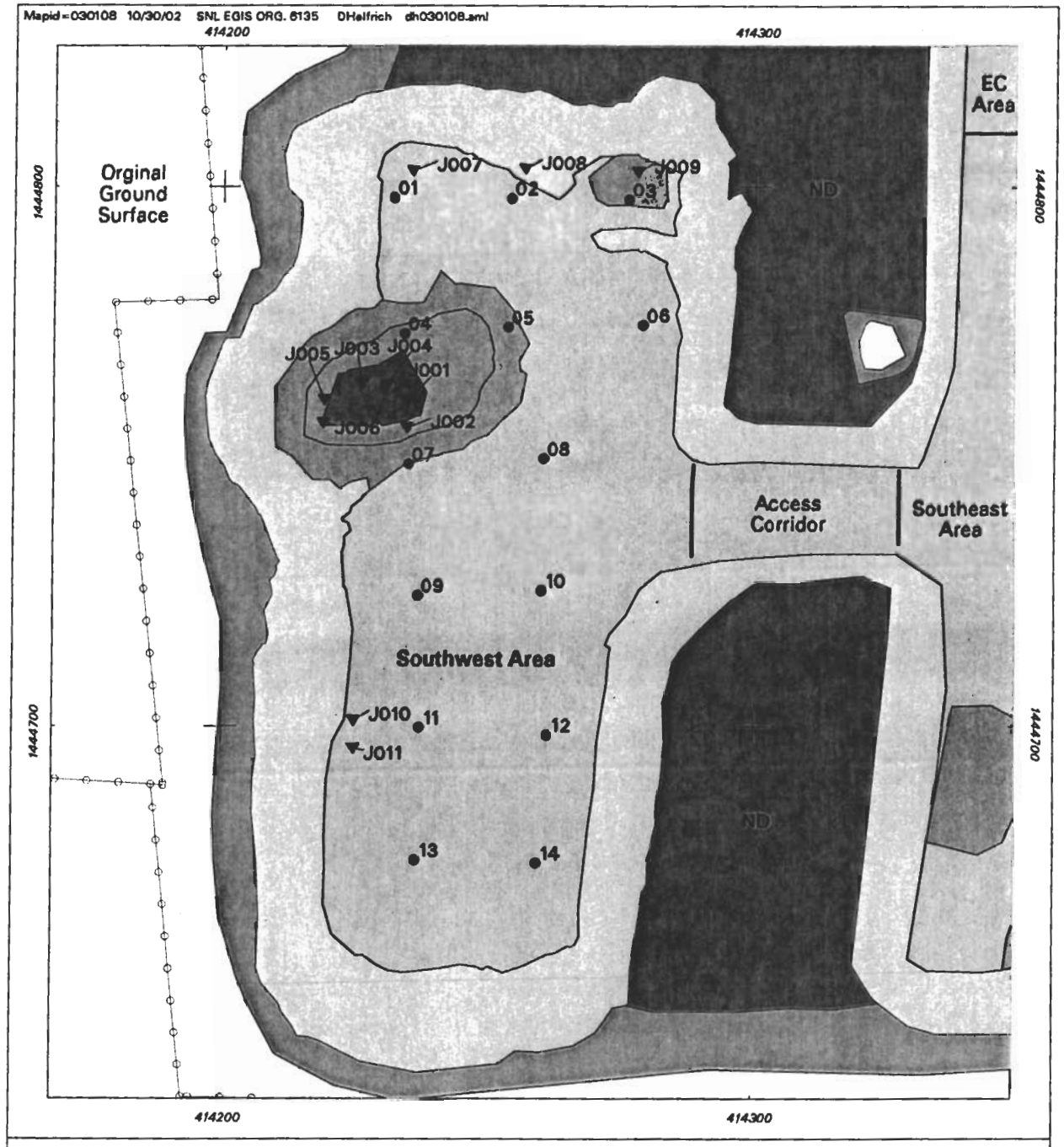

Legend

- Verification Grid Sample
- Judgmental Sample
- Area Boundary
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0 - 4′
- 4′ ND Floor
- 4 - 12′
- 12′ Floor
- 12 - 14′
- 14 - 16′
- 16 - 18′
- 0′ No Excavation

Figure 4-9
Southwest Area Verification Grid and Judgmental Sample Locations Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

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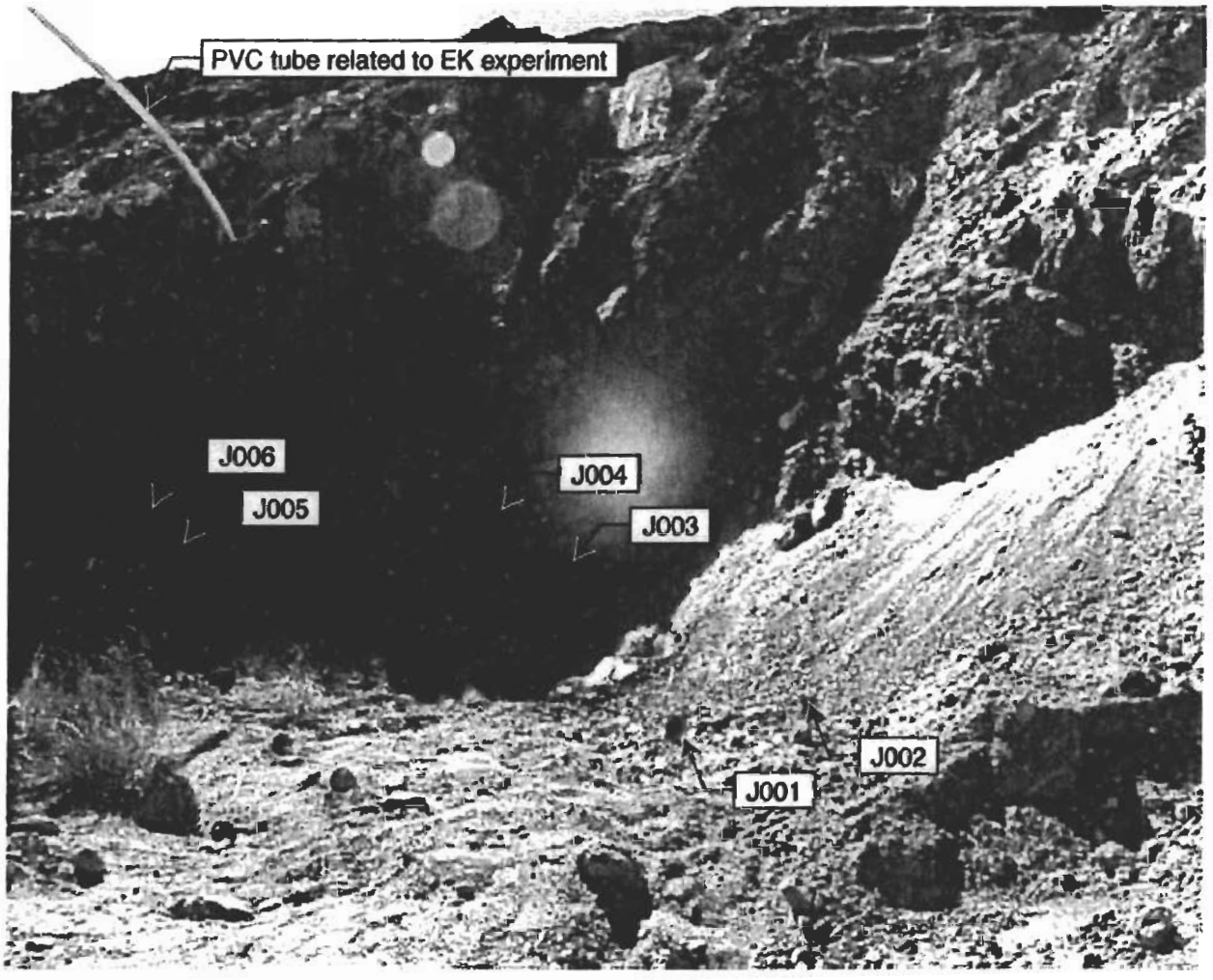


Figure 4-10
Location of Judgmental Samples J001 through J006 in the Southwest Area

To address the two samples that exceeded risk-based criteria, the excavation was extended laterally, approximately 10 feet into the slope of the excavation, and to a uniform depth of 18 feet bgs on March 26 and 27, 2001 (Figure 4-9). Excavation ceased when no visible hardened black soil remained in the vicinity. Approximately 290 cy of soil was excavated as Excavation Block 38 (Figure 3-1).

4.4.2 Pre-Verification Sampling Results (Southwest Area)

Pre-verification grid point samples were collected from the floor of the Southwest Area during the month of April 2001, after the removal of the hardened, black soil layer in February and March 2001. Excavation floor Grid Points 1 through 14 were sampled along with three judgmental locations, J007 through J009, which were grid points relocated along the northern boundary of the Southwest Area (see Figure 4-9). The results were submitted for risk screening during the week of June 25, 2001. Preliminary risk analysis indicated that one sample (J009) failed the risk-based criteria for human health (aniline, hazard index ([HI] greater than 2) and Grid Sample Locations 11 and 13 (samples V011 and V013) failed risk screening for PCBs (greater than 100 mg/kg) (see Figure 4-9). Table 4-10 shows the verification grid locations that were sampled in April 2001, the depth, and the risk screening analysis results.

Excavation of J009 occurred during July 2001 and involved the removal of a 2-foot-thick layer of soil to a total depth of 14 feet bgs (Excavation Block 33, Figure 3-1). The excavated area formed an approximate 15-foot square centered on the judgmental sampling point. Excavation in the area was limited by the close proximity of the sidewall to the north. Approximately 70 cy of soil was excavated from this area. J009 was resampled and passed preliminary risk screening at the 14-foot-bgs depth (see Table 4-10).

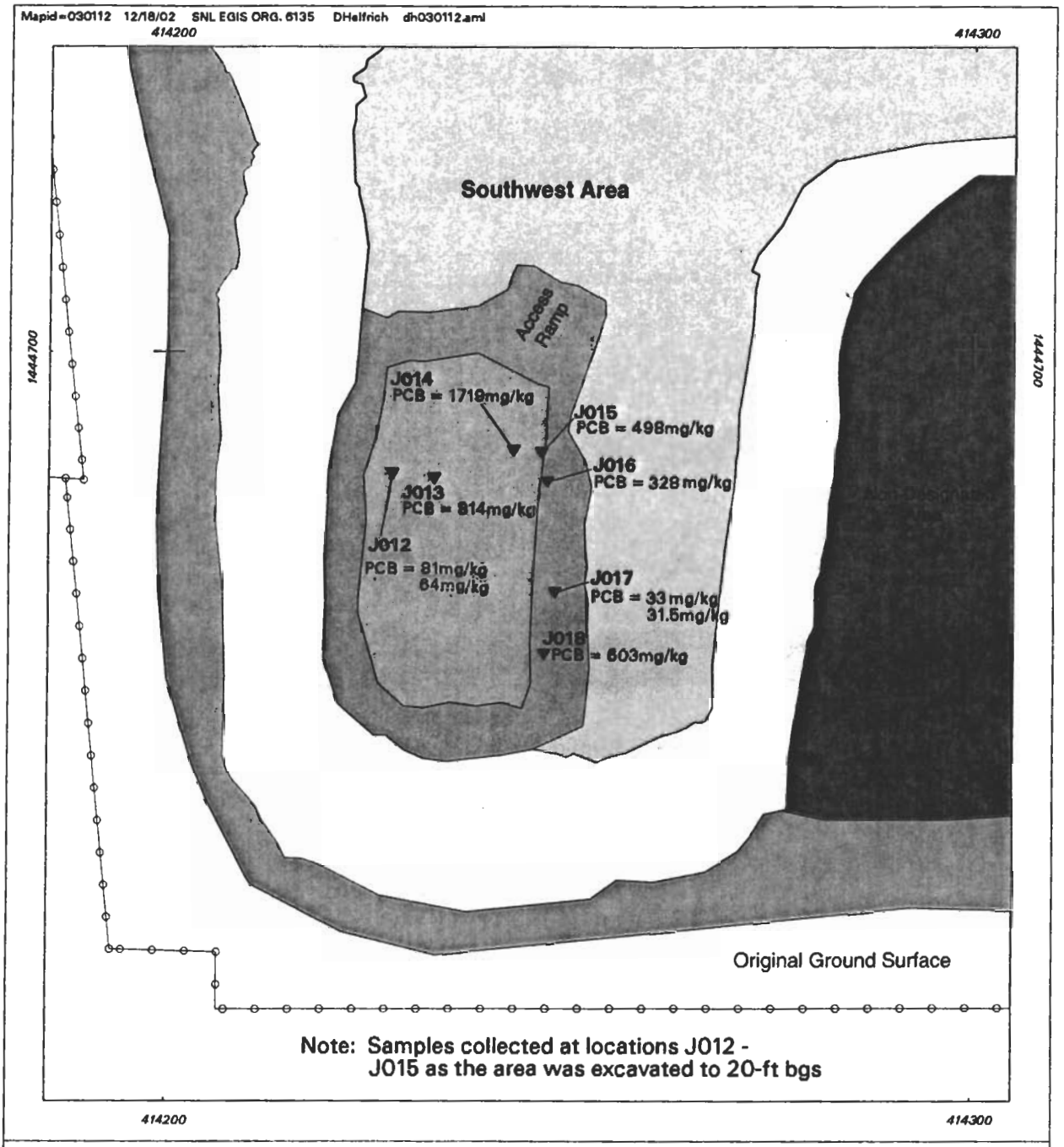
Next, two pre-verification judgmental samples were collected from the western sidewall of the Southwest Area where a yellow color, suspected of being chromium staining, was apparent on the soil surface. Sample J010 was collected at a depth of 15 feet bgs, and J011 at depth of 16 feet bgs in the western sidewall (see Figure 4-9). The samples were analyzed for metals only, and the total chromium results were 95 and 34 mg/kg, respectively (the subsurface background level for chromium is 15.9 mg/kg). Because these results passed risk screening (see Table 4-10), no further excavation was performed in this area. The yellow color is the result of a very thin coating of oxidized chromium that forms on the sidewall surface when it is exposed to the atmosphere and is not indicative of unacceptable chromium concentrations in the soil.

Excavation below 12 feet bgs in the southwestern half of the Southwest Area began on August 20, 2001, based upon the 12-foot-bgs pre-verification PCB sample results from Grid Locations 11 (Sample V011 at 169 mg/kg total PCBs) and 13 (Sample V013 at 129 mg/kg total PCBs). Because visual analysis and judgmental sample results from depths of 13, 16, and 17 feet bgs continued to indicate elevated levels of PCBs (greater than 100 mg/kg), digging progressed and excavation was completed to the planned maximum depth of 20 feet bgs (as specified in the CWL SAP [SNL/NM November 1998a]) across the entire southwestern half of the Southwest Area represented by Grid Points 11 and 13 (see Figures 4-9 and 4-11). Results for judgmental sample locations J012, J013, J014, and J015 collected during the excavation are included in Table 4-10 and shown in Figure 4-11. Two results are shown for Location J012 because a duplicate sample was collected at this location. The excavated area was approximately 25 feet wide (east to west) and 50 feet long (north to south). Approximately 900 cy of PCB-contaminated soil were excavated from this area, which represents Excavation Block 43 (Figure 3-1).

Table 4-10
Southwest Area: Preliminary Risk Screening Results
CWL LE VCM

Sample Date	Sample Location	Sample ID	Sample Depth (ft)	Preliminary Risk Screening Analysis (Pass/Fail)
4/18/01	Floor	74-SW-D012-V001	12	PASS
4/19/01	Floor	74-SW-D012-V002	12	PASS
4/18/01	Floor	74-SW-D012-V003	12	PASS
4/18/01	Floor	74-SW-D019-V004	19	PASS
4/18/01	Floor	74-SW-D017-V005	17	PASS
4/18/01	Floor	74-SW-D012-V006	12	PASS
4/18/01	Floor	74-SW-D012-V007	12	PASS
4/18/01	Floor	74-SW-D012-V008	12	PASS
4/18/01	Floor	74-SW-D012-V009	12	PASS
4/18/01	Floor	74-SW-D012-V010	12	PASS
4/24/01	Floor	74-SW-D012-V011	12	FAIL (PCB >100 mg/kg)
4/24/01	Floor	74-SW-D012-V012	12	PASS
4/24/01	Floor	74-SW-D012-V013	12	FAIL (PCB >100 mg/kg)
4/24/01	Floor	74-SW-D012-V014	12	PASS
4/24/01	Floor	74-SW-D012-J007	12	PASS
4/24/01	Floor	74-SW-D012-J008	12	PASS
4/24/01	Floor	74-SW-D012-J009	12	FAIL (HI >2)
7/24/01	Floor	74-SW-D014-J009	14	PASS
Samples Collected as Excavation Proceeded Below 12 ft bgs in the Southwestern Half of the Area				
7/25/01	Sidewall	74-SW-D015-J010	12	PASS (metals only)
7/25/01	Sidewall	74-SW-D016-J011	12	PASS (metals only)
7/25/01	Floor	74-SW-D013-J012	12	PASS (PCBs <100 mg/kg)
7/25/01	Floor	74-SW-D013-J012 Duplicate	12	PASS (PCBs <100 mg/kg)
7/25/01	Floor	74-SW-D017-J013	17	FAIL (PCBs >100 mg/kg)
7/25/01	Floor	74-SW-D017-J014	17	FAIL (PCBs >100 mg/kg)
7/25/01	Floor	74-SW-D016-J015	16	FAIL (PCBs >100 mg/kg)
Samples Collected from Sidewall Separating the 12- and 20-ft-bgs Areas in the Southwestern Half of the Southwest Area				
10/25/01	Sidewall	74-SW-D016-J016	16	FAIL (PCBs >100 mg/kg)
10/25/01	Sidewall	74-SW-D015-J017	15	PASS
10/25/01	Sidewall	74-SW-D015-J017 Duplicate	15	PASS
10/25/01	Sidewall	74-SW-D016-J018	16	FAIL (PCBs >100 mg/kg)

CWL = Chemical Waste Landfill.
bgs = Below ground surface.
ft = Foot (feet).
HI = Hazard Index.
ID = Identification.
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
PCB = Polychlorinated biphenyl.
SW = Southwest
VCM = Voluntary Corrective Measure.



Legend

- Judgmental Sample
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor
- 12-20'
- 20'

Figure 4-11
Southwest Area Preliminary Excavation PCB Judgmental Sample Locations and Results Chemical Waste Landfill

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

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Dark-stained soil, visible on the 20-foot-bgs floor, suggested that PCB contamination existed at depths greater than 20 feet bgs. A new SAP was prepared and submitted to the NMED as ICN #4 to the SAP (SNL/NM December 2001) and to the EPA as part of the Supplemental Information for the Risk-Based Approval Request (SNL/NM October 2001a, b) (Table 3-1). The additional sampling in this SAP was intended to define the lateral and vertical extent of the PCB contamination within this area so that final planning and excavation, if required, could be completed.

Risk screening cover sheets and analytical results for the Southwest Area pre-verification samples are provided in Annex F. Cover sheets are not provided for samples that were analyzed for total PCBs only. Results for these samples were compared directly to the established threshold values.

4.4.2.1 PCB Investigation (Southwest Area)

ICN #4 to the SAP (SNL/NM December 2001) was developed to document an expedited, phased approach to characterizing the extent of PCB contamination using the OSML to provide quick turnaround analytical results. ICN #4 to the SAP also included options for limited excavation (soil removal) between sampling phases, based upon OSML results and visual screening of soil. Each phase of sampling was intended to provide information that would be used to determine whether excavation was required and/or to help refine/focus the strategy for the subsequent sampling phase.

The sampling and excavation phases associated with this ICN are summarized in chronological order in Table 4-11, and the results of each phase are presented in the following sections of this report. Photographs documenting the various phases of field work and field notes associated with the sidewall and excavation subsurface sampling phases are included in a report detailing the results of implementing ICN #4 to the SAP submitted to both the NMED and the EPA as part of the Supplemental Information for the Risk-Based Approval Request (SNL/NM October 2001a, b). The following information is summarized from this report, which is included as Annex H.

Sidewall Between the 20- and 12-Foot-bgs Areas (Southwest Area)

After excavation to 20 feet bgs based upon the results of Grid Samples 11 and 13, as well as judgmental samples J012 through J015, the southern end of the Southwest Area was divided into two halves: the western half at 20 feet bgs and the eastern half at 12 feet bgs (see Figure 4-11). Three judgmental samples (J016, J017, and J018) were then collected from the sidewall separating these two areas on October 25, 2001. Two of the three samples (J016 and J018) were collected from a coarse-grained sediment layer (sand with gravel) that was visibly stained. These samples contained total PCB concentrations greater than the threshold value of 100 mg/kg (328 and 603 mg/kg, respectively), thus confirming the visual observations. The J017 sample and associated duplicate sample were collected from a finer grained (silty) horizon that did not appear stained. The results for these two samples were below 50 mg/kg (31.5 and 33 mg/kg, respectively).

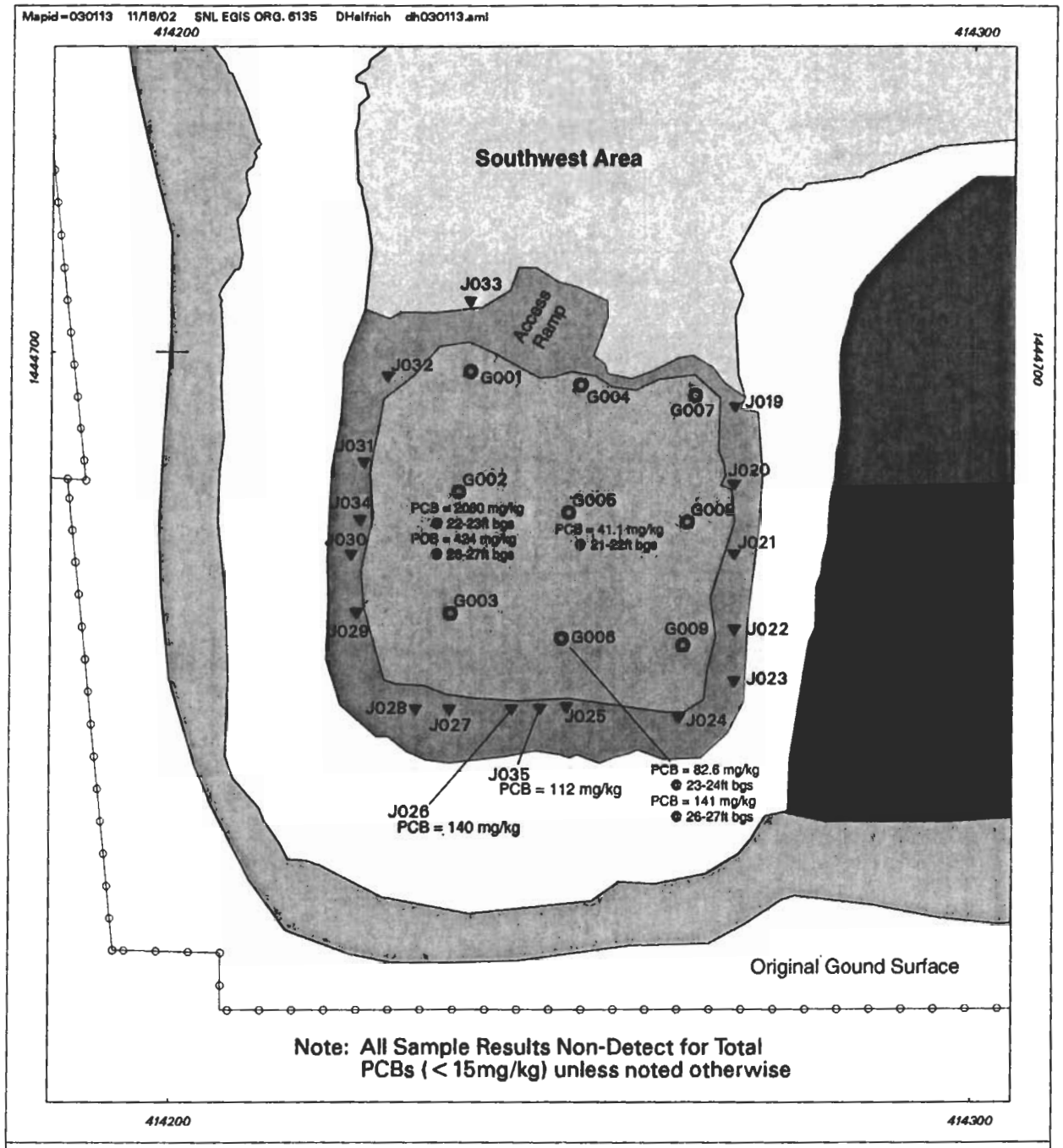
Total PCB results for J016 through J018 are included in Table 4-10 and shown in Figure 4-11. In late October 2001, the entire southeastern half of the Southwest Area (Grid Points 12 and 14) was excavated to 20 feet bgs, leaving the entire southern part of the Southwest Area a uniform 20 feet bgs in depth, approximately 50 feet wide by 50 feet long. Approximately 560 cy of soil

Table 4-11
Chronology of Sampling and Excavation Conducted in the Southwest Area
CWL LE VCM

	Sampling or Excavation Phase	Date Work Performed	Results
Activities prior to developing the PCB SAP	Pre-Verification 25 ft bgs Grid sampling at 12 ft bgs	April 24, 2001	2 out of 4 grid locations (11 and 13) in the southern part of the area had PCB results >100 mg/kg. See Figure 4-9 for locations.
	Excavation of the southwestern half of the area to a depth of 20 ft bgs	July 20 and August 22, 2001	4 judgmental samples (J012–J015) collected during excavation contained 3 results for PCBs >100 mg/kg. See Figure 4-11 for locations and results. Area excavated measured approximately 25 by 50 ft. Approximately 830 cy of contaminated soil were removed.
Activities detailed in ICN #4 to the SAP	Sidewall between the 20- and 12-ft-bgs areas	October 25, 2001	3 judgmental samples collected from the sidewall surface included 2 biased toward stained soil areas (J016 and J018) and 1 biased toward non-stained soil area (J017). The 2 stained soil results exceeded 100 mg/kg for total PCBs. See Figure 4-11 for locations and results.
	Excavation of the 12-ft-bgs southeastern half of the area to 20 ft bgs	October 30, 2001	No samples were collected during excavation. Staining previously visible in the sidewall was no longer apparent after excavation to eastern boundary. Area excavated measured approximately 25 by 50 ft. Approximately 560 cy of contaminated soil were removed.
	Main Sidewall Characterization	November 8, 2001	17 samples collected from the 20-ft eastern, southern, and western sidewalls (including 1 sample from the 8-ft northern sidewall). Depths ranged from 14 to 19 ft bgs; lateral spacing was generally 10 ft. Sampling biased to alluvial units/layers more likely to be contaminated (coarser-grained layers). All results were "non-detect" except for 2 adjacent samples from the south-central sidewall. See Figure 4-12 for locations and results.
	Subsurface Characterization (Geoprobe® sampling) beneath the 20-ft-bgs floor	November 12, 2001	9 borehole locations laid out in a grid pattern on the 20-ft-bgs excavation floor, spacing ~8 ft from the sidewalls and 10 to 15 ft between each location. 3 or 4 subsurface samples collected at each location, for a total of 29 samples. 5 detections of total PCBs from 3 sample locations, 3 of which were >100 mg/kg. 23 results were "non-detect" (<15 mg/kg). See Figure 4-12 for locations and results.
	Excavation Floor – Surface Verification Sampling at 20 ft bgs	November 19, 2001	4 verification samples collected for off-site laboratory analysis from the 25-ft verification grid locations at a depth of 20 ft bgs (Locations 11 through 14, see Figure 4-9). Split samples from Locations 11, 13, and 14 were collected by the NMED-DOE Oversight Bureau.
	Limited Excavation and Verification Sampling	December 5, 2001	An area approximately 15 ft wide by 4 ft deep (into sidewall) was removed (~170 cubic yards). 2 verification samples J036 and J037) were collected from the upper and lower southern sidewall after excavation. Results were "non-detect" for total PCBs (<15 mg/kg). See Figure 4-13 for locations and results.

Note: Shaded rows indicate "Excavation Activities"; unshaded rows indicate "Sampling Activities."

bgs = Below ground surface.
CWL = Chemical Waste Landfill.
cy = Cubic yard(s).
DOE = U.S. Department of Energy.
ft = Foot (feet).
ICN = Interim Change Notice.
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
NMED = New Mexico Environment Department.
PCB = Polychlorinated biphenyl.
SAP = Sampling and Analysis Plan.
VCM = Voluntary Corrective Measure.



Legend

- PCB Judgmental Sample
- Geoprobe Borehole
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor
- 12-20'
- 20'

Figure 4-12
Southwest Area PCB Judgmental Sidewall and Geoprobe Sample Locations and Results
Chemical Waste Landfill

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

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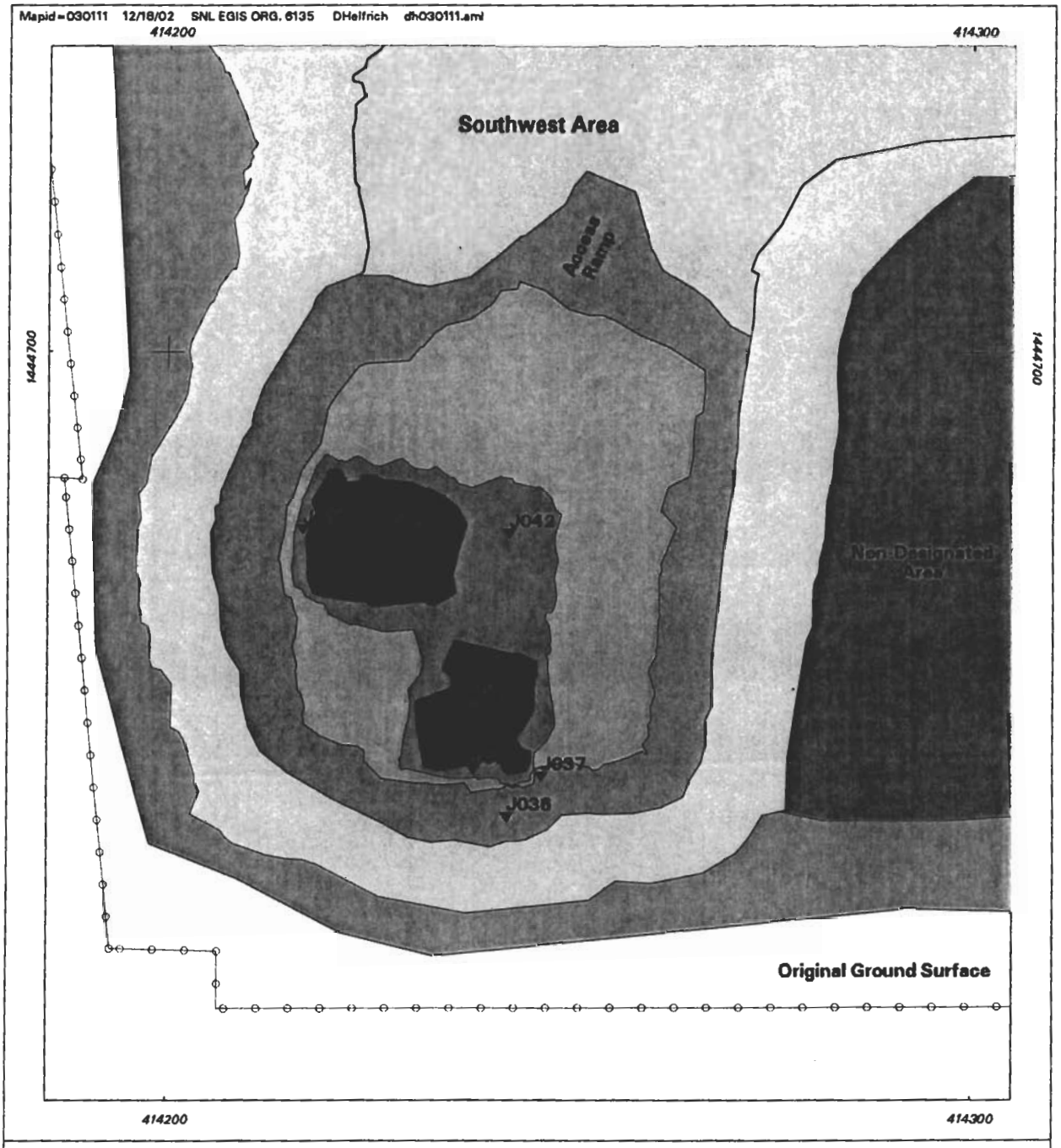

Legend

- PCB Judgmental Sample
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor
- 12 - 20'
- 20'
- 25'
- 30'

Figure 4-13
Southwest Area Final Excavation
PCB Judgmental Sample Locations
Chemical Waste Landfill

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

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were removed as Excavation Block 47 (Figure 3-1), processed through the Screen-All®, and protectively managed as PCB-contaminated soil within the CWL SOB.

Main Sidewall Characterization

After completing the excavation described above, a comprehensive sidewall sampling event was conducted on November 8, 2001. The main purpose of sampling the sidewall was to locate where PCB contamination may have migrated laterally out of the CWL boundary. Prior to collecting any samples, all of the sidewalls were examined and described in field notes, which are included in Annex H as Attachment 2. The eastern, southern and western sidewalls were 20 feet tall, with a near-vertical bottom section 4 feet high that transitioned into a sloped upper section leading up to the original ground surface. The northern sidewall separated the southern 20-foot-bgs area from the northern part of the Southwest Area, which remained at 12 feet bgs, except for the area defined by sample locations J001 through J006 (excavated to 18 feet bgs) and sample location J009 (excavated to 14 feet bgs). The northern sidewall was also cut by an access ramp (see Figure 4-11).

After logging the sidewalls, 17 sample locations were selected at various depths. Since no staining was observed, locations were biased towards the coarse-grained layers/intervals. Sample depth varied between 14 and 19 feet bgs, with most samples collected between 15 and 18 feet bgs. At each sample location, a fresh surface was prepared by scraping the area with a shovel. After sample collection, the immediate area sampled was described and documented.

Table 4-12 shows the OSML total PCB analytical results for the 17 sidewall samples and Figure 4-12 shows the sample locations (J019 through J035). Lateral sample spacing was typically 10 feet or less. Of the 17 sample results, there were only two PCB detections, which occurred at adjacent locations J035 and J026 (112 and 140 mg/kg, respectively, Figure 4-12). The results support the conclusion that the lateral distribution of PCB contamination was largely limited to the former disposal boundary of the CWL (as projected downward from the original disposal area).

Excavation Subsurface Characterization

Sampling beneath the 20-foot-bgs area was conducted after the sidewall sampling event to determine the lateral and vertical extent beneath the current excavation floor. The objective of this sampling was to provide a detailed vertical extent profile of PCB contamination.

The boreholes and sample locations were closely spaced in order to accurately determine the additional scope of work necessary to remove contaminated soil using this data set. Nine boreholes were laid out in a grid pattern on the excavation floor and are shown in Figure 4-8. Locations bordering 20-foot-high sidewalls were spaced a minimum of 8 feet from the 4-foot sidewalls. All boreholes were started at 20 feet bgs and completed to a total depth of 32 feet bgs, except for the G001 borehole (completed to a depth of 33 feet bgs). Sampling methods and a detailed description of the Geoprobe® borehole sampling is presented in Annex H.

On November 12, 2001, all nine locations were drilled and sampled. A total of 29 samples (no duplicates) were collected below 20 feet bgs from locations G001 and G007.

Table 4-12
PCB Analytical Results for the Southwest Area Sidewalls
CWL LE VCM

Location	Sample ID[a]	Depth in ft bgs	PCB OSML Analytical Results
Eastern sidewall with J019 starting at the north end to J023 at the south end.	74-SW-D017-J019	17	ND (<15 mg/kg)
	74-SW-D018-J020	18	ND (<15 mg/kg)
	74-SW-D015-J021	15	ND (<15 mg/kg)
	74-SW-D018-J022	18	ND (<15 mg/kg)
	74-SW-D017-J023	17	ND (<15 mg/kg)
Southern sidewall with J024 at the east end to J028 at the west end. J035 located between J025 and J026 at the base of the sidewall.	74-SW-D018-J024	18	ND (<15 mg/kg)
	74-SW-D015-J025	15	ND (<15 mg/kg)
	74-SW-D019-J035	19	112 mg/kg
	74-SW-D014-J026	14	140 mg/kg
	74-SW-D017-J027	17	ND (<15 mg/kg)
	74-SW-D018-J028	18	ND (<15 mg/kg)
Western sidewall with J029 at the south end and J032 on the north end. J034 located between J030 and J031.	74-SW-D016-J029	16	ND (<15 mg/kg)
	74-SW-D018-J030	18	ND (<15 mg/kg)
	74-SW-D014-J034	14	ND (<15 mg/kg)
	74-SW-D015-J031	15	ND (<15 mg/kg)
	74-SW-D015-J032	15	ND (<15 mg/kg)
North sidewall west of the access ramp.	74-SW-D016-J033	16	ND (<15 mg/kg)

[a]See Figure 4-12 for sample locations.
CWL = Chemical Waste Landfill.
bgs = Below ground surface.
ft = Foot (feet).
ID = Identification.
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
ND = Not detected.
OSML = On-Site Mobile Laboratory.
PCB = Polychlorinated biphenyl.
SW = Southwest.
VCM = Voluntary Corrective Measure.

Figure 4-12 shows the borehole locations and corresponding detections of PCBs. Table 4-13 shows the total PCB analytical results by location and depth. Of the 29 samples collected, there were five detections from three locations, of which only three results exceeded 100 mg/kg for total PCBs (from two Geoprobe® locations). All of the deepest interval samples from each location (typically 30 to 31 feet bgs) were nondetections (less than 15 mg/kg). All sample results for locations along the northern (G001, G004, and G007) and eastern (G007, G008, and G009) boundary of the 20-foot-bgs area were nondetections. Only two samples from G002 and one sample from G006 were greater than 100 mg/kg. PCBs were detected at only one other location (G005 at 41.1 mg/kg) from a depth of 21 to 22 feet bgs. The G006 location is approximately 8 feet from the only two sidewall locations that had detectable PCB levels (J035 and J026), both at greater than 100 mg/kg (see Figure 4-12). These data show that PCB contamination greater than the 15 mg/kg detection limit below 20 feet bgs was very limited and restricted to the G002, G005, and G006 sampling locations.

The sample with the highest PCB concentration, Sample 74-SW-D022-G002 at 2,060 mg/kg, was also analyzed at the OSML for VOCs as requested by NMED and as stipulated in ICN #4 to the SAP. Based upon these results, SNL/NM excavated further and performed additional VOC analyses at this location as part of the final verification sampling.

Excavation Floor–Surface Verification Sampling (Southwest Area)

Verification sampling of the Southwest Area floor (at 20 feet bgs) was conducted on November 19, 2001. This sampling was performed prior to additional excavation at Locations G002, G006, G005, and Sidewall Locations J035 and J026 (excavation depth was 20 feet bgs). Off-site laboratory samples were collected from Grid Points 11 through 14 within the southern portion of the Southwest Area, and split samples were collected for the NMED (see Figure 4-9). The results are presented in Section 5.3.

Limited Excavation and Verification Sampling (Southwest Area)

On December 5, 2001, the PCB-contaminated area within the southern sidewall was excavated. The area excavated included sidewall samples J035 and J026 (Figure 4-12), which are spaced approximately 4 feet apart laterally and 5 feet apart vertically (19 and 14 feet bgs respectively). An area 15 feet wide at the bottom of the excavation (20 feet bgs), centered on these locations, was excavated 4 feet into the sidewall (to the south). To maintain adequate sloping of the sidewall, the area excavated had to be extended to the original ground surface. The width of the excavated area was expanded gradually, from 15 feet at the base to a width of 25 feet at the surface. A total of 170 cy of soil were removed as Excavation Block 50 (Figure 3-1).

Two verification samples (74-SW-D019-J036 and 74-SW-D014-J037) were collected from the new sidewall at the same approximate locations as the previously collected 74-SW-D019-J035 and 74-SW-D014-J026 samples, only 4 feet further south on the new excavation sidewall surface (Figure 4-13). Both samples were analyzed at the OSML for total PCBs and the results were nondetections (less than 15 mg/kg). To provide final verification data, two additional samples were collected from the same locations for off-site PCB laboratory analyses. These results are presented in Section 5.3 and are consistent with the OSML results (less than 15 mg/kg).

Table 4-13
PCB Analytical Results for the Excavation Subsurface Borehole Sampling
Southwest Area, CWL LE VCM

Location	Sample Identification	Depth Interval in ft bgs	PCB OSML Analytical Results (mg/kg)
Northwest corner, west side of area	CWL-74-SW-D021-G001	21-22	ND (<15)
	CWL-74-SW-D026-G001	26-27	ND (<15)
	CWL-74-SW-D029-G001	29-30	ND (<15)
	CWL-74-SW-D032-G001	32-33	ND (<15)
Central location, west side	CWL-74-SW-D022-G002	22-23	2060
	CWL-74-SW-D026-G002	26-27	424
	CWL-74-SW-D030-G002	30-31	ND (<15)
Southwest corner, west side of area	CWL-74-SW-D022-G003	22-23	ND (<15)
	CWL-74-SW-D026-G003	26-27	ND (<15)
	CWL-74-SW-D031-G003	31-32	ND (<15)
Northern end, central area	CWL-74-SW-D022-G004	22-23	ND (<15)
	CWL-74-SW-D026-G004	26-27	ND (<15)
	CWL-74-SW-D030-G004	30-31	ND (<15)
Center location of central area	CWL-74-SW-D021-G005	21-22	41.1
	CWL-74-SW-D026-G005	26-27	ND (<15)
	CWL-74-SW-D031-G005	31-32	ND (<15)
Southern end, central area	CWL-74-SW-D023-G006	23-24	82.6
	CWL-74-SW-D026-G006	26-27	141
	CWL-74-SW-D031-G006	31-32	ND (<15)
Northern end, east side	CWL-74-SW-D022-G007	22-23	ND (<15)
	CWL-74-SW-D026-G007	26-27	ND (<15)
	CWL-74-SW-D029-G007	29-30	ND (<15)
	CWL-74-SW-D031-G007	31-32	ND (<15)
Central location, east side	CWL-74-SW-D023-G008	23-24	ND (<15)
	CWL-74-SW-D026-G008	26-27	ND (<15)
	CWL-74-SW-D030-G008	30-31	ND (<15)
Southern end, east side	CWL-74-SW-D023-G009	23-24	ND (<15)
	CWL-74-SW-D026-G009	26-27	ND (<15)
	CWL-74-SW-D030-G009	30-31	ND (<15)

Note: See Figure 4-12 for sample locations.
CWL = Chemical Waste Landfill.
bgs = Below ground surface.
ft = Foot (feet).
LE = Landfill Excavation.
mg/kg = Milligram(s) per kilogram.
ND = Not detected.
OSML = On-Site Mobile Laboratory.
PCB = Polychlorinated biphenyl.
SW = Southwest.
VCM = Voluntary Corrective Measure.

Based upon the visual screening, excavation, and analytical results presented above, the remaining PCB contamination was limited to discrete areas associated with G002, G005, and G006 Geoprobe® sample locations. SNL/NM proposed "spot-excavation" of the remaining contaminated areas followed by verification sampling, based upon the limited number of PCB detections (7 detections out of 46 samples) and the results of the sidewall excavation. EPA Region VI verbally granted approval to proceed after review of the information submitted in the Supplemental Information for the TSCA Risk-Based Approval Request (SNL/NM October 2001a, b).

Final Excavation at Locations G006, G002, and G005

Excavation of the three remaining locations in the Southwest Area where total PCB concentrations exceeded or were close to 50 mg/kg was completed in February 2002 to conclude the CWL LE VCM. Verification sample locations associated with this excavation effort are shown in Figure 4-13. A summary of the excavation and sampling activities that were performed is provided below by location.

- G006 location (8 feet north of the southern sidewall): PCB contamination identified to a depth of 27 feet bgs (41.1 mg/kg in the 21- to 22-foot-bgs samples and 141 mg/kg in the 26- to 27-foot-bgs sample). The 31- to 32-foot-bgs sample was a nondetection (less than 15 mg/kg).
  - A 15- by 15- by 10-foot-deep area was excavated to a total depth of 30 feet bgs, centered on G006, as Excavation Block 51 (Figure 3-1).
  - On- and off-site samples for total PCBs were collected only from the excavation bottom and south sidewall (J038 and J039) to verify removal of contaminated soil and confirm lateral extent. Final verification off-site laboratory results were less than 1 mg/kg total PCBs.
- G002 location (central location on the west side): Samples from both the 22- to 23-foot-bgs and 26- to 27-foot-bgs depth intervals contained detectable total PCB results of 2,060 and 424 mg/kg, respectively. The 31- to 32-foot-bgs sample was a nondetection (less than 15 mg/kg).
  - A 15- by 15- by 10-foot-deep area was excavated to a total depth of 30 feet bgs, centered on G002, as Excavation Block 51 (Figure 3-1).
  - On- and off-site samples for VOCs and PCBs were collected only from the excavation floor and west sidewall (J040 and J041) to verify removal of contaminated soil and confirm lateral extent. Final verification off-site laboratory results were less than 10 mg/kg total PCBs.
- G005 location (15 feet due north of G006): Only the 21- to 22-foot-bgs sample contained detectable total PCB results (41.1 mg/kg) at this location.
  - A 15- by 15- by 5-foot-deep (total depth of 25 feet bgs) area centered on G005 was excavated as Excavation Block 51 (Figure 3-1).

- An on- and off-site sample for total PCBs were collected from the excavation bottom (J042) to verify removal of contaminated soil and confirm vertical extent.

- Final verification off-site laboratory results reported less than 1 mg/kg total PCBs.

As part of this Southwest Area excavation effort, additional sidewall material was removed to create adequate sloping along the southwestern side. This material represents Excavation Block 49 (Figure 3-1). All verification samples were collected from the excavator bucket because of health and safety issues associated with the steeply sloped sidewalls. Site personnel were not permitted to access areas greater than 20 feet bgs. Off-site samples shipped to the laboratory for analysis after rapid-turnaround OSML results were received confirmed that the concentration of total PCBs was less than 50 mg/kg. VOC results from the G002 location were evaluated using the CWL risk-based approach and are included in Section 5.3. The final risk screening assessment is presented in Chapter 6.0. Since none of these final verification sample results for total PCBs were equal to or greater than 50 mg/kg, additional excavation was not necessary and the PCB-related excavation work was concluded.

4.4.3 Benzidine Removal (Southwest Area)

Benzidine (an SVOC) was detected at only one final verification sample location (see Section 5-3). This detection occurred in the soil sample from Grid Location 08 at 12 feet bgs in the central portion of the Southwest Area (Figure 4-9). A preliminary risk screening assessment determined that benzidine was a major contributor to the calculated excess cancer risk. Following the NMED-approved risk-based criteria, the sole benzidine detection caused the cumulative excess cancer risk to reach the threshold level established for the CWL (SNL/NM August 2000). After discussing these results with the NMED, SNL/NM proceeded with additional excavation and sampling on January 15, 2003, to verify removal of the soil associated with this benzidine detection.

Access to this grid location was possible because backfilling had not been performed in this area. A small excavator was used to remove a 3- by 3- by 2-foot-deep volume of soil, centered on the Grid Location 08. Just under 1 cy of soil was removed and the final depth was 14 feet bgs.

Following this excavation, a final verification sample was collected at Grid Location 08 at 14 feet bgs. Since no other detected analytes from the original 12-foot-bgs sample from this location were significant relative to the risk-screening assessment, only benzidine results were requested from the off-site laboratory in the 14-foot-bgs sample. Benzidine was not detected in this sample, confirming the removal (see Section 5.3). Although the soil from Grid Location 08 at 12 feet bgs was removed during this additional excavation, all results for the Grid Location 08 12-foot-bgs soil sample, except for benzidine, have been included in the final risk screening assessment presented in Chapter 6.0 and Annex A.

4.5 North Excavation Area

The North Area, approximately 0.52 acres in size, is the largest of the excavation areas. The depth of buried materials and associated contaminated soil was estimated to extend to 12 feet

bgs in this area. The volume of buried materials and potentially contaminated soil in this area was estimated to be 11,111 cy (SNL/NM November 1998c).

Excavation in this area was completed to a maximum depth of 12 feet bgs, including the removal of Excavation Blocks 24 through 32, 34, and 36 through 42. The average excavation rate for the North Area was 417 cy per week. Excavated materials included rocks greater than 2 inches in size, chemical containers, bulk debris, thermal batteries, radioactively contaminated soft debris, ACM, and one radioactively contaminated glove box containing other waste items (e.g., PPE, tubing, saw blades, etc.). Table 4-14 summarizes the excavated soil and bulk debris.

Table 4-14
North Area Excavated Waste Volumes
CWL LE VCM

Excavated Materials	Estimated Volumes (cy)
Soil	18,930
Rocks (> 2 inches)	530
Soft Debris	40
Metal	75
Wood	15
Resins	30

CWL = Chemical Waste Landfill.
cy = Cubic yard(s).
LE = Landfill Excavation.
VCM = Voluntary Corrective Measure.

4.5.1 Excavation to 12 Feet bgs (North Area)

Excavation of the North Area began on August 24, 2000, and was completed to a depth of 12 feet bgs on July 9, 2001. In general, buried debris was observed in sparse groupings distributed throughout the area. In June 2001, additional excavation was performed in the northwest corner to remove shallowly buried debris that was visible from the surface. This localized area, outside the designated excavation boundary along the northern boundary on the west side, was excavated to a depth of 4 feet bgs to remove the buried debris and to verify that no other debris was buried in this region (Figure 4-14). During confirmatory trenching of the Non-Designated Area along the western boundary at the north end of the North Area, additional debris was encountered. Buried metal was removed from the 0- to 4-foot-bgs depth in this area along the western boundary at the north end. However, to ensure no other debris was located below the 4-foot-bgs depth, the area (approximately 25 feet wide [east-west] by 50 feet long [north-south]) was excavated to 12 feet bgs (Figure 4-14).

No significant additional excavation of the area was required based upon the confirmatory geophysical survey; however, one location in the central part of the northern wall was excavated to remove soil with elevated radiation readings (relative to background) based upon the confirmatory radiation walkover survey. Some hand-excavation was performed to remove debris (e.g., nails, small metal fragments) near the surface identified as minor geophysical anomalies during the metal detector walkover survey.

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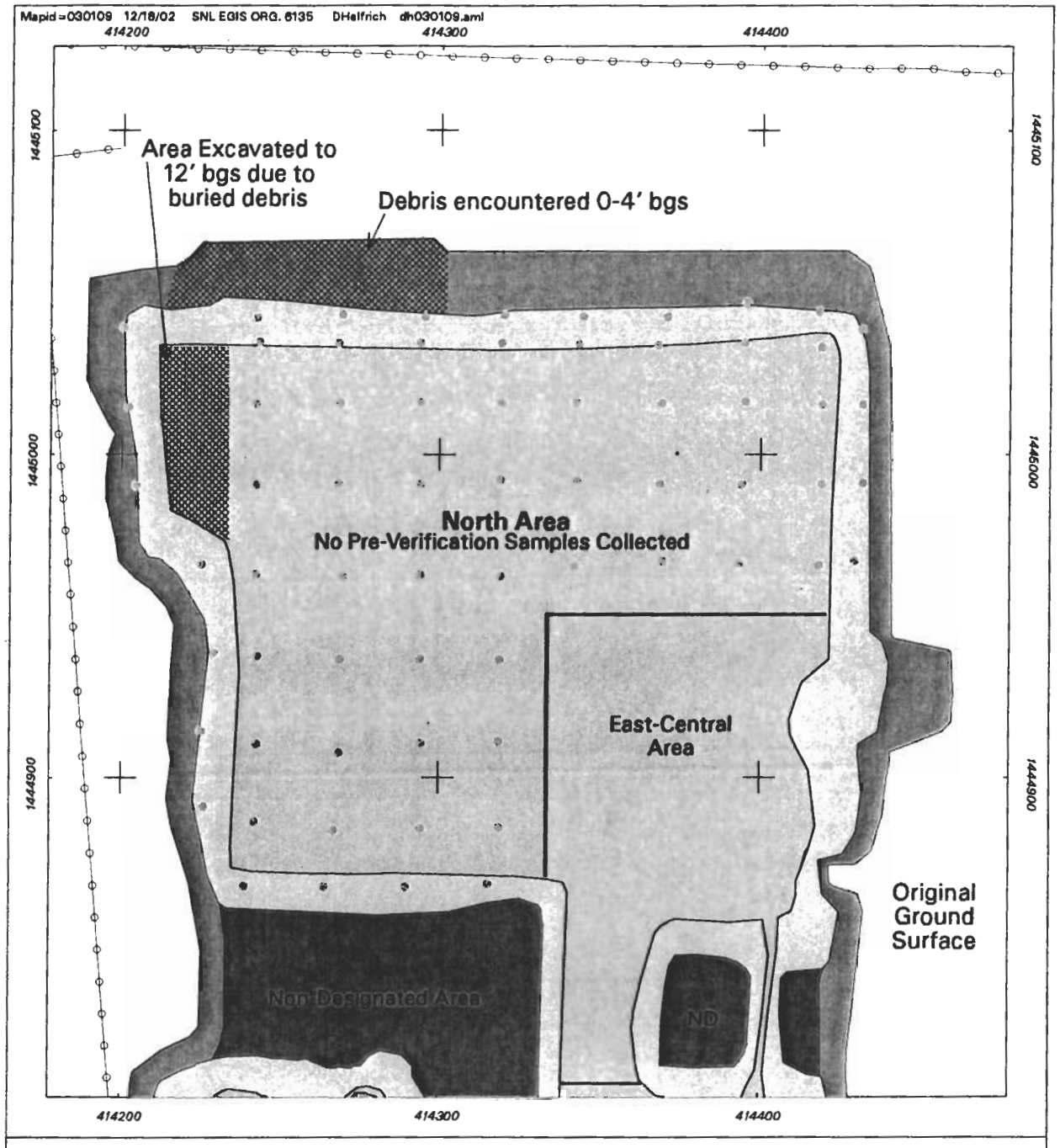

Legend

- Verification Grid Sample
- East-Central Area Boundary
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4 - 12'
- 4' ND Floor
- 12' Floor
- Area of Further Excavation

Figure 4-14
North Area
Verification Grid Sample Locations
Classified Waste Landfill

0 25 50
Scale in Feet

0 6 12
Scale in Meters

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4.5.2 Pre-Verification Sampling Results (North Area)

Excavation of the North Area was completed on July 9, 2001. Preliminary results indicated that soil excavated from this area was less contaminated than that from the other disposal areas. Therefore, based upon ICN #3 to the SAP (SNL/NM July 2001b), no pre-verification samples were collected from the North Area.

4.6 Non-Designated Area

The Non-Designated Area, approximately 0.69 acres in size, is defined as the area within the CWL boundary fence that was not used for disposal according to historical documentation and pre-LE VCM field work, especially geophysical surveys (Hyndman August 1998, Annex B).

4.6.1 Excavation in the Non-Designated Area

To address the fact that some partially buried debris was visible in the Non-Designated Area, an excavation and sampling strategy was developed and approved as part of ICN #1 to the SAP (SNL/NM March 1999a). The entire Non-Designated Area was excavated to a depth of 4 feet bgs and 10 confirmatory trenches were excavated to 12 feet bgs at various locations to verify that disposal pits were not located in the area. Twelve trenches were proposed in ICN #1 to the SAP and are shown in Figure 4-15; however, only nine trenches were actually excavated. Two trench locations (11 and 12) were planned for the area that was excavated to 12 feet bgs when buried debris was encountered along the western boundary at the north end of the North Area (Figures 4-14 and 4-15). Trench 1 was planned for the area separating the East-Central and Southeast Areas, which was excavated to 12 feet bgs due to sloping requirements before trenching activities at the Non-Designated Area began. Visual observations during excavation and the results of pre-verification samples collected from the 4-foot-bgs depth, as well as from the base of the 12-foot-bgs confirmatory trenches, were used to determine that the Non-Designated Area was not impacted by disposal operations. Pre-verification sampling was performed consistent with 25-foot spacing for the verification grid for the areas excavated to 4 feet bgs, and approximately one sample per 20 linear feet on the floor of the confirmatory trenches (SNL/NM March 1999a). Figure 4-15 shows the location of the Non-Designated Area, confirmatory trenches, and associated sample locations.

Excavation of the Non-Designated Area was conducted in conjunction with the adjacent designated areas. In August 1999, Trench 2 was completed to 12 feet bgs between the southern border of the East-Central Area and the northern margin of the Southeast Area after both were excavated to 12 feet bgs. This trench confirmed that no debris was buried in this area and was the only Non-Designated Area trench left open. The soil from Trench 2 (approximately 50 cy) was sampled, classified as "No Treatment Required," and sent to the CAMU.

The other planned north-south trench in this vicinity (Trench 1) was not excavated. After realizing that proper sloping would effectively eliminate this section of the Non-Designated Area, it was decided to uniformly excavate the immediate vicinity to 12 feet bgs, creating an access corridor between the East-Central and Southeast Areas (see Figure 4-15). The planned sample location associated with this trench was collected from the excavation floor at the planned depth

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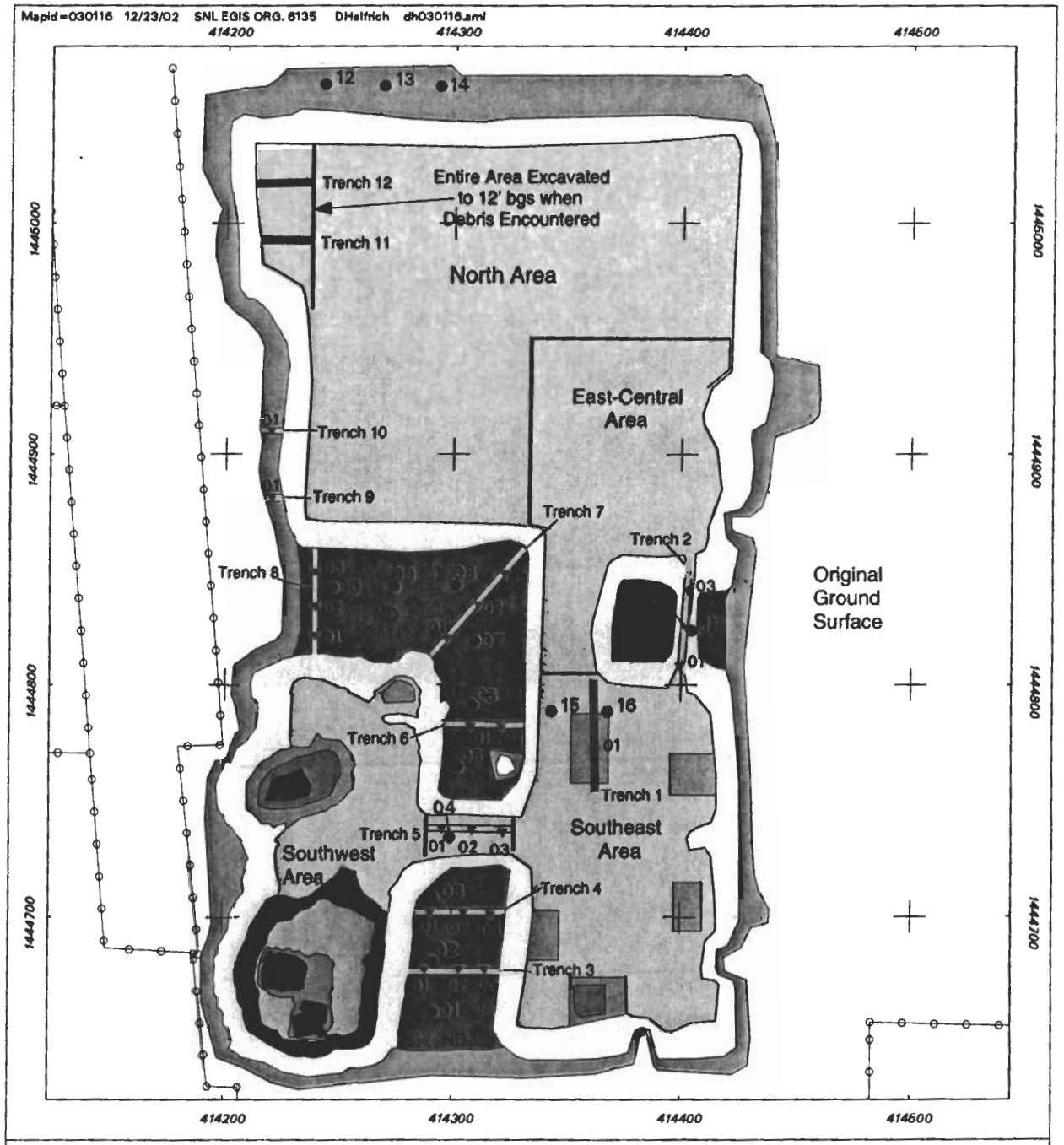

Legend

- Verification Grid Sample
- Trench Sample
- Fence
- Uninstalled Trench
- Trench
- Excavation Area Boundary

Depth of Excavation (ND = Non-Designated Area)

0 - 4'	12 - 14'	0' No Excavation
4' NDA Floor	14 - 16'	20'
4 - 12'	16 - 18'	25'
12' Floor	12-20'	30'

Scale in Feet: 0 35 70

Scale in Meters: 0 8.4 16.8

Figure 4-15
Non-Designated Area Verification Grid and Confirmatory Trench Sample Locations
Chemical Waste Landfill

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of 12 feet bgs. In addition to the proposed trench locations, the top 4 feet of soil were uniformly removed between the East-Central and Southeast Areas. No debris was found within these areas.

On February 4, 2000, Trenches 3 through 5 were completed between the Southeast and Southwest Areas before excavation of the Southwest Area, and Trench 6 was completed between the Southwest and East-Central Areas (see Figure 4-15). During the excavation of Trench 7, a clean sand was encountered that was not native material. Aerial photographs and information contained in the report by Roy F. Weston, Inc. (Weston 1984) indicated a small borrow pit or depression in this area that probably had been backfilled with clean sand. Additional subsidence occurred in this depression area shortly after excavation began in 1998. During trenching activities, there were no indications of debris or waste disposal in this area, including the location of Trench 8. Removal of the top 4 feet of soil in the Non-Designated Area between the Southeast and Southwest Areas was completed incrementally as the excavation of the Southwest Area progressed from south to north. No debris was found in these areas.

No visibly stained soil was encountered in the Non-Designated Area. However, debris was encountered in the Non-Designated Area in two localized areas associated with the North Area: 1) along the northern boundary on the west end, and 2) along the western boundary at the north end (see Figures 4-14 and 4-15). Along the northern boundary on the west end, excavation to 4 feet bgs was sufficient to successfully remove all buried debris. Initially, Trench 11 was partially excavated to approximately 1 foot bgs, where debris was encountered. Upon discovery of debris at this location, the western boundary at the north end of the North Area was excavated to 12 feet bgs in order to remove all buried debris. This expanded the North Area Excavation approximately 25 feet west over a north-to-south distance of approximately 50 feet (see Figure 4-14). This additional excavation of the North Area effectively eliminated the two proposed trench locations (Trenches 11 and 12) that were planned for the Non-Designated Area (see Figure 4-15). Excavated soil and debris associated with this area are included in the summary of materials excavated for the North Area.

4.6.2 Pre-Verification Sampling Results (Non-Designated Area)

Pre-verification samples were collected from both the 4-foot-bgs area and the 12-foot-bgs confirmatory trenches. Because the trenches were not sloped, samples were collected from the floor of the trenches using the excavator bucket. After excavation and sampling, the trenches were immediately backfilled to 4 feet bgs (except for Trench 2).

Table 4-15 presents the results of the risk screening analysis performed on the pre-verification samples. Non-Designated pre-verification sample identifications follow the same format as pre-verification samples from other designated areas. The following example provides the trench sample identification format:

Example Sample Identification: 74-ND-U001-V003

- 74-ND = CWL-Non-Designated Area
- U001 = Trench #1
- V003 = Third verification sample collected from Trench #1 from a depth of 12 feet bgs (all trench samples are from 12 feet bgs).

Table 4-15
Non-Designated Area: Pre-Verification Sample Risk Screening Results
CWL LE VCM

Sample Date	Sample Location[a]	Sample ID[a]	Sample Depth (ft)	Preliminary Risk Screening Analysis (Pass/Fail)
5/09/01	Floor	74-ND-D004-V001	4	PASS
5/09/01	Floor	74-ND-D004-V002	4	PASS
5/15/01	Floor	74-ND-D004-V003	4	PASS
5/15/01	Floor	74-ND-D013-V004	12	PASS
5/15/01	Floor	74-ND-D004-V005	4	PASS
5/16/01	Floor	74-ND-D004-V006	4	PASS
5/16/01	Floor	74-ND-D004-V007	4	PASS
5/16/01	Floor	74-ND-D004-V008	4	PASS
5/16/01	Floor	74-ND-D004-V009	4	PASS
5/16/01	Floor	74-ND-D004-V010	4	PASS
5/16/01	Floor	74-ND-D004-V011	4	PASS
Confirmatory Trench Samples				
9/24/99	Floor	74-ND-U001-V001	12	PASS
9/24/99	Floor	74-ND-U002-V001	12	PASS
9/24/99	Floor	74-ND-U002-V002	12	PASS
9/24/99	Floor	74-ND-U002-V003	12	PASS
1/28/00	Floor	74-ND-U003-V001	12	PASS
1/28/00	Floor	74-ND-U003-V002	12	PASS
1/28/00	Floor	74-ND-U003-V003	12	PASS
1/28/00	Floor	74-ND-U004-V001	12	PASS
1/28/00	Floor	74-ND-U004-V002	12	PASS
1/28/00	Floor	74-ND-U004-V003	12	PASS
1/28/00	Floor	74-ND-U005-V001	12	PASS
1/28/00	Floor	74-ND-U005-V002	12	PASS
1/28/00	Floor	74-ND-U006-V001	12	PASS
1/28/00	Floor	74-ND-U006-V002	12	PASS
8/04/00	Floor	74-ND-U007-V001	12	PASS
8/04/00	Floor	74-ND-U007-V002	12	PASS
8/04/00	Floor	74-ND-U007-V003	12	PASS
8/04/00	Floor	74-ND-U008-V001	12	PASS
8/04/00	Floor	74-ND-U008-V002	12	PASS
8/04/00	Floor	74-ND-U008-V003	12	PASS
10/04/00	Floor	74-ND-U009-V001	12	PASS
10/04/00	Floor	74-ND-U010-V001	12	PASS

[a]See Figure 4-15 for the location of the samples listed.
CWL = Chemical Waste Landfill.
ft = Foot (feet).
ID = Identification.
LE = Landfill Excavation.
ND = Non-Designated Area sample.
VCM = Voluntary Corrective Measure.

The sample from Location 04 was collected at a depth of 12 feet bgs (versus 4 feet bgs) because this area had already been excavated to 12 feet bgs to create an access corridor between the Southeast and Southwest Areas (see Figure 4-15). Locations V006 through V011 were sampled for VOCs, but the results are not reported in Annex F due to laboratory quality control (QC) issues. No pre-verification samples were collected from Grid Locations 12 through 16. Final verification samples only were collected in accordance with ICN #3 to the SAP (SNL/NM July 2001b). The eastern half of the North Area's northern boundary (east of Locations 12 through 14 where debris was excavated from the 0- to 4-foot depth) was judgmentally sampled (J001 through J005) as part of the Non-Designated Area final verification sampling. No pre-verification samples were collected from these judgmental locations. Locations 15 and 16 occur in an area between the Southeast and East-Central Areas that was uniformly excavated to 12 feet bgs (creating an access corridor between the East-Central and Southeast Areas) because properly sloping this area would have eliminated it. The Non-Designated Area pre-verification sample locations are shown in Figure 4-15. All pre-verification results passed the risk-based criteria; therefore, no further excavation of the Non-Designated Area was required. Only pre-verification samples were collected from the confirmatory trenches. Risk screening cover sheets and analytical results are provided in Annex F.

4.7 Excavation Backfilling Summary

Backfilling began in June 2002 by spreading decontaminated excavated rocks (1,250 cy) and concrete (approximately 35 cy) across the excavation floor in the North, East-Central, and Southeast Areas to form a marker layer, as described in the CWL Backfill and Compaction Plan (SNL/NM July 2002). However, the rock layer did not completely cover the southern end of the Southeast Area. Figure 4-16 shows an oblique aerial view of the excavation (from the south, looking north) with the rock layer prior to the placement and compaction of the replaceable soil fill. All concrete was placed in the Southeast Area at the two deeper excavation locations (14 feet bgs) associated with Grid Locations 05 and 13 (Figure 4-8). Figure 4-17 shows an oblique aerial view (from the southwest, looking northeast) of the rock layer and concrete placement within the Southeast Area. Replaceable soil (5,670 cy) was placed and compacted directly over the rock layer in two, 12-inch loose lifts. The second lift, like the rock layer, did not extend over the entire southern part of the Southeast Area. The estimated thickness of the replaceable soil layer is 16 inches, with the exception of the southern part of the Southeast Area, where the thickness is approximately 8 inches (one compacted lift). The minimum depth to replaceable soil is greater than 10 feet bgs in the North, East-Central, and northern portion of the Southeast Areas. In the southern part of the Southeast Area, the minimum depth of the replaceable soil is greater than 11 feet bgs.

Clean fill sources have been identified in the CWL Backfill and Compaction Plan (SNL/NM July 2002) and include various locations within the general vicinity of the CWL and the CAMU. One source is the large soil pile excavated when the CAMU containment cell was constructed (CAMU Spoils Pile). Another source is the borrow pit area defined just west of the CAMU. An additional source of fill material is the SOB soil that was scraped, stockpiled in 1,000-cy piles, and sampled as clean fill.

Approximately 14,240 cy of the clean fill (CAMU Spoils Pile) had been placed and compacted directly over the replaceable soil layer to complete backfilling operations to 40 percent (volume) in August 2002. Backfilling operations were temporarily suspended in August 2002 while soil treatment at the CAMU was started. Currently, backfilling is planned to resume in June 2003,

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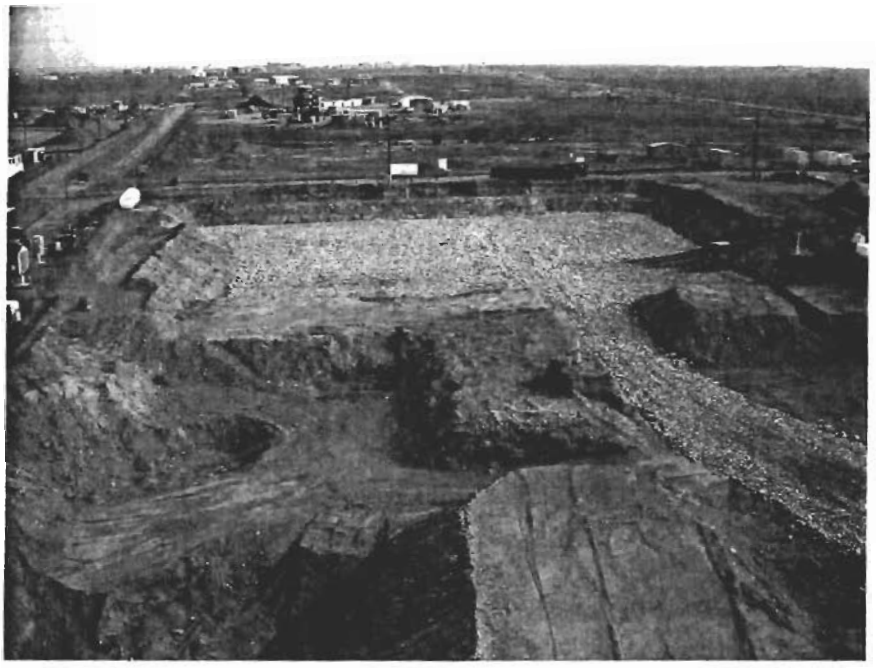

Figure 4-16
View of the Excavation Looking North with the Rock Layer in Place

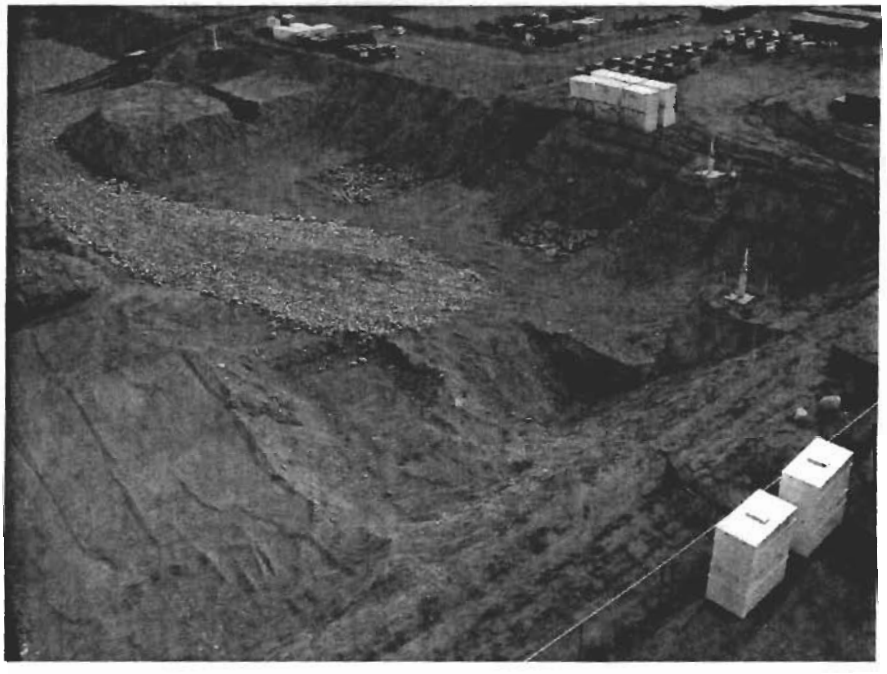

Figure 4-17
View of the Southeast Area Looking Northeast with the Rock Layer and Concrete in Place

with completion to grade planned by October 2003. The North Area is currently backfilled to the highest level, at approximately 4 to 5 feet bgs at the north end and 5 to 6 feet bgs at the south.

All final verification soil sample results for replaceable soil and clean fill material are presented in Chapter 5.0 and included in the final risk screening assessment presented in Chapter 6.0 and Annex A. In the unlikely event that additional fill material is required to complete backfilling, the associated verification soil sample results will be incorporated into the final risk screening assessment presented in this report to verify that the CWL risk-based criteria have been met (SNL/NM August 2000). If additional fill material is required, the results of this updated risk screening assessment will be provided to the NMED prior to placing the fill material into the excavation.

The surface of the compacted fill material slopes to the south through the East-Central and Southeast Areas for drainage. The East-Central Area is backfilled to approximately 6 to 7 feet bgs, and the Southeast Area to approximately 9 feet bgs. More detailed information on the backfilling operations will be provided in an engineering report after completion of all final corrective actions at the site.

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5.0 VERIFICATION AND BACKFILL MATERIAL ANALYTICAL RESULTS

From June 2001 through March 2002, final verification samples (off-site laboratory analysis) were collected at the CWL from the excavation sidewalls and floor. The final verification 25-foot grid node and judgmental sample locations are shown in Figure 5-1 for the North, East-Central, Southeast, Southwest, and Non-Designated Areas. Only locations with final verification, off-site data are shown in Figure 5-1.

Final verification sampling was initiated in the excavation areas after pre-verification sampling was completed and analytical results were evaluated against the risk-based criteria. The analytical results from the final verification sampling are provided in Volume 2 of this report. Additional excavation was performed in the Southeast and Southwest Areas based upon pre-verification results. Judgmental samples collected during final verification sampling were typically located in areas not covered by a 25-foot grid node location where additional excavation was performed. The samples were collected in conformance with the CWL SAP (SNL/NM November 1998a) and the SAP ICNs #1 (SNL/NM March 1999a), #2 (SNL/NM December 2000), #3 (SNL/NM July 2001b), and #4 (SNL/NM December 2001) and analyzed for the typical CWL analytical suite of RCRA metals plus beryllium, copper, nickel, and hexavalent chromium; VOCs; SVOCs; PCBs; and radionuclides. Judgmental samples were analyzed for either the full analytical suite or only the specific COCs that exceeded risk-based criteria/threshold values in that specific location prior to additional excavation. Grid samples that failed to meet risk-based criteria upon pre-verification results were typically resampled at the deeper excavated depth for only the constituent(s) that exceeded risk-based criteria.

Sample identification schemes are similar to those of the pre-verification samples and identify specific information regarding the samples. For example:

- 74-NO-D005-F050
  - "74" designates the sample as collected from the CWL.
  - "NO" indicates that the sample was collected from the North Area.
  - "D005" indicates that the sample was collected from a depth of 5 feet bgs. If the sample depth is less than 12 feet bgs, it generally means that the sample was collected from the sidewalls. The exception to this is the Non-Designated Area samples, which are mostly 4 feet bgs and are not sidewall samples.
  - "F050" designates the sample as a final verification grid sample collected from Grid Location 50 (in the North Area).
- 74-SW-D019-J037
  - "74" designates the sample as collected from the CWL.
  - "SW" indicates that the sample was collected from the Southwest Area.

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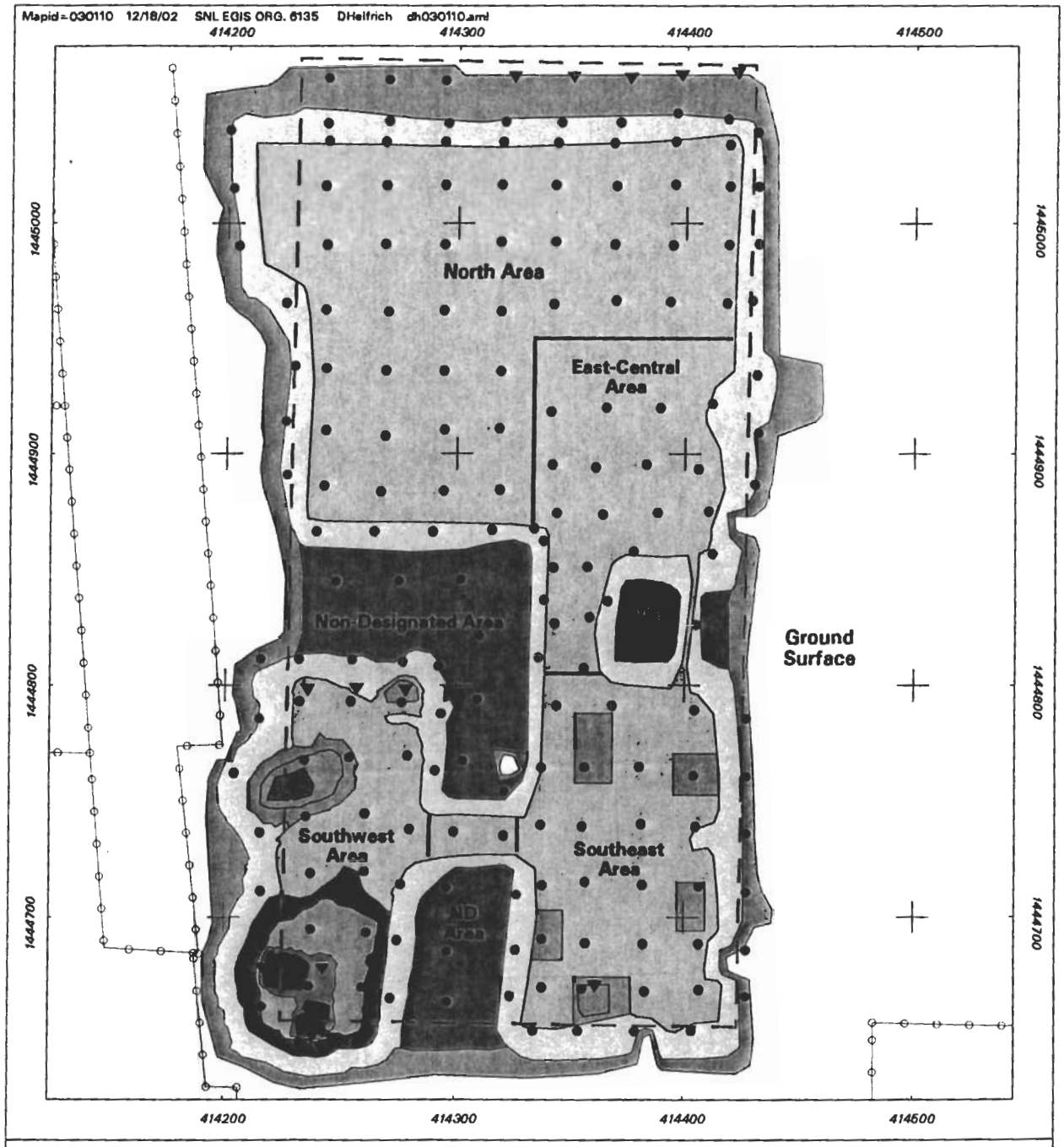

Legend

- Verification Grid Sample
- Judgmental Sample
- Area Boundary
- Fence
- CWL Boundary

Depth of Excavation

0 - 4′	12 - 14′	0′ No Excavation
4′ NDA Floor	14 - 16′	20′
4 - 12′	16 - 18′	25′
12′ Floor	12-20′	30′

Scale in Feet: 0 35 70

Scale in Meters: 0 8.4 16.8

Figure 5-1
Final Verification Grid and Judgmental Locations for the CWL Excavation

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Environmental Geographic Information System

- "D019" indicates that the sample was collected from a depth of 19 feet bgs.

- "J037" designates the sample as a final verification judgmental sample collected from Judgmental Location 37 (in the Southwest Area).

Sections 5.1 through 5.5 describe the results of final verification sampling at the CWL. In addition to the excavation verification sample results, final off-site analytical results for all fill materials being used to backfill the CWL excavation are presented in Section 5.6. This backfill material includes the excavated replaceable soil, soil from the CAMU spoils pile, and clean fill from various sources. All final verification and backfill data summary tables are found in Volume 2 of this report. All off-site analytical data are incorporated into the final risk screening assessment presented in Chapter 6.0 and Annex A.

5.1 East-Central Area Verification Sampling

A total of 27 final verification grid samples and 1 duplicate sample were collected from the floor and sidewalls of the excavation in the East-Central Area. Grid Locations 01 through 17 are floor samples, and Grid Locations 18 through 27 are sidewall samples (Figure 5-2). No final verification judgmental samples were collected in the East-Central Area.

Tables EC-1 through EC-8 in Volume 2 summarize the final verification soil sampling analyses. Tables EC-1, EC-2, EC-4, EC-6, and EC-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the verification soil samples collected from the East-Central Area. Tables EC-3, EC-5, and EC-7 provide the analytical method detection limits (MDLs) for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.1.1 Metals

Table EC-1 presents the metals analytical results for the 27 verification soil samples and 1 duplicate sample collected from the East-Central Area.

Arsenic, beryllium, chromium, chromium (VI), copper, lead, mercury, nickel, and selenium were detected above approved background concentration limits in varying numbers of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in eight samples. Concentrations ranged from 4.61 to 73.1 mg/kg, with all but three of the detections less than two times background. Beryllium was detected above the background concentration limit of 0.65 mg/kg in four samples. Concentrations ranged from 0.741 to 0.846 mg/kg, with all detections less that two times background. Chromium was detected above the background concentration limit of 15.9 mg/kg in four samples at concentrations ranging from 35.1 J to 1,800 mg/kg. Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in five samples. Concentrations ranged from 1.11 to 10.7 mg/kg. Copper was detected above the background concentration limit of 18.2 mg/kg in two samples at concentrations of 53.6 and 261 mg/kg. Lead was detected above the background concentration limit of 11.8 mg/kg in 13 samples. Concentrations ranged from 11.9 to 30.2 mg/kg, with all but four of the detections less than two times background.

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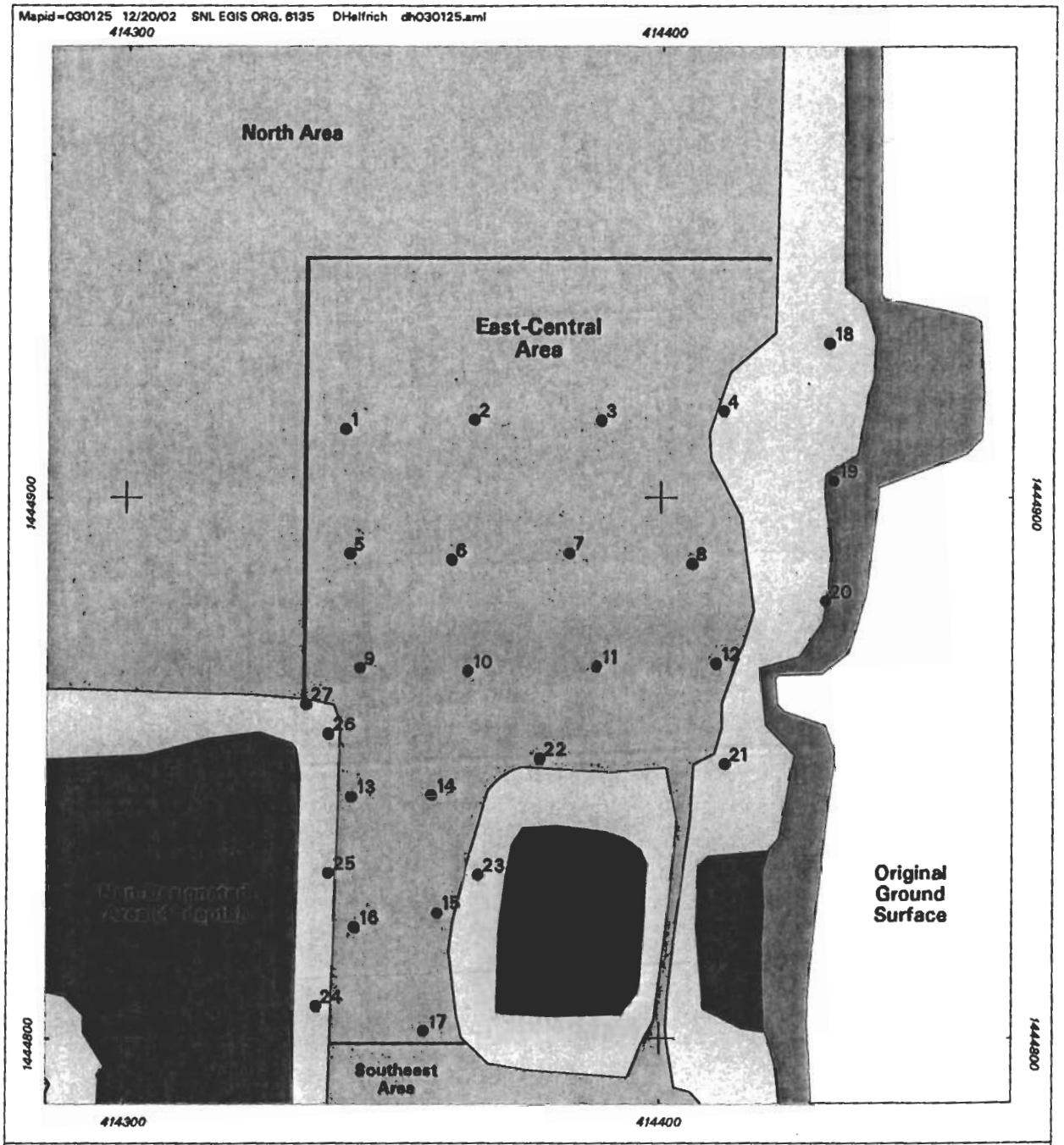

Legend

- Verification Grid Sample
- East-Central Area Boundary

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor

Figure 5-2
East-Central Area Final Verification Grid Sample Locations
Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

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Mercury was detected above the background concentration limit of less than 0.1 mg/kg in 10 samples at concentrations ranging from 0.104 J to 0.928 mg/kg. Nickel was detected above the background concentration limit of 11.5 mg/kg in one sample at a concentration of 15.2 mg/kg. Selenium was detected slightly above the background concentration limit of less than 1.0 mg/kg in one sample at a concentration of 1.07 mg/kg. The detection of metals above background concentration limits in the East-Central Area was sporadic, and no one area of the excavation contained the majority of the detections reported above background limits.

5.1.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the East-Central Area may be considered an indication of contamination. Table EC-2 summarizes the VOC analytical results for the 27 verification soil samples and 1 duplicate sample collected from the East-Central Area.

In the 27 soil samples collected from the East-Central Area of the excavation, 19 VOCs were detected with the majority reported in only 3 of the samples. Seven of the VOCs, acetone, bromoform, methyl methacrylate, 1,1,1,2-tetrachloroethane, 1,3,5-trimethylbenzene, 1,4-dichlorobenzene, and o-xylene, were detected in only one of the samples at low, mainly estimated concentrations. The VOCs 2-butanone, 4-isopropyltoluene, 1,1,2-2 tetrachloroethane, 1,3-dichlorobenzene, and TCE were detected in only two of the samples at low, estimated concentrations. The VOCs naphthalene, 1,2,3-trichloropropane, and PCE were detected in three of the samples at low concentrations. The VOCs 4-methyl-2-pentanone and 1,2,4-trichlorobenzene were detected in four of the samples at low, mostly estimated concentrations. The VOC 1,2-dichlorobenzene was detected in five samples at concentrations ranging from 1.51 to 114 J micrograms (µg)/kg. Toluene was detected in 25 samples with concentrations ranging from 0.639 J to 798 J µg/kg. Slightly less than a third of the detections were estimated, and more than half were less than 20 µg/kg.

Table EC-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.1.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the East-Central Area may be considered an indication of contamination. Table EC-4 summarizes the SVOC analytical results for the 27 verification soil samples and 1 duplicate sample collected from the East-Central Area.

Nine SVOCs were detected in samples collected from the East-Central Area of the excavation. Six of the SVOCs were detected in only one of the samples with all but one at estimated concentrations. Fluoranthene was detected in three samples at concentrations ranging from 8.79 J to 182 µg/kg. Pyrene was detected in three of the samples at concentrations ranging from 42.3 J to 197 µg/kg. Bis(2-ethylhexyl) phthalate was detected in 18 of the samples with concentrations ranging from 38.3 to 57,100 µg/kg.

Table EC-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.1.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the East-Central Area may be considered an indication of contamination. Table EC-6 summarizes the PCB analytical results for the 27 verification soil samples and 1 duplicate sample collected from the East-Central Area.

Three PCBs were detected in the samples collected from the East-Central Area of the excavation. Aroclor-1242 was detected in 11 samples at concentrations ranging from 3 J to 1,730 J µg/kg. Aroclor-1254 was detected in 20 samples at concentrations ranging from 2.4 J to 507 J µg/kg. Aroclor-1260 was detected in 11 samples at concentrations ranging from 1.43 J to 272 J µg/kg. Approximately 75 percent of the detections were reported at estimated concentrations, and none were above the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table EC-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

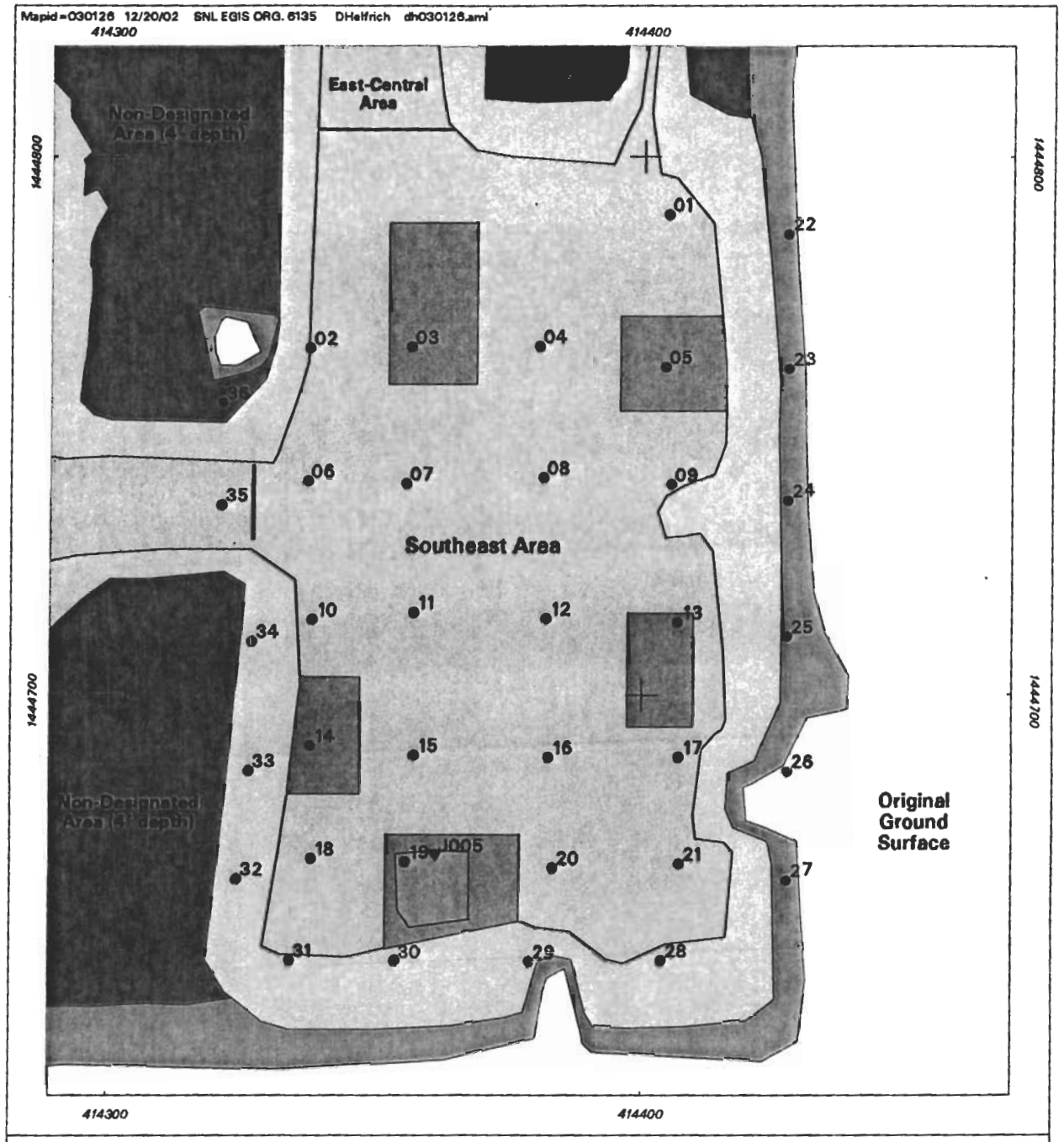
5.1.5 Radionuclides

Table EC-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 27 verification soil samples and 1 duplicate sample collected from the East-Central Area. Activity attributable to tritium was slightly above the 0.021-pCi/gram (g) background activity in one sample at an activity of 0.02625 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in two samples at activities of 1.4 and 1.53 pCi/g. Gamma activities attributable to uranium-235, cesium-137, and thorium-232 were not detected above the minimum detectable activity (MDA) and/or background activity in any of the samples.

5.2 Southeast Area Verification Sampling

A total of 39 final verification samples and 2 duplicate samples were collected from the floor and sidewalls of the excavation in the Southeast Area. Grid Locations 01 through 21 are floor samples, and Grid Locations 22 through 36 are sidewall samples. Grid Locations 08 and 12 were sampled twice at a depth of 12 feet bgs. One judgmental sample, J005, was collected near the vicinity of Grid Location 19, which was excavated to 16 feet bgs to remove debris. Grid Locations 03 and 14 were excavated to 14 feet bgs to remove PCB-contaminated soil based upon pre-verification sample results. The vicinity of Grid Locations 03 and 13 was also excavated to a depth of 14 feet bgs based upon buried debris indicated by the final confirmatory geophysical survey. The samples associated with these locations that were excavated deeper than 12 feet bgs were all analyzed for the full CWL analytical suite. All final verification sample locations are shown in Figure 5-3.

Tables SE-1 through SE-8 in Volume 2 summarize the verification soil sampling analyses. Tables SE-1, SE-2, SE-4, SE-6, and SE-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the verification soil samples collected from the Southeast Area. Tables SE-3, SE-5, and SE-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.



Legend

- Verification Grid Sample
- Judgmental Sample
- Southeast Area Boundary

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' NDA Floor
- 4 - 12'
- 12' Floor
- 12 - 14'
- 14 - 16'

Figure 5-3
Southeast Area Final Verification Grid and Judgmental Sample Locations Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

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5.2.1 Metals

Table SE-1 presents the metals analytical results for the 39 verification soil samples and 2 duplicate samples collected from the Southeast Area. Arsenic, barium, chromium, chromium (VI), copper, lead, and mercury were detected above approved background concentration limits in varying numbers of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in 11 samples. Concentrations ranged from 4.63 J to 11.9 J mg/kg, with all but two of the detections less than two times background. Barium was detected above the background concentration limit of 214 mg/kg in one sample at a concentration of 255 mg/kg. Cadmium was detected above the background concentration limit of 0.9 mg/kg in one sample at a concentration of 1.79 mg/kg. Chromium was detected above the background concentration limit of 15.9 mg/kg in 10 samples. Concentrations ranged from 17.7 J to 192 J mg/kg, with the majority of the detections less than two times background. Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in 10 samples at concentrations ranging from 1.05 J to 15.6 J mg/kg. Copper was detected above the background concentration limit of 18.2 mg/kg in two samples at concentrations of 31.3 and 60.4 mg/kg. Lead was detected above the background concentration limit of 11.8 mg/kg in 20 samples. Concentrations ranged from 12.3 to 108 mg/kg, with 75 percent of the detections less than three times background. Mercury was detected above the background concentration limit of less than 0.1 mg/kg in 18 samples at concentrations ranging from 0.121 to 2.17 mg/kg. The detection of metals above background concentration limits in the Southeast Area was sporadic, and no one area of the excavation contained the majority of the detections reported above background limits.

5.2.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the Southeast Area may be considered an indication of contamination. Table SE-2 summarizes the VOC analytical results for the 39 verification soil samples and 2 duplicate samples collected from the Southeast Area.

In the soil samples collected from the Southeast Area of the excavation, 15 VOCs were detected with the majority reported in only 2 of the samples. Eight of the VOCs, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, 2-butanone, 4-methyl-2-pentanone, carbon disulfide, tetrahydrofuran, n-propylbenzene, and tert-butylbenzene were detected in only one of the samples at very low, estimated concentrations. The VOCs 1,2-dichlorobenzene, acetone, methyl methacrylate, and PCE were detected in only two of the samples at low concentrations. The VOCs naphthalene and 1,4-dichlorobenzene were detected in three and four samples, respectively, at low concentrations. Toluene was detected in 30 samples. Concentrations ranged from 0.633 J to 355 J µg/kg, with less than half reported at estimated concentrations. Half of the detections were less than 20 µg/kg.

Table SE-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.2.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the Southeast Area may be considered an indication of contamination.

Table SE-4 presents the SVOC analytical results for the 39 verification soil samples and 2 duplicate samples collected from the Southeast Area.

In the 41 samples collected from the Southeast Area of the excavation, 15 SVOCs were detected. Eight of the SVOCs were detected in only one of the samples at estimated concentrations. Three of the SVOCs were detected in only two of the samples, most at estimated concentrations. Phenol was detected in three of the samples at concentrations ranging from 36.9 J to 578 µg/kg. Fluoranthene was detected in eight of the samples at concentrations ranging from 3.52 J to 35.8 µg/kg. Pyrene was detected in nine samples at concentrations ranging from 9.51 J to 120 µg/kg. Bis(2-ethylhexyl) phthalate was detected in 26 of the samples. Concentrations ranged from 11.5 J to 18,500 µg/kg, with the majority reported at estimated concentrations.

Table SE-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.2.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the Southeast Area may be considered an indication of contamination. Table SE-6 summarizes the PCB analytical results for the 39 verification soil samples and 2 duplicate samples collected from the Southeast Area.

Four PCBs were detected in four or more of the samples collected from the Southeast Area of the excavation. Aroclor-1242 was detected in 21 samples at concentrations ranging from 17.5 J to 6,780 J µg/kg. Aroclor-1248 was detected in four samples at concentrations ranging from 5.7 J to 940 J µg/kg. Aroclor-1254 was detected in 22 samples at concentrations ranging from 3.1 J to 4,820 J µg/kg. Aroclor-1260 was detected in four samples at concentrations ranging from 2.4 J to 1,560 J µg/kg. More than 75 percent of the detections were at estimated concentrations, and none were above the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table SE-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.2.5 Radionuclides

Table SE-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 39 verification soil samples and 2 duplicate samples collected from the Southeast Area. Activity attributable to tritium was slightly above the 0.021-pCi/g background activity in two samples at activities of 0.098 and 0.02235 pCi/g. Gamma activity attributable to uranium-235 was slightly above the 0.16-pCi/g background activity in one sample at an activity of 0.182 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in three samples at activities ranging from 1.43 to 2.02 pCi/g. Gamma activity attributable to cesium-137 was reported above the 0.079-pCi/g background activity in one sample at an activity of 0.534 pCi/g. Gamma activity attributable to thorium-232 was not detected above the MDA and/or background activity in any of the samples.

5.3 Southwest Area Verification Sampling

A total of 45 final verification samples were collected from the sidewalls and floor of the excavation in the Southwest Area. Grid locations 01 through 14 are floor samples, and Grid Locations 15 through 33 are sidewall samples. Three judgmental samples, J007 through J009, were collected from the excavation floor along the northern boundary. At the J009 location, additional excavation to 14 feet bgs was performed based upon pre-verification results. Grid Location 04 was excavated to a depth of 18 feet bgs to remove a hard-baked, high-chromium cobble/soil layer. Grid Locations 11 through 14 were sampled at the 20-foot-bgs depth before additional excavation was performed in the area to remove PCB-contaminated soil. Samples at these locations were split with the NMED. Additional excavation (25 to 30 feet bgs) in the area removed Grid Locations 13 and 14, but had little impact on Grid Locations 11 and 12. This additional excavation did result in the removal of sidewall material to maintain proper sloping in the vicinity of grid location 25, where the original 3-foot-bgs sidewall sample was collected (see Section 4.4.2.1). The PCB results for this original sample exceeded the risk screening threshold of 1.0 mg/kg (1,000 µg/kg) for the 0- to 5-foot-bgs depth. Following the additional excavation, another sample was collected and analyzed for PCBs only at grid location 25. The PCB results for this new sample were below the threshold value and are included in this section and in the final risk screening assessment presented in Section 6.0 and Annex A. All results for the original grid sample, except for PCBs, have been included in this section and in the final risk screening assessment presented in Section 6.0 and Annex A. Final verification judgmental samples associated with the excavation of PCB contamination in the southern half of the area included J036 through J042. Grid Location 08 was initially sampled at the 12-foot-bgs depth before additional excavation was performed to remove benzidine. This additional excavation (12 to 14 feet bgs) removed the original 12-foot-bgs Grid Location 08, but all results for this 12-foot-bgs grid location, except for benzidine, have been included in this section and in the final risk screening assessment presented in Chapter 6.0 and Annex A. A final verification sample was collected from Grid Location 08 at 14 feet bgs and was analyzed for benzidine only (see Section 4.4.3). Of the 45 final verification samples collected, 36 were analyzed for the typical CWL analytical suite, six (J036 to J039, J042, and F025 at 6 feet bgs) were analyzed for PCBs only, two (J040 and J041) were analyzed for PCBs and VOCs, and one (F008 at 14 feet bgs) was analyzed for benzidine (an SVOC). Figure 5-4 shows the location of all final verification samples for the Southwest Area.

Tables SW-1 through SW-8 in Volume 2 summarize the verification soil sampling analyses. Tables SW-1, SW-2, SW-4, SW-6, and SW-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the verification soil samples collected from the Southwest Area. Tables SW-3, SW-5, and SW-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.3.1 Metals

Table SW-1 summarizes the metals analytical results for the 36 verification soil samples collected from the Southwest Area. Arsenic, barium, chromium, chromium (VI), copper, lead, mercury, nickel, and selenium were detected above approved background concentration limits in less than a third of the samples. Arsenic was detected slightly above the background concentration limit of 4.4 mg/kg in 10 samples. Concentrations ranged from 4.51 to 16.3 mg/kg, with all but one sample less than two times background. Barium was detected above the

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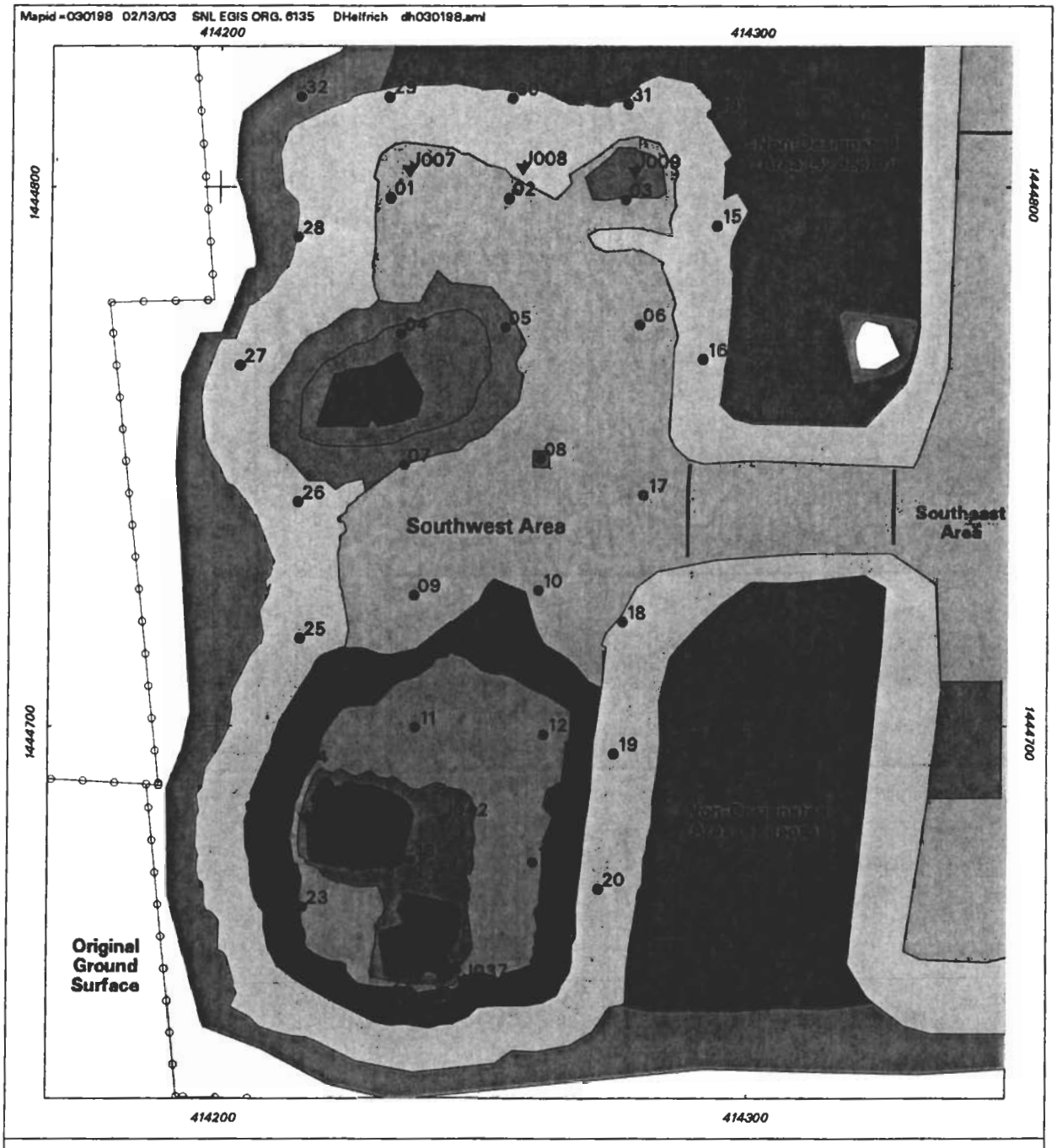

Legend

- Verification Grid Sample
- Judgmental Sample
- Fence
- Area Boundary

Depth of Excavation (ND = Non-Designated Area)

- 0′ No Excavation
- 0 - 4′
- 4′ ND Floor
- 4 - 12′
- 12′ Floor
- 12 - 14′
- 14 - 16′
- 16 - 18′
- 12-20′
- 20′
- 25′
- 30′

Figure 5-4
Southwest Area Final Verification Grid and Judgmental Sample Locations Chemical Waste Landfill

0 15 30
Scale in Feet

0 3.6 7.2
Scale in Meters

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background concentration limit of 214 mg/kg in two samples at concentrations of 367 and 519 mg/kg. Chromium was detected above the background concentration limit of 15.9 mg/kg in seven samples. Concentrations ranged from 19.7 J to 108 J mg/kg, with all but two of the samples more than three times background. Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in 10 samples. Concentrations ranged from 1.02 to 9.15 mg/kg, with half of the samples more than four times background. Copper was detected above the background concentration limit of 18.2 mg/kg in four samples. Concentrations ranged from 20.8 to 44.1 J mg/kg, with only one sample more than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in three samples. Concentrations ranged from 18.9 to 39.1 mg/kg, with only one sample more than three times background.

Mercury was detected above the background concentration limit of less than 0.1 mg/kg in nine samples. Concentrations ranged from 0.112 to 2.35 mg/kg, with only two of the detections significantly above background. Nickel was detected above the background concentration limit of 11.5 mg/kg in two samples at concentrations of 12.4 and 21.2 mg/kg. Selenium was detected above the background concentration limit of less than 1.0 mg/kg in one sample at a concentration of 9.61 mg/kg. The detection of metals above background concentration limits in the Southwest Area was sporadic. Five sample locations contained at least three metals above background concentration limits, but no one area of the excavation contained the majority of the detections reported above background limits.

5.3.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the Southwest Area may be considered an indication of contamination. Table SW-2 summarizes the VOC analytical results for the 38 verification soil samples collected from the Southwest Area.

In the 38 samples collected from the Southwest Area of the excavation, 13 VOCs were detected. The VOCs 1,2-dibromoethane, 1,3-dichlorobenzene, and ethylbenzene were each detected in only one of the samples at very low, mostly estimated concentrations. The VOCs 1,2,3-trichlorobenzene, 1,4-dichlorobenzene, and methylene chloride were each detected in only two of the samples at very low concentrations. The VOCs 1,2-dichlorobenzene and 1,3,5-trimethylbenzene were each detected in only three of the samples at very low, mostly estimated concentrations. The VOC 1,2,4-trichlorobenzene was detected in four of the samples at low, mostly estimated concentrations. The VOC acetone was detected in five of the samples at concentrations less than 11 µg/kg. The VOC 2-butanone was detected in six of the samples at low, estimated concentrations. The VOC 4-methyl-2-pentanone was detected in 10 of the 38 samples at low, estimated concentrations. Toluene was the most widely detected VOC, found in 35 of the 38 samples. Concentrations ranged from 0.561 J to 894 µg/kg, with 18 of the detections above 10 µg/kg. The detection of the VOCs was dispersed in the Southwest Area with no group of locations showing greater VOC contamination.

Table SW-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.3.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the Southwest Area may be considered an indication of contamination. Table SW-4 summarizes the SVOC analytical results for the 37 verification soil samples collected from the Southwest Area.

In the Southwest Area of the excavation, 28 SVOCs were detected in 1 or more of the samples collected. The majority of the detections were reported at low, estimated concentrations. Four of the SVOCs were detected in only one sample. Seven of the SVOCs were detected in only two samples. Six of the SVOCs were detected in only three of the samples. Five of the SVOCs were detected in four of the samples. Phenanthrene was detected in six of the samples at concentrations ranging from 15.8 J to 200 µg/kg. Diethylphthalate was detected in 11 of the samples at concentrations ranging from 26 J to 54.4 J µg/kg. Fluoranthene and pyrene were each detected in 16 of the samples. Concentrations ranged from 7.54 J to 955 µg/kg and 11.5 J to 1510 J µg/kg, respectively. Bis(2-ethylhexyl) phthalate was the most widely dispersed SVOC, detected in 23 of the samples at concentrations ranging from 9.17 J to 2,190 J µg/kg. The majority of the verification samples that contained the greatest number of SVOCs came from the southern part of the Southwest Area of the excavation.

Table SW-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.3.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the Southwest Area may be considered an indication of contamination. Table SW-6 summarizes the PCB analytical results for the 44 verification soil samples collected from the Southwest Area.

Three PCBs were detected in two or more of the samples collected from the Southwest Area of the excavation. Aroclor-1242 was detected in 29 samples at concentrations ranging from 6.1 J to 6,720 J µg/kg. Aroclor-1254 was detected in 24 samples at concentrations ranging from 3.8 to 3,840 J µg/kg. Aroclor-1260 was detected in two samples at concentrations of 12.5 and 47.4 J µg/kg. More than half of the detections were reported at estimated concentrations, and none were above the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table SW-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.3.5 Radionuclides

Table SW-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 36 verification soil samples collected from the Southwest Area. Gamma activity attributable to uranium-235 was slightly above the 0.16-pCi/g background activity in four samples. Activities ranged from 0.161 to 0.227 pCi/g. Activity attributable to tritium was slightly above the 0.021-pCi/g background activity in one sample at an activity of 0.0225 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in five samples at activities ranging from 1.56 to 1.74 pCi/g. Gamma activities attributable to cesium-137 and

thorium-232 were not detected above the MDA and/or background activity in any of the samples.

5.4 North Area Verification Sampling

A total of 67 final verification grid samples and 4 duplicate samples were collected from the floor and sidewalls of the excavation in the North Area. Grid Locations 01 through 44 are floor samples, and Grid Locations 45 through 67 are sidewall samples (Figure 5-5). No final verification judgmental samples were collected in the North Area.

Tables NO-1 through NO-9 in Volume 2 summarize the final verification soil sampling analyses. Tables NO-1, NO-2, NO-4, NO-6, NO-8, and NO-9 summarize the analytical results for metals, VOCs, SVOCs, PCBs, radionuclides, and dioxins/furans, respectively, for the verification soil samples collected from the North Area. Tables NO-3, NO-5, and NO-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.4.1 Metals

Table NO-1 summarizes the metals analytical results for the 67 verification soil samples and 4 duplicate samples collected from the North Area. Arsenic, barium, chromium, chromium (VI), copper, lead, mercury, nickel, and selenium were detected above approved background concentration limits in a few of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in 10 samples at concentrations ranging from 4.63 to 8.82 mg/kg. Barium was detected slightly above the background concentration limit of 214 mg/kg in five samples at concentrations ranging from 215 to 296 mg/kg. Chromium was detected above the background concentration limit of 15.9 mg/kg in two samples at concentrations of 19.5 and 31.9 mg/kg, less than two times background. Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in three samples. Concentrations ranged from 2.69 J to 24.6 mg/kg, with only one sample significantly above background. Copper was detected above the background concentration limit of 18.2 mg/kg in one sample at a concentration of 18.6 mg/kg, less than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in four samples. Concentrations ranged from 13.7 to 162 mg/kg, with only one sample significantly above background. Mercury was detected above the background concentration limit of less than 0.1 mg/kg in one sample at a concentration of 1.04 mg/kg. Nickel was detected above the background concentration limit of 11.5 mg/kg in one sample at a concentration of 23.4 mg/kg, approximately two times background. Selenium was detected above the background concentration limit of less than 1.0 mg/kg in one sample at a concentration of 1.13 mg/kg, less than two times background. The detection of metals above background concentration limits in the North Area was sporadic with the exception of sample 74-NO-D005-F051, which contained five metals above background.

5.4.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the North Area may be considered an indication of contamination.

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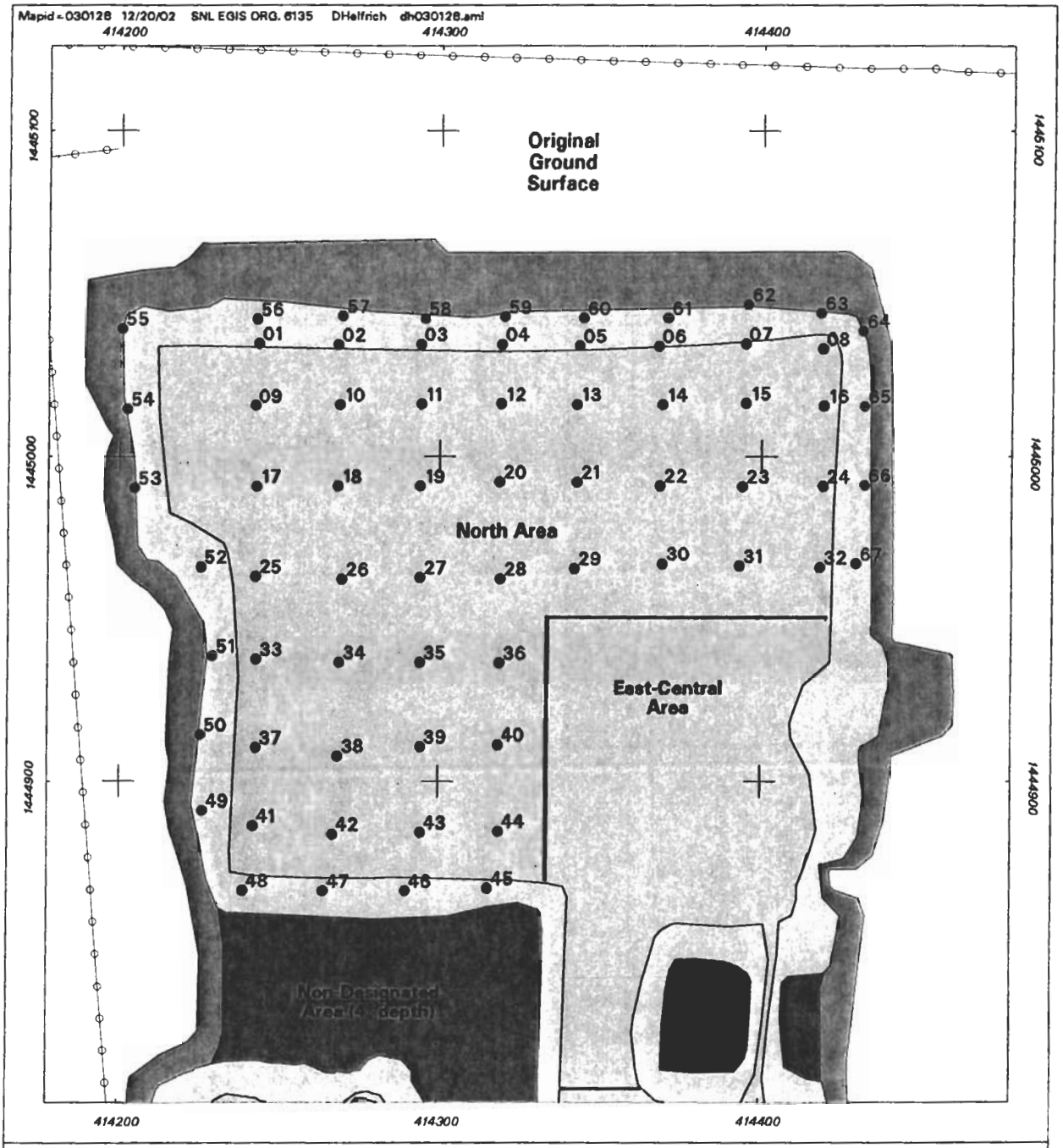

Legend

- Verification Grid Sample
- East-Central Area Boundary
- Fence

Depth of Excavation (ND = Non-Designated Area)

- 0' No Excavation
- 0 - 4'
- 4' ND Floor
- 4 - 12'
- 12' Floor

Figure 5-5
North Area Final Verification Grid Sample Locations
Chemical Waste Landfill

0 25 50
Scale in Feet

0 6 12
Scale in Meters

N

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Table NO-2 summarizes the VOC analytical results for the 67 verification soil samples and 4 duplicate samples collected from the North Area.

Eight VOCs were detected in the 71 samples collected from the North Area of the excavation. The VOCs 1,2-dichlorobenzene, 1,4-dichlorobenzene, and naphthalene were each detected in only one of the samples at very low, mostly estimated concentrations. The VOCs ethylbenzene and methyl methacrylate were each detected in only two of the samples at very low, mostly estimated concentrations. Methylene chloride was detected in three of the samples at very low, estimated concentrations. Acetone was detected in four of the samples at low, estimated concentrations. Toluene was detected in 22 of the 71 samples. Concentrations ranged from 0.724 J to 55.6 µg/kg, with only 14 of the detections above 10 µg/kg.

Table NO-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.4.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the North Area may be considered an indication of contamination. Table NO-4 summarizes the SVOC analytical results for the 67 verification soil samples and 4 duplicate samples collected from the North Area.

In the North Area of the excavation, 30 SVOCs were detected in 1 or more of the samples collected. Fifteen of the SVOCs were detected in only one sample. Six SVOCs were detected in only two samples. Four SVOCs were detected in only three of the samples. Pyrene was detected in four of the samples. Anthracene and phenanthrene were detected in five of the samples. Fluoranthene was detected in eight of the samples. Bis(2-ethylhexyl) phthalate was the most widely dispersed SVOC, detected in 23 of the samples at concentrations ranging from 11 J to 184 J µg/kg . Nearly all of the SVOC detections were at low, estimated concentrations. Three samples, 74-NO-D0003-F055, 74-NO-D0008-F056, and 74-NO-D0012-F015, contained the majority of the SVOC detections. Samples 74-NO-D0003-F055 and 74-NO-D0008-F056 were collected from the northwestern section of the excavation wall, and sample 74-NO-D0012-F015 was collected from the northeast excavation floor.

Table NO-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.4.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the North Area may be considered an indication of contamination. Table NO-6 summarizes the PCB analytical results for the 67 verification soil samples and 4 duplicate samples collected from the North Area.

Four PCBs were detected in one or more of the samples collected from the North Area of the excavation. Aroclor-1242 was detected in four samples at concentrations ranging from 9 to 20.4 J µg/kg. Aroclor-1248 was detected in three samples at concentrations ranging from 3.8 J to 25.5 µg/kg. Aroclor-1254 was detected in 26 samples at concentrations ranging from 1.6 J to 223 µg/kg. Aroclor-1260 was detected in 11 samples at concentrations ranging from 1.6 J to

16 J µg/kg. More than half of the PCB detections were reported at estimated concentrations, and all were more than an order of magnitude below the TSCA cleanup criteria of 25,000 µg/kg (25 ppm).

Table NO-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.4.5 Radionuclides

Table NO-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 67 verification soil samples and 4 duplicate samples collected from the North Area. Gamma activity attributable to uranium-235 was slightly above the 0.16-pCi/g background activity in one sample at 0.175 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in seven samples, with activities ranging from 1.47 to 1.92 pCi/g. Activity attributable to tritium was above the 0.021-pCi/g background activity in eight samples, with activities ranging from 0.0216 to 2.28 pCi/g. Gamma activity attributable to thorium-232 was slightly above the 1.01-pCi/g background activity in one sample at an activity of 1.08 pCi/g. Gamma activity attributable to cesium-137 was not detected above the MDA and/or background activity in any of the samples. Samples with gamma activity above background occurred sporadically in the North Area of the excavation.

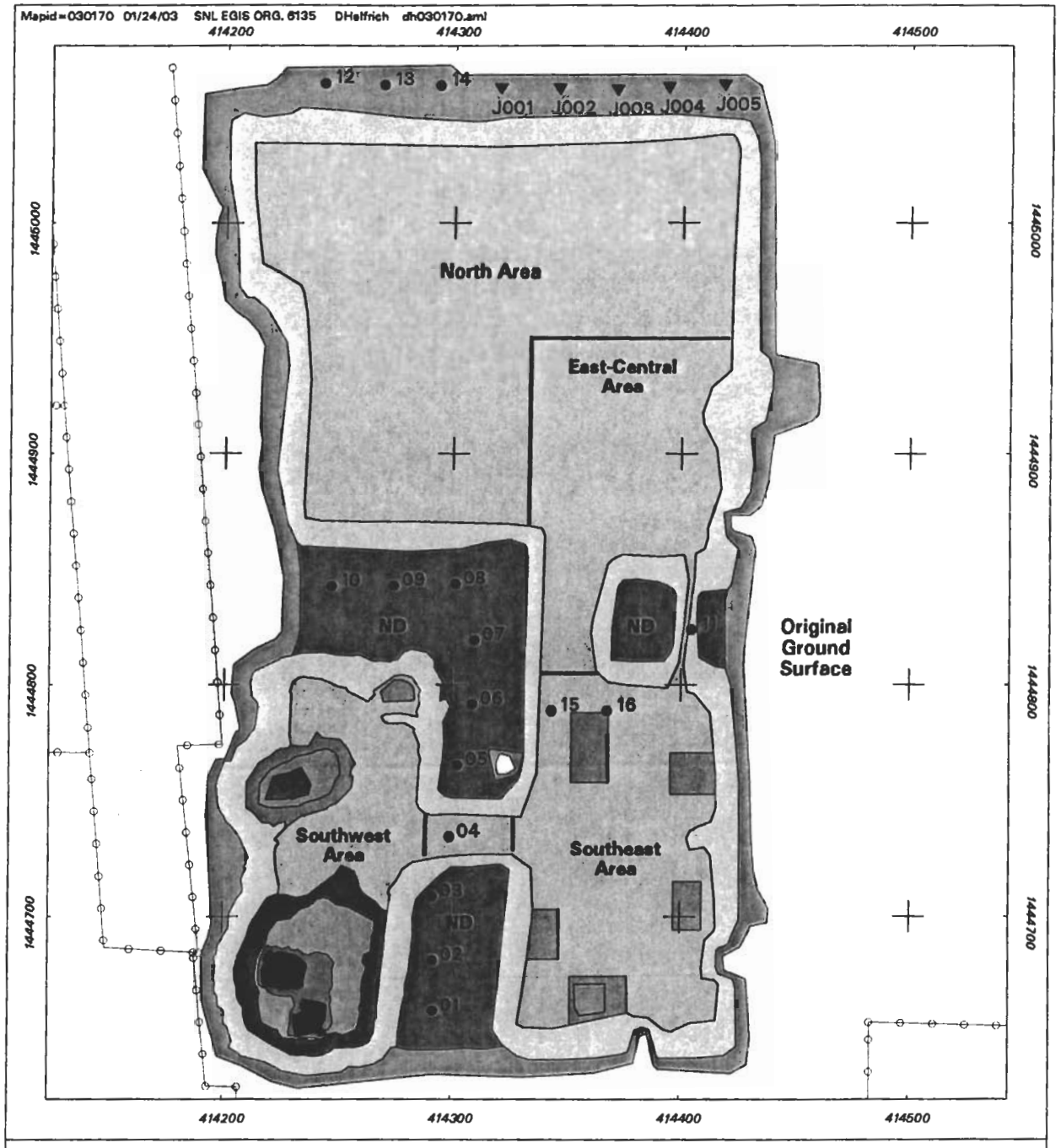
5.4.6 Dioxins and Furans

Because there are no background concentrations for dioxins and furans in soil, detectable dioxins and furans in the samples collected from the North Area of the excavation may be considered an indication of contamination. Table NO-9 summarizes the dioxin and furan analytical results for the six soil samples chosen for dioxin and furan analysis that were collected in areas suspected of having high PCB contamination and/or showed signs of burned material in the disposal area.

One sample, 74-NO-D012-F021, contained seven detected dioxin and furan compounds at very low concentrations. Heptachlorodibenzofuran was also detected in three other samples at very low concentrations. One sample contained 1,2,3,4,6,7,8-heptachlorodibenzofuran.

5.5 Non-Designated Area Verification Sampling

A total of 21 final verification samples and 2 duplicate samples were collected from the base of the excavation in the Non-Designated Area, which was excavated to a depth of 4 feet bgs. The Non-Designated Area in the vicinity of Sample Grid Locations 04, 15, and 16 was excavated to a depth of 12 feet bgs due to sloping issues (Grid Locations 15 and 16) or to the creation of an access corridor between the Southeast and Southwest Areas for equipment and personnel (Grid Location 04). The total of 21 samples includes Grid Locations 01 through 16 and Judgmental Samples J001 through J005, which were collected along the northeastern boundary of the North Area where debris was removed from the 0- to 4-foot-bgs depth. All final verification sample locations for the Non-Designated Area are shown in Figure 5-6.



Legend

- Verification Grid Sample
- Judgmental Sample
- Excavation Area Boundary
- Fence

Depth of Excavation (ND = Non-Designated Area)

0 - 4′	12 - 14′	0′ No Excavation
4′ ND Floor	14 - 16′	20′
4 - 12′	16 - 18′	25′
12′ Floor	12-20′	30′

Figure 5-6
Non-Designated Area
Final Grid and Judgmental Sample Locations
Chemical Waste Landfill

0 35 70
Scale in Feet

0 8.4 16.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Tables ND-1 through ND-8 in Volume 2 summarize the verification soil sampling analyses. Tables ND-1, ND-2, ND-4, ND-6, and ND-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the verification soil samples collected from the Non-Designated Area. Tables ND-3, ND-5, and ND-7 summarize the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.5.1 Metals

Table ND-1 summarizes the metals analytical results for the 21 verification soil samples and 2 duplicate samples collected from the Non-Designated Area. Arsenic, chromium (VI), lead, and mercury were detected above approved background concentration limits in less than 25 percent of the samples. Arsenic was detected slightly above the background concentration limit of 4.4 mg/kg in one sample at a concentration of 6.01 mg/kg, less than two times background.

Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in one sample at a concentration of 1.78 J mg/kg, less than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in two samples at concentrations of 12.4 J and 23.3 mg/kg, less than two times background. Mercury was detected above the background concentration limit of less than 0.1 mg/kg in three samples at concentrations ranging from 0.134 to 0.828 mg/kg. The detection of metals above background concentration limits in the Non-Designated Area was sporadic, and no one area of the excavation contained the majority of the detections reported above background limits.

5.5.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the Non-Designated Area may be considered an indication of contamination. Table ND-2 summarizes the VOC analytical results for the 21 verification soil samples and 2 duplicate samples collected from the Non-Designated Area.

Two VOCs were detected in the soil samples collected from the Non-Designated Area of the excavation. The VOC methyl methacrylate was detected in one sample at a concentration of 2.13 J mg/kg. Toluene was detected in 13 of the 23 samples. Concentrations ranged from 0.769 J to 52 J µg/kg, with almost half of the detections estimated and only two above 10 µg/kg. The detection of VOCs was dispersed in the Non-Designated Area, with no group of locations showing greater VOC contamination.

Table ND-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.5.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the Non-Designated Area may be considered an indication of contamination. Table ND-4 summarizes the SVOC analytical results for the 21 verification soil samples and 2 duplicate samples collected from the Non-Designated Area.

Eight SVOCs were detected in samples collected from the Non-Designated Area of the excavation. Six of the SVOCs, acenaphthene (4.84 J µg/kg), benzo(a)anthracene (49.7 µg/kg), benzo(b)fluoranthene (26.2 J µg/kg), benzo(k)fluoranthene (40.8 µg/kg), chrysene (72.3 µg/kg), and pyrene (70.8 µg/kg), were all detected in sample 74-ND-D012-F015. The SVOC di-n-butyl-phthalate was detected in one sample at a concentration of 26 J µg/kg. Bis(2-ethylhexyl) phthalate was detected in 13 samples. Concentrations ranged from 9.11 J to 259 J µg/kg, with the majority of the detections at estimated concentrations.

Table ND-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.5.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the Non-Designated Area may be considered an indication of contamination. Table ND-6 summarizes the PCB analytical results for the 21 verification soil samples and 2 duplicate samples collected from the Non-Designated Area.

Three PCBs were detected in five or more of the samples collected from the Non-Designated Area of the excavation. Aroclor-1242 was detected in seven samples at concentrations ranging from 2.4 J to 1,400 J µg/kg. Aroclor-1254 was detected in eight samples at concentrations ranging from 4.7 J to 371 J µg/kg. Aroclor-1260 was detected in five samples at concentrations ranging from 8 J to 87.8 J µg/kg. More than half of the detections were reported at estimated concentrations, and none were above the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table ND-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.5.5 Radionuclides

Table ND-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 21 verification soil samples and 2 duplicate samples collected from the Non-Designated Area. Activity attributable to tritium was slightly above the 0.021-pCi/g background activity in two samples at activities of 0.02265 and 0.02285 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in five samples at activities ranging from 1.53 to 3.26 pCi/g. Gamma activities attributable to cesium-137, thorium-232, and uranium-235 were not detected above the MDA and/or background activity in any of the samples.

5.6 Backfill Sampling

Soil being used to backfill the excavation was sampled according to the CWL SAP (SNL/NM November 1998a) and SAP ICNs #1 through #3 (SNL/NM March 1999a, SNL/NM December 2000, and SNL/NM July 2001b) and analyzed for the typical CWL analytical suite of RCRA metals plus beryllium, copper, nickel, and hexavalent chromium; VOCs; SVOCs; PCBs; and radionuclides. The backfill material sampled to date is presented here as four main backfill groups, Replaceable Soil (excavated soil), CAMU Spoils Pile, Clean Fill (additional CAMU Spoils Pile, Borrow Pit, and other local fill sources), and SOB Clean Fill (see Section 4.7). Final off-site laboratory verification samples were collected at a frequency of one sample per 1,000 cy

for the Replaceable Soil, one sample per 3,000 cy for the CAMU Spoils Pile fill, one sample per 3,000 cy for the Clean Fill, and one sample per 1,000 cy for the SOB Clean Fill.

Section 5.6.1 presents the analytical results for the Replaceable Soil and Section 5.6.2 addresses the CAMU Spoils Pile results. Approximately 7,000 cy of CAMU Spoils Pile fill is characterized by the analytical results in Section 5.6.2, but has not yet been placed in the excavation and compacted. Analytical results for the additional Clean Fill and SOB Clean Fill materials that will be used to complete the backfilling effort are discussed in Sections 5.6.3 and 5.6.4. These data represent the Clean Fill material obtained from the CWL/CAMU/Mixed Waste Landfill Borrow Pit area, additional CAMU Spoils Pile material, fill from other local TA-III sources, and the soil scraped from the SOB.

5.6.1 Replaceable Soil

A total of 13 samples were collected from the Replaceable Soil group, which was excavated from the CWL. Tables RS-1 through RS-8 in Volume 2 summarize the soil sampling analyses. Tables RS-1, RS-2, RS-4, RS-6, and RS-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the soil samples collected from the Replaceable Soil. Tables RS-3, RS-5, and RS-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.6.1.1 Metals

Table RS-1 summarizes the metals analytical results for the 13 soil samples collected from the Replaceable Soil. Arsenic, barium, beryllium, cadmium, chromium, chromium (VI), copper, lead, mercury, nickel, and silver were detected above approved background concentration limits in varying numbers of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in seven samples. Concentrations, mostly estimated, ranged from 4.54 to 7.35 mg/kg, with all of the detections less than two times background. Barium was detected above the background concentration limit of 214 mg/kg in four samples. Concentrations, mostly estimated, ranged from 350 to 563 mg/kg, with two of the detections less than two times background. Beryllium was detected above the background concentration limit of 0.65 mg/kg in one sample at a concentration of 0.668 mg/kg, less than two times background. Cadmium was detected above the background concentration limit of 0.9 mg/kg in three samples. Concentrations ranged from 0.931 to 3.21 mg/kg, with two of the detections less than two times background. Chromium was detected above the background concentration limit of 15.9 mg/kg in four samples. Concentrations, all estimated, ranged from 17.4 J to 133 J mg/kg, with all but one of the detections less than two times background. Chromium (VI) was detected above the background concentration limit of 1.0 mg/kg in five samples. Concentrations ranged from 1.02 J to 4.07 mg/kg, with all but two of the detections less than two times background. Copper was detected above the background concentration limit of 18.2 mg/kg in nine samples. Concentrations ranged from 18.9 to 545 mg/kg, with all but three of the detections less than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in 12 samples. Concentrations, mostly estimated, ranged from 11.9 to 192 mg/kg, with all but one of the detections less than two times background. Mercury was detected above the background concentration limit of less than 0.1 mg/kg in all 13 samples at concentrations ranging from 0.238 to 236 mg/kg. Nickel was detected above the background concentration limit of 11.5 mg/kg in four samples. Concentrations ranged from 12.5 J to 26.1 mg/kg, with all but one of the detections less than two times background. Silver was detected above the

background concentration limit of less than 1.0 mg/kg in one sample at a concentration of 1.5 mg/kg, less than two times background. The detection of metals above background concentration limits in the Replaceable Soil samples was sporadic, and no one sample contained the majority of the detections reported above background limits.

5.6.1.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the Replaceable Soil may be considered an indication of contamination. Table RS-2 summarizes the VOC analytical results for the 13 soil samples collected from the Replaceable Soil.

Five VOCs were detected. Four of the VOCs, acetone, ethylbenzene, m-, p-xylene, and o-xylene, were detected in only one of the samples at concentrations of 14.2, 1.43, 17.4, and 3.93 µg/kg, respectively. The VOC methylene chloride was detected in two samples at low, estimated concentrations of 1.67 J and 2.94 J µg/kg. Methylene chloride is a known laboratory contaminant and occurred in eight of the nine quality assurance (QA)/QC samples.

Table RS-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.6.1.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the Replaceable Soil may be considered an indication of contamination. Table RS-4 summarizes the SVOC analytical results for the 13 soil samples collected from the Replaceable Soil.

In one or more of the samples collected, 25 SVOCs were detected. The majority of the detections were reported at low estimated concentrations. Six of the SVOCs were detected in only one of the samples, with all but one at estimated concentrations. Eight of the SVOCs were detected in only two samples, with all but two detections at estimated concentrations. Two of the SVOCs were detected in only three of the samples, with all but two detections at estimated concentrations. Three of the SVOCs were detected in four of the samples, with all but one of the detections at estimated concentrations. Fluorene and phenanthrene were each detected in five of the samples. Concentrations ranged from 3.08 J to 25 J µg/kg and 13.4 J to 113 µg/kg, respectively. Dibenzofuran was detected in six of the samples at concentrations ranging from 2.8 J to 118 J µg/kg. Bis(2-ethylhexyl) phthalate was detected in 10 of the samples at concentrations ranging from 31.5 J to 5,130 µg/kg. Fluoranthene and pyrene were the most widely dispersed SVOCs and were both detected in 11 of the samples at concentrations ranging from 7.48 J to 127 µg/kg and 11.4 J to 606 J µg/kg, respectively.

Table RS-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.6.1.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the Replaceable Soil may be considered an indication of contamination.

Table RS-6 summarizes the PCB analytical results for the 13 soil samples collected from the Replaceable Soil.

Four PCBs were detected in two or more of the samples. Aroclor-1248 was detected in two samples at concentrations of 127 J and 289 J µg/kg. Aroclor-1260 was detected in six samples at concentrations ranging from 23.7 to 225 J µg/kg. Aroclor-1242 was detected in 10 samples at concentrations ranging from 113 to 6,660 J µg/kg. Aroclor-1254 was detected in all 13 samples at concentrations ranging from 70.9 J to 2,450 µg/kg. Almost half of the detections were reported at estimated concentrations and none were above the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table RS-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.6.1.5 Radionuclides

Table RS-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 13 soil samples collected from the Replaceable Soil. Gamma activity attributable to cesium-137 was slightly above the 0.079-pCi/g background activity in one sample at an activity of 0.0811 pCi/g. Gamma activity attributable to uranium-235 was slightly above the 0.16-pCi/g background activity in one sample at an activity of 0.219 pCi/g. Gamma activity attributable to thorium-232 was above the 1.01-pCi/g background activity in two samples at activities of 1.05 and 2.3 pCi/g. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in two samples at activities of 1.49 and 2.05 pCi/g. Activity attributable to tritium was above the 0.21-pCi/g background activity in 11 samples at activities ranging from 0.02365 to 9.9 pCi/g.

5.6.2 CAMU Spoils Pile

A total of seven samples and one duplicate were collected from the CAMU Spoils Pile. Tables CB-1 through CB-7 in Volume 2 summarize the soil sampling analyses. Tables CB-1, CB-2, CB-4, and CB-7 summarize the analytical results for metals, VOCs, SVOCs, and radionuclides, respectively, for the soil samples collected from the CAMU Spoils Pile. Tables CB-3, CB-5, and CB-6 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.6.2.1 Metals

Table CB-1 summarizes the metals analytical results for the seven soil samples and one duplicate sample collected from the CAMU Spoils Pile. Arsenic, chromium, and lead were detected above approved background concentration limits in varying numbers of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in one sample at a concentration of 10 mg/kg. Chromium was detected above the background concentration limit of 15.9 mg/kg in one sample at a concentration of 29.5 mg/kg, less than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in one sample at a concentration of 183 mg/kg. The detection of these three metals above background concentration limits occurred in only one sample from the CAMU Spoils Pile.

5.6.2.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the CAMU Spoils Pile may be considered an indication of contamination. Table CB-2 summarizes the VOC analytical results for the seven soil samples and one duplicate sample collected from the CAMU Spoils Pile.

Only one VOC, styrene, was detected in the soil samples at a low concentration of 2.02 µg/kg.

Table CB-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.6.2.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the CAMU Spoils Pile may be considered an indication of contamination. Table CB-4 summarizes the SVOC analytical results for the seven soil samples and one duplicate sample collected from the CAMU Spoils Pile.

One SVOC, di-n-octyl phthalate, was detected in one of the samples at a concentration of 347 µg/kg.

Table CB-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.6.2.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the CAMU Spoils Pile may be considered an indication of contamination. No PCBs were detected in any of the seven soil samples or the one duplicate sample collected from the CAMU Spoils Pile.

Table CB-6 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.6.2.5 Radionuclides

Table CB-7 summarizes the off-site gamma spectroscopy and tritium analytical results for the seven soil samples and one duplicate sample collected from CAMU Spoils Pile. Gamma activity attributable to uranium-238 was slightly above the 1.4-pCi/g background activity in one sample at an activity of 1.55 pCi/g. Activities attributable to cesium-137, thorium-232, tritium, and uranium-235 were not detected above the MDA and/or background activity in any of the samples.

5.6.3 Clean Fill

A total of 11 samples and 1 duplicate sample were collected from the Clean Fill group. Tables CF-1 through CF-8 in Volume 2 summarize the soil sampling analyses. Tables CF-1,

CF-2, CF-4, CF-6, and CF-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the soil samples collected from the Clean Fill. Tables CF-3, CF-5, and CF-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.6.3.1 Metals

Table CF-1 summarizes the metals analytical results for the 11 soil samples and 1 duplicate sample collected from the Clean Fill. Arsenic and beryllium were detected slightly above approved background concentration limits in two of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in one sample at a concentration of 4.56 mg/kg, less than two times background. Beryllium was detected above the background concentration limit of 0.65 mg/kg in one sample at a concentration of 0.655 mg/kg, less than two times background. The detection of these two metals above background concentration limits occurred in two samples from the Clean Fill.

5.6.3.2 VOCs

Because there are no background concentrations for VOCs in soil, detectable VOCs in the samples collected from the Clean Fill may be considered an indication of contamination. Table CF-2 summarizes the VOC analytical results for the 11 soil samples and 1 duplicate sample collected from the Clean Fill.

Only one VOC, TCE, was detected in 10 samples at very low, estimated concentrations ranging from 0.438 J to 0.88 J µg/kg.

Table CF-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.6.3.3 SVOCs

Because there are no background concentrations for SVOCs in soil, detectable SVOCs in the samples collected from the Clean Fill may be considered an indication of contamination. Table CF-4 summarizes the SVOC analytical results for the 11 soil samples and 1 duplicate sample collected from the Clean Fill.

Seven SVOCs were detected in only one of the samples, and all of the detections were reported at estimated concentrations.

Table CF-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.6.3.4 PCBs

Because there are no background concentrations for PCBs in soil, detectable PCBs in the samples collected from the Clean Fill may be considered an indication of contamination. Table CF-6 summarizes the PCB analytical results for the 11 soil samples and 1 duplicate sample collected from the Clean Fill.

Only one PCB, Aroclor-1254, was detected in two samples at concentrations of 3 J and 11.8 µg/kg, well below the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table CF-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.6.3.5 Radionuclides

Table CF-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the 11 soil samples and 1 duplicate sample collected from Clean Fill. Gamma activity attributable to thorium-232 was slightly above the 1.01-pCi/g background activity in one sample at an activity of 1.1 pCi/g. Gamma activity attributable to uranium-235 was slightly above the 0.16-pCi/g background activity in one sample at an activity of 0.196 pCi/g. Gamma activity attributable to cesium-137 was above the 0.079-pCi/g background activity in seven samples at activities ranging from 0.118 to 0.378 pCi/g. Activities attributable to tritium and uranium-238 were not detected above the MDA and/or background activity in any of the samples.

5.6.4 SOB Clean Fill

A total of four samples were collected from the SOB Clean Fill, which was soil scraped from the surface of the SOB. Tables SOB-CF-1 through SOB-CF-8 in Volume 2 summarize the soil sampling analyses. Tables SOB-CF-1, SOB-CF-2, SOB-CF-4, SOB-CF-6, and SOB-CF-8 summarize the analytical results for metals, VOCs, SVOCs, PCBs, and radionuclides, respectively, for the soil samples collected from the SOB Clean fill. Tables SOB-CF-3, SOB-CF-5, and SOB-CF-7 provide the analytical MDLs for the target analyte list for VOC, SVOC, and PCB compounds, respectively.

5.6.4.1 Metals

Table SOB-CF-1 summarizes the metals analytical results for the four soil samples collected from the SOB Clean Fill. Arsenic, cadmium, chromium, chromium (VI), copper, lead, mercury, and selenium were detected above approved background concentration limits in varying numbers of the samples. Arsenic was detected above the background concentration limit of 4.4 mg/kg in two samples at concentrations of 5.63 mg/kg and 9.81 mg/kg. Cadmium was detected above the background concentration limit of 0.9 mg/kg in one sample at a concentration of 15.6 mg/kg. Chromium was detected above the background concentration limit of 15.9 mg/kg in two samples at concentrations of 22.2 mg/kg and 23.9 mg/kg, with both less than two times background. Chromium (VI) was detected slightly above the background concentration limit of 1.0 mg/kg in one sample at an estimated concentration of 1.18 J mg/kg. Copper was detected above the background concentration limit of 18.2 mg/kg in one sample at a concentration of 23.4 mg/kg, less than two times background. Lead was detected above the background concentration limit of 11.8 mg/kg in three samples. Concentrations ranged from 18.7 to 57.5 mg/kg. Mercury was detected above the background concentration limit of less than 0.1 mg/kg in three samples. Concentrations ranged from 0.412 to 1.8 mg/kg. Selenium was detected slightly above the background concentration limit of less than 1.0 mg/kg in one sample at a concentration of 1.01 mg/kg. The detection of these metals above background concentration limits occurred in three of the four samples from the SOB Clean Fill.

5.6.4.2 VOCs

Because there are no background concentrations for VOCs in soil, any detectable VOCs in the samples collected from the SOB Clean Fill may be considered an indication of contamination. Table SOB-CF-2 summarizes the VOC analytical results for the four soil samples collected from the SOB Clean Fill.

Only one VOC was detected in the soil samples collected from the SOB Clean Fill. The VOC acetone was detected in three samples. Concentrations ranged from 4.52 J to 11.7 µg/kg.

Table SOB-CF-3 provides the MDLs used by the off-site laboratory for analyzing VOCs.

5.6.4.3 SVOCs

Because there are no background concentrations for SVOCs in soil, any detectable SVOCs in the samples collected from the SOB Clean Fill may be considered an indication of contamination. Table SOB-CF-4 summarizes the SVOC analytical results for the four soil samples collected from the SOB Clean Fill.

Ten SVOCs were detected in the four samples collected from the SOB Clean Fill. The majority of the detections were reported at low estimated concentrations. Two of the SVOCs were detected in only one of the samples at estimated concentrations. Three of the SVOCs were detected in only two samples, with all at estimated concentrations. Chrysene was detected in three samples, with concentrations ranging from 29.5 J to 153 J µg/kg. Fluoranthene was detected in three samples, with concentrations ranging from 71 to 370 J µg/kg. Phenanthrene was detected in three samples, with concentrations ranging from 45.8 to 196 J µg/kg. Pyrene was detected in three samples, with estimated concentrations ranging from 81 J to 585 J µg/kg. Bis(2-ethylhexyl) phthalate was detected in all four samples. Concentrations ranged from 40.2 J to 1,760 µg/kg, with all but one estimated.

Table SOB-CF-5 provides the MDLs used by the off-site laboratory for analyzing SVOCs.

5.6.4.4 PCBs

Because there are no background concentrations for PCBs in soil, any detectable PCBs in the samples collected from the SOB Clean Fill may be considered an indication of contamination. Table SOB-CF-6 summarizes the PCB analytical results for the four soil samples collected from the SOB Clean Fill.

Three PCBs were detected in all four of the samples collected from the SOB Clean Fill. Aroclor-1242 was detected in all four samples at concentrations ranging from 23.4 to 2,300 µg/kg. Aroclor-1254 was detected in all four samples at concentrations ranging from 24.9 to 940 µg/kg. Aroclor-1260 was detected in all four samples at concentrations ranging from 3.6 to 178 J µg/kg, with all but one estimated. All PCB detections were well below the TSCA cleanup goal of 25,000 µg/kg (25 ppm).

Table SOB-CF-7 provides the MDLs used by the off-site laboratory for analyzing PCBs.

5.6.4.5 Radionuclides

Table SOB-CF-8 summarizes the off-site gamma spectroscopy and tritium analytical results for the four soil samples collected from the SOB Clean Fill. Activity attributable to tritium was slightly above the 0.021-pCi/g background activity in one sample at an activity 0.02825 pCi/g. Gamma activity attributable to uranium-238 was above the 1.4-pCi/g background activity in one sample at an estimated activity of 1.95 J pCi/g. Gamma activities attributable to cesium-137, thorium-232, and uranium-235 were not detected above the MDA and/or background activity in any of the samples.

6.0 RISK SCREENING ASSESSMENT SUMMARY

The following sections summarize the final risk screening assessment report (Annex A) for the CWL. Although background information is already presented in other sections of this report, it is summarized here for completeness and to provide a context for the human health (Section 6.4.6) and ecological (Section 6.5.8) risk screening results.

Under an industrial land use scenario, using conservative assumptions and a reasonable maximum exposure (RME) approach to risk assessment, the final risk screening assessment demonstrates that the CWL meets the risk-based criteria determined by the NMED for an adequately characterized site. This risk screening assessment evaluates the CWL both with and without backfill materials placed to grade. Initially, the risk was calculated not taking into account the impact of backfill materials in the excavation. The total calculated HI is 0.25 (versus the most conservative guideline of 1) and the total estimated excess cancer risk is 8E-6 (versus 1E-5) when using the 95% upper confidence limit (UCL) of the mean concentrations for the main risk contributors (arsenic, chromium, mercury, aniline, and 1,2,3-trichloropropane). This approach using the 95% UCLs of the mean for compounds with the greatest impact on calculated risk is consistent with the SNL/NM ER Project risk screening guidance and has been applied at numerous other SNL/NM ER Project sites that were approved for No Further Action (NFA) by the NMED. For radiological COCs under the industrial land use scenario, the incremental total effective dose equivalent (TEDE) is 3.9 millirem (mrem)/year, which is significantly less than EPA's numerical guideline of 15 mrem/year. Incremental estimated excess cancer risk is 5.7E-5.

Furthermore, for radiological COCs not taking into account the backfill material, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is only 11.7 mrem/year with an associated excess cancer risk of 1.5E-4. The guideline for this scenario is 75 mrem/year (SNL/NM February 1998). Therefore, the site is eligible for unrestricted radiological release.

The risk was then calculated incorporating the backfill material for nonradiological COCs that were determined to be the main risk drivers. The results of this assessment are within acceptable ranges for both the industrial and residential land use scenarios compared to established numerical guidance for human health.

Backfilling to 40 percent has been completed as of August 2002. Backfilling to 100 percent (i.e., former grade) is scheduled for October 2003. Verification analytical results for both the excavation (sidewalls and floor) and backfill soil have been incorporated into the final risk screening assessment, which includes 236 samples (not including duplicates). The final risk screening assessment addresses the excavated former disposal area and vadose zone immediately surrounding it. The VOC vapor plume in the deeper vadose zone and groundwater are also addressed in this assessment based upon modeling included in the CWL Risk-Based Approach (SNL/NM August 2000) that was approved by the NMED (Lewis October 2000).

The purpose of this final risk screening assessment is three-fold and includes the following objectives:

- Demonstrate that the risk-based criteria developed for the CWL LE VCM have been met.

- Obtain NMED approval to backfill the excavation.

- Provide the foundation for additional risk screening/modeling to be incorporated into the CMS and used to develop, evaluate, and select final corrective action alternatives.

Although additional risk screening and/or modeling will be performed as part of the CMS, this is the final risk screening assessment for the CWL excavation and incorporates all relevant final verification analytical data.

6.1 Site Description and History

The CWL at SNL/NM is a 1.9-acre disposal site, located in the southeastern corner of TA-III. SNL/NM disposed of wastes into unlined pits at the CWL from 1962 until 1985. No record of disposal practices was kept between 1962 and 1975. However, from reconnaissance studies, it was inferred that the waste pits were, for the most part, uniformly distributed. In 1981, all liquid waste disposal was discontinued, and the landfill was operated under RCRA interim status as a storage facility with a capacity for 300 hazardous waste drums. Waste drums were staged in segregated areas according to waste type. In May 1988, in accordance with the interim status regulations, the DOE, SNL/NM, and the NMED began negotiating a Closure Plan to identify the activities necessary for closure of the CWL. In 1989, all CWL disposal and storage operations were discontinued completely, and all pits were covered with soil.

From September 1998 to February 2002, the CWL was completely excavated as part of the LE VCM. More than 52,000 cy of contaminated soil and debris were removed, segregated, and managed prior to final treatment and/or disposal. Approximately 89 percent of the excavated soil has been moved to the adjacent CAMU for final disposition. Approximately 11 percent of the excavated soil has been returned to the excavation as backfill material. Final off-site waste disposal will include less than 1 percent of the total volume of material excavated. Backfilling the excavation, SOB sampling and closure, and off-site disposal are ongoing activities. Additional clean fill material will be sampled and screened against the risk criteria prior to placement in the excavation; however, the majority of backfill material analytical results are included in this final risk screening assessment.

6.2 Data Quality Objectives

The Data Quality Objectives (DQOs) presented in the CWL LE SAP (SNL/NM November 1998a) and subsequent ICNs #1 (SNL/NM March 1999a), #2 (SNL/NM December 2000), #3 (SNL/NM July 2001b), and #4 (SNL/NM December 2001) identified the site-specific sample locations, sample depths, sampling procedures, and analytical requirements to adequately characterize and verify the nature and extent of COCs remaining after the excavation was completed. The SAP outlined the QA/QC requirements necessary for producing defensible analytical data suitable for risk assessment purposes. The VCM sampling was designed to determine whether COCs remained in the excavation floor and sidewalls at levels exceeding risk-based criteria established for the site (SNL/NM August 2000). In addition, the sampling frequency and analytical protocol for characterizing backfill materials were also defined in the CWL LE SAP (SNL/NM November 1998a) and ICNs #1 through #3 (SNL/NM March 1999a,

SNL/NM December 2000, and SNL/NM July 2001b). These project documents were submitted to and approved by the NMED.

6.3 Site Conceptual Model

6.3.1 Introduction

The initial determination of the nature, migration rate, and extent of contamination at the CWL was based upon the pre-LE VCM conceptual model presented in the CWL LE SAP (SNL/NM November 1998a) and Section 2.2 of this report. This model has been validated during the LE VCM based upon complete excavation of the original disposal area and associated waste, along with post-VCM verification sampling at the site.

Results from previous characterization investigations, summarized in Section 2.1.1, were used to develop the pre-LE VCM conceptual model, including estimating the nature and extent of contamination. The following conclusions summarize the findings of these investigations and present updated information from the LE VCM findings.

- Pre-LE VCM Model: Lateral spreading of organic and inorganic COCs from the original disposal areas is minimal, except for the UCAP and 60s pits chromic acid disposal areas, where constituents appear to have spread laterally under capillary forces.

- LE VCM excavation and sampling results confirmed this interpretation, including the UCAP and 60s pits chromic acid disposal areas. In these two areas, lateral spreading occurred but was not extensive (less than 15 feet).

- Pre-LE VCM Model: Vertical migration of organic and inorganic COCs from the original disposal areas is minimal, except in two areas: 1) chromium, associated with spent chromic acid disposal, is shown to have migrated to approximately 65 feet bgs beneath the unlined chromic acid trench, and 2) organic contamination in the southwestern corner of the Southwest Area appears to have migrated to a maximum depth of approximately 30 feet bgs based upon a partitioning interwell tracer test performed in December 1995 (INTERA 1995).

- LE VCM excavation and sampling results confirmed these interpretations:

  - In general, vertical migration appears to be minimal in most of the former landfill disposal areas based upon excavation floor final verification sampling results.

  - Significant chromium-contaminated soil was excavated to a depth of 18 feet bgs in the former location of the unlined chromic acid trench; however, final verification sampling in this location, and in other areas where chromic acid was disposed, indicated residual chromium levels met risk screening criteria.

  - In the southwestern corner of the Southwest Area, excavation proceeded to 30 feet bgs due to PCB contamination that exceeded the threshold values to a depth of approximately 27 feet bgs.

As discussed in the CWL Groundwater Assessment Report (SNL/NM October 1995), the VOC vapor plume impacted groundwater beneath the CWL, resulting in TCE levels that exceeded the regulatory limit of 5 ppb. Since removal of a significant portion of the VOC vapor plume during the VE VCM that was completed in July 1998, TCE concentrations in groundwater have been below 5 ppb. This information supports the conclusion that the VOC vapor plume was the cause of TCE groundwater contamination. Groundwater and vapor monitoring data collected since July 1998 confirm the vapor plume is no longer impacting groundwater such that regulatory limits are exceeded.

Both the nature of contamination and the potential for the degradation of COCs were evaluated using laboratory analyses of final verification soil samples. COCs included metals, VOCs, SVOCs, PCBs, and radionuclides.

6.3.2 Rate of Contaminant Migration

The CWL is an inactive site that has been remediated during the VE and LE VCMs. The rate of COC migration from subsurface soil depends predominantly upon precipitation and occasional surface-water flow. Data available from previous CWL investigations, groundwater and vapor plume monitoring; numerous CWL-specific modeling studies; SNL/NM monitoring programs for air, water, and radionuclides; various biological surveys; meteorological monitoring; and the technical literature are adequate for characterizing the rate of COC migration at the CWL.

6.3.3 Extent of Contamination

Contamination at the CWL resulted from past disposal of both liquid and solid waste. All buried waste was removed from the original disposal area of the CWL during the LE VCM. Although some residual COCs remain in the excavation floor, sidewalls, and fill material, the LE VCM was successful in removing the original waste materials and soil contaminated as a result of past disposal operations. The collection of more than 220 final verification soil samples (not including duplicate samples) across the 1.9-acre site and from the associated backfill material was sufficient to characterize residual contamination present after completion of the LE VCM.

Comparison of COCs to Background Screening Levels

Site history and characterization activities were used to identify potential COCs. Generally, COCs that were evaluated in this risk assessment included all detected organic as well as inorganic and radiological COCs for which samples were analyzed. In order to provide conservatism in this risk assessment, the background screening process used only the maximum concentration value of each COC found for the entire site. The NMED-approved background concentration was selected to provide the background screening values (Dinwiddie September 1997 and Tharp February 1999).

6.3.4 Fate and Transport

COCs at this site include both inorganic constituents (metals and radionuclides) and organic compounds that occur as residual contaminants in unexcavated and backfill soil. Until

backfilling is complete and the site is covered with clean soil, wind is a potential mechanism for transport of these COCs; however, this interim period is expected to be short (backfilling is scheduled to be completed in October 2003). Surface water is controlled by a swale surrounding the site and other strategically placed surface-water control features, such as hay bales and silt fencing. These features are routinely inspected and maintained as part of the ongoing management of the site that will continue until final closure and postclosure care activities are defined and approved by the NMED. Leaching of COCs into the groundwater at this site is highly unlikely due to the low rainfall, high evaporation rate, and depth to groundwater (approximately 485 feet bgs). Groundwater has been impacted in the past by the VOC vapor plume (SNL/NM October 1995). This migration pathway was previously addressed as part of the VE VCM (SNL/NM May 2000) and briefly discussed in Section 1.2.1. In addition, this migration pathway is addressed in the scope of this risk screening assessment (Annex A, Section VI.3) through modeling that was approved by the NMED as part of the CWL Risk-Based Approach (SNL/NM August 2000). Essentially, no uptake into the food chain is expected at this site due to the highly disturbed nature of the habitat. The potential for future uptake by biota is low because the excavation will be covered by 10 feet of clean fill. For inorganic COCs, the potential for degradation is low. Decay of radiological COCs is insignificant due to long half lives (except for tritium). Degradation and/or biotransformation of some organic COCs, however, may be more significant as a mechanism of loss.

6.4 Human Health Risk Screening Assessment

The human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents present in the site soils.

6.4.1 Screening Procedures

The results of the background and Subpart S screening procedures are presented in the following subsections.

6.4.1.1 Background Screening Procedure

Maximum COC concentrations were compared to the SNL/NM maximum background values (Dinwiddie September 1997 and Tharp February 1999) for the CWL human health risk screening assessment. For the nonradiological COCs, 12 constituents were measured at concentrations greater than background screening values. Seventy-seven constituents were organic compounds that do not have background screening values.

The maximum concentration value for lead was 192 mg/kg. The EPA intentionally does not provide human health toxicological data on lead; therefore, no risk parameter values could be calculated. However, the NMED guidance for lead screening concentrations for construction and industrial land use scenarios are 750 and 1,500 mg/kg, respectively (Olson and Moats March 2000). The EPA screening guidance value for a residential land use scenario is 400 mg/kg (Laws July 1994). The maximum concentration value for lead at this site was less than all the screening values; therefore, lead is eliminated from further consideration in the human health risk assessment.

The maximum concentration for total PCBs was 11.45 J mg/kg. A graded approach was applied in determining the PCB screening level and included several factors such as the low occupancy rate of the area, varied potential for exposure routes, the requirement for placement of an engineered cover, and post-closure administrative controls. Based upon this graded approach, if soil contains PCBs at concentrations less than 25,000 µg/kg (25 ppm), no TSCA controls would be required (SNL/NM October 2001a, b). The maximum concentration for total PCBs at this site is less than this screening value; therefore, total PCBs are eliminated from further consideration in the human health risk assessment.

For the radiological COCs, six constituents (tritium, cobalt-60, cesium-137, uranium-235, uranium-238, and thorium-232) exhibited activity concentrations greater than background screening values.

6.4.1.2 Subpart S Screening Procedure

Because there were more than 10 constituents that did not pass the background screening procedure, the Subpart S screening procedure was not performed. Therefore, all nonradiological COCs that were not eliminated during the background screening process for the CWL were carried forward in the risk assessment process. The constituents that drove the human health risk were identified and an individual hazard quotient (HQ) and excess cancer risk value were calculated for each COC classified as a risk driver.

Because radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, this step in the screening process was not performed for radiological COCs.

6.4.2 Pathway Identification

The CWL has been designated with a future land use scenario of industrial (DOE et al. September 1995). Because of the location and characteristics of the potential contaminants, the primary pathway for human exposure, when ignoring the backfill between the contaminant source and the receptor, is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both the nonradiological and radiological COCs is also included because the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well.

When the backfill and ensuing institutional controls are considered, the potential for exposure from the soil ingestion pathway is eliminated. The inhalation pathway becomes the primary pathway for human exposure.

No water pathways to the groundwater are considered. Depth to groundwater at the CWL is approximately 485 feet bgs. VLEACH v. 2.2a (Ravi and Johnson 1997), a one-dimensional model that simulates water and chemical movement in the vadose zone, was used to estimate possible groundwater impact as part of developing the risk-based approach for the CWL (SNL/NM August 2000). TCE was selected as the modeled compound as it has been identified as the primary VOC of concern for migration to groundwater. Two TCE sources at the CWL were included in the model. The TCE sources include an existing, moderately deep subsurface soil vapor plume (SNL October 1995) and TCE-containing soil in a potential near-surface

backfilled layer. The modeling showed that the total concentration of TCE in the backfill material would have to be 4,176 mg/kg in order for the groundwater concentration to equal 5 ppb (0.005 mg/L). The maximum concentration of TCE was 0.00206 J mg/kg in the residual CWL soil. Thus, the maximum concentration found in residual soils located with the landfill is six orders of magnitude less than the predicted concentration required to exceed 5 ppb, which is the EPA maximum contaminant level for drinking water. Based upon these modeling results, the groundwater pathway is not included in the calculation of risk in this analysis.

Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is not considered significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land use scenario. However, plant uptake is considered for the residential land use scenario.

6.4.3 Identification of Toxicological Parameters

The toxicological values used for calculation of risk associated with the nonradiological COCs were obtained from the Integrated Risk Information System (IRIS) (EPA 1998a), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), and the EPA Region 9 (EPA 1996) and EPA Region 3 (EPA 1997b) electronic databases. Dose conversion factors used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993).

6.4.4 Exposure Assessment and Risk Characterization

6.4.5 Exposure Assessment

Appendix 1 of Annex A provides the equations and parameter input values used to calculate intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land use scenarios. The equations for nonradiological COCs are based upon the Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989), as well as other EPA guidance documents, and reflect the RME approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in the RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD* (Yu et al. 1993).

Although the designated land use scenario for this site is industrial, risk and TEDE values for a residential land use scenario were also evaluated to provide perspective of potential risk to human health under the more restrictive land use scenario.

6.4.6 Risk Characterization

An HI of 2 for the CWL nonradiological COCs and an estimated excess cancer risk of 7E-5 was calculated for the designated industrial land use scenario. The numbers presented include exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs, and do

not take into account the backfill materials. An HI of 0.01 and an estimated excess cancer risk of 2E-6 was calculated for the maximum background screening levels for the designated industrial land use scenario.

It should be noted that maximum dioxin and furan concentrations were converted via a toxicity equivalency factor to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and then summed (Van den Berg et al. 1998). The risk from all dioxins and furans was then calculated from this sum in terms of 2,3,7,8-TCDD. For comparison, it was determined that the SNL/NM calculated excess cancer risk for 2,3,7,8-TCDD is 2.8 times more conservative than the EPA Region 6 calculated excess cancer risk for the same concentration (EPA 2002).

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land use scenario, a TEDE was calculated for an industrial worker who works equal time indoors and outdoors on the site. This resulted in an incremental TEDE of 3.9 mrem/year. In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/year is used for the probable land use scenario (industrial in this case); the calculated dose value for the CWL for industrial land use is well below this guideline. The estimated excess cancer risk is 5.7E-5.

For the residential land use scenario nonradioactive COCs, the HI is 432 and the estimated excess cancer risk is 9E-4. The numbers in the table included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (EPA 1991) generally recommends that inhalation not be included in a residential land use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1 of Annex A). For the CWL associated background constituents, the HI is 1 and the estimated excess cancer risk is 5E-5.

For the radiological COCs, the incremental TEDE for the residential land use scenario is 11.7 mrem/year. The guideline being used is an excess TEDE of 75 mrem/year (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for the CWL for the residential land use scenario is well below this guideline. Consequently, the site is eligible for unrestricted radiological release as the residential land use scenario resulted in an incremental TEDE of less than 75 mrem/year to the on-site receptor. The estimated excess cancer risk is 1.5E-4. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the RAGS (EPA 1989).

6.4.7 Comparison of Risk Values to Numerical Guidelines

The human health risk assessment analysis evaluated the potential for adverse health effects for both the industrial land use scenario (the designated land use scenario for this site) and the residential land use scenario.

For the industrial land use scenario nonradiological COCs, the HI is 2 (above the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at 7E-5. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is above the suggested

acceptable risk value. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and the residential land use scenarios. Assuming the industrial land use scenario, for nonradiological COCs the HI is 0.01 and the excess cancer risk was 2E-6. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituents that do not have quantified background concentrations are assumed to have a HQ of 0.00. Incremental HI is 2.47 and the estimated incremental cancer risk is 7.13E-5 for the industrial land use scenario. These incremental risk calculations indicate potential risk to human health from nonradiological COCs considering an industrial land use scenario.

The HI and estimated excess cancer risk are above the NMED guideline when maximum concentrations were used in the risk calculation. Since the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the 95% UCL of the mean concentrations for the main contributors to excess cancer risk including arsenic (7.5 mg/kg), chromium (98 mg/kg), mercury (11.1 mg/kg), aniline (0.04 mg/kg), and 1,2,3-trichloropropane (0.003 mg/kg), the total and incremental HI is reduced to 0.25 and 0.24, respectively. The total and incremental estimated excess cancer risk is reduced to 8E-6 and 5.76E-6, respectively. Thus, using more realistic concentrations in the risk calculations that more accurately depict actual site conditions, the HI and estimated excess cancer risk are below NMED guidelines. This approach using 95% UCLs of the mean for compounds with the greatest impact on calculated risk is consistent with the SNL/NM ER Project risk screening guidance. This approach has been applied at numerous other ER Project sites that were approved by the NMED for NFA.

For radiological COCs of the industrial land use scenario, incremental TEDE is 3.9 mrem/year, which is significantly less than EPA's numerical guideline of 15 mrem/year. Incremental estimated excess cancer risk is 5.7E-5.

The calculated HI for the residential land use scenario nonradiological COCs is 432, which is above the numerical guidance. The excess cancer risk was estimated to be 9E-4. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is above the suggested acceptable risk value. The HI for associated background for the residential land use scenario is 1; the estimated excess cancer risk is 5E-5. The incremental HI is 431.34 and the estimated incremental cancer risk is 8.93E-4 for the residential land use scenario. Both the incremental HI and excess cancer risk calculations are above NMED guidelines considering a residential land use scenario.

The incremental TEDE for a residential land use scenario from the radiological components is 11.7 mrem/year, which is significantly less than the numerical guideline of 75 mrem/year suggested in the SNL/NM "RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The estimated excess cancer risk is 1.5E-4.

It should be noted that all radiological COCs will also be covered with 10 feet of clean backfill. However, this backfill was not included in the risk modeling with the RESRAD code in order to achieve conservative results.

6.4.8 Identification of Nonradiological Risk Drivers

The HQs and estimated excess cancer risk for the individual CWL COCs were calculated from the maximum reported concentrations. It should be noted that both ingestion and inhalation pathways were considered valid for this risk driver determination. COCs were classified as risk drivers when either the HI exceeded 0.2 or the excess cancer risk exceeded 1E-6. These risk drivers are modeled in Section VI.9 of Annex A as to what level of exposure a potential receptor might receive taking into account the clean backfill between the source area and the receptor. Risk drivers identified by an HQ of greater than 0.2 included arsenic (0.24), chromium (0.47), mercury (0.77), and aniline (0.94). Risk drivers identified by an excess cancer risk of greater than 1E-6 included arsenic (4E-5), and 1,2,3-trichloropropane (3E-5).

6.4.9 Risk Driver Modeling

The risk drivers identified were carried forward in a modeling effort. The CWL will be backfilled at least to grade. Most risk drivers will be located beneath 10 feet of clean fill. To provide a realistic estimation of risk to a receptor standing on top of the landfill, a model was developed to simulate vapor flow contaminant transport through the clean fill. Therefore, the only pathway of concern is COC volatilization into outdoor air (i.e., hydrocarbon chemicals in the soil that may be inhaled). Risks were evaluated using an NFA scenario that assumes no additional remedial action will be performed at the site. There are numerous models of vapor flow transport of VOCs from both soil and groundwater releases. One such model is Risk-Based Corrective Action (RBCA) (Connor, et al. 2000). For the Tier 2 evaluation, the RBCA input values were modified to more closely represent the conditions and land use at the CWL.

None of the four risk-driver noncarcinogenic COCs were volatile. In addition, none of these COCs exceed an HQ of 1.0 assuming direct contact with the contaminated soil. Therefore, the addition of the clean fill will completely eliminate potential exposure pathways and associated risk (i.e., HI is 0.00). One of the carcinogenic COCs, 1,2,3-trichloropropane, has the potential to volatilize to the surface through the cap. However, the resulting cancer risk is significantly below 1E-5. Based upon the results of the Tier 2 RBCA, none of the COCs exceed the risk screening levels. Therefore, the volatilization to outdoor air of the COCs in the subsurface soil does not pose a significant risk to human health.

6.4.10 Comparison of Risk Values to Numerical Guidelines

The human health risk assessment analysis evaluated the potential for adverse health effects for both the industrial land use scenario (the designated land use scenario for this site) and the residential land use scenario.

For the industrial land use scenario, the HI for nonradiological COCs is 0.00 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at 3.1E-8. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is below the suggested acceptable risk value.

For the residential land use scenario, the calculated HI for nonradiological COCs is 0.00, which is below the numerical guidance. Excess cancer risk is estimated at 5.2E-8. NMED guidance

states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is below the suggested acceptable risk value.

6.4.11 Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at the CWL was based upon an initial conceptual model that was validated with complete excavation and final verification sampling conducted across the site. The LE VCM and verification sampling were implemented in accordance with the LE VCM SAP (SNL/NM November 1998a) and subsequent ICNs #1 (SNL/NM March 1999a), #2 (SNL/NM December 2000), #3 (SNL/NM July 2001b), and #4 (SNL/NM December 2001). The DQOs contained in the SAP and ICNs are appropriate and were developed for use in the final risk screening assessment. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. The analytical data quality was verified/validated in accordance with SNL/NM procedures (SNL/NM January 2000). Therefore, there is no uncertainty associated with the data quality used to perform the final risk screening assessment at the CWL.

Because of the location, history of the site, and future land use (DOE et al. September 1995), there is low uncertainty in both the land use scenario and potentially affected populations that were considered in performing the risk assessment analysis. Because the COCs are found in surface and near-surface soil (within 30 feet bgs), and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that the parameter values in the calculations are conservative and that calculated intakes are probably overestimated. Maximum values of COC concentrations measured in soil samples are used to provide conservative results.

Table 9 in Annex A shows the uncertainties (confidence level) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998a), HEAST (EPA 1997a), the EPA Region 3 (EPA 1997b), and EPA Region 9 (EPA 1996) electronic databases. Where values are not provided, information is not available from these sources. Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusions of the risk assessment analysis.

In the analysis of the landfill without backfill, the HI and estimated excess cancer risk were initially above NMED guidelines when maximum concentrations were used in the risk calculation. Since the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the 95% UCL of the mean concentrations for the main contributors to excess cancer risk including arsenic (7.5 mg/kg), chromium (98 mg/kg), mercury (11.1 mg/kg), aniline (0.04 mg/kg), and 1,2,3-trichloropropane (0.003 mg/kg), the total and incremental HI is reduced to below NMED guidelines. This stepped approach is consistent with the SNL/NM ER Project risk screening guidance and has been applied at numerous other ER Project sites that have been approved for NFA by the NMED.

This risk screening assessment also determined risk drivers by assuming that direct contact would occur using maximum COC concentrations. The risk drivers were then modeled under

more site-specific conditions taking into account backfill that will be placed in between the COC source and the receptor.

Risk assessment values calculated from the modeling effort for nonradiological COCs are within acceptable ranges for both the industrial and residential land use scenarios compared to established numerical guidance for human health.

For radiological COCs, the conclusion of the risk assessment is that potential effects on human health for both the industrial and residential land use scenarios represent only a small fraction of the estimated 360 mrem/year received by the average United States population (NCRP 1987). It should be noted that all radiological COCs will be covered with 10 feet of clean backfill. However, this backfill was not included in the risk modeling with the RESRAD code in order to achieve conservative results.

The overall uncertainty in all of the steps in the risk assessment process is not considered to be significant with respect to the conclusion reached.

6.4.12 Summary

The CWL contains identified COCs consisting of some inorganic, organic and radiological constituents. Because of the location of the site, the designated industrial land use scenario, and the nature of contamination, potential exposure pathways identified for this site included volatile inhalation.

The HI and estimated excess cancer risk were initially above NMED guidelines when maximum concentrations were used in the risk calculation. Since the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the 95% UCL of the mean concentrations for the main contributors to excess cancer risk including arsenic (7.5 mg/kg), chromium (98 mg/kg), mercury (11.1 mg/kg), aniline (0.04 mg/kg), and 1,2,3-trichloropropane (0.003 mg/kg), the total and incremental HI is reduced to below NMED guidelines.

This risk screening assessment also determined risk drivers by assuming that direct contact would occur using maximum COC concentrations. The risk drivers were then modeled under more site-specific conditions taking into account backfill that will be placed in between the COC source and the receptor.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs from the modeling show that for the industrial land use scenario, the HI (0.00) is significantly lower than the accepted numerical guidance from EPA. Excess cancer risk (3.1E-8) is also below the acceptable risk value provided by NMED for an industrial land use scenario (Bearzi January 2001).

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 3.9 mrem/year for the industrial land use scenario. This value is much less than the numerical guidance of 15 mrem/year in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value is 5.7E-5 for the industrial land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is only 11.7 mrem/year with

an associated risk of 1.5E-4. The guideline for this scenario is 75 mrem/year (SNL/NM February 1998). Therefore, the site is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservatism of the risk assessment analysis. Therefore, it is concluded that this site poses insignificant risk to human health under both the industrial and residential land use scenarios.

6.5 Ecological Risk Screening Assessment

6.5.1 Introduction

A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological screening assessment that corresponds with that presented in EPA's Ecological RAGS (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (EPA 1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

6.5.2 Background Screening Procedures

Maximum COC concentrations were compared to the SNL/NM maximum background values (Dinwiddie September 1997) for the CWL ecological risk screening assessment. For the nonradiological COCs, 10 constituents were measured at concentrations greater than or did not have quantified background screening values. Thirty-three constituents were organic compounds and therefore do not have background screening values.

For the radiological COCs, four constituents (tritium, uranium-235, uranium-238, and thorium-232) exhibited activity concentrations greater than background screening values.

The maximum concentration for total PCBs was 0.94 mg/kg. A graded approach was applied in determining the PCB screening level and included several factors such as the low occupancy rate of the area, varied potential for exposure routes, the requirement for placement of an engineered cover, and post-closure administrative controls. Based upon this graded approach, if soil contains PCBs at concentrations less than 25 ppm, no Toxic Substance Control Act controls would be required (SNL/NM October 2001a, b). Based upon the requirements of the risk-based approach for the CWL (SNL/NM August 2000), total PCBs for soil from 0 to 5 feet depth must be less than 1 mg/kg. The maximum concentration for total PCBs from a depth of 0 to 5 feet is less than both screening values. Therefore, total PCBs were eliminated from further consideration in the ecological risk assessment.

6.5.3 Fate and Transport Potential

Wind is expected to be a potential transport mechanism for contaminants of potential ecological concern (COPECs) at this site until the time when it is covered with the clean soil layer.

Surface-water runoff is controlled by a surrounding swale and is, therefore, not a potential transport mechanism. Migration to groundwater is not anticipated. Because of the disturbed nature of the site, food chain uptake is not a viable transport mechanism. Degradation (decay) and transformation for the inorganic COPECs and radionuclides is expected to be of low significance, but may be of moderate significance for some of the organic COPECs.

6.5.4 Ecological Pathways and Setting

The CWL is approximately 1.9 acres in size. The site is located in an area dominated by grassland habitat; however, because of the excavation and backfilling of the site, no natural habitat remains within this area. Upon completion of the backfilling, the clean soil layer will be revegetated. Use of the site by wildlife is limited by the surrounding fence (the site will be fenced as part of final closure) and by the lack of habitat. No threatened, endangered, or other sensitive species occur within this site.

Although unlikely because of habitat disturbance, complete ecological pathways were assumed to exist at this site through the exposure of plants and wildlife to COPECs in the backfill soil. It was assumed that direct uptake of COPECs from this soil would be the major route of exposure for plants. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways and external radiation. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion.

6.5.5 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with the site. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent a top predator at this site. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

6.5.6 Exposure Estimation

For nonradiological COPECs, direct uptake from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as

deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake.

Exposures for this risk assessment were modeled using an area use factor of 1.0, implying that all food items and soil ingested come from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose-rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from tritium, thorium-232, uranium-235, and uranium-238. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from DOE (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998). Radionuclide-dependent data for the dose-rate calculations were obtained from Baker and Soldat (1992). The external dose-rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose-rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose-rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides transfer only a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose-rate results are summed to calculate a total dose rate from exposure to tritium, thorium-232, uranium-235, and uranium-238 in soil.

6.5.7 Ecological Effects Evaluation

For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Sufficient toxicity information was not available to estimate the LOAELs or NOAELs for some COPECs.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also protect other groups within the terrestrial habitat of the site.

6.5.8 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. HQs are used to quantify the comparison with benchmarks for plant and wildlife exposure.

HQs for plants exceed unity for total chromium, chromium (VI), lead, mercury, and selenium. Because of a lack of sufficient toxicity information, HQs for plants could not be determined for 17 of the 32 organic COPECs. HQs exceed unity for all three dietary regimes in the deer mouse for selenium and for mercury when it is assumed to be entirely in organic form. HQs exceed unity for the omnivorous and insectivorous deer mice for arsenic and barium. Because of a lack of sufficient toxicity information, HQs for the deer mice could not be determined for dibenzofuran. For the burrowing owl, the only HQs that exceed unity are for bis(2-ethylhexyl)-phthalate and for mercury when it is assumed to be entirely in organic form. HQs for beryllium, chromium (VI), silver, and all organic COPECs, except bis(2-ethylhexyl) phthalate and di-n-butyl-phthalate, could not be determined for the burrowing owl because of a lack of sufficient toxicity information. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). Total HIs for all receptors are greater than unity, with a maximum HI of 82 for plants.

The total radiation dose rate to the deer mouse was predicted to be 7.4E-4 rad/day and that for the burrowing owl was 7.2E-4 rad/day. The dose rates for the deer mouse and the burrowing owl are less than the benchmark of 0.1 rad/day.

6.5.9 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at the CWL, resulting from assumptions used in calculating risk that could overestimate or underestimate true risk presented at the site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of maximum analyte concentrations measured in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the assumption of an area use factor of 1.0, and the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse. Each of these uncertainties is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors from exposure to tritium, thorium-232, uranium-235, and uranium-238 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors. The dose-rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's internal and external exposure to radionuclides in soil.

Predicted ecological HQs based upon exposures to metals at the corresponding background screening levels were calculated and exceed 1.0 for some metals. These include the HQs for the omnivorous and insectivorous deer mice from background exposures to arsenic and barium,

the HQ for plants from background exposures to chromium, and the HQ for the burrowing owl from background exposure to mercury when it is assumed to be in organic form. These results demonstrate the conservative nature of the HQs in predicting potential risk to these receptors. The HQs for inorganic and organic mercury represent the extremes of potential toxicity of this element based upon its form in the environment. Although the form of mercury in soil is continuously in flux, organic mercury is typically a minor component of the total. Incorporation of mercury into organic complexes (methylation) is typically associated with biological activity. At the CWL, the potential for significant methylation of mercury is expected to be low due to the low biological activity in the soil of this arid environment. Therefore, the risk to the deer mouse from mercury exposure is expected to be negligible, as indicated by the HQs for the inorganic form of this element.

The use of the maximum concentrations as the basis for estimating exposure results in conservative HQ values. For the evaluation of ecological risk, mean concentrations, as conservatively estimated by the 95% UCL of the mean, provide a more realistic quantification of actual risk. Of the metals that resulted in HQs greater than unity for one or more of the ecological receptors, the 95% UCL concentrations resulted in values less than the corresponding background screening levels. The HQ for barium, as based upon the 95% UCL concentration (169 mg/kg), is below the background screening level. Similarly, the 95% UCL concentrations of arsenic and total chromium (4.79 and 18.4 mg/kg, respectively) only marginally exceed the background screening levels of 4.4 and 15.9 mg/kg, respectively. Therefore, the potential risk to ecological receptors from exposures to arsenic and total chromium, based upon the 95% UCL concentrations of these COPECs, is only marginally higher than that from background exposure, and for this reason is considered negligible.

For chromium (VI), exposure of plants to the 95% UCL concentration (1.72 mg/kg) results in an HQ of 1.7. In the case of lead, exposure of plants to the 95% UCL concentration (46.5 mg/kg) reduces the HQ to 0.93. Similarly, exposures of deer mice to the 95% UCL concentration of selenium (1.92 mg/kg) reduce all HQs to values less than 1 (HQs of 0.40, 0.59, and 0.78 for the herbivorous, omnivorous, and insectivorous deer mouse, respectively). In plants, exposure at this level of selenium results in an HQ of 1.9. For mercury, the HQ for plants is reduced to 1.8 when exposure is based upon the 95% UCL concentration (0.54 mg/kg). Under the conservative assumption that all mercury at the CWL is in organic form, the HQs for the deer mouse and the burrowing owl are reduced to 1.4 and 7.7, respectively, when based upon exposure to the 95% UCL of the mean concentration. Finally, when burrowing owl exposure to bis(2-ethylhexyl) phthalate is based upon the 95% UCL of this compound (0.24 mg/kg), the HQ is reduced to 1.6. Therefore, when based upon the 95% UCL concentrations, all HQs for the COPECs at the CWL are reduced to values less than 2 with the single exception of exposure to organic mercury in the burrowing owl. These levels of potential risk are considered low and unlikely to have significant ecological impact.

The two HQs that are greater than unity for the burrowing owl (bis[2-ethylhexyl] phthalate and organic mercury) are based upon the assumption that all prey eaten by the owl comes from the area of contamination. Because the home range of the burrowing owl is expected to be greater than 35 acres and the area of the CWL is 1.9 acres, it is expected that no more than 5 percent of the owl's prey would come from the area of potential exposure to COPECs. Adjusting the quantity of prey taken from the site to 5 percent of the total prey eaten by the owl reduces the HQ value for bis(2-ethylhexyl) phthalate to approximately 0.27 and that for organic mercury to 1.6 (based upon the maximum concentrations of both constituents). In the latter case, if the exposure is based upon the 95% UCL of the mean concentration of mercury, the HQ is reduced to 0.39. Therefore, the risk to the burrowing owl is within NMED guidelines when more realistic

assumptions of area use and exposure concentration are used in the calculation of HQs for bis(2-ethylhexyl) phthalate and mercury, regardless of the form in which mercury occurs at the site.

Based upon this uncertainty analysis, the potential for ecological risk at the CWL is generally low. Although conservatively estimated exposures of ecological receptors to COPECs resulted in some HQs of greater than 1.0, the incorporation of more realistic assumptions into the estimation of ecological risk for the CWL backfill soil results in predictions of potential risk that are low and within acceptable ranges.

6.5.10 Risk Interpretation

Ecological risks associated with the CWL were estimated through a screening assessment that incorporated site-specific information when available. Overall, risks to ecological receptors are expected to be low because predicted risks associated with exposure to COPECs are based upon calculations using maximum detected values. The 95% UCL concentrations of arsenic, barium, and total chromium were found to be within background ranges. The application of more realistic assumptions of mean concentration (as estimated by the 95% UCL of the mean) and limited site use by the burrowing owl resulted in all HQs being less than or equal to unity with only two exceptions. The HQs for plant exposure to chromium (VI) and selenium at the 95% UCL concentrations resulted in HQs of 1.2 and 1.7, respectively. It is likely, however, that these HQs overestimate actual risk because the plant toxicity benchmarks are based upon exposure to more highly available forms of these metals than those that are likely to occur at the site. Further, no vegetation currently exists at the site. Revegetation of the final covering of clean soil will limit the potential for future exposure of plants to these COPECs. Based upon this final analysis, ecological risks associated with the CWL are expected to be low.

6.5.11 Screening Assessment Scientific/Management Decision Point

After potential ecological risks associated with the site have been assessed, a decision is made regarding whether adequate data exists to support the conclusions of the risk assessment or whether additional data should be collected to assess actual ecological risk at the site more thoroughly. With respect to the CWL, it is concluded that adequate data exist to support a final decision that the potential for ecological risks associated with this site is low.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The results of the excavation, final verification soil sampling, and final risk screening assessment presented in this report demonstrate that the LE VCM has achieved the objective of complete removal of all waste from the former disposal areas at the CWL. Furthermore, the risk screening assessment documents that the NMED-approved risk-based criteria for excavation completion and backfilling (SNL/NM August 2000) have been met.

7.2 Recommendations

NMED approval of the LE VCM final risk screening assessment is recommended. Submittal of the final risk screening assessment and final verification analytical results in this report completes SNL/NM's response to the NMED's "Approval with Conditions: Class 1 Modification: Backfill and Compaction Plan, Addendum C to Appendix S, Chemical Waste Landfill Closure Plan, April 2002" (Bearzi June 2002). The final risk screening assessment is provided in Annex A and is discussed in Chapter 6.0. The final verification analytical results are provided in Volume 2 and are discussed in Chapter 5.0.

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