Mr. Michael J. Zamorski, Acting Area Manager
Department of Energy
Albuquerque Operations Office
Kirtland Area Office
Albuquerque, New Mexico 87115

RE: Transmittal of the Approved Class 3 Permit Modification for the Corrective Action Management Unit at Sandia National Laboratories, EPA ID No. NM5890110518

Dear Mr. Zamorski:

Enclosed is a copy of your permit modification to operate a hazardous waste Corrective Action Management Unit, pursuant to the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA). Also enclosed is a copy of the final HSWA permit.

Please note that EPA received no objectional comments during the public comment period and made no changes to the modified permit (except 1 misspelled word). The effective date of this modification is the same as the issuance date.

If you have any questions, please contact Mr. David Neleigh at (214) 665-7442.

Sincerely yours,

Allyn M. Davis
Director
Multimedia Planning and Permitting Division

Enclosure

cc: Mr. Benito Garcia, NMED
AUTHORIZATION TO OPERATE UNDER THE
RESOURCE CONSERVATION AND RECOVERY ACT

In compliance with the Resource Conservation and Recovery Act (RCRA), as amended,

Sandia National Laboratories
Within the Boundaries of Kirtland AFB
DOE Technical Area No.3
Albuquerque, New Mexico 87115

is authorized to operate a Corrective Action Management Unit for the disposal of hazardous waste in accordance with the limitations, requirements, and other conditions set forth herein at a facility located in Bernalillo County, Albuquerque, New Mexico (North Latitude 35°02'30", West Longitude 106°32'30").

This permit modification is issued by the Environmental Protection Agency (EPA) pursuant to the Hazardous and Solid Waste Amendments of 1984 (HSWA), amending RCRA.

This permit is based on the assumption that all information contained in the permit application is accurate and that the facility will be constructed and operated as specified in the permit application. The permit application consists of the following submitted information regarding this facility: Sandia's Class III Permit Application for the CAMU dated June 1996; Revision 1.0 of the CAMU Application dated February 1997; Revision 2.0 of the CAMU Application dated July 1997; and the final CAMU Application dated September 1997. The permit may be modified, revoked and reissued, or terminated for cause, which includes failing to fully disclose all relevant facts in the application or during permit issuance, or misrepresentation of any relevant facts at any time. (See 40 CFR 270.41, 270.42, and 270.43).

The permit provision issued under the above cited Federal authority shall be effective on September 25, 1997 and shall expire at midnight on September 20, 2002.

Issued this 25th day of September, 1997.

by
Allyn M. Davis
Director
Multimedia Planning and Permitting Division
CLASS III PERMIT MODIFICATION REQUEST FOR THE MANAGEMENT OF HAZARDOUS REMEDIATION WASTE IN THE CORRECTIVE ACTION MANAGEMENT UNIT TECHNICAL AREA III SANDIA NATIONAL LABORATORIES/NEW MEXICO ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
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<td>Description</td>
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<td>----------------------</td>
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<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<tr>
<td>CAMU</td>
<td>Corrective action management unit</td>
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<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>CMTU</td>
<td>CAMU mobile treatment unit</td>
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<td>COLIWASA</td>
<td>Composite liquid waste sampler</td>
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<td>DOE</td>
<td>U.S. Department of Energy</td>
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<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<td>ER</td>
<td>Environmental Restoration</td>
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<tr>
<td>GCL</td>
<td>Geosynthetic clay layer</td>
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<td>HDPE</td>
<td>High-density polyethylene</td>
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<tr>
<td>KAFB</td>
<td>Kirtland Air Force Base</td>
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<td>LCRS</td>
<td>Leachate collection and removal system</td>
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<td>LDR</td>
<td>Land disposal restrictions</td>
</tr>
<tr>
<td>NA</td>
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<td>NMED</td>
<td>New Mexico Environment Department</td>
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<td>PCB</td>
<td>Polychlorinated biphenyls</td>
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<td>PPE</td>
<td>Personal protective equipment</td>
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<td>PVC</td>
<td>Polyvinyl chloride</td>
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<td>QA</td>
<td>Quality assurance</td>
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<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<td>RMWMF</td>
<td>Radioactive and Mixed Waste Management Facility</td>
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<td>SNL/NM</td>
<td>Sandia National Laboratories/New Mexico</td>
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<td>TA</td>
<td>Technical Area</td>
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<td>TSCA</td>
<td>Toxic Substances Control Act</td>
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<td>TSDF</td>
<td>Treatment, storage, and disposal facility</td>
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<td>USFS</td>
<td>U.S. Forest Service</td>
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<td>VZMS</td>
<td>Vadose zone monitoring system</td>
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Table 1
Regulatory Cross-Reference Table
Corrective Action Management Unit
Class III Permit Modification Request

Final

NOTE: The following table provides a list of regulatory citations for which information is to be provided, as applicable, for a Class III permit modification as required by Title 40 of the Code of Federal Regulations (40 CFR) Section (§) 270.42(c)(1)(iv). In addition, the table includes regulatory citations for corrective action management units (40 CFR §264.552), including the seven decision criteria to be considered for establishing corrective action management unit standards (40 CFR §264.552[c]). The table also identifies location(s) where information requirements are addressed. Unless otherwise noted, locations refer to this document.

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<td>264.552(a)</td>
<td>NA</td>
<td>This section calls for Regional Administrator Action.</td>
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<td>NA</td>
<td>No specific action required.</td>
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<td>264.552(a)(2)</td>
<td>NA</td>
<td>SNL/NM is not requesting that a regulated unit be designated as a CAMU nor will a regulated unit be incorporated in the CAMU designation.</td>
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<td>264.552(c)</td>
<td>NA</td>
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<td>Purpose; Waste Staging Operations; Waste Management Operations; Potential for Exposure to Humans and Environmental Receptors</td>
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<td>1.0, 2.2</td>
<td>Purpose; Containment Cell</td>
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<td>Purpose; Treatment Area</td>
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<td>264.552(c)(5)</td>
<td>1.0</td>
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<td>Purpose</td>
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<td>264.552(c)(7)</td>
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<td>Purpose</td>
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<td>264.552(d)</td>
<td>All</td>
<td>Requirement to provide sufficient information to enable the Regional Administrator to designate a CAMU.</td>
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<td>NA</td>
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<tr>
<td>264.552(f)</td>
<td>NA</td>
<td>This section calls for Regional Administrator action.</td>
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<td>264.552(g)</td>
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<td>NA No specific action required.</td>
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**Class III Permit Modification Request**

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<td>NA</td>
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<td>Releases to the Atmosphere</td>
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<td>3.7</td>
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<td>270.14(b)(10)</td>
<td>2.1.3</td>
<td>Traffic Patterns</td>
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<td>270.14(b)(11)</td>
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<td>Seismic Considerations</td>
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<td>Floodplain</td>
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<td>3.8</td>
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<td>264.16</td>
<td>3.8</td>
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<td>264, Subpart E</td>
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<td>Recordkeeping and Reporting</td>
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<td>270.14(b)(13)</td>
<td>3.9</td>
<td>Closure Plan</td>
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<td>264, Subpart G</td>
<td>3.9</td>
<td>Closure Plan for the CAMU</td>
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<td>270.14(b)(14)</td>
<td>NA</td>
<td>The CAMU is not a closed hazardous waste disposal unit.</td>
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<td>270.14(b)(15)</td>
<td>NA</td>
<td>Federal facilities are exempt from financial assurance requirements.</td>
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<td>270.14(b)(16)</td>
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<td>270.14(b)(17)</td>
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<td>270.14(b)(18)</td>
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**Final**

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<th>40 CFR Citation</th>
<th>Location of Information</th>
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<tr>
<td>270.14(b)(19)(i)</td>
<td>Topographic Map</td>
</tr>
<tr>
<td>270.14(b)(19)(ii)</td>
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<td>270.14(b)(19)(iii)</td>
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<td>270.14(b)(19)(iv)</td>
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<td>270.14(b)(20)</td>
<td>NA</td>
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<tr>
<td>270.3</td>
<td>SNL/NM complies with all applicable requirements of the Wild and Scenic Rivers Act, the National Historic Preservation Act of 1966, the Endangered Species Act, the Coastal Zone Management Act, and the Fish and Wildlife Coordination Act.</td>
</tr>
<tr>
<td>270.14(b)(21)</td>
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<tr>
<td>270.14(c)</td>
<td>Potential for Exposure to Humans and Environmental Receptors</td>
</tr>
<tr>
<td>264.90</td>
<td>Requirements for Groundwater Monitoring</td>
</tr>
<tr>
<td>264.101</td>
<td>Proposed Alternative to Groundwater Monitoring for the CAMU</td>
</tr>
<tr>
<td>264.552(e)(3)</td>
<td>&quot;</td>
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<tr>
<td>and Appendix E</td>
<td>&quot;</td>
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<tr>
<td>270.14(d)</td>
<td>Description of ER Site 107 and Its Qualifications for CAMU Designation</td>
</tr>
<tr>
<td>270.15(a) and (b)</td>
<td>Container Management</td>
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<tr>
<td>264, Subpart I</td>
<td>&quot;</td>
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<td>264.35</td>
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<td>270.15(a)(1)</td>
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<td>Container Management</td>
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<td>270.15(c)</td>
<td>Prevention of Reaction of Ignitable, Reactive, and Incompatible Waste</td>
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<tr>
<td>270.15(d)</td>
<td>Prevention of Reaction of Ignitable, Reactive, and Incompatible Waste</td>
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### Table 1 (Continued)

**Regulatory Cross-Reference Table**

**Corrective Action Management Unit**

**Class III Permit Modification Request**

#### Final

<table>
<thead>
<tr>
<th>40 CFR Citation</th>
<th>Location of Information</th>
<th>Section</th>
<th>Title</th>
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<tr>
<td>270.15(e)</td>
<td>Subpart CC is not applicable to waste management units used solely for the on-site treatment or storage of hazardous waste generated as the result of implementing remedial activities required under corrective action authorities of the RCRA 3004(u), 3004(v), or 3008(h).</td>
<td>NA</td>
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<td>270.27</td>
<td></td>
<td>NA</td>
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<tr>
<td>270.16</td>
<td>Tanks associated with the CAMU will be &lt;90 day storage tanks and will be managed in accordance with 40 CFR §262.34(a).</td>
<td>NA</td>
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<tr>
<td>270.17</td>
<td>A surface impoundment will not be managed within the CAMU.</td>
<td>NA</td>
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<tr>
<td>270.18</td>
<td>A waste pile will not be managed within the CAMU.</td>
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<td>270.19</td>
<td>An incinerator will not be managed within the CAMU.</td>
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<tr>
<td>270.20</td>
<td>A land treatment facility will not be managed within the CAMU.</td>
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</tr>
<tr>
<td>270.21</td>
<td>A landfill will not be managed within the CAMU.</td>
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</tr>
<tr>
<td>270.22</td>
<td>A boiler or industrial furnace will not be managed within the CAMU.</td>
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</tr>
<tr>
<td>270.62</td>
<td>An incinerator will not be managed within the CAMU.</td>
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<td>270.63</td>
<td>A land treatment demonstration will not be performed within the CAMU.</td>
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</tr>
<tr>
<td>270.66</td>
<td>A boiler or industrial furnace will not be managed within the CAMU.</td>
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<td></td>
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</tbody>
</table>

**Abbreviations**

- **CAMU**: Corrective action management unit
- **ER**: Environmental Restoration
- **NA**: Not applicable
- **RCRA**: Resource Conservation and Recovery Act
- **SNL/NM**: Sandia National Laboratories/New Mexico
The purpose of this submittal is to address regulatory requirements for designation of a Corrective Action Management Unit (CAMU) at Environmental Restoration (ER) Project Site 107 at Sandia National Laboratories/New Mexico (SNL/NM), U.S. Environmental Protection Agency (EPA) Identification Number NM5890110518. The CAMU will be used for the staging, treatment, and containment of hazardous remediation waste generated during ER Project activities.

The mission of the ER Project is to assess and remediate, when necessary, sites where releases of hazardous waste, constituents, or substances have occurred. The designation of a CAMU at SNL/NM will facilitate and expedite the achievement of the ER Project mission.

The CAMU will be designed and permitted in accordance with the requirements specified in Title 40 of the Code of Federal Regulations (40 CFR), Section (§) 264.552. Permitting will be initiated through a Class III permit modification request for designation of the CAMU. An addition to a corrective action program is categorized as a Class III permit modification request, as set forth by 40 CFR §270.42, Appendix I.

The CAMU will be designed to address the seven decision criteria outlined in 40 CFR §264.552(c), against which the CAMU permit modification request will be evaluated. These criteria, followed by a brief description of how the criteria will be met, are provided below.

The CAMU shall facilitate the implementation of reliable, effective, protective, and cost-effective remedies (40 CFR §264.552[c][1]). The CAMU will consist of on-site staging, treatment, and containment capabilities for hazardous remediation wastes. These functions will be designed, constructed, and operated in accordance with stringent administrative and institutional controls. Proven, off-the-shelf treatment technologies proposed for the CAMU will be capable of meeting negotiated treatment performance standards. On-site, permanent waste containment will allow for cost-effective and controlled management and surveillance of hazardous remediation wastes.

Waste management activities associated with the CAMU shall not create unacceptable risks to humans or to the environment resulting from exposure to hazardous wastes or hazardous constituents (40 CFR §264.552[c][2]). The CAMU will be located in a remote area of Kirtland Air Force Base (KAFB) within Technical Area (TA) III. SNL/NM security
personnel will provide controlled access. The CAMU is situated in the vicinity of the
Chemical Waste Landfill, from which most of the hazardous remediation waste to be managed
in the CAMU will originate. On-site management of hazardous remediation waste will reduce
risks associated with off-site transport. Additionally, the waste will be treated to significantly
decrease or eliminate the presence of hazardous constituents prior to being placed in an on­
site containment cell engineered to minimize the impact of any hazardous remediation waste
emplaced in the cell on the environment.

The CAMU shall include uncontaminated areas of the facility, only if including such areas for
the purpose of managing remediation waste is more protective than management of such
wastes at contaminated areas of the facility (40 CFR §264.552[c][3]). The proposed location
of the CAMU is at ER Site 107, a solid waste management unit included in Module IV of the
Resource Conservation and Recovery Act (RCRA) Hazardous Waste Facility Operating Permit
Number NM5890110518-1. Based on the results of site characterization data, no significant
contamination has been found at this site. However, during the SNL/NM CAMU site
selection process, the use of ER Site 107 as a CAMU location was determined to be more
protective of human health and the environment than the use of any of the contaminated ER
sites considered. The site is located in an access-controlled, remote location that is centralized
relative to individual ER Project sites requiring corrective action.

Areas within the CAMU, where wastes remain in place after closure of the CAMU, shall be
managed and contained so as to minimize future releases, to the extent practicable (40 CFR
§264.552[c][4]). All hazardous remediation waste, with the exception of debris, will be
treated to meet specific treatment standards prior to being transferred for bulk emplacement in
the on-site containment cell. Debris wastes and treated wastes not meeting treatment
standards will be stabilized in containers before being transferred to the on-site containment
cell. The containment cell itself will be designed with a leachate collection and removal/leak
detection system to monitor and withdraw fluid from the cell either during operation or during
the postclosure period of the CAMU. In addition, a vadose zone monitoring system (VZMS)
will provide real-time information on the CAMU containment cell performance.

The CAMU shall expedite the timing of remedial activity implementation, when appropriate
and practicable (40 CFR §264.552[c][5]). The CAMU will allow multiple areas of
contamination to be remediated and co-located within a centralized facility, thus expediting
the corrective action process.
The CAMU shall enable the use, when appropriate, of treatment technologies (including innovative technologies) to enhance the long-term effectiveness of remedial actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU (40 CFR §264.552(c)(6)). The CAMU will be designed to incorporate proven and innovative treatment technologies to significantly reduce the toxicity and mobility of remediation waste prior to incorporation into the on-site containment cell.

The CAMU shall, to the extent practicable, minimize the land area of the facility upon which wastes will remain in place after closure of the CAMU (40 CFR §264.552(c)(7)). Consolidating hazardous remediation waste from multiple ER Project sites into one centralized location minimizes the land area of the facility at which wastes will remain in place after closure. The CAMU containment cell design is based on estimated waste volumes. The cell will use a phased approach allowing flexibility in the total volume of waste without increasing the required land area. Waste staging and treatment areas will be clean closed as part of the CAMU closure.

The information presented in this Class III Permit Modification Request to Module IV of the RCRA Hazardous Waste Facility Operating Permit Number NM5890110518-1 has been prepared in accordance with 40 CFR §§264.552 and 270.42(c), as applicable.

2.0 Facility Description and Areal Configuration of the CAMU—40 CFR §264.552(e)(1)

2.1 General Description of SNL/NM—40 CFR §§264.552(e)(1) and 270.14(b)(1)
SNL/NM is located within the boundaries of KAFB (Figure 2-1), immediately south of the city of Albuquerque in Bernalillo County, New Mexico. KAFB occupies 52,233 acres. The major SNL/NM research and administration facilities are divided into five TAs, designated I through V, and several additional test areas, occupying 2,842 acres. TAs I, II, and IV are separate but clustered in the northwestern portion of KAFB. Contiguous areas of TAs III and V are more remote than the other TAs and together form a large rectangular area in the southwestern portion of KAFB.

SNL/NM is owned by the U.S. Department of Energy (DOE) and is co-operated by the DOE and Sandia Corporation, a wholly-owned subsidiary of Lockheed Martin Corporation. SNL/NM performs research and development in support of various energy and weapons
Figure 2-1
Sandia National Laboratories/New Mexico Technical Areas (TA) and the Corrective Action Management Unit (CAMU) in Relation to KAFB
programs. It also performs work for the U.S. Department of Defense and the U.S. Nuclear Regulatory Commission. SNL/NM falls under Standard Industrial Classification Numbers 9711 (National Defense Organizations) and 7391 (Research and Development).

The proposed CAMU will be located at ER Site 107, a 23-acre triangle-shaped area in the southeast corner of TA III at SNL/NM (Figure 2-1). In 1989, the Radioactive and Mixed Waste Management Facility (RMWMF) was constructed on a portion of ER Site 107; most of the remaining area within ER Site 107 is undeveloped. An area within the proposed CAMU boundary of approximately 0.75 acres, immediately to the north of the RMWMF, is the site of an approved Temporary Unit. The CAMU will encompass the Temporary Unit structures. Figure 2-2 shows the areal configuration of the CAMU.

2.1.1 Topographic Map—40 CFR §270.14(b)(19)

Figure 2-3 is a facility location map showing topography, locations of SNL/NM TAs, and the proposed CAMU in the southeastern corner of TA III. Figure 2-3 also includes the following, as required by 40 CFR §270.14(b)(19):

- Map scale and date (40 CFR §270.14[b][19][i])
- 100-year floodplain area (40 CFR §270.14[b][19][ii])
- Surface waters including intermittent streams (40 CFR §270.14[b][19][iii])
- A wind rose (40 CFR §270.14[b][19][v])
- Map orientation (i.e., north arrow) (40 CFR §270.14[b][19][vi])
- Wells both on and off site (40 CFR §270.14[b][19][ix])
- Location of the operational unit (i.e., proposed CAMU) (40 CFR §270.14[b][19][xii]).

Additional requirements of 40 CFR §270.14(b)(19) are provided in the following figures:

- Figure 2-4: Legal boundaries of the hazardous waste management facility site (i.e., the proposed CAMU) (40 CFR §270.14[b][19][vii])
- Figure 2-4: Access control (e.g., fences, gates) (40 CFR §270.14[b][19][viii])
Figure 2-2
Sandia National Laboratories/New Mexico
Corrective Action Management Unit (CAMU) Areal Configuration
TO VIEW THE MAP AND/OR MAPS WITH THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT.
• Figure 2-4: Buildings; treatment, staging, and containment operations; other structures (runoff control systems, access and internal roads, loading and unloading areas, fire control facilities) (40 CFR §270.14[b][19][x])

• Figures 2-4 and 3-15: Barriers for drainage or flood control (40 CFR §270.14[b][19][xi])

• Figures 2-5 and 2-6: Surrounding land use (40 CFR §270.14[b][19][iv]).

Figures 2-3 and 3-15 are topographic maps that, in combination, address the scale and distance requirements of 40 CFR §270.14(b)(19). Figure 2-3 shows a distance of more than 1,000 feet around the proposed CAMU.

2.1.2 Surrounding Land Use—40 CFR §270.14(b)(19)(iv)

Albuquerque, the largest population center in Bernalillo County, is the closest population center to KAFB and SNL/NM. An estimated total population of 572,000 people live within a 50-mile radius of KAFB (DOC, 1991).

SNL/NM is essentially surrounded by KAFB, with co-use agreements on some portions of KAFB. An additional 22,500-acre area to the east of KAFB has been withdrawn from the U.S. Forest Service (USFS) for the exclusive use of KAFB. High explosive tests, explosives storage, and other hazardous operations are buffered and barricaded by the mountainous terrain toward the eastern edge of this withdrawal area. Areas to the west and south, by agreements with the State of New Mexico and Isleta Pueblo, serve as buffer zones for other test operations.

The SNL/NM facility is comprised of five TAs and several additional test areas spread over 17,845 acres which are under diverse land ownership. SNL/NM occupies 2,842 acres owned by the DOE and an additional 15,003 acres that have been made available through a series of land-use agreements or permits among the DOE-Albuquerque Operations, the DOE Transportation Safeguards Division, KAFB, the USFS, the Bureau of Land Management, the State of New Mexico, the Phillips Laboratory (a private contractor), the Central Training Academy, and the Isleta Pueblo.

TA III is composed of 20 test facilities including environmental test facilities (e.g., sled track, centrifuges, and a radiant heat facility), a paper incinerator, an inactive chemical waste landfill, an inactive mixed waste landfill, a large melt facility, a melting and solidification
Figure 2-4
Corrective Action Management Unit (CAMU)
Legal Boundary, Access Locations and Topography
Figure 2-5
Land Uses Adjacent to Sandia National Laboratories/New Mexico and Kirtland Air Force Base
Figure 2-6
Land Ownership/Uses within Kirtland Air Force Base (including Sandia National Laboratories)
laboratory, and an active classified waste landfill. Development in TA III is limited due to safety and buffer zones for test activities.

Land use in the vicinity of SNL/NM and KAFB is urban to the northwest, north, and northeast. Undeveloped grazing land of the Isleta Pueblo is located to the south. Undeveloped state-owned land lies to the west and southwest of KAFB.

The urbanized area immediately northeast, north, and northwest of SNL/NM is predominantly residential, with commercial development along more heavily traveled streets. Military (e.g., KAFB) housing is located adjacent to the northern edge of SNL/NM near TA I. Albuquerque International Sunport is located west of KAFB. Figure 2-5 shows land uses in the areas adjacent to KAFB. Figure 2-6 shows land ownership and uses within KAFB.

At its nearest point, the proposed CAMU is approximately 4.5 miles south of Interstate 40 and 6.5 miles east of Interstate 25 and downtown Albuquerque. There are no residential areas within one mile of the proposed CAMU. The closest residences are in Zia Park, a KAFB residential area located approximately 3 miles north-northwest of the proposed CAMU.

2.1.3 Traffic Patterns—40 CFR §270.14(b)(10)

In 1984, the average number of vehicles passing through the KAFB gates during normal workday hours from Monday to Friday was estimated by Meyers (1991) to be:

- Carlisle-Gibson gate—5,200 vehicles
- Truman-Gibson gate—10,200 vehicles
- Louisiana-Gibson gate—18,000 vehicles
- Wyoming gate—21,600 vehicles
- Eubank gate—12,200 vehicles

The number of employees at SNL/NM has not significantly changed since 1984; therefore, SNL/NM has no reason to believe that the 1995 traffic pattern is significantly different from the 1984 traffic data.

The majority of this traffic consists of commuting employees in personal automobiles and light-duty trucks. Currently, about 8,400 people are employed at SNL/NM (including SNL/NM personnel and contractors). An estimated additional 21,000 people are employed at the adjoining KAFB and DOE facilities (Jackson, 1991).
Due to the remote location of the proposed CAMU in TA III, the general SNL/NM traffic patterns described above will neither affect nor be affected by proposed CAMU operations and CAMU-related traffic.

Traffic flow within KAFB is controlled by traffic lights, stop signs, and yield signs. The proposed CAMU is accessed from TAs I, II, and IV via Wyoming Boulevard which joins Pennsylvania Avenue south of TA IV. Pennsylvania Avenue crosses Tijeras Arroyo on a concrete bridge, approximately 1,300 feet long, with a 7-ton load limit. Dirt bypass roads, one on either side of the bridge, are designed for heavier vehicles. The proposed CAMU is reached from remote areas to the east and south of TA III via a system of interior paved and dirt roads (Figure 2-7) that lead to Pennsylvania Avenue.

A two-lane paved road to TA III turns southwest off Pennsylvania Avenue at a point just over five miles south of the Wyoming entrance gate to KAFB. Traffic access to and egress from the proposed CAMU will be along the access roads shown in Figure 2-8. Figure 2-8 also shows the location of traffic control signs in TA III.

The proposed CAMU is located in the southeastern corner of TA III. CAMU construction and operations will increase the flow of heavy and light-duty trucks to TA III from remediation activities in other SNL/NM technical areas. All vehicles must stop at the TA III controlled-access gate prior to entering or leaving TA III. CAMU construction and operations will also slightly increase the flow of heavy and light-duty trucks within TA III. The increase in CAMU-related traffic flow will correspond to SNL/NM’s corrective action activities at any given time.

Hazardous remediation waste will be transported within the proposed CAMU following the routes outlined on Figure 2-9. Trucks carrying hazardous remediation waste will enter the proposed CAMU through the east entrance gate. Waste characteristics (e.g., contaminant types and concentrations, waste forms) and operational considerations (e.g., capacity at each waste staging area) will determine transport routes upon acceptance at the CAMU. Trucks may travel north then west to the Sprung™ structures (and return on the same route) or west then south to the bulk waste staging area or west then north to the containerized waste staging area. Trucks returning from the bulk waste staging area and containerized waste staging areas will typically return via the east-west route to the north of the Sprung™ structures in order to proceed to the decontamination pad prior to exiting the CAMU. The waste may also be taken north directly to the treatment area (and return on the same route). Within the proposed
Note: Heavy equipment will follow the dirt bypass rather than use the bridge crossing Tijeras Arroyo on Pennsylvania Avenue.

Figure 2-7
Sandia National Laboratories/New Mexico Remediation Waste Transport Routes
Figure 2-8
Traffic Routes for Remediation Waste Transport in Technical Area III
Figure 2-9
Sandia National Laboratories/New Mexico Remediation
Waste Transport Routes Within the Corrective
Action Management Unit (CAMU)
CAMU, hazardous remediation waste may be transported north from either the waste staging areas or the Sprung™ structures to the treatment area. Treated hazardous remediation waste may then be transported east to the containment cell. Waste may also be staged for transport to and disposal at an off-site (i.e., outside of the KAFB boundary) treatment, storage and disposal facility (TSDF) at any of the waste staging areas. All roads within the proposed CAMU will be two-way. An emergency exit is located along the west fence.

All of the paved roads at SNL/NM were generally built in conformance to the New Mexico State Highway Standards or the City of Albuquerque Development Process Manual, Standards for Residential Streets. These standards are in conformance with national specifications prepared by the American Association of State Highway Transportation Officials. All of the paved roads at SNL/NM are designed and constructed to accommodate heavy truck traffic and were generally built in conformance to standard earthwork and paving specifications.

CAMU access roads have been designed to accommodate a design-basis vehicle based on an 18-wheel tractor-trailer truck with a maximum width of 8.5 feet, a gross vehicle weight of 80,000 pounds, and a turning radius of 50 feet. Vehicles for transporting remediation waste and equipment may include dump trucks, trucks hauling roll-off containers, end-dumps, cranes, fork-lifts, front-end loaders, and tractor trailers. The existing improved gravel road (6 inches of base course on compacted subgrade) from the eastern CAMU entrance/exit to the front of the Sprung™ structures will be extended around and behind the Sprung™ structures back to the entrance and to the northern entrance of the bulk waste staging area, providing an improved road surface for the predominant traffic flow area. The access road from the pavement south of the RMWMF to the CAMU entrance/exit will also be improved to 6 inches of base course on compacted subgrade. Other access roads within the CAMU and around the CAMU perimeter will be compacted dirt roads.

2.2 Description of ER Site 107 and Its Qualifications for CAMU Designation—40 CFR §§264.552(c)(3)

ER Site 107 is located within a 23-acre triangle-shaped area in the southeast corner of TA III at SNL/NM (Figure 2-1). The RMWMF was constructed on a portion of ER Site 107 in 1989. The remainder of ER Site 107 is undeveloped or occupied by Temporary Unit structures and is the proposed CAMU site at SNL/NM. The dominant soil type within ER Site 107 is Madurez loamy fine sand and Tijeras gravelly fine sandy loam, a well-drained soil formed in unconsolidated alluvium modified by wind, on slopes ranging from one to five percent gradient.
ER Site 107 was reportedly used for high explosives testing from the 1950s until 1972. The majority of the explosives testing conducted at ER Site 107 was reported to be shock-wave-related. Information on the types and amounts of high explosives used for testing is not available. Contaminants of concern at ER Site 107 included high explosives, metals such as lead and silver, and nitrates/nitrites. In a May 1994 RCRA Facility Investigation, 13 composite soil samples collected from ER Site 107 were analyzed for high explosives, target analyte list metals, and nitrates/nitrites. No constituents of concern were detected in samples from ER Site 107 in excess of background levels (at the 95 percent upper threshold limit) at SNL/NM.

Based on these results, no significant contamination has been detected at ER Site 107. However, during the CAMU location and evaluation process based on EPA- and SNL/NM-specific criteria, the use of ER Site 107 as a CAMU location was determined to be more protective of human health and the environment than the use of the more contaminated ER Project sites considered.

2.2.1 Floodplain—40 CFR §264.18(b)
The locations of the 100-year floodplains of Tijeras Arroyo and Arroyo del Coyote are shown in Figure 2-3. The floodplain portion of Figure 2-3 was derived from a U.S. Army Corps of Engineers map, prepared using Federal Emergency Management Administration guidelines which are equivalent to the mapping techniques used to prepare Federal Insurance Administration floodplain maps. The proposed CAMU is not located within a 100-year floodplain as defined in 40 CFR §264.18(b)(2)(i), and as regulated under 40 CFR §264.18(b)(1). Floodplain regulations are not applicable to the proposed CAMU.

2.2.2 Seismic Considerations—40 CFR §264.18(a)
SNL/NM is located in Bernalillo County, New Mexico, which is listed in Appendix VI of 40 CFR Part 264. The hazardous waste management areas of the proposed CAMU are not located within 200 feet of any fault or fault trace with Holocene displacements as defined in 40 CFR §264.18(a)(2) nor is the CAMU located within 3,000 feet of any fault or fault trace with Holocene displacement. The proposed CAMU is located approximately 5,000 feet from the nearest faults (the intersection of the Hubbell Springs and Tijeras Arroyo faults [Figure 2-3]). Therefore, the CAMU is not regulated under 40 CFR §264.18(a)(1).
3.0 CAMU Design, Operating, and Closure Standards—40 CFR §§264.552(e)(2) and (4) 

Only the CAMU land-based areas (e.g., waste staging areas, treatment area, and containment cell) are discussed in this section. The CAMU mobile treatment units (CMTU) to be located at the treatment area are not land-based units. As non-land-based units, they have separate regulatory identity and will therefore be addressed in future permit applications or modification requests to the New Mexico Environment Department (NMED) under the base RCRA permit. Support structures and functions at the proposed CAMU include the storm water retention ponds, the less-than-90-day leachate collection tank for the containment cell, the administration trailers, the decontamination pad with associated less-than-90-day collection tank, emergency eyewash stations, and electrical and water hookups. These are not RCRA units subject to permitting requirements and, therefore, are not described in detail in this section.

3.1 Requirements for Remediation Waste Management—40 CFR §§264.552(c)(2), (4), and (6); and 264.552(e)(2) 

The proposed CAMU will be used for the staging, treatment, and containment of hazardous remediation waste. Placement of remediation waste into or within a CAMU does not constitute land disposal of hazardous waste (40 CFR §264.552[a][1]), nor does consolidation or placement of remediation waste into or within a CAMU constitute creation of a unit subject to minimum technology requirements (40 CFR §264.552[a][2]). However, the proposed CAMU is designed to be protective of human health and the environment.

The EPA has stated that the treatment standards prescribed in the “Superfund LDR Guide #6A (2nd Edition), Obtaining a Soil and Debris Treatability Variance for Remedial Actions,” (EPA, 1990) are appropriate for remediation purposes (Volume 58, Federal Register Page 8659) (EPA, 1993). Establishing alternate treatment standards based on the EPA’s Superfund LDR Guide #6A for placement of hazardous remediation wastes at the CAMU is appropriate for several reasons. First, 40 CFR Part 264, Subpart S (i.e., the CAMU regulations) states that “placement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous wastes”; however, Subpart S also states that “the CAMU shall enable the use, when appropriate, of treatment technologies...to enhance the long-term effectiveness of remedial actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU.” Thus, based on the first requirement, the application of land disposal restrictions (LDR) treatment standards to wastes emplaced within
the CAMU is inappropriate, yet the application of alternative standards is warranted to comply with the second requirement. Further, the LDR treatment standards were established based on treating wastes derived from less complex, more well-defined industrial processes. The SNL/NM ER remediation wastes to be treated and placed within the CAMU are not from well-defined industrial processes. On the contrary, these wastes will consist largely of heterogeneous soil and debris wastes from corrective action activities.

Under the Superfund LDR Guide #6A, alternate treatment levels based on data from actual treatment of soil (or best management practices for debris wastes) become the treatment standards that must be met. The treatment standard will be either a percent reduction of the pretreatment concentration of the contaminant or a reduction of the contaminant concentration to within a specified concentration range. Use of the percent reduction treatment standard or the concentration range treatment standard is established based on threshold concentrations provided in the Superfund LDR Guide #6A. If the concentration of the contaminant is below the threshold concentration but above the specified concentration range in the Superfund LDR Guide #6A, the waste should be treated to within the specified concentration range. The post-treatment concentration of the contaminant must not exceed the upper limit specified in the Superfund LDR Guide #6A concentration range (see Table 3-1). If the concentration of the contaminant is below the threshold concentration and is within or below the specified concentration range, the waste will not require treatment and may be placed in the CAMU containment cell untreated. If the concentration of the contaminant is above the threshold, the waste should be treated to reduce the concentration of the waste to within the specified percent reduction range. Additional information on these alternative treatment standards will be included in the RCRA permit application or modification request to be submitted for the CMTUs. Waste treatment and/or emplacement in the containment cell at the CAMU will not commence until treatment standards have been approved by the regulatory authorities through regulatory approval of a Class III permit modification.

This section describes how operations at the proposed CAMU will not create unacceptable risks to human health or the environment (40 CFR §264.552[e][2]); how areas within the CAMU will be managed to minimize future releases (40 CFR §264.552[c][4]); and how treatment technologies will be used to reduce the toxicity, mobility, and volume of waste to remain in place after closure of the CAMU (40 CFR §264.552[c][6]). Additionally, this section presents the requirements and specifications of the design, operation and closure of the CAMU (40 CFR §264.552[e][2]).
3.1.1 Physical and Chemical Characteristics of Waste to be Managed—40 CFR §§270.14(b)(2) and (3)

Only hazardous remediation waste generated during ER Project corrective action activities will be managed at the CAMU, as outlined in the Waste Analysis Plan for the CAMU (Appendix A). Hazardous remediation waste may include, but is not limited to: soil, solid debris, personal protective equipment (PPE), decontamination solutions, monitor well purge and development water, sampling equipment, drilling mud, and sludges. Soil waste may include but is not limited to soil generated from sampling, drilling, excavation, and monitoring well installation. Solid debris waste may include, but is not limited to, materials such as concrete, scrap metal, rubble, wood, and electronic components. PPE and sampling equipment (e.g., gloves, booties, rags, swipes, filters, composite liquid waste samplers [COLIWASA]) are also likely to be generated during ER Project corrective action activities. Sludges may be generated from drilling muds or soil treatment operations.

The hazardous remediation waste to be managed in the CAMU includes both RCRA-regulated characteristic and listed hazardous waste. The hazardous characteristic wastes and associated EPA Hazardous Waste Numbers may include: ignitable waste (D001); corrosive waste (D002); reactive waste (D003); toxicity characteristic metals (D004 through D011); or toxicity characteristic organic compounds (D012 through D043). The listed hazardous waste and associated EPA Hazardous Waste Numbers may include: possible releases from non-specific sources with F-listed hazardous waste (F001, F002, F003, and F005); and leachate generated from the containment cell (F039). Hazardous remediation waste containing non-regulated levels of Toxic Substances Control Act (TSCA) contaminants (i.e., polychlorinated biphenyls [PCB] and asbestos) may also be generated as a result of ER Project corrective action activities and subsequently managed at the proposed CAMU.

The majority of the hazardous remediation waste to be managed at the CAMU is expected to be generated at ER Site 74, the Chemical Waste Landfill. Table 3-1 summarizes the RCRA contaminant concentrations identified during site investigations (to date) at the Chemical Waste Landfill. Actual contaminant concentrations of waste derived from future remedial actions at the Chemical Waste Landfill and managed at the CAMU may differ. The potential EPA Hazardous Waste Numbers have been added to the table to show representative RCRA hazardous waste which may be managed at the CAMU.
Table 3-1
RCRA Contaminant Concentrations at the Chemical Waste Landfill (ER Site 74)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Halogenated Non-Polar Aromatics</td>
<td>D027</td>
<td>3.8</td>
<td>100.0</td>
</tr>
<tr>
<td>PCBs</td>
<td>NA</td>
<td>0.034</td>
<td>0.1 – 1.0 ppm or &gt;90% reduction</td>
</tr>
<tr>
<td>Halogenated Phenols</td>
<td>D027</td>
<td>6.7</td>
<td>400.0</td>
</tr>
<tr>
<td>Halogenated Aliphatics</td>
<td>F001, F002</td>
<td>0.0054</td>
<td>0.5 – 2 ppm or &gt;95% reduction</td>
</tr>
<tr>
<td>Chloroform</td>
<td>D022</td>
<td>0.012</td>
<td>40.0</td>
</tr>
<tr>
<td>Chloroform</td>
<td>D022</td>
<td>0.011</td>
<td>40.0</td>
</tr>
<tr>
<td>Dichloromethane (methylene chloride)</td>
<td>F001, F002</td>
<td>0.0061</td>
<td>40.0</td>
</tr>
<tr>
<td>Dichloromethane (methylene chloride)</td>
<td>F001, F002</td>
<td>0.0061</td>
<td>40.0</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>D039, F001, F002</td>
<td>0.009</td>
<td>40.0</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>D039, F001, F002</td>
<td>0.02</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table 3-1 (Continued)
RCRA Contaminant Concentrations at the Chemical Waste Landfill (ER Site 74)*

<table>
<thead>
<tr>
<th>Superfund LDR Guide #6A Structural Functional Groupb</th>
<th>ER Site 74 Contaminantc</th>
<th>Potential EPA Hazardous Waste Numbersd</th>
<th>Concentration in ER Site 74 Waste Samples (ppm)</th>
<th>Superfund LDR Guide #6A Treatment Threshold Performance Standarde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halogenated Aliphatics (Continued)</td>
<td>Trichloroethene</td>
<td>D040, F001, F002</td>
<td>Minimum: 0.007</td>
<td>Maximum: 9,500</td>
</tr>
<tr>
<td>Other polar organics</td>
<td>Acetone</td>
<td>F003</td>
<td>Minimum: 0.011</td>
<td>Maximum: 1,300</td>
</tr>
<tr>
<td></td>
<td>Acetone</td>
<td>F003</td>
<td>Minimum: 0.011</td>
<td>Maximum: 270</td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
<td>D018, F005</td>
<td>Minimum: 0.046</td>
<td>Maximum: 0.046</td>
</tr>
<tr>
<td></td>
<td>Ethyl benzene</td>
<td>F003</td>
<td>Minimum: 0.006</td>
<td>Maximum: 26</td>
</tr>
<tr>
<td></td>
<td>Ethyl benzene</td>
<td>F003</td>
<td>Minimum: 3.0</td>
<td>Maximum: 230</td>
</tr>
<tr>
<td></td>
<td>Toluene</td>
<td>F005</td>
<td>Minimum: 0.0093</td>
<td>Maximum: 680</td>
</tr>
<tr>
<td></td>
<td>Toluene</td>
<td>F005</td>
<td>Minimum: 0.0059</td>
<td>Maximum: 1,300</td>
</tr>
<tr>
<td></td>
<td>Total xylenes</td>
<td>F003</td>
<td>Minimum: 0.007</td>
<td>Maximum: 810</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table 3-1 (Continued)
RCRA Contaminant Concentrations at the Chemical Waste Landfill (ER Site 74)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Polar Organics (Continued)</td>
<td>Total xylenes</td>
<td>F003</td>
<td>0.006 1,110 225.853 100</td>
<td>0.5–10 ppm or &gt;90% reduction</td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td>Arsenic</td>
<td>D004</td>
<td>0.43 93 3.89 10h</td>
<td>0.3–1 mg/L or &gt;90% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barium</td>
<td>D005</td>
<td>2.7 730 85.39 400h</td>
<td>0.1–40 mg/L or &gt;90% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cadmium</td>
<td>D006</td>
<td>0.1 87 1.96 40h 42</td>
<td>0.2–2 mg/L or &gt;95% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chromium</td>
<td>D007</td>
<td>1.6 61,700 363.06 120h</td>
<td>0.5–6 mg/L or &gt;95% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chromium</td>
<td>D007</td>
<td>0.037 35,400 1,421.1 120h</td>
<td>0.5–6 mg/L or &gt;95% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lead</td>
<td>D008</td>
<td>1 45,100 275.79 300h</td>
<td>0.1–3 mg/L or &gt;99% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mercury</td>
<td>D009</td>
<td>0.05 17.2 1.02 0.08h</td>
<td>0.0002–0.008 mg/L or &gt;90% reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selenium</td>
<td>D010</td>
<td>0.18 78 26.25 0.05h</td>
<td>0.005 mg/L or &gt;90% reduction</td>
<td></td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table 3-1 (Continued)
RCRA Contaminant Concentrations at the Chemical Waste Landfill (ER Site 74)\(^a\)

<table>
<thead>
<tr>
<th>Structural Functional Group(^b)</th>
<th>ER Site 74 Contaminant(^c)</th>
<th>Potential EPA Hazardous Waste Numbers(^d)</th>
<th>Concentration in ER Site 74 Waste Samples (ppm)</th>
<th>Superfund LDR Guide #6A Treatment Performance Standard(^f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals (Continued)</td>
<td>Selenium total</td>
<td>D010</td>
<td>Minimum 0.2, Maximum 21, Average 1.81</td>
<td>0.05(^h) mg/L or &gt;90% reduction</td>
</tr>
<tr>
<td></td>
<td>Silver</td>
<td>D011</td>
<td>Minimum 0.2, Maximum 23, Average 2.63</td>
<td>Proposed &gt;90% reduction</td>
</tr>
</tbody>
</table>

Provided by Sandia National Laboratories/New Mexico based on site investigation data collected to date (June 1996). Actual contaminant concentrations of waste derived from future remedial actions at the Chemical Waste Landfill and managed in the CAMU may differ.


Note: Information in this table is derived from two sets of data from different sampling events at the Chemical Waste Landfill. For some chemical constituents there were insufficient data in the two data sets to calculate statistically valid averages and standard deviations. Thus, for these constituents, the values from each individual data set are included.

The potential EPA hazardous waste numbers were taken from Title 40 of the Code of Federal Regulations (40 CFR) Part 261.


Taken from EPA, 1990, “Superfund LDR Guide #6A, 2nd Edition, Obtaining a Soil and Debris Treatability Variance for Remedial Actions.” The treatment standard may be a reduction of the contaminant concentration to within a specified range or a percent reduction of the contaminant concentration. The actual treatment performance standard is determined by comparing the concentration of the waste to the threshold concentration. If the concentration of the waste is less than the threshold concentration, then the concentration range standard is used. If the concentration of the waste exceeds the threshold concentration, then the percent reduction standard is used.

"PCBs" includes Aroclors 1016, 1242, 1254, and 1260.

As determined by the toxicity characteristic leaching procedure.

Table 3-1 (Continued)
RCRA Contaminant Concentrations at the Chemical Waste Landfill (ER Site 74)*

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>ER</td>
<td>Environmental Restoration</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
</tr>
<tr>
<td>NA</td>
<td>Not applicable</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyl</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
</tbody>
</table>
3.1.2 Waste Staging Areas—40 CFR §264.552(c)(2)

Waste staging areas used at the proposed CAMU will provide space for the accumulation of sufficient hazardous remediation waste volumes to facilitate treatment, and to provide space for treated waste awaiting results of verification analyses. These waste staging areas have been designed to ensure contamination control by accommodating the potential forms in which hazardous remediation waste will be brought to the CAMU. The four waste staging areas include:

- A containerized waste staging area for containerized waste (e.g., drums, roll-off bins, transportainers, and waste boxes)
- Up to four Sprung™ structures for containerized waste
- A bulk waste staging area for uncontainerized soil and debris and other containerized waste
- Two treated waste staging areas.

These areas are described in the following sections.

3.1.2.1 Containerized Waste Staging Area

The containerized waste staging area will be located west of the Sprung™ structures and north of the bulk waste staging area (Figure 2-2). This area is intended to provide temporary staging capacity for containerized waste. Typical container types may include, but are not limited to, large containers (e.g., roll-off bins, transportainers, and waste boxes) and drums. The containerized waste staging area may also be used for the temporary staging of equipment and materials.

The containerized waste staging area will consist of a pad approximately 10,000 square feet in size. The pad design is circular with an approximate 112.5-foot diameter and consists of compacted subgrade and a 6-inch aggregate base course surface. A cross-section of the base course pad construction is shown in Figure 3-1 (Note: As-built drawings of the CAMU will be provided to NMED and EPA within 90 days after expiration of the construction contract).
3.1.2.2 Sprung™ Structures
Up to four prefabricated temporary Sprung™ structures will be located in the center of the CAMU immediately south of the treatment area and containment cell (Figure 2-2). The Sprung™ structures will be used primarily for staging containerized waste. Each structure is nominally 50 feet wide, 24 feet high, and 100 feet long and is constructed of polyvinyl chloride (PVC)-coated, fire-retardant polyester scrim stretched over aluminum ribbing. The structures will be attached to a concrete pad with steel anchor bolts through steel base plates. The concrete pad, crowned at the center, will be designed for a load-bearing capacity of at least 1,000 pounds per square foot. The area around each concrete pad will be graded to create swales that will direct water away from the structures. Each structure will be accessed through one of two personnel doors or through an end-sliding cargo door. Figures 3-2 through 3-5 illustrate design aspects of the Sprung™ structures.

3.1.2.3 Bulk Waste Staging Area
The bulk waste staging area will be located west of the RMWMF in the southwest portion of the CAMU (Figure 2-2). The bulk waste staging area will provide temporary staging capacity primarily for uncontainerized soil and debris. In addition, this area may be used for additional containerized waste staging capacity, if needed. Segregation and staging of soil and debris in bulk will be based on potential constituents of concern (see Appendix A) and on treatment requirements. The maximum capacity for staging bulk soil and debris is approximately 600,000 cubic feet. Flexibility is available to accommodate various mound configurations as needed.

The physical layout of the bulk waste staging area will consist of a rectangular asphaltic concrete pad surrounded by a 15-foot-high concrete masonry-unit wall. The east and west sides of the asphaltic concrete pad will be approximately 300 feet long, and the north and south sides will be approximately 375 feet long. A 75-foot-wide access corridor running north and south will divide the bulk waste staging area into two symmetrical halves.

In addition to the perimeter wall, four concrete masonry-unit wall extensions (two on each side) will be located interior to the bulk waste staging area. These interior walls will be perpendicular to the perimeter wall on the east and west sides. The interior walls will extend inward from the perimeter to the access corridor and will essentially form six compartments (three on each side). The purpose of these compartments will be to provide physical barriers that will separate and isolate different waste types, as needed. Figures 3-6 and 3-7 illustrate design aspects of the bulk waste staging area.
Figure 3-2
Sprung™ Structure-Plan View
Fabric to be Fastened to Concrete Face Using Flat Bar & Concrete Fastener

Slope Grade Away from Structure Base for Positive Drainage

Steel Base Plate

Steel Base Angle

1/2 inch Concrete Ready Anchor 2 Places

Concrete Slab (To be crowned at center)

Fabric Retainer

Fabric (polyvinyl chloride-coated polyester scrim)

4 inch x 6 inch Aluminum I-Beam

Figure 3-4
Sprung™ Structure-Foundation Detail
Figure 3-5
Proposed Sprung Structure
Foundation Plan

CONCRETE & REINFORCEMENT NOTES

1. ALL CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS AS LISTED BELOW

2. ALL REINFORCING STEEL SHALL BE ASTM AND GRADE AS MINIMUM TENSILE STRENGTH OF 60,000 - ALL TIES SHALL BE ASTM AND GRADE 40 - MINIMUM TENSILE STRENGTH OF 58,000 PSI. REINFORCING TO BE USED SHALL HAVE A CARBON EQUIVALENT NOT MORE THAN 0.25% OF THE CARBON. WELDING CODE: REINFORCING STEEL AND TIES 0.2% CARBON, ALL REINFORCING STEEL SHALL BE IN ACCORDANCE WITH ASTM/AS 13 CURRENT EDITION.

3. PROVIDE STEEL BAR SUPPORTS AND SPACERS FOR REBAR IN ACCORDANCE WITH A533 AND STEEL CARRIES WITH 2 IN. CUBE SAND PLATES FOR ALL CEMENT CASTING. HORIZONTAL SUPPORTS AND DIAMETERS ON 2'-0" UNLESS OTHERWISE NOTED.

4. VERTICAL, HORIZONTAL AND CONSECUTIVE REINFORCEMENT 3/4" BAR DIAMETERS ON 2'-0" MINIMUM UNLESS OTHERWISE NOTED.

5. WHERE LAPPED SPLICES IN REINFORCING OCCUR THE LAP SHALL BE MADE AS FOLLOWS: HORIZONTAL AND VERTICAL REINFORCEMENT 3/4" BAR DIAMETERS ON 2'-0" MINIMUM UNLESS OTHERWISE NOTED.

6. ARIAL AND REINFORCING IN CONTINUOUS FOUNDATIONS AND WALLS SHALL BE CONTINUOUS AROUND CORNERS OR JOINTS AND HORIZONTAL AND VERTICAL REINFORCEMENT SHALL BE CONTINUOUS THROUGH JOINTS AND WALLS. HOLES SHALL BE MADE WITH 1'-0" OF ANY DIAMETER.

7. CONCRETE COVER FOR REINFORCING SHALL BE AS FOLLOWS:

- FOOTINGS - 1'-0" FROM BOTTOM AND SIDE
- GRADE BEAMS - 1'-0" FROM TOP AND 4'-0" FROM SIDE
- SLABS ON GRADE - 3'-0"

8. THE CONTRACTOR SHALL BE RESPONSIBLE TO ENSURE THAT ALL REBAR IS PROPERLY ALIGNED AND TIED IN PLACE BEFORE PLACING CONCRETE. ALL VERTICAL STEEL SHALL BE ACCURATELY LOCATED AND TIED IN PLACE SO THAT IT REMAINS IN POSITION DURING THE PLACING OPERATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING THE GEO-ENGINEERING REEERESSIONS, SHOULDER WIDTHS AND UNIVERSITY, ALL REBAR TIES MUST BE ALIGNED. ANY REINFORCEMENT FOUND TO BE IMPROPERLY INSTALLED SHALL BE REMOVED AND REPLACED AT THE CONTRACTOR'S EXPENSE.

8. THE CONTRACTOR SHALL MOUNT ALL DIMENSIONS IN THE FIELD.

MISCELLANEOUS NOTES

1. WHERE CONFLICTS OCCUR BETWEEN SPECIFICATIONS, REFERENCED CODES, AEROSPACE COMMAND, THE MOST STRINGENT REQUIREMENTS SHALL APPLY.
Figure 3-6
Bulk Waste Staging Area-Plan View
3.1.2.4 Treated Waste Staging Areas

The treated waste staging areas are considered part of the treatment area, to be located to the east of the treatment pad. The treated waste staging area east of the thermal desorption area of the treatment pad will be approximately 150 by 270 feet, and the treated waste staging area to the northeast of the soil washing area of the treatment pad will be approximately 115 by 120 feet. The treated waste staging areas will consist of prepared compacted soil, as shown on the cross-section for a compacted dirt road on Figure 3-1. Treated waste will be staged in temporary stockpiles at the treated waste staging areas pending receipt of analytical results to determine treatment effectiveness.

3.1.3 Treatment Area—40 CFR §264.552(c)(6)

Waste treatment at the CAMU will be performed to meet the criteria provided in 40 CFR §264.552(c)(6). Treatment technologies have been selected to enhance the long-term effectiveness of remedial actions by reducing the toxicity, mobility, and volume of waste that will remain in place after closure of the CAMU. Treatment will be performed using CMTUs, which will be vendor-supplied and operated technologies to be described and permitted in a RCRA Subtitle C permit application or modification request to be submitted at a later date.

The physical layout of the treatment area (Figure 3-8) will include a treatment pad with distinct areas to support the three principle treatment technologies (i.e., thermal desorption, soil washing, and stabilization/solidification) as well as the treated waste staging areas discussed in Section 3.1.2.1.4.

The treatment area will be located in the northwest area of the proposed CAMU, north of the bulk waste staging area and west of the containment cell. The entire waste treatment area is situated within a rectangular space with approximately 450-foot-long east and west sides and 280-foot-long north and south sides. Within the waste treatment area, the treatment pad will consist of a bermed, asphaltic concrete foundation (approximately 4 inches of asphaltic concrete paving over 6 inches of base course over approximately 12 inches of prepared subgrade) designed with a minimal slope to facilitate runoff flow. Figure 3-1 shows a cross-section of a paved area that is representative of the treatment pad. The thermal desorption area of the treatment pad will be approximately 100 by 100 feet, the soil washing area of the treatment pad will be approximately 150 by 150 feet, and the stabilization/solidification area of the treatment pad will be approximately 40 by 60 feet. The dimensions of the treatment pad allow for the deployment of ancillary equipment such as fractionalization tanks, scrubbers, condensers, air pollution control units, and/or material storage that may be associated with
Figure 3-8
Sandia National Laboratories/New Mexico
Corrective Action Management Unit (CAMU) Treatment Area
operations. The overall treatment area configuration allows for the efficient flow of material from staging to treatment to emplacement in the containment cell or staging for off-site disposition, as appropriate.

**3.1.4 Containment Cell—40 CFR §264.552(c)(4)**

The proposed CAMU containment cell design consists of engineered barriers and incorporates a liner system and associated leachate collection and removal system (LCRS), a VZMS, and a final cover system. A description of the liner system and associated LCRS is provided in this section. The VZMS and final cover system are also described briefly in this section, and in detail in Appendices E and D, respectively. Figures 3-9, 3-10, and 3-11 present details on the containment cell and associated features.

The proposed CAMU containment cell is designed to accommodate approximately 1 million cubic feet of waste. The cell will be excavated into the native subgrade with 2:1 (horizontal to vertical) sidewall slopes. Following sampling to assess treatment effectiveness, treated waste may be placed directly into the containment cell or containerized prior to stabilization/solidification and emplacement in the containment cell. The containerized waste will be placed at least 2 feet from either the sidewall liner system or bottom liner systems of the containment cell, and bulk treated waste or clean fill material will be placed around the containerized waste. The waste will be compacted to minimize containment cell subsidence.

The containment cell will include an engineered liner system designed to prevent migration of hazardous constituents from leachate, contaminated runoff, and hazardous waste decomposition products to adjacent geologic materials or to groundwater or surface water during CAMU operations and the post-closure period. The liner system components are designed of materials that are chemically resistant to the waste and also to any leachate generated. The materials are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste compaction, waste cover materials, and equipment used at the containment cell.

Construction quality assurance (QA) for the containment cell and associated liner system, the LCRS, and the final cover system will be controlled by measures used to inspect and document the quality of materials and the condition and manner of their installation. These measures include control of construction activities, identification of organizational responsibilities and authorities, and construction personnel qualifications. Inspection and sampling activities, including observations and tests, will be performed before, during, and
after construction to ensure that construction materials and the installed containment cell components meet the design specifications. Discussions of relevant minimum QA parameters are included in the following sections, where applicable.

3.1.4.1 Containment Cell Excavation and Capacity

The containment cell is designed to accommodate approximately 72 percent of the maximum anticipated volume of waste below grade (Figure 3-12). The depth of the bottom of the waste below grade will range from 15 feet at the south end to 20 feet at the north end of the containment cell to direct any leachate to the sump at the northern end of the cell. With a 2:1 (horizontal to vertical) slope, a minimum depth of 15 feet, and a surface footprint of 200 by 300 feet, a below-grade capacity of approximately 720,000 cubic feet is provided. If additional waste capacity is required, waste will be mounded above grade to a maximum height of 7.1 feet. At this height, a 3:1 (horizontal to vertical) slope transitioning to a final grade of three percent will accommodate an additional 280,000 cubic feet as shown in Figure 3-12, thereby providing a total capacity of 1 million cubic feet. Due to areal constraints at the proposed CAMU containment cell location, placing a portion of the waste above grade provides maximum volume flexibility. If the actual volume of waste placed in the CAMU containment cell is less than 1 million cubic feet, clean fill material will be used to achieve the above-grade waste/fill height of 7.1 feet required for final cover design. Regardless of the volume of waste emplaced, the containment cell design is in accordance with 40 CFR §264.552(c)(7) and the land area of the facility upon which wastes will remain in place after closure of the CAMU is minimized. The use of vertical mounding for additional capacity results in a smaller overall footprint.

3.1.4.2 Description of Containment Cell Liner System

The engineered containment cell liner system includes bottom liner system and sidewall liner system components. The bottom liner system components include the following in descending order (Figures 3-9, 3-10, 3-11):

- Protective cover: A minimum 18-inch-thick protective cover consisting of native, compacted on-site soil
- LCRS: geocomposite drainage layer consisting of a geonet with a nonwoven geotextile bonded to the upper surface with drainage to a collection sump
- Geomembrane: 60-mil smooth high-density polyethylene (HDPE)
Figure 3-12
North-South Profile of Containment Cell at 72 Percent Total Capacity and 100 Percent Total Capacity
• Geosynthetic clay liner (GCL): nonwoven geotextile outer layers needle-punched through an inner layer of low-permeability sodium bentonite.

Each of these bottom liner system components is discussed in detail in Sections 3.1.4.2.1 through 3.1.4.2.4. The sidewall liner system components are presented in Section 3.1.4.4.

3.1.4.2.1 Protective Cover Soil

The cover soil component of the containment cell liner system provides protection of the underlying liner system components prior to and during emplacement of waste. The cover soil protects the geotextile from ultraviolet degradation as well as prevents any uplift or movement of the underlying components that may be caused by winds prior to waste emplacement. Additionally, it protects the underlying liner system components from puncture or damage during heavy equipment and waste placement operations.

The protective cover material will consist of 18 inches of soil obtained from the site. The soil will be free of rocks in excess of 0.5-inch in diameter and deleterious material such as organic matter subject to decay. The soil will meet the following minimum gradation requirements:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>50–100</td>
</tr>
<tr>
<td>No. 200</td>
<td>5–30</td>
</tr>
</tbody>
</table>

The protective cover soil will be placed directly above the geocomposite in the bottom of the containment cell (Figure 3-11) and above the access road in the cell. The soil cover will be installed in multiple lifts to result in a compacted thickness of approximately 18 inches in the floor of the containment cell and approximately 24 inches on the access road. The protective soil cover will be compacted to a minimum relative density of not less than 90 percent.

Construction QA for the protective cover soil will include field and laboratory testing as well as observations and inspections by QA personnel. Laboratory tests of the protective cover soil will be performed to document its engineering properties and to verify the acceptability of the material for use in construction. The laboratory tests will include determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with American Society for Testing and Materials (ASTM) Standard D 1557, and grain size
analysis in accordance with ASTM D 422. QA personnel will perform visual observations and inspections during placement of the protective cover soil to detect the presence of organic matter, rubble, trash, and deleterious material; inspect individual and final lift thicknesses; and observe the method of installation of the protective cover soil. To determine whether construction performance meets project requirements, field testing of in situ portions of the protective cover soil will be performed for soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017.

3.1.4.2.2 Leachate Collection and Removal System

The LCRS will be constructed in the bottom of the containment cell to collect and withdraw fluid from the cell during operations and during the post-closure period (Figure 3-11). The LCRS includes a sump in the north end of the containment cell, a pipe in a central trench located above the geomembrane liner system, a dedicated pump to remove liquids that appear in the sump, and a geocomposite layer. The LCRS trench will be centrally located at the bottom of the containment cell (Figure 3-9). The trench will traverse the bottom of the containment cell from the south to the north and will be sloped approximately 1 percent toward the north. The bottom of the containment cell will have an approximately 2 percent double-inward slope to drain toward the central trench (Figure 3-9). The trench will receive any leachate from the geocomposite drainage layer. The following specific LCRS components are discussed in this section:

- The geocomposite layer.
- Geotextile wrap installed around the drain aggregate in the LCRS trench.
- The pipe system with pipe bedding and drain aggregate installed within the geotextile wrap in the LCRS trench.
- Fill materials that will be backfilled around piping exiting the surface of the containment cell.
- A dedicated pump to remove liquids that appear in the sump

Minimum general specifications, installation procedures, and QA requirements for the LCRS components are presented in this section under the following headings: Geocomposite; Geotextile Wrap; LCRS piping, pipe bedding, and drain aggregate; LCRS fill materials; and LCRS pumps. Additional LCRS design and construction information is provided in Section 3.1.4.6.
**Geocomposite**

The geocomposite consists of a geotextile bonded to a geonet. The geotextile serves as a separator between the overlying protective soil layer and the geonet and acts as a filter to prevent clogging of the geonet drainage layer. This separation ensures the proper performance of the collection layer through the post-closure period for the containment cell. The geonet bonded to the geotextile has open uniform channels that collect and transfer leachate at an approximate 2-percent slope to the centralized leachate collection trench, which then slopes at 1 percent to the collection sump. The geonet is manufactured from polyethylene and has a minimum transmissivity of $3 \times 10^{-5}$ square meters per second.

The geocomposite will be made from geonet and geotextile products conforming to the following minimum general specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geocomposite</strong></td>
<td></td>
</tr>
<tr>
<td>Laminate Bond Strength</td>
<td>400 grams per inch</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.24 inches</td>
</tr>
<tr>
<td>Transmissivity (at 10,000 pounds per square foot)</td>
<td>$16 \times 10^{-3}$ square feet per second</td>
</tr>
<tr>
<td><strong>Geonet</strong></td>
<td></td>
</tr>
<tr>
<td>Compression (at 20,000 pounds per square foot)</td>
<td>50 percent</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.20 inches</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>2.5 percent</td>
</tr>
<tr>
<td><strong>Geotextile</strong></td>
<td></td>
</tr>
<tr>
<td>Tear Strength</td>
<td>105/95 pounds</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>300/235 pounds</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>115 pounds</td>
</tr>
<tr>
<td>Apparent Open Size</td>
<td>70 U.S. Standard Sieve Size</td>
</tr>
</tbody>
</table>

The geocomposite will be placed to channel flow of any leachate to the LCRS trench. Deployment of the geocomposite will be either manual or by low ground contact pressure vehicle (i.e., less than 6 pounds per square inch). A visual examination of the deployed geocomposite will be made to verify that no potentially harmful objects (e.g., stones, sharp objects, small tools, sandbags) are present. When connecting the geocomposite rolls, the rolls will be deployed side by side and the geonet joined together at approximately 5-foot intervals. The geotextile will be overlapped a minimum of 3 inches and overlaps will be secured. When connecting the geocomposite rolls end-to-end, the materials will be overlapped a minimum of 12 inches and tied approximately every 6 inches across the width of the roll. The geotextile will be overlapped and secured. Holes or tears in the geonet will be repaired.
by placing a patch of the same type of material over the damaged area. The patch will extend at least 4 inches beyond the edges of the hole or tear. Holes or tears in the geotextile will be repaired using a patch of the same type of material. The patch will extend at least 12 inches beyond any portion of the damaged geotextile.

QA personnel will verify proper installation of the geocomposite. Storage and handling of the geocomposite will be conducted in accordance with ASTM D 4873 to prevent physical damage and exposure to degrading conditions. QA personnel will perform visual observations and inspections during placement, joining, repairs, and covering of the geocomposite.

**Geotextile Wrap**

A geotextile wrap will be installed around the drain aggregate in the LCRS trench, which will be lined with an HDPE geomembrane (Figure 3-11). The geotextile wrap functions as a separator and cushion between the aggregate and the underlying geomembrane liner and between the aggregate and the overlying geocomposite. The geotextile wrap will be a nonwoven fabric consisting of continuous chain polymeric filaments or yarns of polyester, formed into a stable network by needle punching. The fabric will be resistant to biological and chemical degradation normally encountered in a landfill environment. Additionally, the fabric will conform to the following minimum general specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>70 mils</td>
</tr>
<tr>
<td>Tear Strength</td>
<td>55/50 pounds</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>150/125 pounds</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>65 pounds</td>
</tr>
<tr>
<td>Vertical Water Flow</td>
<td>190 gallons per minute per square foot</td>
</tr>
</tbody>
</table>

Deployment of the geotextile wrap will be either manual or by low ground contact pressure vehicle (i.e., less than 6 pounds per square inch). The geotextile roll edges (i.e., end to end in the cell floor and those brought together over the aggregate) will have a minimum overlap of 12 inches and all overlaps will be secured. Patch material used for repair of a hole or tear will be the same type of material as the damaged geotextile. The patch will extend at least 12 inches beyond any portion of the damaged geotextile.

QA personnel will verify proper installation of the geotextile wrap. Storage and handling of the geotextile will be conducted in accordance with ASTM D 4873 to prevent physical...
damage and exposure to degrading conditions. QA personnel will perform visual observations and inspections during placement, seaming, and repair of the geotextile wrap.

**LCRS Piping, Pipe Bedding, and Drain Aggregate**
An LCRS pipe system, pipe bedding, and drain aggregate will be installed within the geotextile wrap in the LCRS trench (Figure 3-11). PVC pipe will be installed within the LCRS trench to transfer leachate to the surface for collection and storage. Pipe located in the bottom of the containment cell will be placed on a prepared pipe bedding surface, which will be Class IA, IB, or II according to ASTM D 2321.

PVC materials will conform to ASTM D 1755. PVC pipe will conform to ASTM D 1785 and will be flush threaded unless otherwise noted. PVC pipe fittings will be in accordance with ASTM D 3034. Schedule 40 PVC pipe (4-inch nominal pipe size) will conform to the following minimum general specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Diameter</td>
<td>4.500 inches</td>
</tr>
<tr>
<td>Average Inner Diameter</td>
<td>4.026 inches</td>
</tr>
<tr>
<td>Minimum Wall Thickness</td>
<td>0.237 inches</td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td>220 pounds per square inch</td>
</tr>
</tbody>
</table>

Schedule 80 PVC pipe (4-inch and 10-inch nominal pipe sizes) will meet the following minimum general specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Diameter</td>
<td></td>
</tr>
<tr>
<td>• 4-inch</td>
<td>4.500 inches</td>
</tr>
<tr>
<td>• 10-inch</td>
<td>10.7500 inches</td>
</tr>
<tr>
<td>Inner Diameter</td>
<td></td>
</tr>
<tr>
<td>• 4-inch</td>
<td>3.826 inches</td>
</tr>
<tr>
<td>• 10-inch</td>
<td>9.564 inches</td>
</tr>
<tr>
<td>Minimum Wall Thickness</td>
<td></td>
</tr>
<tr>
<td>• 4-inch</td>
<td>0.337 inches</td>
</tr>
<tr>
<td>• 10-inch</td>
<td>0.593 inches</td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td></td>
</tr>
<tr>
<td>• 4-inch</td>
<td>160 pounds per square inch</td>
</tr>
<tr>
<td>• 10-inch</td>
<td>NA</td>
</tr>
</tbody>
</table>
Piping will be installed within the collection trench located in the floor and side slopes of the containment cell and at the surface of the containment cell. Piping will be installed true to line and grade and will be free of cracks or defects. Fittings, elbows, and couplings will be threaded.

QA personnel will verify proper installation of the LCRS piping, and will inspect the piping for diameter, thickness, and perforation; and verify that all pipe openings and nozzles are adequately protected.

Prior to placing the bedding and the pipe, the QA Engineer will verify that the bedding beneath and around the pipe is Class IA, IB or II according to ASTM D 2321 and meets the minimum gradation requirements. Additionally, the QA Engineer will verify that field testing and inspections of piping, valves, and fittings are performed in accordance with the specifications. The LCRS pipe bedding material will consist of coarse sand, Class IA, IB, or II according to ASTM D 2321, and will conform to the following minimum gradations:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>75–100</td>
</tr>
<tr>
<td>No. 8</td>
<td>&gt;50</td>
</tr>
<tr>
<td>No. 100</td>
<td>0–10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0–3</td>
</tr>
</tbody>
</table>

The pipe bedding material will be laid beneath the PVC pipe in the bottom of the cell and beneath the 4-inch PVC pipe at the surface on the north end of the cell (Figure 3-11). The bedding material will be laid and compacted in 6-inch maximum layers to a minimum relative density of 90 percent in accordance with ASTM D 4254.

The drain aggregate to be placed within the LCRS trench will be clean, durable, subrounded natural rock fragments, free of organic matter or other deleterious matter. The aggregate will consist of granitic, basic igneous, or quartzitic material and will be Class IA, IB, or II according to ASTM D 2321. At a minimum, the drain aggregate will meet the following gradations:
<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>80–100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>60–100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0–50</td>
</tr>
<tr>
<td>No. 8</td>
<td>0–10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0–3</td>
</tr>
</tbody>
</table>

The drain aggregate will be placed within the collection trench and over the PVC piping.

QA personnel will verify proper placement of pipe bedding and drain aggregate. Laboratory tests of pipe bedding and drain aggregate materials will be performed to document their engineering properties and to verify the acceptability of the material for construction. The laboratory tests will include determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 and grain size analysis in accordance with ASTM D 422. QA personnel will perform visual observations and inspections during placement to ensure adherence to the construction drawings. Field testing of in situ portions of the pipe bedding will be performed to ensure adequate pipe bedding in-place density and moisture content.

**LCRS Fill Materials**

The LCRS fill materials consists of a bentonite/soil mix that will be backfilled around piping exiting the surface of the containment cell (Figure 3-10). Approved soil that will be mixed with bentonite will be obtained from the soils excavated at the containment cell site and will be free of deleterious materials (e.g., rocks, debris, organic material). The approved soil will be mixed with approximately 20 percent by weight bentonite and compacted in 6-inch maximum layers at the top of slope around each LCRS pipe (Figure 3-10) to achieve a minimum relative density of 90 percent in accordance with ASTM D 4254.

Laboratory tests of LCRS fill materials (i.e., bentonite/soil mix) will be performed to document their engineering properties and to verify the acceptability of the material for construction. Bentonite will conform to the following minimum gradation requirements:
<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>97–100</td>
</tr>
<tr>
<td>No. 10</td>
<td>15–20</td>
</tr>
<tr>
<td>No. 20</td>
<td>0–1</td>
</tr>
<tr>
<td>No. 200</td>
<td>0–1</td>
</tr>
</tbody>
</table>

Field testing of in situ portions of the bentonite/soil backfill for density will be performed to verify that construction performance meets the design requirements. Field tests on the fill materials include determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017.

**LCRS Pumps**

The LCRS pneumatic pump is designed to accommodate anticipated leachate flow rates for average precipitation events. This submersible pump is capable of pumping up to 9.5 gallons per minute while requiring minimal maintenance throughout the life of the containment cell. If a significantly large storm event (e.g., 25-year, 24-hour storm) occurs during early stages of waste placement, the pneumatic pump will be temporarily replaced with a higher capacity (i.e., 40 gallons-per-minute) portable electric pump to expedite the removal of leachate from the containment cell. The electric pump will operate at much higher flow rates than the pneumatic pump and, therefore, will cycle on and off frequently during average precipitation events, increasing wear on the pump. Additionally, the electric pump has rotatory parts which can clog and require frequent maintenance. The pneumatic pump will offer greater reliability with lower maintenance than the electric pump. Thus, it is preferable to use the portable electric pump only during extreme precipitation events for short periods of time if they occur during early stages of waste placement.

**3.1.4.2.3 Geomembrane Liner System**

Across the entire containment cell and below the LCRS is a 60-mil HDPE liner system, smooth on both sides (Figure 3-11). The liner system will act as the initial barrier for preventing leachate migration out of the containment cell. A second 60-mil HDPE liner system is placed in the sump area to provide additional redundancy. HDPE exhibits excellent weather resistance, is resistant to many chemicals, has a high degree of puncture resistance, and can be readily joined in the field. The HDPE liner will meet minimum general specifications for the following properties:
<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>60 mil</td>
</tr>
<tr>
<td>Density</td>
<td>0.94 grams per cubic centimeter</td>
</tr>
<tr>
<td>Tensile Strength (at break)</td>
<td>300 pounds per inch-width</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>50 pounds</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>90 pounds</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>2 percent</td>
</tr>
</tbody>
</table>

Installation of the geomembrane will conform to approved manufacturer’s installation guidelines. In addition, QA personnel will observe the placement and covering of the geomembranes. Construction equipment will not be operated directly on the underlying GCL or the geomembrane. In cases where rolls must be moved over the previously placed GCL or geomembrane, the materials will be moved by hand or by small lifting units on pneumatic tires. Tire contact pressures will be limited to a maximum value of 6 pounds per square inch.

Destructive testing will be accomplished by cutting out and removing a portion of the completed production seam and then further cutting the sample into appropriately sized test specimens. Tests on these test strips will be conducted to estimate the quality of the production field seams. The test strips will be made in sufficient lengths, as a single continuous seam, for required testing purposes. Test strips will be made approximately every four hours, whenever the installation crew or equipment are changed, and when climatic conditions reflect wide changes in geomembrane temperature, or when other conditions occur that could affect seam quality. Samples will be cut into five shear and five peel test specimens.

All field seams will be nondestructively tested over their full length using a vacuum test unit, air pressure testing, or other QA-approved method where applicable. Nondestructive testing is meant to verify the continuity of field seams.

3.1.4.2.4 Geosynthetic Clay Liner System
A GCL will underlie the geomembrane and will function as a leachate barrier layer in the event that the overlying HDPE geomembrane fails. The GCL will be placed directly above the prepared wicking materials in the bottom of the cell and over the prepared side slopes (Figures 3-10 and 3-11). The GCL consists of nonwoven geotextile outer layers needle-punched through an inner layer of low-permeability sodium bentonite. Sodium bentonite is a clay mineral with very high swelling potential and water absorption capacity. A double
nonwoven needle-punched GCL was selected because of its high internal shear strength, resistance to lateral migration of the bentonite, and low permeability. The GCL specified has a maximum hydraulic conductivity of $1 \times 10^{-9}$ centimeters per second with a minimum of 1 pound per square foot of sodium bentonite clay. The GCL will meet minimum general specifications for the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>0.24 inches</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>210 pounds</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>220 pounds</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>15 pounds</td>
</tr>
<tr>
<td>Water Permeability</td>
<td>$1 \times 10^{-9}$ centimeters per second</td>
</tr>
</tbody>
</table>

The deployed GCL will be visually inspected to verify that no potentially harmful objects are present (e.g., stones, tools). The GCL rolls will be laid in accordance with the manufacturer’s recommendations and design considerations. Adjacent GCL sheets will be overlapped according to match lines on the bottom sheet. Overlap distance will be approximately 10 inches from the edge of the sheet. On the side slopes, the rolls will be secured at the top of the slope and extended down the slope as recommended by the manufacturer. Any patch used for repair of a tear or rip in the GCL will consist of the same material as the damaged GCL or other approved geotextile. The patch will extend a minimum of 12 inches beyond any damaged portion and will be sealed using the same bentonite in the overlap region.

QA personnel will verify proper installation of the GCL. Upon delivery of GCL rolls to the field site, the QA Engineer will inspect delivery tickets and the GCL manufacturer’s QA reports, verify that QA certificates have been provided for the rolls delivered, and visually inspect the rolls for damage. Handling and storage of GCL rolls will be in accordance with ASTM D 4873. QA personnel will perform visual observations and inspections to ensure proper placement, joining, repair, and covering of the GCL.

### 3.1.4.3 Evaluation of Bottom Liner System Components

The following geosynthetic liner system components were evaluated through modeling, calculations, and a review of vendor information for performance under the anticipated containment cell loading conditions:

- Geonet with a bonded geotextile (leachate collection and removal layer)
• Geotextile wrap
• GCL.

The static loadings as well as dynamic loadings produced by construction equipment were considered in this evaluation. In addition, factors of safety for puncture resistance were calculated for the appropriate bottom liner system components and determined to be acceptable for the anticipated loads. The following sections present the results of the analyses of each component.

### 3.1.4.3.1 Geonet with a Bonded Geotextile

The geocomposite consists of a geotextile bonded to one side of a geonet. The geocomposite will have low compressibility in order to maintain high-flow capacity over a wide range of confining pressures and to prevent collapse under the pressures exerted by the overlying waste, the final cover system, and heavy equipment operations. The geocomposite will maintain a high flow under long-term loading conditions and will be resistant to biological or chemical degradation normally encountered in a soil environment.

The critical aspect of the geocomposite is flow capacity under loaded conditions. The transmissivity for the geocomposite under a maximum expected static load of about 3,600 pounds per square foot is $1.8 \times 10^{-3}$ square meters per second. Although the containment cell is not subject to the requirements for a RCRA landfill as specified in 40 CFR §264.301, this transmissivity offers a two-order-of-magnitude increase over the 40 CFR Part 264, Subpart N, requirement that the LCRS have a geonet drainage material with a transmissivity of $3 \times 10^{-5}$ square meters per second or more.

Other design aspects that have been included in the geonet design are safety factors for intrusion of geotextiles into the geonet core space and creep deformation of the geonet. Additionally, the geonet is designed to minimize chemical and biological clogging during the active life and post-closure period. An evaluation, which included the aforementioned safety factors, was performed for the overall geonet transmissivity. The evaluation resulted in an overall minimum allowable transmissivity of $3.5 \times 10^{-4}$ square meters per second, which in turn produces an acceptable safety factor of 12.

### 3.1.4.3.2 Geotextiles

The geotextiles will consist of polyester nonwoven fabric. Geotextiles are specified for two separate applications in the containment cell. A geotextile wrap will be placed around the
LCRS trench to provide protection of the other liner system components from the drainage rock associated with the trench. Additionally, a geocomposite drainage layer consisting of a geotextile bonded to the upper surface of a geonet will be placed across the bottom of the containment cell.

The critical aspect of the geotextile wrap is puncture resistance. The maximum size of the drainage rock aggregate will be 0.75 inches. Based on this aggregate size and the maximum static load anticipated, the safety factor against puncture of the geotextile wrap is 1.8. Although this safety factor is acceptable, a blunt, nonsharp aggregate (as opposed to crushed rock) will be used for added protection against puncture.

Adequate flow capability was evaluated assuming a flow into the geotextile equal to the 25-year, 24-hour storm event. Results indicate that the permeability of the geotextile is several orders of magnitude greater than the required permeability. Adequate soil retention was evaluated using sieve analysis data obtained during the geotechnical investigation for the proposed CAMU. As a result of the soil retention evaluation, a gradation requirement was specified for the protective soil cover which will allow the use of selected on-site soil for the protective cover and prevent the migration of fines into the LCRS.

### 3.1.4.3.3 Double Nonwoven Geosynthetic Clay Liner

The critical aspect of the GCL is permeability under loaded conditions. The technical specifications for the proposed product indicate that the water permeability for the expected maximum static load of about 3,600 pounds per square foot is $1 \times 10^{-9}$ centimeters per second. Although the containment cell is not subject to 40 CFR Part 264, Subpart N, requirements, this permeability is two orders of magnitude less than the maximum required Subpart N permeability of $1 \times 10^{-7}$ centimeters per second typically required for 3-foot-thick compacted soil material.

### 3.1.4.3.4 Chemical Compatibility

The chemical compatibility of the geotextile materials was evaluated relative to the contaminants of concern associated with ER Project wastes, treatment performance specifications, and properties of the geosynthetics. Based on the current understanding of the hazardous remediation wastes requiring emplacement in the containment cell, the geotextile materials selected are inert to all potential contaminants in the treated hazardous remediation wastes.
The geotextiles, geonet, and geomembrane are composed of polypropylene, polyethylene, and HDPE, respectively. Chemical resistance data obtained from vendor information for these materials indicate no chemical compatibility problems for the anticipated chemical constituents and concentrations after treatment.

Hydration of the GCL was evaluated with regard to potential bentonite hydration effects caused by anticipated leachate characteristics. Landfill leachate containing hydrocarbons is known to have detrimental effects on bentonite hydration (i.e., hydraulic conductivity values are much higher). However, because the treated hazardous remediation waste to be placed in the containment cell will be solid and will not contain significant concentrations of hydrocarbons, no problems associated with hydration of the GCL are anticipated.

3.1.4.4 Description of Sidewall Liner System Components

The sidewall components of the liner system are described in this section (Figures 3-9, 3-10, and 3-11). Liner system components will extend up the entire length of the containment cell sideslope and will be secured in an anchor trench surrounding the containment cell. Installation of the sidewall components of the liner system is independent of the volume of waste to be emplaced. An HDPE protective cover sheet will be placed over the LCRS trench on the side slopes to protect the underlying drainage layers.

The sidewall liner system components include the following in descending order:

- Protective cover sheet: 60-mil smooth HDPE (placed over the LCRS trench on the side slopes)
- Geomembrane: 60-mil smooth HDPE
- Geosynthetic clay liner
- Prepared subgrade.

Material specifications, installation procedures, and construction QA for the sidewall liner components are identical to those described for the bottom liner components (see Sections 3.1.4.2.3 and 3.1.4.2.4).

3.1.4.4.1 Protective Cover Sheet

A 60-mil HDPE cover sheet (smooth on both sides) will be placed over the LCRS trench on the north and south side slopes (Figure 3-10). The cover sheet will protect the underlying
geotextile wrap surrounding the drain rock from ultraviolet degradation and from clogging via windblown dust and dirt. The protective cover sheet will be field-welded to the geomembrane liner system at the edges of the LCRS trench.

3.1.4.4.2 **Geomembrane Liner System**

With the exception of the LCRS trench, a 60-mil HDPE geomembrane liner system that is smooth on both sides will be the uppermost layer on the sidewalls (Figure 3-10). The geomembrane will provide the initial barrier for the prevention of leachate migration out of the containment cell. HDPE exhibits excellent weather resistance, is resistant to many chemicals, has a high degree of puncture resistance, and can be readily joined in the field.

3.1.4.4.3 **Geosynthetic Clay Liner System**

The sidewall liner system GCL is identical to the bottom liner system GCL described in Section 3.1.4.2.4.

3.1.4.4.4 **Prepared Subgrade**

The prepared subgrade will be below and in direct contact with the GCL and, therefore, must be properly prepared prior to the installation of the GCL. The subgrade will be compacted so that it will not rut or deform under the weight of installation equipment. The base must be smooth and free of roots, debris, large voids, and rocks greater than 0.5 inch in diameter.

3.1.4.5 **Sidewall Liner System Slope Stability**

Slope stability analysis of the containment cell sidewall liner system was performed using the computer model STABLSM for a 2:1 slope. Safety factors for each liner system component interface were calculated for an empty cell condition. The analysis was performed on the containment cell slope with the maximum length (40 feet) and associated maximum depth (20 feet) for both static and dynamic (earthquake) conditions.

Slope stability modeling performed on the sidewall liner system resulted in minimum safety factors of 2.69 for static conditions and 2.16 for dynamic conditions. If the calculated safety factor falls below 1.0, a slope stability failure is anticipated. These safety factors are significantly greater than one and are considered acceptable with regard to side slope stability.

3.1.4.6 **Additional LCRS Details**

As presented in Section 3.1.4.2.2, the LCRS will be constructed in the bottom of the containment cell to collect and withdraw fluid, if any, from the cell during operations and
during the post-closure period. The system includes a sump in the north end of the containment cell, a pipe in a central trench located above the geomembrane liner system, and a dedicated pump to remove liquids that appear in the sump, and a geocomposite layer (Figures 3-9, 3-10, and 3-11). The following sections describe additional details regarding the design of the LCRS and its components.

3.1.4.6.1 Components of the Leachate Collection and Removal System

The LCRS trench will be centrally located at the bottom of the containment cell (Figure 3-9). The trench will traverse the bottom of the containment cell from the south to the north and will be sloped approximately 1 percent toward the north. The bottom of the containment cell will have an approximate 2-percent double-inward slope to drain toward the central trench. The trench will receive any leachate from the geocomposite drainage layer.

The collection pipe in the bottom trench will be constructed of slotted 4-inch-diameter PVC pipe. The slotted portion of the 4-inch collection pipe will have four rows of slots, 0.125-inch wide, and an outside slot length of 1.75 inches with 0.5-inch between slots. The 4-inch pipe will be placed on 4 inches of bedding/haunching material along the bottom of the trench and covered by subrounded 0.75-inch drain rock. The drain rock will provide both support to the piping and additional capacity in the trench and sump. A geotextile wrap will surround the drain rock and will protect adjacent liner system materials from puncture. A 4-inch-diameter PVC riser pipe will extend from the LCRS trench on the south end, up the sidewall trench, to provide an LCRS cleanout capability.

The sump, or low point for drainage of leachate, will be located at the north end of the containment cell. The sump will be sloped to the north five percent to a maximum depth of 2 feet below the base of the bottom of the cell. The sump will contain a 10-inch-diameter PVC riser access pipe that is slotted at the bottom to collect leachate. The slotted portion of the 10-inch pipe will have six rows of slots, 0.125-inch wide, and an outside slot length of 2.75 inches with 0.5-inch between slots. Minimum specifications for the PVC pipe have been discussed previously in Section 3.1.4.2.2. A submersible pneumatic pump will be fitted into the base of the riser pipe. A 1.25-inch-diameter nylon tube will be connected to the submersible pump to deliver leachate to the above-ground leachate collection tank, which will be managed in accordance with applicable requirements of 40 CFR §262.34(a).
Schedule 80 pipe is used for all LCRS applications within the containment cell. Schedule 40 PVC pipe serves as secondary containment for the nylon tubing leachate discharge line from the surface of the cell to the drain box in the leachate storage area. All PVC pipe connections will be flush threaded. After the pipe has been installed and the bedding and drain aggregate placed, the interior of the pipe will be inspected for proper installation using acceptable inspection methods, such as video camera.

3.1.4.6.2 **Components of the Leachate Collection Area**

The leachate collection area will be located north of the containment cell, across the perimeter road from the cell. The collection area will be comprised of a bermed asphaltic concrete pad and a single 20,000-gallon tank. The leachate collection tank will be a less-than-90-day collection tank operated in accordance with the applicable requirements of 40 CFR §262.34(a). The bermed asphaltic concrete pad provides secondary containment for the capacity of the leachate collection tank.

A 4-inch diameter PVC pipe will double contain 1.25-inch nylon tubing and will convey leachate from the LCRS sump to the leachate collection tank. The double-contained pipe will be routed across the drainage swale and buried two feet under the perimeter road. The 4-inch-diameter PVC pipe will be stubbed in within the collection area in the immediate vicinity of the leachate collection tank. This pipe will also be used to route air and control lines back to the pneumatic pump located in the bottom of the LCRS sump. A high-level sensor will be installed through an opening in the top of the leachate collection tank. When liquid is detected at tank capacity, the sensor will activate a switch that will shut down the LCRS pneumatic pump to prevent overfilling of the tank.

The 20,000-gallon tank will accommodate the leachate generated during the routine waste emplacement operations at the CAMU and during the post-closure period. Leachate will be managed as a listed hazardous waste (e.g., EPA Hazardous Waste Number F039).

3.1.4.7 **Final Cover**

The final cover of the containment cell, described in detail in the closure plan (Appendix D), is designed and will be constructed to meet the following performance standards:

- Provide long-term minimization of migration of liquids through the closed containment cell
• Accommodate for settling and subsidence so that the integrity of the containment cell cover is maintained

• Have an unsaturated hydraulic conductivity less than or equal to that of any bottom liner system or natural subsoils

• Promote drainage and minimize erosion or abrasion of the containment cell cover.

The final cover designed for the CAMU is intended to ensure protection of human health and the environment during the CAMU postclosure period.

3.1.4.8 Vadose Zone Monitoring System

A VZMS, which is described in detail in the proposed alternative to groundwater monitoring (Appendix E), will be placed under the containment cell and is intended to provide real-time information on the containment cell’s performance. The VZMS consists of the following three subsystems:

• Primary Subliner Monitoring Subsystem
• Vertical Sensor Array Monitoring Subsystem
• Chemical Waste Landfill and Sanitary Sewer Line Monitoring Subsystem.

The three subsystems are designed to be used in an integrated fashion to achieve a high probability of detecting “real” leakage from the containment cell (i.e., low false-negative rate) and to avoid false detections caused by environmental factors outside the control of CAMU operation (i.e., low false-positive rate). The design allows for detection monitoring and if a leak is suspected, for additional activities (i.e., assessment monitoring) to effectively determine whether a leak has actually occurred, and if so, the general character and magnitude of the leak. The design includes features that will allow identification of a situation where in situ condensation buildup, moisture increases from a nearby sanitary sewer, and/or organic vapors from a nearby inactive landfill have resulted in false indication of containment cell leakage.

3.1.5 Waste Management Operations—40 CFR §264.552(c)(2)

Design and stringent administrative and institutional controls for waste management activities associated with the CAMU will reduce unacceptable risks to humans or the environment resulting from exposure to hazardous remediation waste.
Section 3.1.1 describes the hazardous remediation waste to be managed at the CAMU. Remediation waste will be characterized and appropriately segregated at the generation site to assure proper staging and management upon acceptance at the CAMU. Analytical results and other waste identification documentation will accompany the remediation waste to the CAMU. At a minimum, other waste identification documentation will consist of a disposal request form, waste profile form, or an equivalent form completed and signed by the generator. If analytical results and other waste identification documentation do not accompany the waste to the CAMU, if there is a discrepancy between the documentation and the waste, or if the documentation indicates that the waste contains radioactive contamination or TSCA-regulated levels of PCBs or asbestos, the remediation waste will not be accepted into the CAMU. Upon acceptance at the CAMU, the hazardous remediation waste will be tracked by CAMU personnel from the entrance, to the waste staging areas, to the treatment area, and to the containment cell or transportation off-site. Figure 3-13 presents the overall CAMU waste material flow from the point of acceptance to disposition.

Waste generated at the CAMU that is suspected of being contaminated with hazardous constituents (e.g., leachate, stormwater runoff, decontamination liquids) will be characterized by process knowledge and/or sampling and analysis, as appropriate, to determine proper management and disposition. If determined to be hazardous, such wastes will either be managed at the CAMU as remediation waste or transferred to SNL/NM Waste Operations and managed with other “as-generated” hazardous waste. Section 3.1.4.6.2 describes the management of leachate generated from the CAMU containment cell. Similarly, management of stormwater collected within the CAMU is described in Section 3.5.2. Decontamination fluids may be used as makeup water for the treatment systems (e.g., stabilization) or managed similar to stormwater if determined to be non-hazardous.

3.1.5.1 Bulk Waste Management Operations

Bulk wastes are those wastes which are not containerized. Bulk wastes will be characterized and appropriately segregated at the site of generation. The volume and potential constituents of concern for the bulk waste will be recorded, and the bulk hazardous remediation waste will then be taken to the appropriate location at the bulk waste staging area or to the treatment area, as directed by the CAMU Operations Coordinator or designee.

At the bulk waste staging area, bulk RCRA-regulated listed hazardous waste will be segregated from bulk RCRA-regulated characteristic hazardous waste to eliminate cross-contamination. As described in Section 3.1.2.3, the bulk waste staging area consists of an
Corrective Action Management Unit (CAMU) General Waste Material Flow: Point of Acceptance to Disposition
asphaltic concrete pad surrounded by a 15-foot-high concrete masonry-unit wall. The staging area is divided into six compartments by 15-foot-high interior walls (see Figure 3-6), which will provide physical barriers to segregate the bulk listed wastes from the bulk characteristic (i.e., ignitable, corrosive, reactive, or toxic) wastes. Temporary concrete barriers may be added to any of the six compartments to provide additional segregation capability. Bulk waste will be sampled prior to treatment. Typically, bulk listed hazardous wastes may be blended with other bulk listed waste prior to batch treatment, but will not be blended with bulk characteristic hazardous waste. Similarly, bulk characteristic hazardous waste may be blended with other bulk characteristic waste prior to batch treatment, but will not be blended with listed hazardous waste.

Front-end loaders may be used to manage the bulk waste within the bulk waste staging and treatment areas. The bulk waste will remain covered with plastic sheeting while awaiting treatment to reduce fugitive dust and potential exposure by human or environmental receptors. The cover will be removed from the bulk waste only to add waste to the mound or to transport the bulk waste to the treatment area.

Operations at the bulk waste staging area refer to waste handling activities associated with managing waste. During periods when contaminated waste is not being actively transported at the area, the bulk waste staging area is considered to be in a maintenance mode. Waste-handling activities include the formation of soil and debris mounds and loading and unloading the haul trucks. Waste-handling activities will be terminated prior to severe weather conditions (e.g., high winds or precipitation). The CAMU Operations Coordinator must be cognizant of current and impending weather conditions and direct CAMU waste management activities accordingly.

Trucks hauling covered bulk waste payloads will enter the bulk waste staging area through the center access road. From the access road, trucks will back up to a predetermined location on the bulk waste staging area pad and dump waste payloads. A front-end loader will then manage the unloaded waste to form soil and debris mounds up to 15 feet high. Immediately following the unloading of contaminated material (soil or debris), any residual soil that may have accumulated on the outside or inside of the truck bed will be removed and the truck bed will be re-covered before the truck leaves the bulk waste staging area. Contaminated soil on the dump truck will be removed manually with standard shop-type push brooms and brushes. This operational procedure will minimize the potential spread of contamination between the bulk waste staging area and the equipment decontamination pad. Before leaving the CAMU,
the trucks will be driven to the equipment decontamination pad where full decontamination will be conducted.

Potentially contaminated areas of the asphaltic concrete pad resulting from formation of soil and debris mounds will be swept clean manually. Any accumulation of residual material from sweeping contaminated areas of the asphaltic concrete pad will be placed in the appropriate soil or debris mound. This operational procedure will minimize surficial contamination on the asphaltic concrete pad that could otherwise contaminate storm water runoff or be carried off-site by wind.

Treated listed or characteristic bulk hazardous waste will be staged by batch at the treated waste staging areas for sampling and analysis to determine if contamination levels meet the established treatment standards. Treated bulk waste will remain covered to reduce fugitive dust and potential exposure to human or environmental receptors. The cover will be removed only to add compatible (i.e., as presented in EPA guidance documents or other chemical compatibility references) bulk treated waste; to transport the bulk treated waste to another CMTU; to transport the bulk treated waste for emplacement into the containment cell; to transport the bulk treated waste to a waste staging area for disposition at an off-site permitted TSDF; or to transport the bulk treated non-RCRA hazardous waste (i.e., treated characteristic hazardous waste) off-site for use by SNL/NM Facilities in construction activities.

Treated bulk waste that is not derived from listed waste and no longer exhibits hazardous waste characteristics may be used as fill in the containment cell or may be used as clean fill for SNL/NM Facilities construction activities at SNL/NM sites only. Only treated characteristic wastes that meet specified treatment standards, defined in a separate permit modification request for CMTUs, may be emplaced in the CAMU containment cell. Disposition of waste generated during the treatment of the bulk hazardous remediation waste (i.e., loaded carbon absorption unit from a thermal desorption treatment unit) will be addressed in a permit modification request to be submitted for CMTUs.

3.1.5.2 Containerized Waste Management and Phased CAMU Operations

Containerized waste may arrive at the CAMU on flat-bed trucks or other large vehicles. Prior to placing waste into containers for transport to the CAMU, the waste is characterized to determine the presence of RCRA-listed waste/constituents and/or hazardous characteristics (i.e., ignitability, reactivity, toxicity). The waste analyses results and other waste characterization documentation (i.e., disposal request form, waste profile form, or an
equivalent form) are reviewed by the CAMU Operations Coordinator or designee (see Appendix C) for acceptance into the CAMU. The volume and potential contaminants of concern for the containerized waste will be recorded, and the containerized waste may be taken directly to the treatment area, or the containerized waste may be staged at the bulk waste staging area, the containerized waste staging area, or in the Sprung™ structures. All containers of liquid waste and containers of waste that may include free liquids will be placed inside the Sprung™ structures on commercially-available pallets that provide adequate secondary containment in accordance with 40 CFR §264.175(b)(3). Containers of solid waste (e.g., soil, debris, PPE) will be staged at any one of the three staging areas depending on container type, segregation requirements, available capacity, and potential treatment schedule. Incompatible wastes are segregated by placing the waste in separate staging areas or by adequately spacing the waste within the same staging area. Section 3.1.2 presents additional information on the staging areas.

Containerized RCRA-regulated listed hazardous wastes will be segregated from containerized RCRA-regulated characteristic hazardous waste throughout staging, treatment, and subsequent management. Typically, containerized listed hazardous wastes may be blended with other listed waste prior to batch treatment, but will not be blended with characteristic hazardous waste. Characteristic hazardous waste may be blended with other characteristic hazardous waste prior to batch treatment, but will not be blended with listed hazardous waste.

Treated containerized hazardous waste will be staged by batch at the treated waste staging areas for sampling and analysis to determine if contamination levels meet the established treatment standards. Treated waste will remain covered to reduce fugitive dust and potential exposure to human or environmental receptors. The cover will be removed only to add compatible (i.e., as presented in EPA guidance documents on waste compatibilities) treated waste; to transport the treated containerized waste to another CMTU; to transport the treated containerized waste for emplacement into the containment cell; to transport the treated containerized waste to a waste staging area for disposition at an off-site permitted TSDF; or to transport the treated containerized non-RCRA hazardous waste (i.e., treated characteristic hazardous waste) off-site for use by SNL/NM Facilities in construction activities. Figure 3-14 summarizes possible CAMU waste treatment processes. Front-end loaders, fork-lifts, and dump trucks or other appropriate vehicles may be used to transport the waste.

Treated containerized waste that is not derived from listed waste and no longer exhibits hazardous waste characteristics may be used as fill in the containment cell or may be used as
Soil with TCLP organics, TCLP organics and metals, and/or listed hazardous waste

Sludge, drilling mud with TCLP organics; with TCLP organics and metals, and/or with listed hazardous waste

Water vapor: to atmosphere

Vapor phase: carbon adsorption

Contaminated vapor

Soil with TCLP metals

Soil washing

Stabilization

Stabilization materials binder additives water

Grout

Debris with TCLP metals and organics and/or listed hazardous waste

Size reduction

Layout materials

Packaging

In container stabilization grouting

LEGEND

TCLP

Incoming hazardous remediation waste

Toxicity characteristic leaching procedure

Figure 3-14
Corrective Action Management Unit (CAMU) Waste Treatment Detail
clean fill for SNL/NM Facilities construction activities at SNL/NM sites only. Only treated characteristic wastes that meet specified treatment standards, defined in a separate permit modification request for CMTUs, may be emplaced in the CAMU containment cell. Disposition of waste generated during the treatment of the containerized hazardous remediation waste (i.e., loaded carbon absorption unit from a thermal desorption treatment unit) will be addressed in a permit application or modification request to be submitted for CMTUs.

CAMU operations can be divided into two phases. The first phase includes staging of waste prior to treatment with no activities in the containment cell. The second phase includes treatment of waste and placement of waste into the containment cell.

In the first phase of operations, activities are initially restricted to staging operations, during which time hazardous remediation wastes are accumulated and segregated at the CAMU until enough waste is accumulated to begin treatment operations. During the initial period of operation at the CAMU, the containment cell is open. Any precipitation that enters the empty cell will be collected in the LCRS, pumped to the leachate collection tank and either discharged to the surface under a valid Notice of Intent or to the TA-III sanitary sewer system under an approved discharge permit.

In the second phase of operations, waste not requiring treatment (see discussion in Section 3.1) is placed in the containment cell and untreated waste requiring treatment is moved from the staging areas to the treatment area. As waste is treated, each batch is segregated at the treated waste staging area. If the treated listed waste meets negotiated treatment standards, or if the treated characteristic waste no longer exhibits the RCRA-regulated hazardous waste characteristics, the treated waste may be moved from the treated waste staging area to the containment cell. If the waste does not meet the negotiated treatment standards or continues to exhibit hazardous waste characteristics, the waste is containerized and may be placed into the containment cell. Waste entering the containment cell will be unloaded in temporary unloading areas. These areas will be constructed and subsequently covered during waste filling operations. The bulk waste will be spread with a dozer from the unloading areas, placed in maximum loose lifts of 8 to 12 inches, and compacted with a sheepsfoot compactor (or other compaction equipment suitable for granular soils). Individual waste containers will be placed by forklift in an up-right position at least 2 feet from the sidewall liner system. Treated or native soil will be placed around the containers to buffer them from other containers and to keep the containers up-right. The
primary source of "clean" fill will be the material removed during excavation of the containment cell. Soils used as structural fill material will conform to the following minimum gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 200</td>
<td>10-30</td>
</tr>
</tbody>
</table>

In addition, soils used as backfill material will be free from deleterious materials (e.g., roots, grass, other vegetable matter, clay lumps, rocks) and will have a plasticity index of not greater than 15 as determined by ASTM D 4318. No containers with liquids will be placed in the containment cell. Physical segregation of the waste will be necessary to prevent hard or sharp objects from contacting the liner system. No waste containing hard or sharp objects greater than 0.5-inch in diameter will be placed within 2 feet of the sidewall liner system. Additionally, to assure slope stability, no waste shall be placed higher than one lift (i.e., 8 to 12 inches) above the top of any lined sidewall. Placement of waste in the containment cell will be recorded in the operating log.

During the second phase of operations, treatment campaigns may not be continuous. Therefore, placement of waste into the containment cells may be interrupted while additional waste is accumulated for treatment. At the end of each treatment campaign when placement of waste into the containment cell is to be interrupted by more than several weeks, the bulk waste placed into the cell will be covered with approximately 18 inches of clean fill (e.g., native soil removed from the cell during excavation). However, during the short-term interruptions of waste placement (i.e., less than several weeks), the bulk waste in the containment cell will be sprayed with water each day to control fugitive dust. Any precipitation entering the cell is collected in the LCRS and managed as leachate with the EPA Hazardous Waste Number F039.

When treatment operations resume from a longer interruption, approximately 9 inches of the clean fill in the containment cell is removed and segregated at the side of the cell. Additional treated waste is placed in the cell as stated above. If the treatment operations are again interrupted for a long duration, the approximately 9 inches of clean fill is placed on the treated bulk waste, and approximately 9 additional inches of clean fill is placed in the cell.
Removal and placement of clean fill in the cell is conducted using metered poles placed along the sidewalls and survey techniques to ensure that bulk waste material in the containment cell is not disturbed.

3.1.6 Potential for Exposure to Humans and Environmental Receptors—40 CFR §264.552(c)(2)

The proposed CAMU design, operations, maintenance, and closure procedures ensure that staging, treatment, and containment of hazardous remediation waste will be conducted in a manner that protects human health and the environment, in accordance with 40 CFR §264.552(c)(2). The design and hazardous remediation waste management practices for the CAMU are described in Sections 3.1.1 through 3.1.5. Emergency response actions to be taken to minimize adverse impacts of unanticipated events are described in the contingency plan (see Appendix B). Procedures and equipment used to prevent hazards are discussed in Section 3.5.

3.1.6.1 Protection of Groundwater

The management and containment of hazardous remediation waste at the CAMU will effectively prevent environmental contamination, including migration of hazardous remediation waste constituents to the groundwater. Furthermore, in the unlikely event of a release from the containment cell to the subsurface soil, the VZMS is capable of detecting any release of a volume capable of migrating to groundwater (see Appendix E). Therefore, adverse effects on human health or the environment due to the migration of hazardous remediation waste constituents to the groundwater as a result of CAMU operations are unlikely.

Hydrogeologic Assessment and Potential Pathways and Exposure Routes

SNL/NM is located in an arid region with an average annual precipitation of approximately 9 inches. Half of the average annual precipitation occurs in the form of brief but heavy thunderstorms during the summer period, July through September. Evapotranspiration in the area has been estimated at 95 percent of the annual rainfall. The depth to saturated groundwater underlying ER Site 107 is approximately 500 feet.

SNL/NM has an established extensive groundwater monitoring system to assess the quality of the groundwater in the SNL/NM area. The monitoring network includes observation wells, test wells, production wells, and other hydrogeologic devices. Routine samples are analyzed for toxic constituents, basic water quality, and water levels. The results are published
annually in the “Groundwater Monitoring Report.” Several major well fields have been developed in the regional aquifer to support the City of Albuquerque, KAFB, and surrounding areas. The closest well field is located approximately 4.5 miles north-northwest and downgradient of the proposed CAMU, and the closest downgradient water-supply well is KAFB-4.

The waste management areas at the CAMU have been designed with engineered barriers (e.g., concrete and asphaltic concrete pads) in place between the hazardous remediation waste and the soil surface, and berms and masonry walls to further reduce the potential for contact between the waste and soil surface. The types of barriers at the CAMU include asphaltic concrete at the bulk waste staging area and treatment area, base course at the containerized waste staging area, concrete at the Sprung™ structures, and a liner system associated with the containment cell. In addition, administrative and operational controls will be instituted at the CAMU to minimize the potential for environmental contamination that would result from precipitation contacting hazardous remediation waste or from the direct contact of hazardous remediation waste and surface soil. The CAMU is designed and will be operated to limit the potential groundwater pathway and exposure routes.

3.1.6.2 Protection of Surface Water
The hazardous remediation waste management practices and containment features at the CAMU will effectively prevent environmental contamination, including migration of hazardous remediation waste to surface water or wetlands. Therefore, adverse effects on human health or the environment due to the migration of hazardous remediation waste to surface water or wetlands as a result of CAMU operations are unlikely.

Hydrologic Assessment and Potential Pathways and Exposure Routes
As discussed in Section 3.1.6.1, SNL/NM is located in an arid region that receives approximately 9 inches of precipitation annually. The only surface water at SNL/NM is in the form of sheet flow that drains into small gullies during precipitation events. The water is carried by natural and artificial flow paths into intermittent surface channels at SNL/NM; however, most of the water does not reach the Rio Grande because of evapotranspiration and percolation (SNL/NM, 1993).

The topography in the vicinity of the CAMU is relatively flat, and stream flow is slow. Waste management areas at the CAMU are bermed to collect and direct precipitation to one of four storm water retention ponds: the sitewide storm water retention pond, the bulk waste
staging area storm water retention pond, the treatment area storm water retention pond, or the
containment cell perimeter storm water retention pond. Administrative and operational
controls will be followed at the CAMU to minimize the potential for environmental
contamination that would result from precipitation contacting hazardous remediation waste.
SNL/NM administrative and operational controls for storm water retention ponds will be
followed which describe sample collection, analysis, and storm water management. The
CAMU has been designed and will be operated to limit the potential surface water pathway
and exposure routes.

3.1.6.3 Protection of Surface Soil

The hazardous remediation waste management practices and containment features at the
CAMU will effectively prevent environmental contamination, including migration of
hazardous remediation waste to surface soil. Therefore, adverse effects on human health or
the environment due to the migration of hazardous remediation waste to surface soil as a
result of CAMU operations are unlikely.

Geologic Assessment and Potential Pathways and Exposure Routes

Soil at ER Site 107 is predominantly Madurez loamy fine sand and Tijeras gravelly fine
sandy loam with a 1 to 5 percent slope, and moderate runoff and water erosion potentials
(SNL/NM, 1993).

The waste management areas at the CAMU are designed with engineered barriers in place
between the hazardous remediation waste and the soil surface, and berms and masonry walls
to further reduce the potential for contact between the waste and soil surface. The types of
barriers at the CAMU include asphaltic concrete at the bulk waste staging and treatment areas,
concrete at the Sprung™ structures, base course at the containerized waste staging area, and a
liner system at the containment cell. In addition, administrative and operational controls will
be followed at the CAMU to minimize the potential for environmental contamination that
would result from precipitation contacting hazardous remediation waste or from the direct
contact of the hazardous remediation waste and the surface soil, limiting the pathway and
exposure routes. Plastic sheeting or similar material will be secured over the waste between
waste handling operations or during storm events. In the unlikely event that a release from
the bulk waste staging area or treatment area occurs and reaches the soil surface, soil erosion
by storm water or winds could potentially transport these contaminants to the surrounding
area.
Administrative and operational controls will be followed at the CAMU to minimize the potential for environmental contamination that would result from hazardous remediation waste contacting the surface soil. Preventive measures to be included in the administrative and operational controls are good housekeeping procedures, decontamination procedures, and waste handling procedures (see Sections 3.1.5.1, 3.1.5.2, and 3.1.6.4). The CAMU is designed and will be operated to limit the potential surface soil pathway and exposure routes.

3.1.6.4 Protection of the Atmosphere

The hazardous remediation waste management practices and containment features at the CAMU will effectively prevent environmental contamination, including migration of hazardous remediation waste to the atmosphere. Therefore, adverse effects on human health or the environment due to the migration of hazardous remediation waste to the atmosphere as a result of CAMU operations are unlikely.

Meteorologic Assessment and Potential Pathways and Exposure Routes

The surface winds at SNL/NM are light, averaging 9 miles per hour. Winds at SNL/NM are almost equally probable from all directions under normal conditions (SNL/NM, 1993); however, the prevailing wind direction is from the east with speed generally less than 8 miles per hour. The wind rose for SNL/NM is depicted in the legend of Figure 2-3. Under normal conditions, resuspension of particulates is limited.

The CAMU is designed and will be operated to limit the potential atmospheric pathway and exposure routes. Fugitive dust emissions present the highest potential for releases. Administrative and operational controls will be followed at the CAMU to minimize the potential for environmental contamination that would result from hazardous remediation waste being released to the atmosphere. Preventive measures to be included in the administrative and operational controls are good housekeeping procedures, decontamination procedures, waste mound maintenance, cessation of waste management activities during inclement weather, and stringent waste handling procedures. For example, during standard loading and unloading operations, bulk soil will be moistened to prevent fugitive dust emissions. Loading and unloading operations associated with bulk soil will be terminated and all bulk waste will be covered in anticipation of windy conditions to prevent fugitive dust emissions. The bulk waste staging area will be constructed with a 15-foot-high perimeter wall to ensure a physical barrier exists between contaminated soil stockpiles and the surrounding area during loading and unloading operations. The perimeter wall is oriented to provide shielding from the prevailing winds in TA III.
The CAMU containment cell is not a municipal landfill and, as such, is not subject to the requirements for municipal landfills, particularly the requirements for landfill gas venting and management. However, the generation of landfill gases (e.g., methane, hydrogen sulfide) is not expected to occur at the CAMU containment cell and thus, is not expected to present an exposure hazard. This is based on the following factors:

- The treated waste placed in the containment cell will consist only of solids (no liquids will be accepted for disposal).
- During containment cell operations, the cell will be open and will preclude the existence of an anaerobic environment required for landfill gas generation.
- An aqueous environment is required for the anaerobic degradation of waste and consequent methane generation. During containment cell operation and after closure, the LCRS will effectively remove all free liquids and preclude an aqueous environment.
- Municipal-type wastes (e.g., food products, paper materials) capable of degrading and producing landfill gases will not be accepted at the CAMU.
- All wastes received at the CAMU will be appropriately treated prior to emplacement, thereby eliminating or greatly reducing the potential for generation of volatile organic compounds or semivolatile organic compounds through off-gassing.

### 3.1.6.5 Health or Risk Assessment Reports

SNL/NM conducted a risk assessment using EPA guidance (EPA, 1989) as part of an environmental assessment for the ER Project (DOE, 1996). The risk assessment was performed to identify the risks to human health and environmental receptors for no action (i.e., not disturbing the ER Project sites), and the proposed action of remediating the ER Project sites. The proposed action includes cleanup activities at ER sites and the construction and operation of the CAMU. Accidental injuries or fatalities unrelated to releases were not addressed in the risk assessment.

The risk assessment utilized conservative estimates of the number of sites to be remediated and the volumes of contaminated soils to be managed at the CAMU. Modeling human health and ecological effects associated with potential contaminant releases from excavation and treatment was based on an assumption that each site would require one year to remediate. The contaminant concentrations were assumed to be released during excavation, in spite of
fugitive dust emission mitigation measures. The exposure routes evaluated included inhalation, ingestion, dermal contact, and direct exposure to radiation.

The total incremental cancer risk for managing the anticipated hazardous remediation waste at the CAMU is estimated to be $4.1 \times 10^{-3}$, while the total incremental cancer risk for no action (e.g., leaving the waste in place at the ER Project sites) is $5.0 \times 10^{-4}$. The hazard index for both managing the hazardous remediation waste at the CAMU and for no action is less than 1. Therefore, activities at the CAMU do not pose an unacceptable risk to human health and the environment.

3.2 Security Precautions—40 CFR §§270.14(b)(4) and 264.14

The design and operation of the proposed CAMU will fully meet the security requirements contained in 40 CFR §264.14(b) and (c). A waiver under 40 CFR §264.14(a) is not requested because the proposed CAMU will have 24-hour security surveillance and a means to control entry. In addition, warning signs will be provided. The proposed CAMU will meet the security requirements as described in the following sections.

3.2.1 24-Hour Surveillance

TA III has a 24-hour surveillance system (i.e., surveillance by SNL/NM Safeguards personnel who continuously monitor and control entry into TA III). SNL/NM Safeguards personnel patrol according to a 24-hour, seven-days-a-week schedule and document security patrols of the TA III perimeter fence. Consequently, because the proposed CAMU will be located within TA III, the site is in compliance with the requirements of 40 CFR §264.14(b)(1).

3.2.2 Barrier and Means to Control Entry

TA III and the RMWMF within TA III are surrounded by chain-link fence. In addition, the proposed CAMU will be surrounded by an additional four-strand barbed-wire fence. The high level of security in TA III and remote location of ER Site 107 in the southeastern corner of TA III preclude the likelihood that intruders could come into contact with the waste managed in the proposed CAMU.

Entrance to TA III, whether by personnel or vehicles, is through a single, controlled gate. TA III access control procedures are designed to assure that only properly identified and authorized persons, vehicles, and property are allowed entrance to and exit from TA III. A personnel identification and access control system is maintained within TA III. Employees identify themselves with an identification badge when entering or leaving the premises.
Visitors are required to demonstrate proper authorization and sign in at the SNL/NM security guard station located at the entrance to TA III. Because entry to the active portion of the proposed CAMU will be controlled at all times, the requirements of 40 CFR §264.14(b)(2)(ii) are met.

The proposed CAMU will be completely enclosed by a contiguous barbed-wire fence with one main gate which will be locked during non-operational hours. An emergency exit is located opposite of the entrance gate. When the proposed CAMU is closed or unpatrolled by CAMU staff, the Sprung™ structures will be locked. Keys to the locks will be controlled by authorized CAMU personnel.

3.2.3 Warning Signs
The CAMU four-strand barbed-wire fence will be posted with warning signs with the legend “Danger—Unauthorized Personnel Keep Out.” The signs will be posted on all sides of the CAMU. The signs will be legible from a distance of at least 25 feet, visible from any approach to the CAMU, and fully compliant with the requirements of 40 CFR §264.14(c).

3.3 Inspections—40 CFR §§270.14(b)(5), 264.15(b), and 264.174
In accordance with 40 CFR §264.15(a), the proposed CAMU will be routinely inspected for malfunctions, deterioration, operator errors, and/or discharges which could cause or lead to a release of hazardous waste contaminants to the environment or pose a threat to human health. In accordance with 40 CFR §264.15(b), a written inspection schedule will be developed and followed for inspecting potential problems with monitoring equipment, safety and emergency equipment, security devices, and operating and structural equipment that are important to preventing, detecting, or responding to hazards. The inspection schedule will be maintained at the proposed CAMU and will identify the types of problems which are to be looked for during inspections.

Applicable requirements of 40 CFR §§264.15(b) and 264.174 will be met by the inspections for each item or system included in Tables 3-2 and 3-3. CAMU personnel will use inspection forms that are functionally equivalent to that shown in Tables 3-2 and 3-3. Items related to the CAMU, such as emergency equipment, waste handling equipment, and CAMU features, as well as waste containers and waste management areas (e.g., staging, treatment, containment) will be inspected weekly when waste is present. The items in Sections IV and V of Table 3-3 must also be inspected after storms. During the operational period of the containment cell, prior to construction of the final cover system, precipitation will enter the containment cell.
Table 3-2
Corrective Action Management Unit
Daily Inspection Form

I. Date of Inspection __________
2. Time of Inspection __________
3. Name of Inspector ________________

NOTE: Answer Yes, No, or N/A to all questions.

I. CONDITIONS AT LOADING AND UNLOADING AREAS
A. __ Is waste handling equipment in satisfactory condition?
B. __ Are work practices safe (e.g., professional conduct, proper personal protective equipment used, personnel adequately trained, no smoking/eating in waste handling areas)?
C. __ Is the loading/unloading area clear of obstructions?
D. __ Is the loading/unloading area free of cracks, uneven surfaces that would affect safe waste handling?
E. __ Is the loading/unloading area free of weather caused hazards (e.g., mud or water) that would affect safe waste handling operations?

II. COMMENTS AND NOTES
Any deficiencies noted must be addressed immediately; reference the section and question.

Action assigned to ___________________________ Date action completed ___________

Inspector’s Signature ________________________________

Original to: CAMU Operating Record
Copy to: 7500 Environmental Operations Records Center, MS-1309

Comments: ____________________________________________
______________________________________________________
______________________________________________________
______________________________________________________
Table 3-3  
Corrective Action Management Unit  
Weekly Inspection Form

1. Date of Inspection ___________________  
2. Time of Inspection ___________________  
3. Name of Inspector ___________________  

NOTE: Answer YES, NO, or N/A to all questions.

I. CONDITION OF CONTAINERS  
A. Is adequate aisle space available to inspect each waste container and to allow the unobstructed movement of personnel, fire protection equipment, and decontamination equipment to any area of unit operation?  
B. Are hazardous waste containers free of leaks or potential leak sources (e.g., off-gassing, punctures, swelling)?  
C. Are hazardous waste containers in good (e.g., noncorroded and rust-free) condition?  
D. Are hazardous waste containers closed?  

II. CONTAINER LABELS AND MARKINGS  
A. Are all hazardous waste containers marked with the appropriate labels (e.g., Hazardous Waste)?  
B. Are the hazardous waste container labels legible and adhering to the container?  
C. Are all hazardous waste containers marked with the appropriate date(s)?  

III. SEPARATION OF INCOMPATIBLE WASTES  
A. Are containers holding one type of waste stored so that a reasonable distance is maintained from other containers which contain any incompatible waste?  
B. If the incompatible waste containers are not separated by distance, are they separated by a physical barrier such as a wall, containment pallet, or other device?  

IV. CONDITION OF BULK WASTE STAGING AREA  
A. Are run-on and run-off control systems free of deterioration?  
B. Are run-on and run-off control systems functioning properly?  
C. Are wind dispersal control systems functioning properly?
<table>
<thead>
<tr>
<th>V.</th>
<th>CONDITION OF CONTAINMENT CELL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Are run-on and run-off control systems free of deterioration?</td>
</tr>
<tr>
<td>B.</td>
<td>Are run-on and run-off control systems functioning properly?</td>
</tr>
<tr>
<td>C.</td>
<td>Is the leachate collection and removal system free of accumulated leachate?</td>
</tr>
<tr>
<td>D.</td>
<td>Is the leachate collection and removal system functioning properly?</td>
</tr>
<tr>
<td>E.</td>
<td>Is the leak detection system sump functioning properly and in good condition?</td>
</tr>
<tr>
<td>F.</td>
<td>Record the amount of liquid, if any, removed from the leak detection sump.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VI.</th>
<th>EMERGENCY EQUIPMENT AND SUPPLIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Is the equipment listed below available, in operable condition, and present in required quantities at the site?</td>
</tr>
<tr>
<td>Fire extinguishers</td>
<td></td>
</tr>
<tr>
<td>Spill kits, adsorbents, brooms, shovels</td>
<td></td>
</tr>
<tr>
<td>Bullhorns</td>
<td></td>
</tr>
<tr>
<td>Cellular Phone</td>
<td></td>
</tr>
<tr>
<td>Fire Hydrant</td>
<td></td>
</tr>
<tr>
<td>Shower, eyewash, swabs, portable water canisters with spray nozzles</td>
<td></td>
</tr>
<tr>
<td>Overpack containers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VII.</th>
<th>COMMENTS AND NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any deficiencies noted must be addressed immediately; reference the section and question.</td>
<td></td>
</tr>
<tr>
<td>Action assigned to ______________ Date action completed ______________</td>
<td></td>
</tr>
<tr>
<td>Inspector’s Signature ____________________________</td>
<td></td>
</tr>
</tbody>
</table>

Original to: CAMU Operating Record
Copy to: 7500 Environmental Operations Records Center, MS-1309

Comments: ____________________________________________________________
__________________________________________________________
__________________________________________________________
Assuming that listed waste is emplaced in the containment cell, the resulting leachate will be collected and managed as a listed hazardous waste (F039). Areas subject to spills such as loading and unloading areas will be inspected daily when operations occur at the CAMU. If waste is not present at the CAMU or in a specific waste management area of the CAMU, inspection frequency will be based on the rate of possible deterioration of the equipment and the probability of an environmental or human health incident if the deterioration or malfunction, or any operator error, goes undetected between inspections.

In accordance with 40 CFR §264.15(c), corrective or remedial actions will be taken to ensure protection of human health and the environment and mitigate any potential hazards. If an inspection of the CAMU reveals that a nonemergency problem (e.g., safety and emergency equipment, security devices, or operational equipment are found to be damaged, incomplete, or nonoperational) has developed, remedial action including repairs, maintenance, and replacement will be completed as soon as practical to preclude further damage and reduce the possibility that emergency repairs will be needed. If a hazard appears imminent or if a hazardous situation already exists, remedial action will be immediately initiated, including implementation of the Contingency Plan for the CAMU (Appendix B), if necessary. Any remedial action taken pursuant to an inspection will be noted on the inspection form (Tables 3-2 and 3-3 or functional equivalents).

In accordance with 40 CFR §264.15(d), inspection results will be recorded in an inspection log (i.e., a collection of completed inspection forms) to be maintained for at least three years from the date of inspection. The inspection forms will include the date and time of inspection, the name of the inspector, a notation of the observations made, and the date and nature of any repairs or other remedial actions.

### 3.4 Contingency Plan—40 CFR §270.14(b)(7) and 40 CFR 264, Subpart D

The Contingency Plan for the CAMU is provided in Appendix B. The Contingency Plan was prepared in accordance with the requirements of 40 CFR 264, Subpart D.

### 3.5 Procedures, Structures, or Equipment Used to Prevent Hazards—40 CFR §270.14(b)(8)

This section details the procedures, structures, and equipment that will be used at the CAMU to prevent and/or mitigate hazards that could occur during operations, pursuant to the requirements of 40 CFR §270.14(b)(8).
### 3.5.1 Loading/Unloading Operations—40 CFR §270.14(b)(8)(i)

Only qualified personnel trained in hazardous remediation waste handling procedures will be allowed to handle hazardous remediation waste at the CAMU. Furthermore, only qualified drivers will be authorized to operate appropriate vehicles, forklifts, and tools for the safe transport and handling of hazardous remediation waste loading and unloading operations.

CAMU personnel will accept waste only if it is generated during ER Project corrective action activities, as documented by the quality assurance/quality control procedures in Section 4.4 of the Waste Analysis Plan for the CAMU (Appendix A). Only adequately characterized remediation waste will be accepted for management at the CAMU.

Small waste containers may be loaded or unloaded manually. Containers on pallets may be lowered using a standard forklift; containers may be lowered from the truck using a hydraulic lift gate and moved by hand or hand tools, if appropriate. A forklift may be used, as necessary, to move containers inside the Sprung™ structures or other container staging area. Only personnel trained and qualified in hazardous waste handling and the operation of the waste transport equipment/vehicle will be allowed to load or unload waste.

Bulk wastes will be unloaded from haul trucks onto a predetermined location at the bulk waste staging area. Front-end loaders will be used to manipulate the bulk waste into mounds for staging. When an adequate waste volume is staged and ready for the performance of a cost-effective treatment campaign, bulk waste will be loaded onto haul truck for transport to the treatment area. Again, only personnel trained and qualified in hazardous waste handling and operation of the waste transport equipment/vehicle will be allowed to load or unload waste.

Wastes will be loaded at the treated waste staging area and transported to and unloaded at the containment cell (or unloaded at a waste staging area pending off-site transport, as appropriate) by properly trained and qualified personnel using appropriate equipment/vehicles.

The combination of adequate training and appropriate equipment/vehicles will assure that loading/unloading operations are performed in a manner that prevents hazards.

### 3.5.2 Run-off/Run-on Controls—40 CFR §270.14(b)(8)(ii)

A grading plan and drainage swales will be used to prevent run-on to the CAMU (Figure 3-15). Drainage within the CAMU boundaries will be routed to storm water retention...
ponds to prevent uncontrolled runoff. Storm water retention ponds at the CAMU will be constructed to accommodate a 25-year, 24-hour storm event.

General sitewide runoff will be in the form of sheet flow. The CAMU will be graded and bermed to collect and direct all sheet flow from the CAMU to the sitewide storm water retention pond in the southwestern corner of the CAMU.

A dedicated storm water retention pond at the bulk waste staging area will be located near the northwestern corner of the staging area. It will contain and collect all runoff precipitation from inside the bulk waste staging area. The asphaltic concrete pad will provide a relatively impermeable surface upon which storm water runoff can be collected and controlled. Containment will be achieved by the perimeter walls and asphalt berms at the entrances. The asphaltic concrete pad will be sloped to direct runoff toward the center of the area, forming a drainage channel that is sloped to direct runoff to the center of the area. Runoff from the bulk waste staging area will flow into a catch basin from which a subsurface drain pipe will direct runoff to a lined storm water retention pond.

A dedicated storm water retention pond for the waste treatment pad will be located in the southwestern corner of the treatment area. The primary means of storm water conveyance to the retention pond will be sheet flow. The treatment area storm water retention pond will be lined and approximately 50 feet wide, 50 feet long, and 8 feet deep. The perimeter of the retention pond will be bermed to prevent potential run-on water from entering the pond from other areas of the CAMU.

Because hazardous waste will be placed directly on the bulk waste staging area pad and on the waste treatment pad, administrative procedures will be implemented to prevent rain water or cleaning water at these pads from becoming contaminated. Contaminated areas on these pads will be manually swept clean after any loading and/or unloading activities. Any accumulations of residual material from sweeping contaminated areas of the asphaltic concrete pads will be placed on the appropriate soil or debris mound. This operational procedure will minimize surficial contamination on the asphaltic concrete pads that could otherwise contaminate storm-water runoff or be carried off site by wind.

Additional administrative procedures will be implemented to ensure vehicles transporting hazardous waste within the CAMU do not create a potential for contaminated runoff. Immediately following the unloading of hazardous waste, dump truck beds will be covered
and any residual soil that may have accumulated on the outside of the truck bed will be removed before the truck leaves the bulk waste staging area or waste treatment area. Contaminated soil on the exterior of the dump truck beds will be removed manually and will be placed on the appropriate soil or debris mound. This operational procedure will minimize the potential spread of contamination between the bulk waste staging area, the waste treatment area, and the equipment decontamination pad that could otherwise contaminate general sitewide runoff or be carried off site by wind.

During periods of precipitation, procedures will be implemented to prevent contamination of storm-water runoff. Soil and debris mounds will be covered with plastic sheeting, which will be anchored with sandbags. Contaminated areas of the asphaltic concrete pads will also be covered with plastic sheeting anchored down with sandbags. All potentially contaminated equipment components (e.g., front-end loader buckets) will be covered with plastic sheeting.

A storm water retention pond for the perimeter of the containment cell will be located to the northwest of the cell. A drainage swale will be constructed around the containment cell to prevent run-on. Runoff from the cell perimeter will flow into a catch basin. A subsurface drain pipe will direct runoff from the catch basin to the dedicated, lined storm water retention pond.

Because contaminated waste will not be placed directly on the containerized waste staging area or on the Sprung™ structure pads (i.e., materials will be containerized and drums containing liquids will be placed on commercially-available pallets that provide adequate secondary containment in accordance with 40 CFR §264.175[b][3]), the pads will not be bermed, and runoff will be directed to the general sitewide storm water retention pond.

All storm water discharges will be subject to the New Mexico Water Quality Control Commission regulations. CAMU operating procedures will ensure that contamination of storm water is not a normal occurrence. If water is known to be storm water resulting from precipitation and is not suspected of being contaminated with any hazardous waste constituents, it will be either discharged to the surface under a valid Notice of Intent or to the TA III sanitary sewer system under an approved discharge permit, as appropriate. If the storm water is suspected of being contaminated with any hazardous constituents, it will be characterized by knowledge of process and/or sampling and analysis, as appropriate, to determine the proper disposal method.
3.5.3 Water Supplies—40 CFR §270.14(b)(8)(iii)
The use of adequate secondary containment for containers holding free liquids, the performance of waste handling activities, and prompt spill response and cleanup measures at the CAMU make potential contamination of the water supply unlikely. Furthermore, the depth to the main drinking water aquifer is approximately 485 feet at the CAMU. The potential for any contamination of water supplies will be controlled/minimized by administrative and operational procedures and the physical location of the CAMU.

3.5.4 Equipment and Power Failure—40 CFR §270.14(b)(8)(iv)
Backup power is unnecessary at the CAMU because electrical power will not be required for the safe operation of the CAMU. All equipment used in CAMU operations will undergo routine maintenance in accordance with manufacturer’s specifications. Electricity is only necessary for the heavy equipment decontamination area, soil washing treatment area, and leachate collection area. An interruption of power service to these areas would halt operations but would not result in accidental releases to the environment.

3.5.5 Personnel Protection—40 CFR §270.14(b)(8)(v)
PPE will be specified for all CAMU personnel based on the hazards associated with constituents present in the hazardous waste being managed in the CAMU and the nature of the individual’s activities.

Personnel decontamination facilities and procedures will be provided to adequately remove potential contamination from operations personnel prior to exiting the CAMU.

3.5.6 Releases to the Atmosphere—40 CFR §270.14(b)(8)(vi)
The primary source of potential releases to the atmosphere is in the form of fugitive dust generation which may result from uncontainerized waste management activities. The primary source of wind protection to reduce fugitive dust generation will be achieved by covering uncontainerized hazardous remediation waste with plastic sheeting or similar material, which will be anchored with sandbags. Sun and wind damage will require that the sheeting periodically undergo inspection, repair, or replacement. However, any repair or replacement necessary can be accomplished simply by applying additional sheeting material over the affected area and anchoring the sheeting with sandbags.

Secondary wind protection at the bulk waste staging area will be provided by the perimeter wall surrounding the area. The prevailing wind direction at the CAMU is from the east.
(SNL/NM, 1994). The perimeter wall will be oriented so that the east and west sides are continuous (i.e., discontinuous portions of the perimeter wall for the entrance and exit are located on the north and south side).

Soil contaminated with high levels of volatile organic compounds will be placed in roll-off bins during temporary staging prior to treatment in order to prevent uncontrolled organic compound emissions. CAMU operations will be halted as necessary during inclement weather to prevent uncontrolled releases to the atmosphere.

Contaminated soil managed within the CAMU will be moistened to prevent fugitive dust generation. Water sprays will be applied through the use of forestry-service-type fire-fighting hoses and nozzles attached to a permanent water source. The favorable characteristics of this equipment include the following:

- Intended for outdoor use in extreme environments
- Low-pressure applications
- Low-flow capabilities
- Effective reach from nozzle.

Two ground hydrants (or hose bibs) will be centrally located within the bulk waste staging area. The hydrants will be located at the ends of the two center concrete masonry-unit wall extensions. These interior walls will be recessed approximately 5 feet from the access road to accommodate the ground hydrants and the surrounding protective pole bollards. The ground hydrant will supply a standard 1-inch, forestry-service-type fire-fighting hose. Approximately 200 feet of hose (two 100-foot lengths) per hydrant will be required. Low pressure (75 pounds per square inch), full-cone, 12 gallon-per-minute fogging nozzles will be used to apply water sprays. The approximate reach of such nozzles will be 20 feet.

3.6 Container Management—40 CFR §270.15(a) and (b), and 40 CFR 264, Subpart I

All waste arriving at the CAMU must have been characterized in accordance with the Waste Analysis Plan (Appendix A), unloaded, and placed in the appropriate waste staging or treatment area. Containerized remediation wastes may be staged at the containerized waste staging area or in the Sprung™ structures. Containerized waste may also be staged at the bulk waste staging area.
Only containerized solid hazardous remediation wastes will be staged at the containerized waste staging area or bulk waste staging area. Information supplied by the generator will accompany containers holding only solid hazardous wastes to show that the wastes do not contain free liquids. Containers of solid hazardous waste staged at the containerized waste staging area or at the bulk waste staging area will be placed on pallets or otherwise elevated to prevent accumulated liquids from contacting the containers.

Liquid or solid containerized hazardous remediation wastes may be stored inside the Sprung™ structures. For containers holding only solid hazardous waste, information will be supplied by the generator to show that the wastes do not contain free liquids. Containers holding only solid hazardous wastes and staged within the Sprung™ structures will be placed on pallets or otherwise elevated to prevent contact with accumulated liquids. Containers of solid waste may be stacked up to three containers high inside the Sprung™ structures. Containers of liquid wastes will not be stacked but will be staged on commercially-available secondary containment pallets. The containment pallets are elevated by design to prevent accumulated liquids from contacting the waste containers. The containment pallets will have sufficient capacity to contain 10 percent of the total volume of the potential liquid-bearing containers or the volume of the largest container, whichever is greater. Because waste containers will be staged inside the Sprung™ structures, run-on into the containment pallets is not likely. In addition, the area around the Sprung™ structures will be graded such that potential run-on will be directed away from the structures. Any liquids that accumulate in the containment pallets will be removed as soon as possible to prevent overflow and will be managed appropriately.

At each of the waste staging areas, CAMU personnel will record each container number, container type, date of staging, and the complete listing of its contents in the facility operating record. In addition, each container shall be labeled with a completed hazardous waste label.

A number of container types may be used for staging, depending on the type of remediation waste. For example, solid hazardous remediation wastes may be placed into U.S. Department of Transportation-approved containers or in Wrangler bags or roll-off bins. Liquids, corrosives, and oxidizers may be stored in polyethylene or steel drums. Liners must be used in steel drums containing corrosive wastes.

Containers are only to be repackaged at the CAMU if, during weekly inspections, defective containers are identified. If necessary, defective containers may be repackaged into
appropriate containers, as determined by CAMU personnel. Repackaging waste may be conducted in a designated repackaging area within the CAMU. Liner/waste compatibility will be assured in all cases by CAMU operating procedures. Containers of waste will remain closed during staging at the CAMU except when it is necessary to add or remove waste. In addition, all waste containers will be handled and staged in a manner that does not cause them to rupture or leak.

**Aisle Space—40 CFR §264.35.** A facility must maintain sufficient aisle space to allow the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment to any area of a facility during an emergency.

Waste containers at the CAMU will be staged in the Sprung™ structures or at the containerized waste or bulk waste staging areas such that sufficient space for the unobstructed evacuation of facility personnel, spill cleanup, and emergency response is maintained. Container staging configurations will be determined by the actual numbers and types of containers managed during operations.

Bulk waste staging areas will also be configured and managed to maintain unobstructed evacuation of facility personnel, spill cleanup, and emergency response access.

**Secondary Containment—40 CFR §§270.15(a) and 264.175(b).** Remediation waste containing free liquids will be containerized and placed on commercially-available spill containment pallets to contain potential leaks from containers. Secondary containment pallets will have sufficient capacity to contain 10 percent of the volume of the potential liquid-bearing containers or the volume of the largest liquid-bearing container, whichever is greater.

**3.7 Prevention of Reaction of Ignitable, Reactive, and Incompatible Waste—40 CFR §§270.14(b)(9), 270.15(c) and (d), 264.17, 264.176, and 264.177**

Ignitable and reactive wastes must be containerized prior to staging at the CAMU. Primary containers holding ignitable or reactive waste will be staged inside the Sprung™ structures, or in modular staging units (i.e., transportainer) at the containerized waste staging area, thus protecting the waste from sources of ignition, flames, hot surfaces, sparks, frictional heat, radiant heat, and lightning strikes.

Incompatible remediation waste will be segregated at the CAMU by ensuring that incompatible wastes are never staged in the same waste staging area, in the same container, or in incompatible containers. Furthermore, incompatible wastes will be physically separated
during staging in the containerized waste staging area, within the Sprung™ structures, or in the bulk waste staging area. Waste compatibility shall be determined in accordance with 40 CFR Part 264, Appendix V, or equivalent information.

Smoking shall be prohibited everywhere within the CAMU. “No Smoking” signs will be conspicuously posted in areas where ignitable and reactive wastes are staged. The various staging areas at the CAMU are located at least 50 feet away from SNL/NM boundaries. Documentation of ignitable, reactive, and incompatible waste management compliance (i.e., waste analyses per 40 CFR §264.13) will be maintained in the facility operating record.

3.8 Personnel Training—40 CFR §§270.14(b)(12) and 264.16
The Personnel Training Plan for the CAMU is provided in Appendix C. The Personnel Training Plan was prepared in accordance with the requirements of 40 CFR §264.16.

3.9 Closure Plan—40 CFR §§264.552(e)(4), and 270.14(b)(3)
The closure plan for the CAMU is provided in Appendix D. The plan is designed to meet the following RCRA closure performance standards specified in 40 CFR §§264.111 and 264.552(e)(4)(i):

- To protect human health and environment;
- To preclude the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the groundwater, surface waters, or the atmosphere; and
- To minimize or eliminate the need for future maintenance and monitoring.

The closure plan includes facility and unit descriptions, waste types and volumes, closure methods (including application of the data quality objectives process), sampling strategies, closure schedule, and postclosure care.

3.10 Recordkeeping and Reporting—40 CFR 264, Subpart E
The following unit-specific records will be maintained at the CAMU, as applicable:

- A current copy of the RCRA operating permit, contingency plan, waste analysis plan, training plan, and closure plan
- Correspondence and other documents from governmental agencies
- A written operating record that describes:
- the type and quantity of each RCRA-regulated hazardous waste received
- the location of RCRA-regulated hazardous waste and the quantity at each location
- the method(s) and dates of storage and/or treatment of the RCRA-regulated hazardous waste
- records and results of RCRA-regulated hazardous waste analyses and determinations
- reports of any incidents that required the activation of the contingency plan
- inspection forms for the last three years
- monitoring, testing, or analytical data and records of corrective actions taken (in the previous or current calendar year) to prevent or mitigate releases of RCRA-regulated hazardous waste to the environment
- treatment notice and certification (as specified in 40 CFR §268.7 or §268.8)
- storage notice and certification (as specified in 40 CFR §268.7 or §268.8)
  - Training records for current personnel
  - Written inspection schedule.

The following records are maintained either at the CAMU or the SNL/NM Environmental Operations Records Center:

- Notices to off-site generators (as specified in 40 CFR §264.12[b])
- Waste minimization certification
- Training records for former employees (maintained for a minimum of three years from the date the employee last worked at a unit)
- Manifest documents for RCRA-regulated hazardous waste directly shipped off site from the CAMU
- Superseded versions of the RCRA operating permit, contingency plan, waste analysis plan, closure plan, and training plan.
- Quarterly progress reports - a quarterly progress report will be submitted to the EPA Administrator, Region VI and to the Secretary of the NMED beginning no later than ninety (90) calendar days from the effective date of the CAMU operations permit. The quarterly progress report shall document activities conducted at the CAMU, plans for future activities, and any significant changes
to the plans required to be maintained at the CAMU facility. On a semiannual basis, the quarterly progress report will include the sources, kinds, and amount of hazardous waste which enters the CAMU and is emplaced in the containment cell.

**Biennial Report**—In accordance with 40 CFR §264.75, a biennial report on SNL/NM facility activities is prepared and submitted to the Secretary of the NMED.

**Additional Reports**—In compliance with 40 CFR §264.56(j), any release, fire, explosion, or other unusual occurrence that results in the implementation of the contingency plan will be noted in the CAMU operating record and reported in writing within 15 days to the Secretary of the NMED and to the EPA Administrator, Region VI. In accordance with 40 CFR §268.8, appropriate notification and/or certification will be sent with each shipment of RCRA-regulated hazardous waste from the CAMU.

### 3.11 Quality Assurance Measures

The Quality Assurance Plan for the construction of the CAMU cell is presented in Appendix F. The Quality Assurance Plan identifies those measures that will be implemented to ensure that the cell is constructed as designed. Two attachments to the plan provide details on quality assurance measures:

- **Attachment A**: inspection checklists
- **Attachment B**: specifications

The Quality Assurance Plan and its attachments provide very detailed information regarding construction practices and quality assurance measures. Some changes to construction practices will be necessary as work progresses in the field, resulting in changes to the Quality Assurance Plan. Because of the real-time nature of these changes, DOE/SNL/NM will report any significant changes to the Quality Assurance Plan in the quarterly progress reports (see Section 3.10). Changes to the Quality Assurance Plan will not require a permit modification, unless directed in writing by the administrative authority.

Sampling and analysis plans (SAP) are provided in Appendix D (for closure activities) and in Appendix E (for vadose zone monitoring activities). These SAPs include references to operating procedures (OP) which are contained in Appendix G. Significant changes to the operating procedures will be reported in the quarterly progress reports (see Section 3.10). Changes to the operating procedures will not require a permit modification unless directed in writing by the administrative authority.
4.0 Requirements for Groundwater Monitoring—40 CFR §§264.90, 264.101, 264.552(e)(3), and 270.14(c)

Regulatory requirements for CAMUs are set forth in 40 CFR, Part 264, Subpart S. Specific CAMU requirements for groundwater monitoring are provided in 40 CFR §§264.552(e)(3). 40 CFR §264.552(e)(3)(ii) requires that groundwater monitoring be sufficient to detect and subsequently characterize releases of hazardous constituents to groundwater that may occur from areas of the CAMU in which wastes will remain in place after closure of the CAMU. 40 CFR §264.552(e)(3)(i) requires that groundwater monitoring be sufficient to continue to detect and characterize the nature, extent, concentration, direction, and movement of existing releases of hazardous constituents in groundwater from sources located within the CAMU. As stated in Section 2.2, no significant contamination has been detected at ER Site 107 (i.e., at the proposed CAMU location), and historical activities did not involve the use of contaminants that could potentially migrate to groundwater. Therefore, there are no existing releases from the proposed CAMU to groundwater and 40 CFR §264.552(e)(3)(i) is not applicable.

In lieu of conducting groundwater monitoring for the proposed CAMU containment cell at ER Site 107 in TA III, SNL/NM proposes an alternative monitoring program. This alternative program substitutes vadose zone monitoring for groundwater monitoring. Vadose zone monitoring is superior to groundwater monitoring for detection and characterization of potential leaks of hazardous remediation wastes from the proposed CAMU containment cell. Although the intent of vadose zone monitoring is the same as groundwater monitoring, more rigorous and useful results are achievable with vadose zone monitoring. Vadose zone monitoring is capable of providing real-time data on the proposed CAMU containment cell performance and will detect a leak much more quickly than is possible with groundwater monitoring. In addition, vadose zone monitoring will detect a release that is orders of magnitude less in volume than a leak required for detection by groundwater monitoring, and the proposed vadose zone monitoring system may be used to remediate a potential leak. The Proposed Alternative to Groundwater Monitoring, included as Appendix E of this permit modification request, presents information to support SNL/NM’s request for approval of an alternative to groundwater monitoring, including an explanation of how the VZMS may be used to remediate a potential leak (see Section 1.0, Appendix E).

5.0 References

DOC, see U.S. Department of Commerce.

DOE, see U.S. Department of Energy.
EPA, see U.S. Environmental Protection Agency.


SNL/NM, see Sandia National Laboratories/New Mexico.


APPENDIX A

WASTE ANALYSIS PLAN FOR THE CORRECTIVE ACTION MANAGEMENT UNIT TECHNICAL AREA III SANDIA NATIONAL LABORATORIES/NEW MEXICO ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
WASTE ANALYSIS PLAN FOR THE CORRECTIVE ACTION MANAGEMENT UNIT

FINAL

SEPTEMBER 1997
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CAMU</td>
<td>Corrective action management unit</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>COLIWASA</td>
<td>Composite liquid waste sampler</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>ER</td>
<td>Environmental Restoration</td>
</tr>
<tr>
<td>LDR</td>
<td>Land disposal restrictions</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyl</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal protective equipment</td>
</tr>
<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>QC</td>
<td>Quality control</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and development</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
<tr>
<td>SNL/NM</td>
<td>Sandia National Laboratories/New Mexico</td>
</tr>
<tr>
<td>SWMU</td>
<td>Solid waste management unit</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Area</td>
</tr>
<tr>
<td>TSDF</td>
<td>Treatment, storage, and disposal facility</td>
</tr>
<tr>
<td>WAP</td>
<td>Waste analysis plan</td>
</tr>
</tbody>
</table>
1.0 Introduction—40 CFR §§264.13(b) and 270.14(b)(3)

This Waste Analysis Plan (WAP) provides methods for characterizing hazardous remediation waste managed at the Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Project Corrective Action Management Unit (CAMU) in accordance with Title 40 Code of Federal Regulations (40 CFR) Section (§) 270.14(b)(3) and §264.13(b). This WAP was prepared using the U.S. Environmental Protection Agency’s (EPA) “Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes, A Guidance Manual” (EPA, 1994).

Characterization is the process of identifying the hazardous characteristics of waste and involves using sampling and analysis methods, acceptable knowledge methods, or a combination of chemical analysis and acceptable knowledge. This WAP specifically applies to characterization of hazardous remediation wastes that are generated during ER Project activities at SNL/NM and staged, treated, or contained at the CAMU. This WAP describes the parameters for which each hazardous remediation waste will be characterized and the rationale for selecting these parameters; the characterization methods (including sampling and test methods for analytical characterization) which will be used to determine these parameters; the frequency of characterization; and the methods used to meet special waste characterization requirements (i.e., for ignitable, incompatible, and reactive waste as described in 40 CFR §264.17).

The waste characterization requirements for 40 CFR §264.341 (incinerators), 40 CFR §264.1034(d) (process vents), 40 CFR §264.1063(d) (equipment leaks), and 40 CFR §264.1083 (tanks, surface impoundments, and containers at facilities other than Resource Conservation and Recovery Act [RCRA] corrective action sites) are not applicable to CAMU operations and are not addressed in this WAP.

2.0 Facility Description

2.1 Description of Facility Activity

SNL/NM is a multidisciplinary research and development (R&D) laboratory of the U.S. Department of Energy, with work also performed for the U.S. Department of Defense and the U.S. Nuclear Regulatory Commission. SNL/NM falls under Standard Industrial
Classification Numbers 9711 “National Defense Organizations” and 7391 “Research and Development”. Since 1945, many buildings and technical areas (T-) at SNL/NM have been used for R&D related to nuclear weapons, energy, and other programs of national interest.

The waste management unit to which this WAP applies is the CAMU, which is located in TA III. The CAMU is a staging, treatment, and containment area designed to manage hazardous remediation wastes generated during ER Project activities as a result of site investigations, voluntary corrective measures, and RCRA corrective actions undertaken in accordance with Module IV of the Hazardous Waste Facility Operating Permit NM5890110518-1, issued to SNL/NM by the New Mexico Environment Department on August 6, 1992. ER Project activities include assessment and remediation of the solid waste management units (SWMU) at SNL/NM.

2.2 Description of Hazardous Remediation Waste

The investigation and remediation of SWMUs at SNL/NM may generate large quantities of contaminated environmental media, the majority of which is expected to contain only low concentrations of hazardous waste constituents. ER Project activities typically generate waste in the forms of soil, sludge, drilling mud, monitor well purge and development water, decontamination solutions, solid debris, and sampling equipment and personal protective equipment (PPE). ER Project remediation waste is managed as hazardous waste if it exhibits a hazardous characteristic or if the media “contains” listed hazardous wastes. Following is a brief discussion of each waste stream that may be generated by ER Project activities.

2.2.1 Soil

This waste stream includes, but may not be limited to, soils from surface sampling, drilling, excavation, or monitor well installation. Soil itself is not hazardous; therefore, the hazardous waste classification (i.e., listed or characteristic) depends upon the contamination resulting from activities that occurred at the SWMU.

2.2.2 Sludge

This waste stream includes, but may not be limited to, sludges from septic tank pumping activities or other excavation projects. Sludge itself is not hazardous; therefore, the hazardous
waste classification (i.e., listed or characteristic) depends upon the contamination resulting activities that occurred at the SWMU.

2.2.3 Drilling Mud

This waste stream includes, but may not be limited to, muds from well drilling, excavation, or monitor well installation. Drilling mud itself is not hazardous; therefore, the hazardous waste classification (i.e., listed or characteristic) depends upon the contamination resulting from activities that occurred at the SWMU.

2.2.4 Monitor Well Purge and Development Water and Decontamination Solutions

This waste stream includes, but may not be limited to: 1) groundwater from purging monitor wells for aquifer tests and for the collection of environmental samples; 2) groundwater from the development of newly installed monitor wells; and 3) decontamination solutions generated during the decontamination of drill rigs, augers, and various sampling devices between boreholes or sampling events. Water and decontamination solutions themselves are not hazardous; therefore, the hazardous waste classification (i.e., listed or characteristic) depends upon the contamination resulting from activities that occurred at the SWMU.

2.2.5 Solid Debris

This waste stream includes, but may not be limited to, debris found at a SWMU during site investigation or remediation. These wastes are solid, usually heterogeneous materials, and may include but may not be limited to, concrete, scrap metal, rubble, or electronic components or parts. This waste stream also may include solid material used during decontamination operations. The hazardous waste classification (i.e., listed or characteristic) depends upon the nature of the solid material and/or the possible contamination resulting from activities that occurred at the SWMU.

2.2.6 Sampling Equipment and PPE

This waste stream includes both PPE and sampling equipment. PPE includes, but may not be limited to, gloves, booties, laboratory coats, and rags. Sampling equipment includes, but may not be limited to, wipes and swipes, paper, filters, composite liquid waste samplers (COLIWASA) and thieving rods. PPE and sampling equipment themselves are not hazardous;
therefore, the hazardous waste classification (i.e., listed or characteristic) depends upon the contamination resulting from activities at the SWMU.

2.3 On-Site Generated Waste

On-site (i.e., CAMU) generated waste includes, but may not be limited to, the by-products of treatment processes and contaminated waters collected from storm water retention ponds, decontamination solution collection tanks, or the containment cell leachate collection system.

The principal by-products of treatment processes and management of those by-products will be addressed in CAMU mobile treatment unit-specific information to be submitted in a separate RCRA Subtitle C permit application or modification request and prior to mobilization of treatment campaigns.

Waters collected from the storm water retention ponds or from the decontamination solution collection tanks will be managed as hazardous wastes if it is suspected that the liquids exhibit any hazardous characteristics or are derived from any listed wastes staged or treated at the CAMU. SNL/NM will evaluate the potential for contamination of water in storm water retention ponds using release documentation on daily/weekly inspection forms. Water in storm water retention ponds will be managed as potential hazardous waste only if a spill/release is documented on a daily/weekly inspection form. If listed waste was released, the water in the affected storm water retention pond will be managed as listed hazardous waste. If characteristic waste was released, the water in the affected storm water retention pond will be sampled and analyzed for the relevant characteristic(s) and managed accordingly. SNL/NM will evaluate the potential for contamination of liquids in decontamination solution collection tanks using knowledge of wastes managed in CAMU staging, treatment, and containment areas.

If the water is not suspected to be contaminated with any hazardous wastes, it may be discharged to the ground surface under a valid Notice of Intent. If the water is suspected to be the result of a release or to be contaminated with hazardous wastes managed at the CAMU and contaminant levels meet City of Albuquerque wastewater discharge parameters, arrangements will be made for discharge into the City of Albuquerque sewer treatment system with a one-time notice placed in the unit file in accordance with 40 CFR §268.7(a)(6). If the
water cannot be discharged into the City of Albuquerque sewer treatment system, it will be handled through normal procedures at the SNL/NM Hazardous Waste Management Facility. Liquids collected from the leachate collection system will be managed as hazardous waste and disposed at an appropriate off-site treatment, storage, and disposal facility (TSDF).

3.0 Selecting Waste Analysis Parameters—
40 CFR §264.13(b)(1)

3.1 Criteria and Rationale for Parameter Selection
Hazardous remediation waste management activities at the CAMU may include staging, treatment, and containment of ER Project-generated remediation wastes, which generally contain low concentrations of hazardous wastes or constituents, but are high in volume. Most of the ER Project-generated hazardous remediation wastes are solid, except for the waters (refer to Section 2.2). Operating constraints at the CAMU include the available staging space for hazardous remediation wastes and secondary containment for liquids, effectiveness of treatment technologies in achieving negotiated treatment standards, and containment cell capacity. Therefore, the waste parameters that must be determined prior to staging, treatment, or containment are those associated with the identification, hazard classification, contaminant levels, volume, and compatibility of the hazardous remediation wastes to assure that the waste can be uncontainerized or containerized and segregated, moved, staged, treated, and/or contained at the CAMU in a safe and compliant manner. Additional waste characterization may be conducted at the CAMU to assure that: (1) the waste meets the requirements for emplacement in the CAMU containment cell or waste acceptance requirements at an off-site permitted TSDF, as applicable; (2) the waste can be transported off-site, if necessary, safely and in compliance with U.S. Department of Transportation regulations; or (3) the waste meets other applicable requirements, such as negotiated treatment standards (e.g., Superfund LDR Guide #6A [EPA, 1990]).

Table 3-1 provides information on the typical parameters and rationale identified to characterize each waste stream. SNL/NM will characterize waste based on the parameters listed in Table 3-1 unless site-specific information dictates different parameters.
### Table 3-1
Typical Waste Analysis Parameters and Rationale for Selection

<table>
<thead>
<tr>
<th>Waste Stream</th>
<th>Waste Analysis Parameter(s)</th>
<th>Rationale for selection*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Physical state (e.g. presence of free liquids)</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td></td>
<td>Total metals or TCLP metals</td>
<td>1, 3 (D004-D011), 6</td>
</tr>
<tr>
<td></td>
<td>TCLP organics</td>
<td>3 (D012-D043)</td>
</tr>
<tr>
<td></td>
<td>Appropriate hazardous constituents</td>
<td>3 (F001, F002, F003, F005)</td>
</tr>
<tr>
<td></td>
<td>PCBs</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Asbestos</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td>Sludge and Drilling Mud</td>
<td>Physical state (e.g. presence of free liquids)</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td></td>
<td>Total metals or TCLP metals</td>
<td>1, 3 (D004-D011), 6</td>
</tr>
<tr>
<td></td>
<td>TCLP organics</td>
<td>3 (D012-D043)</td>
</tr>
<tr>
<td></td>
<td>Appropriate hazardous constituents</td>
<td>3 (F001, F002, F003, F005)</td>
</tr>
<tr>
<td></td>
<td>PCBs</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Asbestos</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td>Monitor Well Purge and Development Water, and Decontamination Solutions</td>
<td>Physical state (e.g. presence of suspended solids or multiphase)</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td></td>
<td>Total metals</td>
<td>1, 3 (D004-D011), 6</td>
</tr>
<tr>
<td></td>
<td>TCLP organics</td>
<td>3 (D012-D043)</td>
</tr>
<tr>
<td></td>
<td>RCRA characteristics (e.g. pH)</td>
<td>3 (D002), 4</td>
</tr>
<tr>
<td></td>
<td>Appropriate hazardous constituents</td>
<td>3 (F001, F002, F003, F005)</td>
</tr>
<tr>
<td></td>
<td>PCBs</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Asbestos</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td>Solid Debris</td>
<td>Physical state</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td></td>
<td>Total metals or TCLP metals</td>
<td>1, 3 (D004-D011), 6</td>
</tr>
<tr>
<td></td>
<td>TCLP organics</td>
<td>3 (D012-D043)</td>
</tr>
<tr>
<td></td>
<td>RCRA characteristics</td>
<td>3 (D003), 5 (reactive)</td>
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<td></td>
<td>PCBs</td>
<td>1, 4, 5, 6</td>
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<tr>
<td></td>
<td>Asbestos</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td>PPE and Sampling Equipment</td>
<td>TCLP metals &amp; organics</td>
<td>3 (D004-D043)</td>
</tr>
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<td></td>
<td>Appropriate hazardous constituents</td>
<td>3 (F001, F002, F003, F005)</td>
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<td></td>
<td>PCBs</td>
<td>1, 4, 5, 6</td>
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<td></td>
<td>Asbestos</td>
<td>1, 4, 5, 6</td>
</tr>
<tr>
<td>Leachate</td>
<td>Appropriate hazardous constituents</td>
<td>3 (F039)</td>
</tr>
</tbody>
</table>

*1 = Used to verify that the waste matches the expected nature of that waste.
2 = Used to determine appropriate and compatible sampling equipment.
3 = Used to determine applicable U.S. Environmental Protection Agency Hazardous Waste Numbers (shown in parenthesis).
4 = Used to determine safe and appropriate handling and storage conditions.
5 = Used to identify special health and safety precautions and procedures.
6 = Used to determine Environmental Restoration Project site characterization.
PCB = Polychlorinated biphenyls
PPE = Personal protective equipment
TCLP = Toxicity characteristic leaching procedure
RCRA = Resource Conservation and Recovery Act
3.2 Parameter Selection Process
Table 3-1 indicates general parameters that are typically selected in determining the nature of the waste streams generated by ER Project activities. However, the actual parameters selected for each container or waste item are very site-specific. In general, the SNL/NM approach for identifying hazardous waste is consistent with EPA guidance for Comprehensive Environmental Response, Compensation, and Liability Act and/or RCRA corrective action sites.

The ER Project team investigates a site by reviewing all information that is reasonably ascertainable. Site histories may be developed from employee interview records, operating records and procedures, waste disposal records, site observations, and any other relevant information about the constituents potentially present and the processes conducted at the site. Depending on the site, the ER Project team may also collect site-specific characterization data, such as soil sample analysis, groundwater analysis, or borehole data. Based on these site investigations, the site-specific parameters will be selected.

3.3 Special Parameter Selection Requirements
Most of the ER Project waste is compatible, nonreactive, and nonignitable. However, it is possible that a liquid may exhibit corrosivity or ignitability. Also, it is possible that incompatible or reactive waste may be discovered, such as gas cylinders under pressure, explosive material, or containerized waste that is ignitable, reactive, cyanide-bearing, oxidizing, or corrosive. It is also possible that some waste streams may be contaminated with polychlorinated biphenyls (PCB) or asbestos. These wastes would be small volume and exceptions to the wastes routinely managed at the CAMU. The analytical parameters for these wastes are selected on a case-by-case basis. Table 3-1 provides typical parameters that may be selected.

4.0 Selecting Sampling Procedures—40 CFR §264.13(b)(3)

4.1 Sampling Strategies
The objective of the sampling program is to obtain a physical sample of material that is representative of the media being tested. All waste sampling performed at SNL/NM is consistent with the guidance found in “Test Methods for Evaluating Solid Waste,
Physical/Chemical Methods,” SW-846 (EPA, 1986). The methods specified in 40 CFR Part 261 will be followed, as applicable. Any pertinent information that contributes toward the goal of representativeness will be used, such as substantial variability in waste composition and the physical state of the waste. The following sampling strategies will be used for hazardous remediation waste sampling as much as possible, unless a better sampling strategy is deemed appropriate for a specific waste item based on specific historical processes or waste information.

- If the volume of waste is so small that sampling would consume the waste, SNL/NM may decide to forego sampling and analysis (e.g., a quantity of metal chips less than the quantity required for analyses).

- If the sampling or analysis of the waste would pose a serious threat to the environment or to human health, SNL/NM may forego sampling and analysis (e.g., explosive-contaminated waste or damaged compressed gas cylinders).

- For heterogeneous solid waste, such as soil waste or solid debris, samples will be obtained from areas that are most likely to be contaminated, based on visual inspection of the waste or knowledge of the activity which generated the waste.

- For solid wastes whose surface is suspected to be contaminated with hazardous waste or PCBs, such as contaminated debris and PPE, surface wipe samples may be taken.

- For solid wastes with compositions that may exhibit toxic characteristics, such as contaminated equipment, a sample may be taken and analyzed from a nonwaste item that is similar to the waste item.

- For liquid wastes with more than one phase, samples will be taken of each phase.

- For waste items in multiple containers, there will be one sample taken per batch of waste. For example, if 10 containers of decontamination water are generated during one cleaning event, one composite sample will be collected from those containers.

- Handling and collection techniques will be consistent with SW-846 (EPA, 1986) and will be conducted to preserve the nature of the waste sample.
4.2 Selecting, Maintaining, and Decontaminating Sampling Equipment

The selection of sampling equipment, containers, and PPE must be made prior to the sampling event. Procedures are designed to minimize the generation of hazardous waste during the sampling event. Sampling equipment is decontaminated to limit the introduction of contaminants from equipment to sampled media, to limit cross-contamination between sampling points, and to protect worker health and safety. The physical and chemical nature of waste (e.g., physical state, volume, hazardous characteristics, homogeneity, stratification, and accessibility) and the potential interactions between sampling equipment or container materials with analytes of interest are evaluated in the choice of sampling equipment and sample containers. The equipment listed in Table 4-1, or in SW-846, Chapter 9 (EPA, 1986), or in other EPA-approved guidance, are used to sample ER Project hazardous remediation wastes to be managed at the CAMU.

<table>
<thead>
<tr>
<th>Waste Media</th>
<th>Sampling Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquids</td>
<td>COLIWASA, pipette, or Bennett pump</td>
</tr>
<tr>
<td>Sludges</td>
<td>Trier</td>
</tr>
<tr>
<td>Soil</td>
<td>Auger, split-spoon sampler, scoop</td>
</tr>
</tbody>
</table>

4.3 Sample Preservation and Storage

In many low-concentration samples, preservation is necessary to prevent the constituents from chemically, physically, or biologically altering prior to analysis. Typical techniques include the addition of appropriate chemicals, sample refrigeration, sample storage using appropriate containers and lids, and holding time limitations between sampling and analysis. SNL/NM uses the current EPA-approved preservation and storage techniques, such as those described in Tables 4-2 and 4-3, or in SW-846 (EPA, 1986).

4.4 Establishing Quality Assurance/Quality Control Procedures

SNL/NM has developed sampling quality assurance (QA)/quality control (QC) procedures to assure that analytical results can be attributed to specific containers of waste or specific sampling sites. The sampling program is designed to meet the requirements of SW-846, Chapter 1.0 (EPA, 1986).
### Table 4-2

**Examples of Sample Collection and Preservation Techniques for Solids**

<table>
<thead>
<tr>
<th>Matrix/Parameter to be Analyzed</th>
<th>Sample Container Type and Materials</th>
<th>Preservation Method</th>
<th>Maximum Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total volatile organics</td>
<td>Widemouth glass with Teflon™ liner</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Total semivolatile organics</td>
<td>Widemouth glass with Teflon™ liner</td>
<td>Cool to 4°C</td>
<td>14 days for extraction 40 days for analysis</td>
</tr>
<tr>
<td>Total mercury</td>
<td>Widemouth glass</td>
<td>Cool to 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>Widemouth glass or polyethylene</td>
<td>Cool to 4°C</td>
<td>Recommended as soon as possible</td>
</tr>
<tr>
<td>All other metals (total)</td>
<td>Widemouth glass or polyethylene</td>
<td>Cool to 4°C</td>
<td>6 months</td>
</tr>
<tr>
<td>pH</td>
<td>Widemouth glass</td>
<td>None</td>
<td>Analyze immediately</td>
</tr>
<tr>
<td>Total organic halogens</td>
<td>Widemouth glass with Teflon™ liner</td>
<td>Cool to 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>Widemouth polyethylene with Teflon™ liner</td>
<td>Cool to 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Volatile organics (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>14 days for TCLP 14 days for analysis</td>
</tr>
<tr>
<td>Semivolatile organics (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>14 days for TCLP 7 days for extraction 40 days for analysis</td>
</tr>
<tr>
<td>Metals (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>6 months for TCLP 6 months for analysis</td>
</tr>
<tr>
<td>Mercury (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>28 days for TCLP 28 days for analysis</td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>Widemouth 8 ounce glass with Teflon™ liner</td>
<td>Cool to 4°C</td>
<td>14 days for extraction 40 days for analysis</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Widemouth glass</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

*C* = Degrees Celsius

TCLP = Toxicity characteristic leaching procedure
Table 4-3
Examples of Sample Collection and Preservation Techniques for Liquids

<table>
<thead>
<tr>
<th>Matrix/Parameters To Be Analyzed</th>
<th>Sample Container Type and Materials</th>
<th>Preservation Method</th>
<th>Maximum Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>180 days for TCLP; 180 days for analysis</td>
</tr>
<tr>
<td>Mercury (TCLP)</td>
<td>Widemouth glass</td>
<td>May be cooled to 4°C</td>
<td>28 days for TCLP; 28 days for analysis</td>
</tr>
<tr>
<td>Volatile organics</td>
<td>40 ml vial, Teflon™-lined septum</td>
<td>Cool to 4°C; pH&lt;2 HCl</td>
<td>14 days</td>
</tr>
<tr>
<td>Semivolatile organics</td>
<td>1 liter glass</td>
<td>Cool to 4°C</td>
<td>7 days for extraction; 40 days for analysis</td>
</tr>
<tr>
<td>Total metals</td>
<td>1 liter polyethylene or glass</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Total mercury</td>
<td>1 liter polyethylene or glass</td>
<td>pH&lt;2 HNO₃</td>
<td>28 days</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>500 ml glass or polyethylene</td>
<td>Cool to 4°C</td>
<td>24 hours</td>
</tr>
<tr>
<td>pH</td>
<td>Glass or polyethylene</td>
<td>None</td>
<td>24 hours</td>
</tr>
<tr>
<td>Total phenols</td>
<td>500 ml glass Teflon™-lined cap, no headspace</td>
<td>Cool to 4°C; pH&lt;2 H₂SO₄ or HCl</td>
<td>28 days</td>
</tr>
<tr>
<td>Total organic halogens</td>
<td>1 liter glass</td>
<td>Cool to 4°C; pH&lt;2 H₂SO₄</td>
<td>28 days</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>1 liter polyethylene or glass</td>
<td>Cool to 4°C; pH&lt;2 HCl or H₂SO₄</td>
<td>28 days</td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>1 liter amber glass with Teflon™-lined cap</td>
<td>Cool to 4°C</td>
<td>7 days for extraction; 40 days for analysis</td>
</tr>
<tr>
<td>Asbestos</td>
<td>1 liter glass</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

°C = Degrees Celsius
HCl = Hydrochloric acid
HNO₃ = Nitric acid
H₂SO₄ = Sulfuric acid
ml = milliliter
TCLP = Toxicity characteristic leaching procedure
After a sample is collected, a label providing the following minimum information is affixed to the sample container:

- Sample number
- Date and time of collection
- Sampling location or container number
- Type of sample (e.g., liquid, gas, solid, sludge)
- Name of collector.

Sample numbers are unique to each sample. The sample number is also recorded on a sample collection log, which includes the following information for each sample:

- Sample number
- Sample and analysis request number
- Date and time of sample collection
- Sampling location or container number
- Type of sample (e.g., gas, solid, sludge, liquid)
- Purpose of sample collection
- Number and volume of samples
- Sample description (e.g., grab, composite)
- Results of field observations or measurements
- Name of sample collector
- Signature of sample collector.

To assure that the sample is traceable from the time of collection to the time of analysis, an analysis request and chain-of-custody form is completed and maintained for each sample. The analysis request and chain-of-custody form includes the following minimum information:

- Sample number
- Date and time of sample collection
- Sampling location or container number
- Type of sample (e.g., gas, solid, sludge, liquid)
- Required analytical testing
- Sample description (e.g., grab, composite)
- Results of field observations or measurements
- Name of sample collector
- Signature of sample collector
- Signatures of persons involved in the chain of custody
- Dates of possession.

Samples will be analyzed only by SNL/NM-approved laboratories operating in accordance with contract requirements and EPA laboratory QA/QC guidance (EPA, 1986). Documentation that
demonstrates QA/QC procedures (e.g., tabulation of results of blank analyses, calibration curves) is prepared and permanently maintained in the analytical laboratory’s files. All hazardous remediation waste analytical results are reported and signed by the analytical laboratory’s chemist or his/her supervisor.

5.0 Selecting a Laboratory and Laboratory Testing and Analytical Methods—40 CFR §264.13(b)(2)

5.1 Selecting a Laboratory

Samples may be analyzed at on-site and/or off-site laboratories for the purposes of waste characterization for acceptance into the CAMU.

SNL/NM may submit samples to the on-site ER Project Field Office Chemistry Laboratory for analyses or characterization of waste within the CAMU (e.g., treatment effectiveness verifications or characterization of spill cleanup materials [if necessary]). The ER Project Field Office Chemistry Laboratory uses EPA-approved SW-846 procedures in accordance with an SNL/NM-approved QA plan and program. ER Project Field Office Chemistry Laboratory-generated data is validated in accordance with SNL/NM Sample Management Office protocol. Chain-of-custody and associated documentation for samples analyzed at the ER Project Field Office Chemistry Laboratory is maintained by the SNL/NM Environmental Operations Records Center.

SNL/NM only uses off-site laboratories under contract with SNL/NM. Generally, SNL/NM has three to six off-site laboratories with current contracts. Before awarding contracts, each bidding laboratory is audited to assure that it meets minimum requirements with respect to cost, technical abilities, QA/QC, and regulatory compliance, (e.g., maintaining appropriate licenses and permits; performing the sample preparation and analytical methods in accordance with current EPA guidance; maintaining chain of custody and associated documentation; and using a data validation process).

5.2 Selecting Testing and Analytical Methods

Waste characterization is the process of identifying the RCRA hazardous waste characteristics (as defined in 40 CFR 261, Subpart C) and hazardous waste constituents (as defined in 40 CFR 260.10) of remediation waste. Waste characterization involves using full-scale sampling and analysis methods, fingerprint or field analysis methods, acceptable knowledge methods, or a combination of these methods. Full-scale sampling and analysis is used to characterize waste managed at the CAMU. (Possible exceptions to this approach are discussed in Sections 5.2.2 and 5.2.3.) Full-scale sampling and analysis involves the collection of representative samples (using EPA-approved methods and
guidelines) and laboratory analyses of those samples in accordance with EPA-approved analytical methods.

Fingerprint or field analyses are forms of abbreviated waste analysis. Field analyses may be performed prior to waste transfer to the CAMU to generate sufficient and adequate data to safely and responsibly stage the waste within the CAMU. Full-scale sampling and analysis are required prior to waste treatment or bulk disposal in the CAMU containment cell. Fingerprint analyses may be performed as part of the waste verification process prior to waste acceptance at the CAMU. Fingerprint data may be used to verify that the waste shipment matches expected waste characteristics.

Acceptable knowledge is broadly defined to include process knowledge (e.g., the procurement of detailed information on wastes from existing published or documented waste analysis data or studies conducted on hazardous waste generated by similar processes), waste analysis data, and/or records of analyses performed before the effective date of RCRA regulations.

Table 5-1 indicates how the ER Project hazardous remediation waste streams subject to this WAP are typically characterized; however, the actual method used for a specific waste will be determined by site-specific factors. Sections 5.2.1 through 5.2.3 discuss the selection criteria that will be used in determining the characterization method.
Table 5-1
Waste Characterization Methods

<table>
<thead>
<tr>
<th>Waste Streams</th>
<th>Method of Characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Full-scale sampling and analysis and/or fingerprint or field analysis*</td>
</tr>
<tr>
<td>Sludge and Drilling Mud</td>
<td>Full-scale sampling and analysis and/or fingerprint or field analysis*</td>
</tr>
<tr>
<td>Monitor well purge and development water and decontamination solutions</td>
<td>Full-scale sampling and analysis and/or fingerprint or field analysis*</td>
</tr>
<tr>
<td>Solid debris</td>
<td>Acceptable knowledgeb and/or full-scale sampling and analysis</td>
</tr>
<tr>
<td>Personal protective equipment and sampling equipment</td>
<td>Acceptable knowledgeb and/or full-scale sampling and analysis</td>
</tr>
</tbody>
</table>

*Fingerprint and field analyses may be used solely for the purposes of waste characterization verification or preliminary characterization to enable safe and responsible waste staging. Fingerprint and field analyses are not adequate substitutes for full-scale sampling and analysis.

bAcceptable knowledge may be used for waste streams that do not lend themselves to the collection of representative samples.

5.2.1 Using Sampling and Analysis
Table 5-2 lists the analytical methods used for each waste parameter when sampling and analysis is used as the method of characterization. Methods other than “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods” SW-846 (EPA, 1986) may be used if the nature of the sample or improvements in analytical technology warrant the alternative method and the method has been approved by the EPA Regional Administrator.

5.2.2 Using Acceptable Knowledge
According to the EPA’s “Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Waste, A Guidance Manual,” Pages 1-13 and 1-14 (EPA, 1994), “…Generators and TSDFs may use acceptable knowledge alone or in conjunction with sampling and laboratory analysis... There are situations where it may be appropriate to apply acceptable knowledge, including:

- Hazardous constituents in wastes from specific processes are well documented, such as with F-listed wastes.
### Table 5-2
Waste Analysis Test Methods for Waste Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Analytes</th>
<th>Test Method(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Solid Waste Methods(^b) (SW-846)</td>
</tr>
<tr>
<td>pH</td>
<td>Hydrogen ion activity</td>
<td>9040A, 9041A, 9045A</td>
</tr>
<tr>
<td>Free liquid</td>
<td>NA</td>
<td>9095</td>
</tr>
<tr>
<td>Flash point (ignitability)</td>
<td>NA</td>
<td>1010 or 1020A</td>
</tr>
<tr>
<td>Corrosivity</td>
<td>NA</td>
<td>Corrosivity towards steel pH paper pH electrometer</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Total sulfide and total cyanide</td>
<td>9030A and 9010A</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Explosives</td>
<td>None</td>
</tr>
<tr>
<td>TCLP: Organics</td>
<td>TCLP volatile</td>
<td>Extraction method 1311 8260</td>
</tr>
<tr>
<td></td>
<td>TCLP semivolatile</td>
<td>8270</td>
</tr>
<tr>
<td></td>
<td>TCLP organochlorine pesticides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCLP chlorinated herbicides</td>
<td></td>
</tr>
<tr>
<td>Total volatile organic compounds</td>
<td>To be determined by knowledge of process</td>
<td>8260</td>
</tr>
<tr>
<td>Total semivolatile organic compounds</td>
<td>To be determined by knowledge of process</td>
<td>8270</td>
</tr>
<tr>
<td></td>
<td>Barium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cadmium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chromium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mercury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selenium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silver</td>
<td></td>
</tr>
<tr>
<td>Total metals</td>
<td>To be determined by knowledge of process</td>
<td>Extraction by 3010A, 3050A, same methods as TCLP metals or ED XRF</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Analytes</th>
<th>Solid Waste Methods&lt;sup&gt;b&lt;/sup&gt; (SW-846)</th>
<th>Water/Waste-water&lt;sup&gt;c&lt;/sup&gt; Methods</th>
<th>Standard Methods&lt;sup&gt;d&lt;/sup&gt;</th>
<th>ASTM&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state</td>
<td>To be determined by visual examination</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Method dependent on material composition and physical state</td>
<td></td>
</tr>
<tr>
<td>TOX</td>
<td>TOX</td>
<td>9020&lt;sup&gt;b&lt;/sup&gt; or 9022</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Percent moisture (water)</td>
<td>Water</td>
<td>NA</td>
<td>NA</td>
<td>C566(04.02)</td>
<td>NA</td>
</tr>
<tr>
<td>Oxidizing reduction potential</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>2580</td>
<td>D1498 (11.01)</td>
</tr>
<tr>
<td>Total phenols</td>
<td>Phenol</td>
<td>9065, 9066, 9067</td>
<td>420</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>NA</td>
<td>160.2</td>
<td>2540&lt;sup&gt;d&lt;/sup&gt;</td>
<td>D3977 (11.02)</td>
<td>NA</td>
</tr>
<tr>
<td>Total chloride</td>
<td>Chloride</td>
<td>9250, 9251, 9252A or 9253</td>
<td>300.0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>Nitrogen</td>
<td>351</td>
<td>4500-N</td>
<td>D3590-89 (11.01)</td>
<td>NA</td>
</tr>
<tr>
<td>BTU value</td>
<td>NA</td>
<td>5050</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Viscosity</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Method dependent on material composition and physical state</td>
<td></td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>Polychlorinated biphenyls</td>
<td>8080</td>
<td>608</td>
<td>6630</td>
<td>D3304</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Asbestos&lt;sup&gt;r&lt;/sup&gt;</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

<sup>a</sup>Equivalent methods, subject to U.S. Environmental Protection Agency (EPA) approval, may be substituted
<sup>b</sup>Reference: EPA, 1986
<sup>c</sup>Reference: EPA, 1983
<sup>d</sup>Reference: American Public Health Association (APHA), 1992 (18th edition)
<sup>r</sup>Asbestos analysis may be conducted following the "Method for the Determination of Asbestos in Bulk Building Materials (Test Method)" EPA/600-R-93-116.

BTU = British thermal unit
ED XRF = Energy dispersant x-ray fluorescence
NA = Not applicable
TCLP = Toxicity characteristic leaching procedure
TOX = Total organic halogens
• Wastes are discarded, unused commercial chemical products, reagents or chemicals of known physical, and chemical constituents. Several of these fall into the P-listed and U-listed categories.

• Health and safety risks to personnel would not justify sampling and analysis.

• The physical nature of the waste does not lend itself to taking a laboratory sample. For example, to conduct waste analysis of surface-contaminated construction debris, such as steel girders, piping, and linoleum, it may be necessary to use a combination of laboratory analysis and process knowledge. The process knowledge would be applied to identifying the composition of the base construction materials (e.g., steel). One could then collect surface "wipe" samples and conduct laboratory analysis to determine the representative concentrations of any contaminants present" (EPA, 1994).

At SNL/NM, acceptable knowledge may be used in the following situations.¹

• Small-volume waste: In some cases, the volume of a waste item is so small that the sampling activity will consume the waste. This is contrary to the intent of managing hazardous waste because sampling effectively disposes of the waste. Therefore, for small volume wastes of any waste stream, SNL/NM may opt to use acceptable knowledge in lieu of sampling and analysis.

• PPE and sampling equipment: The physical nature of the waste does not lend itself to obtaining a representative sample. If it is suspected that a material is contaminated, SNL/NM may opt to use acceptable knowledge by assigning hazardous waste classification codes based on characterization results from associated waste streams, such as from soil waste or decontamination solutions.

• Solid debris: In many cases, the physical nature of the solid debris does not lend itself to taking a representative sample. If a sample can not be taken, acceptable knowledge may be used instead of or in conjunction with sampling and analysis. For example, wipe samples of the surface of debris may be taken, calculations may be used to estimate probable concentrations of hazardous constituents in debris, or acceptable knowledge may be used to assign waste characteristics.

¹For the specified waste streams (i.e., small volume, PPE and sampling equipment, and solid debris) characterized using acceptable knowledge, hazardous waste codes are assigned based on professional knowledge of constituents or characteristics (e.g., small quantities of explosives are coded as D003, printed circuit boards containing lead solder are coded as D008) and/or characterization results from associated waste streams (e.g., sampling equipment is coded with the same codes as assigned to the sampled media). It is presumed that the waste streams characterized solely through acceptable knowledge do not meet treatment standards (e.g., land disposal restriction or alternate approved standards) and are managed as RCRA-regulated hazardous waste. If these wastes are transported off-site to a permitted treatment, storage, or disposal facility, a notice and certification stating that the waste does or does not meet the applicable land disposal restrictions (LDR) treatment and prohibition standards in 40 CFR 268 accompanies the shipment.
5.2.3 Using Fingerprint and Field Analysis

There are many types of commercially available field analytical equipment/instrumentation available to help characterize a material, such as pH paper, oxidation paper, Hazard Category kits, organic chemical detection kits, gas detection tubes, total halogen kits, PCB screen kits, and hydrometers. Fingerprint analysis can be conducted for certain chemical properties, such as pH, specific gravity, color, physical state, and flashpoint. Both of these methods (i.e., fingerprint analysis and field analysis) can be used fairly effectively and accurately in the field with minimal or no equipment, sampling or personnel exposure. The information generated from the use of these and types of equipment is often sufficient to determine hazard classes and chemical properties of a waste and, thus, facilitate proper waste management. These techniques may be used by SNL/NM under the following conditions:

- Unknown remediation wastes: Because of the potential safety and health risk to personnel, fingerprint or field analysis may be used to characterize these wastes. The results may be used to determine appropriate staging and handling methods or may be used to verify hazardous characteristics that are expected based on information from product documentation, labels, or waste records.

- Small volume remediation waste: In some cases, the volume of a waste item is so small that the sampling activity will consume the waste. This is contrary to the intent of managing hazardous waste because sampling effectively disposes of the waste. Therefore, for small volumes of any waste stream, SNL/NM may opt to use fingerprint or field analysis in lieu of sampling and analysis.

6.0 Selecting Waste Evaluation Frequencies—

40 CFR §264.13(b)(4)

As described in Section 5.2, all wastes managed in the CAMU undergo initial characterization to obtain information which must be known to safely and responsibly stage, treat, or dispose of the waste. In addition, waste analysis will be repeated as necessary to assure that it is accurate and up to date. Analysis will be repeated when ER Project personnel have reason to believe that the process or operation generating the remediation waste has changed in a way that may affect the waste characteristics; new information about the remediation waste or waste site becomes available that may affect the waste characterization; or ER Project personnel determine that the waste does not match previous or expected waste characteristics.

Furthermore, treated wastes to be placed in the CAMU containment cell are sampled and analyzed to determine treatment effectiveness and achievement of treatment standards. This process will be more
completely described in an amendment to this WAP to be submitted with a permit modification request for use of specific treatment technologies at the CAMU.

7.0 Special Procedural Requirements

7.1 Procedures for Receiving Wastes Generated Off-Site—40 CFR §264.13(b)(5)
Hazardous remediation wastes from outside SNL/NM boundaries may be accepted for management at the CAMU only if the wastes result from the cleanup of releases from SNL/NM activities that extend beyond the facility boundary. These wastes will be characterized in accordance with this WAP. Therefore, special waste analysis procedures for off-site wastes are not necessary for this WAP.

7.2 Procedures for Ignitable, Reactive, and Incompatible Wastes—40 CFR §§264.13(b)(6) and 264.17
Waste that has the potential to be ignitable, reactive, explosive, or incompatible will be staged and managed to minimize the possibility of adverse reactions. All ignitable or reactive waste will be kept away from sources of ignition and segregated from other waste types. All water-reactive wastes will be isolated from water or water systems. All incompatible wastes will be segregated from each other by using different structures, containment systems, physical barriers, or adequate distance to prevent commingling.

7.3 Provisions for Complying with Land Disposal Restrictions (LDR) Requirements—40 CFR §268.7
LDR requirements do not apply while hazardous remediation waste is managed at a CAMU. However, if SNL/NM ships waste off-site to a TSDF, SNL/NM is required to determine if the wastes are subject to 40 CFR Part 268 standards by using either testing or acceptable knowledge, depending on the waste stream (refer to Section 5.0). If it is believed that the waste is restricted but meets the LDR treatment standards, confirmatory analysis will be conducted. An LDR certification will accompany the shipment of any waste that is determined through analysis to meet treatment standards. If it is believed that the waste does not meet applicable LDR treatment standards, no analysis will be conducted. LDR notifications will be supplied to the off-site permitted TSDF if the waste is sent off site.

for percent reduction of contaminants or specified concentration may be used at the CAMU.
Additional information on applicable treatment standards will be included in the RCRA Subtitle C
permit application or modification request for the CAMU mobile treatment units.

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APPENDIX B

CONTINGENCY PLAN FOR THE RESOURCE CONSERVATION AND RECOVERY ACT—REGULATED WASTE MANAGEMENT UNITS AT SANDIA NATIONAL LABORATORIES/NEW MEXICO

FINAL

SEPTEMBER 1997
CONTINGENCY PLAN FOR THE
RESOURCE CONSERVATION AND RECOVERY ACT—REGULATED
WASTE MANAGEMENT UNITS AT
SANDIA NATIONAL LABORATORIES/NEW MEXICO

FINAL

SEPTEMBER 1997
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<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
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<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
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<tr>
<td>EC</td>
<td>Emergency Coordinator</td>
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<tr>
<td>EOC</td>
<td>Emergency Operations Center</td>
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<tr>
<td>ERO</td>
<td>Emergency Response Organization</td>
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<td>IC</td>
<td>Incident Commander</td>
</tr>
<tr>
<td>ICS</td>
<td>Incident Command System</td>
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<tr>
<td>KAFB</td>
<td>Kirtland Air Force Base</td>
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<tr>
<td>NMAC</td>
<td>New Mexico Administrative Code</td>
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<td>NMED</td>
<td>New Mexico Environment Department</td>
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<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<td>Sandia National Laboratories/New Mexico</td>
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<td>TA</td>
<td>Technical Area</td>
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1.0 Introduction

1.1 Purpose—40 CFR §§264.50/265.50 and 264.51/265.51
This Contingency Plan has been prepared to address emergencies that may occur during operation of any Resource Conservation and Recovery Act (RCRA)-regulated hazardous waste management unit (unit) at Sandia National Laboratories/New Mexico (SNL/NM). The plan has been prepared in accordance with Title 40 of the Code of Federal Regulations (40 CFR) and/or Title 20 of the New Mexico Administrative Code, Chapter 4, Part 1 (20 NMAC 4.1), Subparts V and VI, Sections (§) 264.50/265.50 through §§264.56/265.56, as applicable for treatment, storage, or disposal facilities.

The purpose of this contingency plan is to define the actions and resources necessary to minimize hazards to human health or to the environment from fires, explosions, or any unplanned sudden or nonsudden release of RCRA-regulated hazardous waste or hazardous waste constituents to the air, soil, or surface water. This plan and the SNL/NM emergency response plans will be activated immediately whenever there is a fire, explosion, or release of RCRA-regulated hazardous waste or hazardous waste constituents that could threaten human health or the environment outside the facility.

1.2 Definitions

**Emergency.** Any fire, explosion, or unplanned sudden or nonsudden release of RCRA-regulated hazardous waste or hazardous waste constituents that significantly threaten human health or the environment outside of a unit are defined as emergencies requiring implementation of this Contingency Plan. Examples of emergencies include, but are not limited to:

- A RCRA-regulated hazardous waste release within the unit that cannot be contained with secondary containment or application of absorbents and is or threatens to be released beyond the unit boundaries,
- An explosion involving RCRA-regulated hazardous waste that has occurred or is imminent,
- A fire involving RCRA-regulated hazardous waste that has occurred or is imminent,
• A structure fire, grass fire, or forest fire that threatens to ignite RCRA-regulated hazardous waste.

**Facility.** All contiguous property under the control of SNL/NM and within the boundaries of Kirtland Air Force Base used for storing, treating, or disposing of mixed or hazardous wastes.

**RCRA-Regulated Hazardous Waste.** A waste that meets the definition of RCRA solid waste and is not exempt from regulation, as long as it exhibits one or more of the characteristics described in 40 CFR Part 261, Subpart C or is listed in 40 CFR Part 261, Subpart D.

**Release.** Unconfined contact of RCRA-regulated hazardous waste or waste constituents to air, soil, or surface water. The term “release” does not refer to RCRA-regulated hazardous waste or waste constituents within secondary containment systems, contact on concrete or impervious surfaces, or contact inside buildings unless the RCRA-regulated hazardous waste or waste constituent is airborne.

**Waste Management Unit (Unit).** Any specific RCRA operational area (e.g., CAMU) used for the treatment, storage, or disposal of RCRA-regulated hazardous waste. The waste management units subject to this Contingency Plan are described in unit-specific attachments.

**Contingency Plan Distribution—40 CFR §§264.53/265.53.** Copies of this Contingency Plan will be on file at the following locations:

- SNL/NM Environmental Operations Records Center
- RCRA Waste Management Units
- SNL/NM Integrated Risk Management Department.

**Contingency Plan Amendments—40 CFR §§264.54/265.54.** This Contingency Plan will be reviewed and immediately amended, if necessary, whenever:

- Applicable regulations or facility permit conditions are revised.
- There is significant change in facility or unit design, construction, maintenance, operation, or other circumstances that increases the potential for emergencies or changes the response necessary in an emergency.
• The list of designated emergency coordinators changes.
• The list of required emergency equipment changes.
• Operating experience, drills, or technical review demonstrate the plan is inappropriate.
• Actual implementation of the plan demonstrates inadequacies.

**SNL/NM Description.** SNL/NM is a multidisciplinary laboratory engaged in research and development of weapons and alternative energy sources. SNL/NM is managed by Sandia Corporation, which is a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy (DOE), with substantial work performed for the U.S. Department of Defense and the U.S. Nuclear Regulatory Commission. SNL/NM falls under Standard Industrial Classification Code Number 8733, “Noncommercial Research” and Number 9711, “National Security.”

SNL/NM is located south of Albuquerque, New Mexico, within the boundaries of Kirtland Air Force Base (KAFB) (Figure 1) in Bernalillo County. SNL/NM consists of five Technical Areas (TA) (TAs I through V) and remote test areas situated in the eastern half of the 492-square-mile KAFB military reservation.

**Unit Descriptions.** Site-specific descriptions of each RCRA-regulated unit subject to 40 CFR Parts 264/265 (or 20 NMAC 4.1, Subpart V/VI), Subpart D, are provided in unit-specific attachments to this plan.

### 2.0 Emergency Response Resources

**Arrangements and Coordination with Emergency Response Teams—40 CFR §§264.52(c)/265.52(c) and 264.37/265.37.** SNL/NM maintains its own emergency response resources to handle most emergencies arising from its activities within the Emergency Response Organization (ERO)—a management system used to coordinate the efforts of all SNL/NM response capabilities and teams and other response teams, such as the KAFB Fire Department, as needed. The ERO is comprised of two elements: the Emergency Operations Center (EOC) and the Incident Command System (ICS). The EOC performs management and oversight functions for emergency response including, but not limited to,
Figure 1
Sandia National Laboratories/New Mexico Technical Areas (TA) in Relation to KAFB
event classification, notification and training (if necessary) of off-site response agency personnel, and procurement of off-site response resources. The ICS establishes a field emergency response system with a recognizable chain-of-command at SNL/NM. The ICS ensures that proper resources are determined, acquired, properly used, and demobilized. During emergencies, the ERO maintains authority and coordination responsibilities. If external emergency support services are needed, DOE/Kirtland Area Office will authorize the use of external agencies and the EOC will: (1) activate the service; (2) familiarize the response teams with the facility, the hazards associated with the facility, and with the emergency conditions; and (3) ensure all response teams understand who is the primary emergency authority.

Coordinated Services. Agreements for emergency support services at SNL/NM exist between the DOE/Albuquerque Office and the Federal Bureau of Investigation, the State of New Mexico, the U.S. Air Force, and others. SNL/NM has also negotiated agreements with local hospitals for medical support and with KAFB for wide-ranging assistance, including KAFB fire department, law enforcement, hospital, civil engineering, and paramedic response. All of these written agreements, which are maintained in the EOC, describe what services are to be provided by the signatories and under what conditions. The SNL/NM EOC is responsible for negotiating and maintaining current copies of these agreements for emergency support services. Copies of these agreements are available for review upon request by the Administrative Authority.

SNL/NM maintains its own emergency response resources (i.e., EOC and Medical services) to provide first-line emergency response at SNL/NM RCRA-regulated hazardous waste management units. Non-SNL/NM emergency response personnel provide support under the direct supervision of SNL/NM EOC personnel.

Emergency Coordinator—40 CFR §§264.52(d)/265.52(d), 264.55/265.55, and 264.56(a)–(h)/265.56(a)–(h). The Emergency Coordinator (EC) has thorough familiarity with the facility contingency plan and unit-specific attachments, unit layout, operations, the location of records, and the locations and characteristics of the hazardous waste managed at the units. The EC has the authority to commit the necessary resources to respond to an emergency at the facility. In the event the EC is not on site or immediately available, an
alternate EC must be contacted. The names, addresses, and phone numbers of the primary and alternate EC(s) are listed in the unit-specific attachments to this plan.

It is the responsibility of the EC to coordinate hands-on emergency response measures at the unit until the Incident Commander (IC) (dispatched by the EOC) arrives.

Specific responsibilities of the EC, or designee, include:

- Activate the unit-specific alarm or signal to notify unit personnel. If required, initiate evacuation procedures.
- Notify EOC personnel (by dialing 911 or 844-0911), who will activate additional resources as needed.
- Identify the character, exact source, amount, and areal extent of any released RCRA-regulated hazardous waste by observing the site, reviewing records, or conducting chemical analyses.
- Assess possible hazards to human health or the environment that may result from the emergency.
- If the emergency could threaten human health beyond SNL/NM boundaries, assure that the emergency is reported to the National Response Center (1-800-424-8802) and local authorities.
- Take all reasonable measures to assure fires, explosions or releases do not occur, recur, or spread.
- Monitor for leaks, pressure build up, gas generation, or ruptures of equipment, when appropriate.
- Provide for storing, treating, or disposing of recovered RCRA-regulated hazardous waste in accordance with applicable requirements.
- Assure that incompatible RCRA-regulated hazardous wastes are not treated, stored, or disposed of until cleanup operations are completed.
- Assure emergency equipment is replaced or decontaminated and is fit for its intended use before operations are resumed.
- Remain on site and serve as technical advisor to the IC by providing information on unit operations, layout, hazardous waste characteristics, location
of records, and other information as necessary to properly respond to the emergency.

Emergency Chain of Command. EOC staff assume primary responsibility for response coordination in the case of an emergency. When activated, the EOC is manned by the Emergency Response Director and a staff consisting of DOE personnel, SNL/NM management, KAFB staff, and representatives from various response groups. The ICS is a system for emergency response by which a field management structure can be set up that assures control, effective use, and mobilization of resources.

If the EC arrives before the IC, the EC will take command of hands-on emergency response. Control of hands-on emergency response will be relinquished to the IC as soon as he/she arrives at the scene. However, the EC is fully responsible for the implementation of this plan including the emergency procedures stipulated in 40 CFR 264.56.

The IC, who reports directly to the Emergency Response Director, is responsible for management of operations at the emergency site. The IC establishes the ICS which he/she builds by designating section chiefs for Operations, Finance, Logistics, and Planning, as necessary. The Operations Section identifies and carries out the actions necessary at the site to contain the emergency. The Finances Section is responsible for assuring that costs and financial arrangements are considered. The Logistics Section identifies, acquires, deploys, and demobilizes the supplies, materials, and equipment needed to deal with an emergency. The Planning Section is responsible for collection, evaluation, dissemination, and use of data (e.g., resources available, weather, field observations about the development of the emergency) and communication of that data to the IC for use in the development and direction of emergency response resources.

Any subgrouping, such as a sector emergency response team, can be fit, unchanged in its form, function, authority, or responsibility, into the ICS structure for a particular incident by slotting it under the appropriate section chief.

Emergency Equipment—40 CFR §§264.32/265.32, 264.33/265.33, 264.34/265.34, and 264.52(e)/265.52(e). Lists of emergency equipment at each unit are provided in the unit-specific attachments to this plan. Emergency equipment is regularly (i.e., weekly)
inspected and maintained, as necessary, to assure its proper operation during emergencies. The equipment that is inspected is listed on site-specific weekly inspection forms.

### 3.0 Response Procedures

**Emergency Notification—40 CFR §§264.52(a)/265.52(a) and 264.56(a)–(h)/265.56(a)–(h).** This section prescribes the responsibilities and operations necessary to control emergencies that may potentially occur at the facility or at a unit.

The first person to become aware of an emergency will contact the EC. The EC or EC designee, will perform the following actions:

1. Activate any necessary unit alarms to notify unit personnel.

2. Immediately contact the EOC at 911 or 844-0911.

3. State and local agencies will be notified by the EOC if state or local response resources are required or if areas outside of a unit require evacuation. In the event of an emergency where human health and the environment outside of SNL/NM are threatened, the EOC will notify the National Response Center (1-800-424-8802) and report the following:
   - His/her name and telephone number
   - Name and address of the facility
   - Time and nature of the emergency
   - Types and quantities of material involved
   - Extent of injuries incurred by personnel
   - Identification of potential hazards to human health and the environment outside the facility

4. Contact the New Mexico Environment Department (NMED) Hazardous and Radioactive Materials Bureau at (505) 827-1557 (during working hours) or (505) 827-9329 (after working hours).
Fire. A fire in a RCRA-regulated unit or any structure, vegetation, or nonhazardous waste fire that threatens to ignite RCRA-regulated hazardous waste is defined as an emergency. The following emergency procedures should be performed:

1. Prior to any firefighting, the KAFB Fire Department and the EOC will be notified by pulling the fire alarm or dialing 911 or 844-0911.

2. If the fire is small, the fuel source is small, and the appropriate type of portable fire extinguisher for the type of fire is nearby, the extinguisher may be used to put out the fire.

3. Upon arrival at a fire, the KAFB Fire Department Officer-in-Charge will be in command of firefighting. He will accept and evaluate the advice of the EC, and other SNL/NM personnel, but he retains the responsibility to select the firefighting methods and tactics.

4. Firefighting personnel must wear appropriate personal protective equipment, considering all hazards (i.e., chemical/radiological hazards as well as normal fire hazards).

5. Whenever possible, unit personnel will remove flammable material from the area of the fire.

6. Whenever possible, fire doors (if present) will be closed to help contain the fire.

7. Measures will be taken to contain potentially hazardous runoff due to firefighting (e.g., build dikes around containers, drains, etc., and close any valves controlling potential discharge).

8. Materials involved in a fire can be identified in the following ways:
   a. The location of the container may indicate the contents of the container
   b. If the location of the container does not indicate its contents, container labels or markings can be used to identify the material either directly or from facility records traceable to the container.
   c. If the label is destroyed by the fire, the material will be treated as an unknown.
9. An appropriate absorbent will be poured over all residues resulting from a fire involving hazardous waste. Once the liquid is absorbed, the waste will be transferred (e.g., swept or shoveled) into properly marked containers.

10. Firefighting water may be contained in a lined impoundment and analyzed to determine an appropriate disposal method.

11. Conduct salvage and cleanup operations (see Chapter 5.0), and document emergency activities (see Chapter 6.0).

**Explosion.** The following procedures are to be implemented in the event of an actual or imminent unplanned explosion involving RCRA-regulated hazardous waste:

1. Immediately evacuate the area (see Chapter 4.0).

2. Immediately transport any injured personnel to the SNL/NM Medical Clinic for treatment.

3. The EC, or designee, will contact the EOC (911 or 844-0911), who will in turn immediately notify the KAFB Fire Department about the explosion and also alert appropriate emergency preparedness personnel and safety-related organizations.

4. Upon arrival at the site, the KAFB Fire Department Officer-in-Charge will be in command of fighting any related fire. If a fire occurs, Steps 3-10 “Fire”, described in the section above, will be followed, as appropriate.

5. Conduct salvage and cleanup operations (see Chapter 5.0) and document emergency activities (see Chapter 6.0).

**Unplanned Sudden or Nonsudden Releases.** The EC will take the following actions in the event that a RCRA-regulated hazardous waste release causes an immediate health hazard, cannot be contained, or threatens to move out of the unit boundaries:

1. Order evacuation of the immediate area (see Chapter 4.0) and notify the EOC at 911 or 844-0911.

2. Determine the identity and characteristics of the released hazardous waste (e.g., by reviewing unit records, observing containers and labels, or observing the site conditions).
3. If possible, secure the source of the release, and contain it (e.g., by uprighting the container, building a dike, or using other appropriate means to contain runoff).

4. Assure that storm ditches, drains and/or sewers do not receive potentially hazardous runoff or release by building dikes around them or by closing any valves controlling discharge.

5. Contain the released hazardous waste by: (a) stabilizing the released material as appropriate; (b) pouring an absorbent over the released material; and/or (c) transferring (e.g., by sweeping or shoveling or pumping) the material into appropriate properly marked containers; or (d) placing damaged or leaking containers in overpack containers.

6. Assure that no other hazardous waste that may be incompatible with the released hazardous waste is treated, stored, or disposed of until cleanup procedures are complete.

7. After collection of the released hazardous waste, sample and analyze the affected area for residual contamination. If contamination is found to exist, implement decontamination procedures and collect, containerize, and remove decontamination residues from the site for disposition in accordance with applicable regulations. Decontamination methods will depend on the specific conditions.

4.0 Evacuation—40 CFR §§264.52(f)/265.52(f)

The EC initially will make the determination to evacuate the unit. Evacuation will be implemented when uncontrolled releases of RCRA-regulated hazardous waste, uncontrollable fires, or actual or imminent explosions, threaten the health and safety of personnel within the unit.

The following procedures will allow for safe, coordinated evacuation:

1. Announce the evacuation by voice command “Evacuate the Area” or by activating the unit-specific evacuation signal.

2. When an evacuation is announced, close any open containers and stop work.

3. Follow established safe shut down procedures which could eliminate further hazards, unless an “immediate” structure evacuation is announced.
4. Proceed to the structure exit. Close all fire doors, if any, behind you if you are the last person out.

5. Do not remain in an affected area except to assist injured personnel.

6. Exit the unit and proceed to the appropriate assembly area for roll call to be taken by the EC or designee. The assembly area should be located upwind of the unit.

7. Do not reenter the unit until the EC or designee determines that it is safe to do so.

8. In the case of any required further evacuation away from assembly areas, implement operations directed by the EOC to ensure traffic control, transportation of evacuees, security of classified materials, necessary communications, and restriction of access to evacuated areas.

Evacuation route maps are in the unit-specific attachments to this plan.

5.0 Post-Emergency Actions—40 CFR §§264.56(f)-(i)/265.56(f)—(i)

Following an emergency, the affected area will be surveyed by appropriate representatives from SNL/NM Environment, Safety and Health (ES&H) and Facilities Departments. Visual inspections of the affected area may be supplemented by sampling and analysis to determine whether cleanup is complete. If it is determined that there are remaining RCRA-regulated hazardous waste or hazardous waste constituents, electrical hazards, or other unsafe conditions, personnel or selected teams equipped with proper personal protective equipment will reenter the area to perform designated tasks to affect decontamination and repairs to enable a return to normal operations. The EC, or a designee, will:

- Monitor the facility for leaks, pressure buildup, gas generation, or ruptures of equipment until operations resume.

- Provide for treatment, storage, or disposal of recovered hazardous waste or other contaminated material. Assure that recovered waste is properly containerized, stored at an approved storage area, and disposed of in compliance with applicable RCRA standards.
• Assure that no hazardous waste that may be incompatible with the released hazardous waste is treated, stored, or disposed of until cleanup procedures are completed.

• Assure that emergency equipment is replaced or cleaned and fit for its intended use before operations are resumed. Equipment will be visually inspected and sampled or surveyed to assure that appropriate cleanup measures that will be used for the type and degree of contamination.

Prior to resuming operations after an emergency involving RCRA-regulated hazardous waste, the appropriate regulatory authorities will be notified that cleanup procedures are completed and emergency equipment is cleaned and fit for its intended use.

6.0 Emergency Reports—40 CFR §§264.56(j)/265.56(j)

Any emergency involving RCRA-regulated hazardous waste that requires implementation of this contingency plan must be recorded in the operating record and reported in writing within 15 days to the NMED Secretary. SNL/NM will prepare the report and submit it to DOE/Kirtland Area Office for submittal to NMED.

The report will include the following information:

• Name, address, and phone number of facility owner and/or operator
• Name, address, and phone number of the facility
• Date, time, and type of incident (e.g., fire, explosion, natural disaster, release)
• Brief description of the incident and its cause
• Name and quantity of waste involved
• Extent of injury (if any)
• Assessment of actual or potential hazards to human health or the environment
• Estimated quantity and disposition of waste recovered from the incident.
ATTACHMENT G

CORRECTIVE ACTION MANAGEMENT UNIT
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<tr>
<td>CAMU</td>
<td>Corrective action management unit</td>
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<tr>
<td>psf</td>
<td>Pounds per square foot</td>
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CORRECTIVE ACTION MANAGEMENT UNIT

The corrective action management unit (CAMU) is located within Environmental Restoration Project Site 107, a 23-acre area in the southeast corner of Technical Area III at Sandia National Laboratories/New Mexico. The site consists of separate hazardous remediation waste staging, treatment, and containment areas. Table 1 presents the list of emergency coordinators for the CAMU. Table 2 presents the list of emergency equipment for the CAMU. Figure 1 presents the evacuation routes and assembly areas.

**Waste Staging.** Untreated hazardous remediation waste may be either in bulk form or containerized, and will be staged at the bulk waste staging area, the containerized waste staging area, or within the Sprung™ structures.

The bulk waste staging area may be used for bulk and/or containerized hazardous remediation waste staging. The area consists of a rectangular asphaltic concrete pad surrounded by a 15-foot-high concrete masonry-unit wall. The east and west sides of the asphaltic concrete pad are approximately 300 feet long, and the north and south sides are approximately 375 feet long. A 75-foot-wide access road running north and south divides the bulk waste staging area into two symmetrical halves. In addition to the perimeter wall, four concrete masonry-unit wall extensions (two on each side) are located interior to the bulk waste staging area. These interior walls are perpendicular to the perimeter wall on the east and west sides. The interior walls extend inward from the perimeter to the access road and essentially form six compartments (three on each side). The purpose of these compartments is to provide barriers that physically separate and isolate different waste types.

The containerized waste staging area is located west of the Sprung™ structures and north of the bulk waste staging area. It consists of a pad that is approximately 10,000 square feet in size. The pad design is circular with an approximate 112.5-foot diameter. The pad consists of compacted subgrade and a 6-inch aggregate base course surface. The containerized waste staging area may be used for large containers (e.g., roll-off bins, transportainers, and waste boxes) and drums. It may also be used for the temporary staging of equipment and materials.

Up to four Sprung™ structures may be utilized for containerized hazardous remediation waste at the CAMU. Each Sprung™ structure is nominally 50 feet wide, 24 feet high, and 100 feet
long and is constructed of polyvinyl chloride-coated, fire-retardant polyester scrim stretched over aluminum ribbing. Each structure is crowned at the center and attached to a four-inch-thick concrete pad with steel anchor bolts through steel base plates. The concrete pads are designed for a load-bearing capacity of at least 1,000 psf. The area around each pad is graded to create swales that direct water away from the Sprung™ structures. The Sprung™ structures are aligned in a row and are at least 30 feet apart, as well as at least 25 feet from the CAMU boundary.

The treated waste staging areas are considered part of the treatment area, to be located to the east of the treatment pad. The treated waste staging area east of the thermal desorption area of the treatment pad will be approximately 150 by 270 feet, and the treated waste staging area to the northeast of the soil washing area of the treatment pad will be approximately 115 by 120 feet. The treated waste staging areas will consist of prepared compacted soil. Treated waste will be staged in temporary stockpiles at the treated waste staging areas pending receipt of analytical results to determine treatment effectiveness.

**Waste Treatment.** Hazardous remediation wastes may be treated within the unit boundary of the CAMU. The physical layout of the waste treatment area includes a treatment pad and two treated waste staging areas. The entire waste treatment area is situated within a rectangular space with approximately 450-foot-long east and west sides and 280-foot-long north and south sides. Within the waste treatment area, the treatment pad will consist of a bermed, asphaltic concrete foundation that will accommodate the CAMU mobile treatment units. Treatment technologies include stabilization/solidification, thermal desorption, and soil washing.

**Waste Disposition.** Hazardous remediation wastes that meet negotiated treatment standards may be placed in bulk form into an on-site containment cell. Hazardous remediation wastes that do not meet negotiated treatment standards may be placed in containers prior to being placed in an on-site containment cell. Cell design (e.g., liner system including a leachate collection and removal system) standards assure protection of human health and the environment. Hazardous remediation wastes that no longer exhibit the hazardous waste characteristic may be used by SNL/NM Facilities Department in construction activities. Hazardous remediation wastes may also be containerized and transported to an off-site
permitted treatment, storage, and disposal facility at the direction of the CAMU Operations Coordinator or designee.

**CAMU Access.** Access to the CAMU is restricted. The keys to the CAMU gates and individual Sprung™ structures are maintained by authorized CAMU personnel. Each Sprung™ structure may be accessed through the end sliding cargo door or one of two double personnel doors. Each door is equipped with a lock and key. Personnel doors are also equipped with emergency exit hardware.

**CAMU Container Management.** Typical containers managed within the CAMU include, but are not limited to: Wrangler bags, roll-off bins, steel boxes, and 55-gallon steel or polyethylene drums. Containers are segregated and labeled in accordance with applicable regulations. Waste types are segregated according to form (e.g., solid, liquid, sludge, gas) and compatibility.

**CAMU Waste Contaminants.** Hazardous remediation waste managed at the CAMU may include soil, solid debris, sampling and personal protective equipment, decontamination solutions, monitor well purge and development waters, drilling mud, and sludges. Hazardous constituents may include, but are not limited to: organic compounds, semivolatile organic compounds, explosives, and toxic and heavy metals. Associated U.S. Environmental Protection Agency Hazardous Waste Numbers may include, but are not limited to: D001 through D043, F001, F002, F003, F005, and F039. Hazardous remediation waste managed at the CAMU may also be co-contaminated with non-regulated levels of Toxic Substances Control Act constituents (i.e., polychlorinated biphenyls or asbestos).
### Table 1

**List of Emergency Coordinators and Incident Commanders for the Corrective Action Management Unit**

<table>
<thead>
<tr>
<th>Emergency Coordinators</th>
<th>Home Telephone</th>
<th>Office Telephone</th>
<th>Cellular or Pager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary: David Szklarz</td>
<td>292-3995</td>
<td>844-0594</td>
<td>263-3591</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>ID: 4159</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P.O. Box 5800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution Prevention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and Hazardous Waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management, MS-1044</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albuquerque, NM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Alternate: Ernest Vinsant</td>
<td>836-3869</td>
<td>284-2507</td>
<td>263-3217</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>ID: 4427</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Alternate: Rarilee Conway</td>
<td>271-0770</td>
<td>284-2547</td>
<td>Cellular: 250-5915</td>
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<tr>
<td>Incident Commanders</td>
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<td></td>
<td>Pager: 845-0142</td>
</tr>
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<td></td>
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</table>
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List of Emergency Equipment for the Corrective Action Management Unit

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill Control</td>
<td>Spill kit, adsorbents, broom, shovel, overpack containers, plastic bags and sheeting, mop</td>
<td>CAMU administration trailer</td>
</tr>
<tr>
<td>Fire Suppression System</td>
<td>Fire extinguishers (multiclass)</td>
<td>At least one in each Sprung™ structure; one at each end of the bulk waste staging area; one at each CAMU mobile treatment unit (while on site); one near containment cell; one in CAMU administration trailer</td>
</tr>
<tr>
<td>Communications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal:</td>
<td>Bullhorn</td>
<td>One within 250 feet of any waste management area (i.e., Sprung™ structures, bulk waste staging area, containment cell, CAMU mobile treatment units)</td>
</tr>
<tr>
<td>Externall:</td>
<td>Cellular phone</td>
<td>At least one available on-site when personnel are present, in possession of CAMU Waste Operations Coordinator or designee CAMU administration trailer</td>
</tr>
<tr>
<td></td>
<td>Commercial telephone system</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Fire hydrant</td>
<td>One located outside southeast CAMU entrance</td>
</tr>
<tr>
<td></td>
<td>Ground hydrant</td>
<td>Two near the treatment area; two near the bulk waste staging area</td>
</tr>
<tr>
<td>Decontamination Supplies</td>
<td>Shower, eyewash, swabs, portable water canisters with spray nozzles</td>
<td>CAMU administration trailer</td>
</tr>
<tr>
<td></td>
<td>Portable shower and eyewash</td>
<td>Each Sprung™ structure; bulk waste staging area; decontamination area; treatment area</td>
</tr>
</tbody>
</table>
LEGEND

- CAMU Boundary
- Road
- Evacuation Route
- Assembly Area
- Fire Hydrant
- Ground Hydrant

**Figure 1**

Sandia National Laboratories/New Mexico
Corrective Action Management Unit (CAMU)
Evacuation Routes and Assembly Areas
APPENDIX C

PERSONNEL TRAINING PLAN FOR THE CORRECTIVE ACTION MANAGEMENT UNIT TECHNICAL AREA III SANDIA NATIONAL LABORATORIES/NEW MEXICO ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
PERSONNEL TRAINING PLAN FOR THE CORRECTIVE ACTION MANAGEMENT UNIT

FINAL

SEPTEMBER 1997
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<td>2-3</td>
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<th>Title</th>
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<td>2-2</td>
<td>Training Content</td>
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</tbody>
</table>

**List of Abbreviations/Acronyms**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CAMU</td>
<td>Corrective action management unit</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
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1.0 Introduction

This plan describes the personnel training program for the Sandia National Laboratories/ New Mexico Corrective Action Management Unit (CAMU) used for the staging, treatment, and containment of hazardous remediation wastes generated during Environmental Restoration Project activities. This plan is written in accordance with Title 40 of the Code of Federal Regulations (40 CFR) §§264.16 and 270.14(b)(12).

The primary objective of this training program is to prepare CAMU personnel to perform job duties in a safe and environmentally sound manner. To achieve this objective, the program provides all employees with training relevant to their positions. CAMU personnel are given, at a minimum, a basic understanding of the regulatory requirements in hazardous waste management, emergency procedures, and operating procedures. CAMU personnel receive classroom and on-the-job training designed specifically to teach them how to perform their duties safely and in conformance with regulatory requirements. CAMU personnel receive the required training before being allowed to work in unsupervised positions.

1.1 Training Director—40 CFR §264.16(a)(2)

The Training Director is responsible for approving this training plan and establishing training requirements for CAMU personnel. The Training Director is knowledgeable of the applicable hazardous waste management regulations and specific waste management operations performed at the unit.

The Training Director may perform training or may delegate training to qualified trainers. Trainers will be qualified to perform training on the basis of attaining one or more of the following, as applicable:

- Certification in the subject matter addressed by the training
- Demonstration of knowledge and competence in the training subject
- Previous on-the-job and/or classroom training in the topics to be covered.

1.2 Relevance of Training to Job Position—40 CFR §264.16(a)(1)

This training program provides employees with training relevant to their positions and training necessary to safely perform their actual job tasks. For example, personnel who are directly involved with hazardous waste handling are taught the potential hazards of the materials with
which they work, procedures for safe handling of the waste, and emergency procedures. Individuals in supervisory or decision-making positions receive training consisting of a comprehensive overview of all aspects of hazardous waste management pertinent to the CAMU. Other personnel with specific or short-term assignments, such as visitors or temporary contractors, will be trained in emergency procedures and operations specific to their job duties. Depending on the job position, training in certain areas may not be necessary. The Training Director or designee will determine the exact content and duration of training required for individual employees.

1.3 Implementation of Training Program—40 CFR §264.16(b)

The training program is implemented to assure that all CAMU personnel receive the appropriate training in a timely manner. All personnel receive the indicated training within six months of their date of hire or transfer to a new position. Personnel do not work in unsupervised positions until they successfully complete the indicated training requirements.

2.0 Outline of the Training Program

2.1 Job Title/Job Description—40 CFR §§264.16(d)(1), (2) and (3), and 270.14(b)(12)

Job titles, descriptions, and qualifications are provided in Figures 2-1 through 2-4 in accordance with 40 CFR §§264.16(d)(1), (2), and (3). The job descriptions include job duties and education, skills, or experience requirements. The required training for each job title is given in Table 2-1.

A list of employees for each job title is maintained by the CAMU Operations Coordinator.

2.2 Training Content, Frequency, and Techniques—40 CFR §§264.16(c), 264.16(d)(3), and 270.14(b)(12)

The training program includes a combination of formal classroom sessions, reviews of written documents, and on-the-job training. The training content will include, at a minimum, the topics shown in Table 2-2. Some training is standardized and given to all applicable employees. Other training is function-specific so that an employee is given training that is appropriate to his job function. Training will be provided at the frequencies shown in Table 2-2. A minimum of 24 hours of initial training is given to all on-site CAMU personnel. All on-site personnel also participate in a minimum of 8 hours annual refresher training, which may include a review of the materials presented during the initial training as
**Job Title:** Corrective Action Management Unit (CAMU) Project Leader

**Job Description:** To provide ongoing oversight, supervision, and coordination at the CAMU relative to the staging, treatment, and containment of hazardous remediation waste

- Coordinate activities related to audits performed at the CAMU
- Review standard operating procedures at the CAMU
- Assure the maintenance of records required by regulation, such as training records, inspection records, reports, and waste analysis results
- Assist in the preparation of reports as needed by regulation
- Assure that the CAMU is operated in accordance with Resource Conservation and Recovery Act Permit Module IV requirements.

**Required Education, Skill, and/or Experience:**

- Bachelors' degree in chemistry, biology, physical science, engineering, or a related environmental science, or
- 2 years experience in environmental restoration or waste management operations.
**Job Title:** Emergency Coordinator

**Job Description:** To evaluate, coordinate, and implement emergency actions in accordance with the Resource Conservation and Recovery Act Contingency Plan during an emergency event at the Corrective Action Management Unit (CAMU)

- Activate the unit-specific alarm or signal to notify unit personnel. If required, initiate evacuation procedures.

- Notify Emergency Operations Center personnel (by dialing 911 or 844-0911), who will activate additional resources as needed.

- Identify the character, exact source, amount, and areal extent of any released hazardous waste by observing the site, reviewing records, or conducting chemical analyses.

- Assess possible hazards to human health or the environment that may result from the emergency.

- If the emergency could threaten human health beyond SNL/NM boundaries, assure that the emergency is reported to the National Response Center (1-800-424-8802) and local authorities.

- Take all reasonable measures to assure fires, explosions or releases do not occur, recur, or spread.

- Monitor for leaks, pressure build up, gas generation, or ruptures of equipment, when appropriate.

- Provide for storing, treating, or disposing of recovered hazardous waste in accordance with applicable requirements.

- Assure that incompatible hazardous wastes are not stored, treated, or disposed of until cleanup operations are completed.

- Assure emergency equipment is replaced or decontaminated and is fit for its intended use before operations are resumed.
**Job Title:** Emergency Coordinator

**Job Description:** (continued)

- Remain on site and serve as technical advisor to the Incident Commander by providing information on unit operations, layout, hazardous waste characteristics, location of records, and other information as necessary to properly respond to the emergency.

**Required Education, Skill, and/or Experience:**

- Bachelors’ degree in chemistry, biology, physical science, engineering, or related environmental science, or
- 2 years experience in environmental restoration and/or waste management operations, and
- Knowledge of CAMU waste operations, unit layout, and emergency procedures.
Job Title: Corrective Action Management Unit (CAMU) Operations Coordinator

Job Description: To provide ongoing oversight and coordination of hazardous remediation waste acceptance, management, staging, treatment, and containment operations at the CAMU in compliance with applicable Resource Conservation and Recovery Act (RCRA) regulations

- Oversee hazardous remediation waste acceptance at the CAMU
- Coordinate the transport, management, staging, treatment, and containment of hazardous remediation waste within the CAMU
- Oversee daily maintenance and housekeeping activities relative to CAMU operations
- Ensure necessary inspections are properly conducted as required by the RCRA inspection schedule for the CAMU
- Supervise the inventory, maintenance, and repair of all tools, supplies, equipment, and vehicles (i.e., ensure that they are in good working order) used for hazardous remediation waste management operations at the CAMU
- Oversight of all CAMU Field Technicians.

Required Education, Skill, and/or Experience:

- Bachelors' degree in a physical science discipline, and
- Minimum of 5 years experience in waste management operations and/or environmental restoration, and
- Project management experience.
**Job Title:** Corrective Action Management Unit (CAMU) Field Technician

**Job Description:** To safely conduct hazardous remediation waste management and staging, treatment, and containment operations in compliance with Resource Conservation and Recovery Act (RCRA) regulations

- Transport and handle hazardous remediation waste within the CAMU
- Perform daily maintenance and housekeeping concerning the CAMU hazardous remediation waste management operations, and staging, treatment, and containment areas
- Perform inspections of operational areas (including waste staging areas, treatment area, the containment cell, sumps, etc.) and containers as required by the RCRA inspection schedule for the CAMU
- Stage, label, and segregate bulk waste and waste containers appropriately
- Stage, label, or prepare hazardous remediation waste for treatment, containment, or transport off-site, as appropriate
- Ensure that the tools, supplies, equipment and vehicles used for hazardous remediation waste management operations are in good working order, receive routine maintenance and repairs, and are inspected as required.

**Required Education, Skill, and/or Experience:**

- High school diploma, and
- Completion of required training in chemical waste handling.
Table 2-1

Required Training for Each Job Title

<table>
<thead>
<tr>
<th></th>
<th>Occupational Safety and Health Administration Hazardous Waste Worker</th>
<th>Occupational Safety and Health Administrative Hazardous Waste Refresher</th>
<th>RCRA Contingency Plan and Emergency Procedures</th>
<th>CAMU Operating Procedures (Applicable Modules)</th>
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</thead>
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<tr>
<td>CAMU Operations Coordinator</td>
<td>X</td>
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<td>CAMU Field Technician</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</table>

RCRA = Resource Conservation and Recovery Act
CAMU = Corrective action management unit

1Please refer to Table 2-2 which includes a general description of the CAMU operating procedures included in initial and annual refresher training.
Table 2-2
Training Content

**Resource Conservation and Recovery Act (RCRA) Contingency Plan and Emergency Procedures**

- **Duration:** 1-4 hours
- **Frequency:** Annual
- **Method:** Procedure Review, On-the-Job Exercises, Safety Briefings, Classroom
- **Minimum Content:**
  - Emergency notification procedures
  - Responses to emergencies
  - Evacuation route and procedure
  - Emergency equipment
  - Emergency Coordinator responsibilities
  - Post-emergency actions
  - Shut down procedures (if any)

**Occupational Safety and Health Administration Hazardous Waste Worker Training and Refresher**

- **Duration:** 24-40 hours initial, 8-hour annual refresher
- **Frequency:** Initial and annual
- **Method:** Classroom
- **Minimum Content:**
  - Proper use of personal protective equipment
  - Overview of federal regulations related to hazardous materials and hazardous waste management
  - Guidelines for safe practices while managing hazardous waste
  - Overview of hazardous materials (i.e., properties, compatibility, toxicology)
### Table 2-2 (Continued)
#### Training Content

| Duration:  | 2-24 hours initial, 2-8 hours annual refresher |
| Frequency: | Initial and annual                             |
| Method:    | Procedure review, on-the-job training          |

Minimum Content: This training is function specific, divided into sections or modules. Each employee must participate in the sections that apply to his specific job function. Example sections may include, but are not limited to the following:

- Written standard operating procedures
- Waste analysis plan
- Safety practices at the CAMU
- Security, site entry, and site control at the CAMU
- Operation, maintenance, and inspection of CAMU equipment
- RCRA facility or operating permit Module IV requirements
- Hazard category procedures
- Sampling procedures

---

1The CAMU Operating Procedures address RCRA hazardous waste management requirements. Personnel complete modules relevant to assigned job duties. The Training Director determines required training.
listed in Table 2-2, and other site-specific information such as the contingency plan. The on-site personnel will also receive, during the initial and refresher training sessions, information on hazardous waste management (e.g., characterization process, waste operations procedures at the CAMU, personnel protection, and safe handling procedures). Information presented during the initial and refresher training sessions will be determined by the Training Coordinator. The Emergency Coordinator and CAMU Project Leader are not considered on-site employees.

2.3 Emergency Training—40 CFR §§264.16(a)(3) and 270.14(b)(12)
All personnel assigned to work at the CAMU are required to participate in unit-specific emergency training to ensure that they are able to respond effectively in an emergency situation. The training consists primarily of classroom training and/or on-site exercises. Topics covered include at a minimum:

1. Emergency notification procedures
2. Response to emergencies, including fires, explosions, and releases of hazardous wastes
3. Procedures for using, inspecting, maintaining, and replacing emergency and monitoring equipment
4. Procedures for shutdown operations (if any)
5. Procedures for evacuation
6. Responsibilities of the Emergency Coordinator
7. Post-emergency reports and actions
8. Contingency plan content, distribution, and amendments.

3.0 Training Records—40 CFR §§264.16(d) and 264.16(e)
Training records will be kept to document the type and amount of training received for each assigned employee. Contents of these records will include the following at a minimum:

- The name of the employee
- Job title and a written job description
- Training requirements for each job position
- Records that document training received, such as certificates, attendance or signature lists, memoranda of training, or reports from computerized training databases.

Training records for current employees will be kept until closure of the CAMU. Training records for any former employee will be kept for a minimum of three years from the last date the employee worked at the unit. A current approved training plan and training records for unit personnel for the previous 12 months are maintained at the CAMU administration trailer. All other training records and documentation are maintained by the Training Director or designee at a centralized facility location.
APPENDIX D

CLOSURE PLAN FOR THE
CORRECTIVE ACTION MANAGEMENT UNIT
TECHNICAL AREA III
SANDIA NATIONAL LABORATORIES/NEW MEXICO
ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
CLOSURE PLAN FOR THE CORRECTIVE ACTION MANAGEMENT UNIT

FINAL

SEPTEMBER 1997
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<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>CAMU</td>
<td>Corrective action management unit</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CMTU</td>
<td>CAMU mobile treatment unit</td>
</tr>
<tr>
<td>CSS</td>
<td>Chemical Waste Landfill and sanitary sewer line</td>
</tr>
<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>DQO</td>
<td>Data quality objectives</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<tr>
<td>ER</td>
<td>Environmental Restoration</td>
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<tr>
<td>ET</td>
<td>Evapotranspiration</td>
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<tr>
<td>HDPE</td>
<td>High-density polyethylene</td>
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<tr>
<td>HELP</td>
<td>EPA’s “Hydrologic Evaluation of Landfill Performance” Model</td>
</tr>
<tr>
<td>KAFB</td>
<td>Kirtland Air Force Base</td>
</tr>
<tr>
<td>LAI</td>
<td>Leaf area index</td>
</tr>
<tr>
<td>LCRS</td>
<td>Leachate collection and removal system</td>
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<tr>
<td>NMED</td>
<td>New Mexico Environment Department</td>
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<tr>
<td>PPE</td>
<td>Personal protective equipment</td>
</tr>
<tr>
<td>PSL</td>
<td>Primary subliner</td>
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<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>QC</td>
<td>Quality control</td>
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<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<tr>
<td>SAP</td>
<td>Sampling and analysis plan</td>
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<td>SNL/NM</td>
<td>Sandia National Laboratories/New Mexico</td>
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<tr>
<td>TA</td>
<td>Technical Area</td>
</tr>
<tr>
<td>T/a/yr</td>
<td>tons per acre per year</td>
</tr>
<tr>
<td>TCLP</td>
<td>Toxicity characteristic leaching procedure</td>
</tr>
<tr>
<td>USLE</td>
<td>Universal Soil Loss Equation</td>
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<tr>
<td>VSA</td>
<td>Vertical sensor array</td>
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<tr>
<td>VZMS</td>
<td>Vadose zone monitoring system</td>
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<td>Section</td>
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1.0 Introduction—40 CFR §§264.111, 264.112(c) and 264.552(e)(4)(i)

This closure plan identifies the steps necessary to close the corrective action management unit (CAMU) in Technical Area (TA) III at Sandia National Laboratories/New Mexico (SNL/NM). The CAMU is used for the staging, treatment, and containment of hazardous remediation waste generated during Environmental Restoration (ER) Project remediation activities. This closure plan is designed to meet the Resource Conservation and Recovery Act (RCRA) closure performance standards in Title 40 of the Code of Federal Regulations (40 CFR) §§264.111 and 264.552(e)(4)(i) listed below:

- To protect human health and the environment
- To control, minimize, or eliminate the postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the groundwater, to surface water, or to the atmosphere
- To minimize the need for future maintenance or monitoring.

If this closure plan requires amending, the U.S. Department of Energy (DOE) and the ER Project will notify the U.S. Environmental Protection Agency (EPA) Region 6 and the New Mexico Environment Department (NMED) in writing in accordance with 40 CFR §264.112(c).

If any changes occur in the operating plans or facility design that affect this closure plan, such as facility size or capacity, types of waste managed on site, maximum waste inventory, or the schedule for closure, DOE and the ER Project will amend this plan. DOE and the ER Project will also amend this plan if, during closure, unexpected events require closure plan modifications.

2.0 Facility Description

This section summarizes facility characteristics and provides the context within which closure activities will occur.
2.1 General Description of SNL/NM

SNL/NM (EPA Identification Number NM5890110518) is a multidisciplinary laboratory engaged in the research and development of weapons and alternative energy sources. SNL/NM is managed by Sandia Corporation, a wholly-owned subsidiary of Lockheed Martin Corporation, for the DOE, with work also performed for the U.S. Department of Defense and the Nuclear Regulatory Commission. Generation and management of hazardous waste occurs at SNL/NM as a result of these activities. SNL/NM is located south of Albuquerque, New Mexico, within the boundaries of Kirtland Air Force Base (KAFB) (Figure 2-1) in Bernalillo County.

2.2 Description of the CAMU

The CAMU is located in the southeast corner of TA III within ER Site 107, a triangle-shaped 23-acre area. The CAMU consists of four waste staging areas (i.e., the bulk waste staging area, the Sprung™ structures, the containerized waste staging area, and two treated waste staging areas); a treatment pad; and a containment cell. Support areas at the CAMU include an equipment decontamination pad with a less-than-90-day collection tank; storm water retention ponds; a less-than-90-day leachate collection tank for the containment cell; and administration trailers. Figure 2-2 presents the areal configuration of the CAMU. Only those CAMU waste management areas subject to RCRA permitting and associated closure requirements are described in the following sections.

2.2.1 Waste Staging Areas

Hazardous remediation waste staging areas at the CAMU provide space for the accumulation of sufficient waste volumes to conduct cost-effective treatment campaigns, and provide space for waste while awaiting treatment verification. These waste staging areas are designed to accommodate the hazardous remediation waste types described in Section 3.0. The waste staging areas at the CAMU include:

- A bulk waste staging area for uncontainerized soils and debris and other containerized waste
- Up to four Sprung™ structures for containerized waste
- A containerized waste staging area for remediation waste in containers (drums, roll-off bins, transportainers, and waste boxes)
- Two treated waste staging areas.
Figure 2-1
Sandia National Laboratories/New Mexico Technical Areas (TA) and the Corrective Action Management Unit (CAMU) in Relation to KAFB
Figure 2-2
Sandia National Laboratories/New Mexico
Corrective Action Management Unit (CAMU) Areal Configuration
2.2.1.1 Bulk Waste Staging Area

The bulk waste staging area, located in the southwestern corner of the CAMU, provides temporary staging capacity for uncontainerized soils and debris. The bulk waste staging area consists of a rectangular asphaltic concrete pad surrounded by a 15-foot-high concrete masonry-unit wall. The east and west sides of the asphalt pad are 300 feet long, and the north and south sides are 375 feet long. A 75-foot-wide access road running north and south essentially splits the bulk waste staging area into two symmetrical halves. In addition to the perimeter wall, four concrete masonry-unit wall extensions (two on each side) are located interior to the bulk waste staging area (Figure 2-2). These interior walls are perpendicular to the perimeter wall on the east and west sides. The interior walls extend inward from the perimeter to the access road and essentially form six compartments (three on each side). The purpose of these compartments is to provide physical barriers that separate and isolate different waste types.

2.2.1.2 Sprung™ Structures

The Sprung™ structures, located in the center of the CAMU, are designated for staging containerized hazardous remediation waste. Four structures may be used to stage waste at the CAMU (Figure 2-2). Each structure is nominally 50 feet wide, 24 feet high, and 100 feet long and constructed of polyvinyl-chloride-coated, fire-retardant polyester scrim stretched over aluminum ribbing. The polyester scrim is also insect-proof and water- and mildew-resistant, and is impregnated with ultraviolet inhibitors to decrease degradation due to sunlight.

Each structure is attached to a four-inch-thick concrete pad with steel anchor bolts through steel base plates. The structure configuration can withstand wind velocities in excess of 100 miles per hour, is earthquake-resistant, and does not enable snow accumulations. Ventilation inside each structure is provided by a roof-mounted, wind-driven turbine ventilator. Each structure may be accessed through one of two double personnel doors or through an end sliding cargo door. Each door is equipped with a lock and key. Personnel doors are also equipped with emergency exit hardware. The concrete pad is designed for a load-bearing capacity of at least 1,000 pounds per square foot. The structures are aligned in a row and are at least 30 feet apart. The area around each concrete pad is graded to create swales that shunt water away from the structures.
2.2.1.3 Containerized Waste Staging Area

The containerized waste staging area is located west of the Sprung™ structures and north of the bulk waste staging area (Figure 2-2). This area is designed to provide temporary staging capacity for large containers (e.g., roll-off bins, transportainers, and waste boxes) and drums of hazardous remediation waste. The containerized waste staging area is also used for the temporary staging of equipment and materials. The containerized waste staging area consists of a pad approximately 10,000 square feet in size. The pad is designed of compacted subgrade and a 6-inch aggregate base course surface.

2.2.1.4 Treated Waste Staging Areas

The treated waste staging areas are located in the northwest area of the CAMU, north of the bulk waste staging area and west of the containment cell (Figure 2-3). One staging area is north of the east bound access road and measures approximately 115 by 120 feet. The other staging area is located in the southeast corner of the treatment system area and measures approximately 270 by 150 feet. The staging areas are prepared compacted soil. These waste staging areas are sized to accommodate anticipated outputs from the thermal desorption, soil washing, and stabilization/solidification units. The waste must be staged for a length of time sufficient to allow for waste sampling and laboratory analysis as well as validation of the data returned from the laboratory prior to removal for disposition or retreatment.

2.2.2 Treatment Area

The treatment area is approximately 450 feet along the western side and 280 feet along the northern side. The treatment area consists of a treatment pad with bermed asphaltic concrete foundation, which accommodates the thermal desorption, soil washing, and solidification/stabilization CAMU mobile treatment units (CMTU) (Figure 2-2); the treated waste staging areas (Section 2.2.1.4); and the treatment area storm water retention pond (i.e., part of the CAMU support structures). Closure of the treatment pad will be addressed in this closure plan. Closure of the CMTUs will be addressed in a separate CMTU RCRA Subtitle C permit application or modification request.

2.2.3 Containment Cell

The containment cell is located in the northeast area of the CAMU, directly east of the treatment pad (Figure 2-2). The containment cell is designed for a maximum capacity of 1 million cubic feet of waste. Treated waste was placed directly into the containment cell following verification sampling to determine treatment effectiveness or was containerized
Figure 2-3
Sandia National Laboratories/New Mexico  
Corrective Action Management Unit (CAMU) Treatment Area
prior to emplacement if waste did not meet treatment standards. The waste was then compacted in order to minimize waste and final cover system subsidence.

The containment cell includes a liner system and final cover system (Section 4.5). The containment cell liner system was designed to prevent migration of hazardous constituents from leachate, contaminated runoff, and hazardous waste decomposition products to the environment during CAMU operations and the postclosure period. The liner system components are designed of materials that are chemically resistant to the waste and the leachate that may be generated. The materials are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and equipment used at the containment cell.

The final cover of the containment cell, described in Section 4.5, was designed and constructed to:

- Provide long-term minimization of migration of liquids through the closed containment cell
- Accommodate for settling and subsidence so that the integrity of the containment cell cover is maintained
- Have an unsaturated hydraulic conductivity less than or equal to that of any bottom liner system or natural subsoils
- Promote drainage and minimize erosion or abrasion of the containment cell cover.

In addition to the containment cell liner system and final cover, a vadose zone monitoring system (VZMS) is in place under the containment cell. The VZMS consists of three subsystems as follows:

- Primary Subliner (PSL) Monitoring Subsystem
- Vertical Sensor Array (VSA) Monitoring Subsystem

The three subsystems have been designed to be used in an integrated fashion to achieve a high probability of detecting “real” leakage from the containment cell (i.e., low false-negative rate) and to avoid false detections caused by environmental factors outside the control of CAMU operation (i.e., low false-positive rate). The design allows for detection monitoring
and if a leak is suspected, for additional activities (i.e., assessment monitoring) to effectively determine whether a leak has actually occurred, and if so, the general character and magnitude of the leak. The design includes features that will allow identification of a situation where in situ condensation buildup, moisture increases from a nearby sanitary sewer, and/or organic vapors from a nearby inactive landfill have resulted in false indication of containment cell leakage.

3.0 **Waste Description and Maximum Volume Managed—40 CFR §264.112(b)(3)**

The CAMU is used for the staging, treatment, and containment of hazardous remediation wastes generated during ER Project corrective action activities (e.g., sampling, excavation, cleanup). Only remediation wastes, as defined in 40 CFR §260.10, are managed in the CAMU. Remediation wastes may include, but are not limited to: soil, debris, personal protective equipment (PPE), decontamination solutions, monitor well purge and development water, sampling equipment, drilling mud, and sludges. Hazardous constituents may include, but are not limited to: organic compounds, semivolatile organic compounds, explosives, and toxic and heavy metals. Associated EPA Hazardous Waste Numbers may include, but are not limited to: D001 through D043, F001 through F003, F005, and F039.

The CAMU containment cell has an estimated maximum volume capacity of approximately 1 million cubic feet of hazardous remediation waste and the waste staging areas have an estimated maximum volume capacity of approximately 777,385 cubic feet of hazardous remediation waste. The estimated total maximum waste volume managed at the CAMU is the sum of the estimated volume capacity of the containment cell and the waste staging areas, or approximately 1,777,385 cubic feet.

4.0 **Closure Methods—40 CFR §§264.112(b)(1), (2), (4), and (5)**

SNL/NM intends to demonstrate conformance to the closure performance standards listed in Section 1.0 of this plan. The following sections describe the process for demonstrating closure using the data quality objectives (DQO) process for the waste staging areas, the treatment pad, and the containment cell.
Closure methods proposed in this plan are based on the following assumptions about conditions during the operational life of the CAMU.

- There have been no undocumented releases of hazardous remediation waste to the environment from the CAMU or as a result of CAMU waste management activities.

- Liquid hazardous remediation waste was staged in containers on appropriate secondary containment pallets. Spills, if any, of liquid hazardous remediation waste were documented in the CAMU operating record, and immediately remediated.

- Containers of hazardous remediation waste were opened only at the treatment pad to process the waste.

- The asphaltic concrete pad and concrete-masonry walls at the bulk waste staging area, the concrete pads and walls of the Sprung™ structures, and the asphaltic concrete pad at the treatment area retained integrity.

Contamination due to waste management activities at the CAMU is expected at the waste staging areas and treatment pad at the time of closure. In order to achieve the closure performance standards listed in Section 1.0 of this plan, and in accordance with 40 CFR §§264.552(e)(4)(ii)(a), (b), and (c), the following activities are proposed.

**Phase I - Application of the DQO Process**

**Phase II - Performance of Hazardous Remediation Waste Surveys:** At closure, any remaining hazardous remediation waste in the waste staging areas or treatment pad will be transferred to the containment cell, if appropriate, or from the CAMU to a RCRA-permitted treatment, storage, or disposal facility. A hazardous waste survey will be conducted.

**Phase III - Decontamination:** If any hazardous remediation waste contamination attributable to CAMU activities is found, decontamination of the affected area will be conducted. Verification of decontamination will be conducted.

**Phase IV - Closure Certification:** The CAMU will be certified as closed by an independent, registered professional engineer.

**4.1 Phase I—Application of the DQO Process**

DQOs are qualitative and quantitative statements derived from a series of seven planning steps based on the scientific method. The DQO process is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the
intended application (EPA, 1993). DQO statements applied to closure of the CAMU are summarized below.

The following sections present the application of Phase I of the DQO process to the areas within the CAMU that require closure certification: the waste staging areas, the treatment pad, and the containment cell.

**4.1.1 Define the Problem**
The waste staging areas, the treatment pad, and the containment cell will be closed under the applicable requirements of 40 CFR Part 264, Subpart G. Closure must meet the performance standards listed in Section 1.0 of this plan.

**4.1.2 Identify the Decision**
The following questions need to be addressed for the waste staging areas, the treatment pad, and the containment cell.

- Do the waste staging area pads (e.g., asphaltic concrete, base course, concrete, and compacted soils) meet the closure performance standards without further decontamination and/or remediation?
- Do the Sprung™ structure and bulk waste staging area wall surfaces meet the closure performance standards without further decontamination and/or remediation?
- Has the containment cell been designed and constructed to control, minimize, or eliminate the postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface water, or the atmosphere?
- Has the containment cell been designed and constructed to minimize or eliminate the need for future maintenance or monitoring?
- Has the containment cell been designed and constructed to provide long-term minimization of migration of liquids through the closed containment cell?
- Have the containment cell and cover been designed and constructed to accommodate for settling and subsidence so that the integrity of the containment cell cover is maintained?
• Has the containment cell cover been designed and constructed to have an unsaturated hydraulic conductivity less than or equal to that of any bottom liner system or natural subsoils?

• Has the containment cell been designed and constructed to promote drainage and minimize erosion or abrasion of the containment cell cover?

If yes, closure certification will be submitted to the EPA Regional Administrator and the Secretary of the NMED. If no, decontamination will be conducted to achieve stated performance standards before closure.

4.1.3 Identify Inputs to the Decision
Pertinent sections of the CAMU operating record (e.g., inspection results, incident reports, hazardous remediation waste descriptions) will be reviewed. Based on this review, potentially contaminated areas, if any, will be identified. Location-biased sampling (see Section 5.1.1) will be performed on the potentially contaminated areas and the samples will be analyzed for the hazardous constituents of concern managed at the area as identified in an area-specific sampling and analysis plan (SAP), to be submitted as a closure plan modification. In addition to location-biased sampling, random sampling (see Section 5.1.2) will also be conducted to demonstrate achievement of the closure performance standards. Monitoring data from the VZMS (both baseline and postclosure measurements, see Section 7.4) will be used to demonstrate achievement of the closure performance standards associated with the containment cell.

4.1.4 Define the Study Boundaries
This study is limited to the pads and wall surfaces of the waste staging areas and the treatment pad where hazardous remediation wastes were managed and to the containment cell at the CAMU. Wall surfaces will be considered for sampling up to a height of 5 feet above pad surfaces. This height includes the area where spill residues, if any, would be most likely to be found. Because containers are not opened during routine operations at the waste staging areas, and because of the design of operations at the CAMU, there is no reason to suspect general site-wide soil contamination due to CAMU activities. Therefore, adjacent ground surfaces are not included in this investigation. If, during the operating record review, a potential for soil or surface contamination outside of the CAMU waste management areas due to CAMU activities is identified, this closure plan will be amended to include a soil or surface sampling strategy.
4.1.5 **Develop the Decision Rule**

RCRA regulations do not address surface contamination criteria for wipe sample data evaluation. Consequently, if analysis of the wipe samples from pads or walls shows that hazardous constituents of concern are not detectable at laboratory reporting levels, the reported decision limits can be used to calculate a detection level per square foot of surface, if necessary. If surface contamination is not found, the closure performance standards are met, and closure will be recommended.

Analytical results of wipe sampling from pads or walls that show detected positive results above the laboratory-reported limit of detection are evaluated against similar results for field blank samples. If investigatory samples show greater than ten times the contaminant value in the associated field blank samples, those results are considered positive indicators of contamination. Positive indicators of contamination are evaluated against the closure performance standards. Pending results of that evaluation, either no further action is recommended and the closure application process proceeds, or decontamination procedures are planned and performed. If decontamination is required, resampling is performed to verify cleanup effectiveness and to evaluate the resampling analytical results against the closure performance standards.

If the laboratory reports positive analysis results above the laboratory limit of detection but less than ten times the reported value in the associated field blank sample, the results are considered inconclusive for determining the presence or absence of contamination. Those results may also be evaluated against the closure performance standards, and either no further action is required and the closure application proceeds, or additional wipe, chip, and/or surface sampling will be performed. This determination is made by the independent professional engineer based on the application of professional judgment.

Surface soil samples will be collected from the 0- to 6-inch depth interval and analyzed for total concentrations of hazardous constituents of concern managed at the waste management area. For areas in which spills have occurred or cracks have developed in the asphaltic concrete, deeper vertical samples may be necessary to adequately characterize these areas. Analytical results above accepted background levels (as established by baseline sampling and analysis at the SNL/NM CAMU site) for hazardous constituents of concern will be considered a positive indication of contamination. Positive indicators of contamination are evaluated against the closure performance standards. Pending results of that evaluation, either no
further action is recommended and the closure application process proceeds, or decontamination procedures are planned and performed. If decontamination is required, resampling is performed to verify cleanup effectiveness and to evaluate the resampling analytical results against the closure performance standards.

Monitoring results from the VZMS subsystem (see Section 7.4) will be compared to the baseline results to determine if the closure performance standards for the containment cell are met. If this comparison suggests leakage from the containment cell, verification sampling will be conducted, as described in Section 7.4.4. If verification sampling results indicate leakage, a corrective action plan will be established.

4.1.6 Specify Limits on Decision Errors
Sampling and analysis data can only estimate true values; therefore, decisions may be in error. Decision errors may be attributed to sampling error (e.g., when incorrect sampling fails to adequately represent the true environment), or to measurement error (e.g., when the combination of random and systematic errors in the measurement process inaccurately represent the true values). The consequences of making either type of decision error when performing regulatory closure of the CAMU will be discussed in the SAP.

4.1.7 Analytical Data Measurement
Chemical analysis data used to document attainment of the closure performance standards for the CAMU will be assessed using SNL/NM data verification and validation procedures.

Sampling and analysis quality control (QC) will be implemented to ensure that measurement data collected meets the information objectives for this investigation by:

- Strictly adhering to sampling procedures described in the SAP
- Documenting sampling activities and sample custody
- Using controlled and standard equipment and materials
-Collecting, analyzing, and evaluating field and laboratory QC samples.

4.2 Phase II—Performance of Hazardous Remediation Waste Surveys
Hazardous remediation waste surveys will be conducted to identify potential contamination resulting from CAMU waste management activities. Chapter 5.0 describes general sampling and analysis procedures that will be used to conduct the surveys. Detailed sampling and analysis procedures will be presented in the SAP to be submitted as a closure plan.
modification. The SAP will specify procedures that address CAMU-specific considerations such as hazardous remediation waste present during operations, actual waste volumes managed, and hazardous remediation waste management activity locations. Development of a detailed plan in the future, when operations and waste streams are known with more certainty, will enable the preparation of a SAP that reflects the most current characterization technologies/EPA guidance and fully addresses any physical modifications to the CAMU unit or spills/releases (if any) during the operational period. SNL/NM will develop the detailed SAP using approved/recommended EPA guidance on sampling and analysis and will submit the plan no later than 4 years into the operational period of the CAMU, but at least 6 months prior to closure, for review and approval.

4.3 Phase III—Decontamination
Decontamination of the waste staging area pads and wall surfaces, and the treatment pad will be performed if contamination is found during the hazardous waste survey. The methods to be used during closure activities include sweeping, washing/wiping pad and wall surfaces, removing surface soil at the treated waste and containerized waste staging areas, and closing the containment cell with waste in place. Decontamination of the containment cell will not be performed. The methods of decontamination are as follows:

- The bulk waste staging area and the Sprung™ structures pads and wall surfaces, and the treatment pad will be swept to remove any surface contamination. The residue will be containerized and managed appropriately.

- The asphaltic concrete pads at the bulk waste staging area and treatment pad, and the concrete pads at the Sprung™ structures will be washed with a warm detergent (e.g., LIQUI-NOX) solution or a hot-water pressure washer, as appropriate for the apparent degree of contamination.

- The walls at the bulk waste staging area and Sprung™ structures will be wiped down with a warm detergent (e.g., LIQUI-NOX) solution using mops and/or sponges to minimize the amount of liquid waste generated as a result of decontamination procedures.

- Samples will be collected from areas identified as spill locations in the CAMU operating record at the containerized waste staging area and analyzed for constituents associated with the hazardous remediation waste managed at the area. Any contaminated base course pad materials and surface soil will be decontaminated by scraping and removing the contaminated mixture. The underlying soil will be resampled and analyzed until the surface soil no longer
exhibits or contains hazardous remediation waste or hazardous constituents. Any removed materials will be managed as hazardous waste.

- Treated listed hazardous remediation waste will be placed directly on the soil at the treated waste staging area; therefore, the treated waste staging area surface soil will be removed to a depth of 2 inches during decontamination activities and managed appropriately. If the operating record identifies a spill of listed hazardous remediation waste at the containerized waste staging area, the spill area and underlying soils will be removed during decontamination activities and managed appropriately. If the operating record identifies spills of characteristic hazardous remediation waste, analytical results (using total analyses) above background levels will be considered positive indication of contamination.

Portable berms will be set up to contain and collect any wash water and preclude the release of potentially contaminated wash water. Berms will be placed along the interior and exterior perimeters of walls so that wash water collects between the portable berms. Berms will also be used to collect the wash water from equipment decontamination. Berms will be placed around contaminated areas on pads to collect wash water.

Prior to decontamination, a sample of the unused wash-down solution will be collected. Prior to operations, samples of surface soil will be collected at the containerized waste staging area and samples of asphaltic concrete will be collected from areas at the CAMU not used for hazardous remediation waste management area. These samples will provide a baseline for decontamination verification. The unused wash-down solution, the baseline surface soil samples, and the baseline asphaltic concrete samples will be analyzed using the toxicity characteristic leaching procedure (TCLP) for hazardous constituents of concern based on the wastes known to have been staged in each area. Used wash water, and surface soil samples and asphaltic concrete samples from hazardous waste management areas will be collected in appropriate containers and will be sampled and analyzed for the same hazardous constituents of concern. If sampling and analysis indicates that hazardous constituents are present above detection levels or baseline concentrations, the area or equipment will be decontaminated (i.e., washed or surface soil removed, as appropriate), a second time in the same manner. Decontamination and sampling and analysis will continue until the areas or equipment have been decontaminated, or the decision is made to manage the walls, pads, or equipment as hazardous waste based on detected contaminants.
Most PPE, plastic sheeting, dry wipes, and sampling equipment used by personnel performing closure activities will be disposable. These materials will be placed in containers and managed as solid or hazardous waste, as appropriate. At final closure, the containerized cleanup materials and equipment will be transported to the containment cell, if appropriate, or to a permitted treatment, storage, or disposal facility.

Nondisposable tools and equipment (e.g., portable berms), used during the wash down will be cleaned with detergent and water, and scraped or brushed as necessary to remove any residue. Decontamination will be ascertained by sampling and analyzing the wash water, as described above. Equipment that cannot be successfully decontaminated will be disposed of as hazardous waste.

All wash water will be containerized and disposed of, as appropriate. Used wash water may be discharged into the City of Albuquerque sewer treatment system provided that the results of wash water sampling and analysis confirm that the water meets all discharge permit criteria. If the water cannot be discharged, it will be managed as hazardous waste.

All waste generated during closure of the CAMU, including portable berms, used wash water, surface soil samples, and asphaltic concrete samples will be characterized (as described above), containerized, and the containers will be appropriately labeled. Containers will be staged for emplacement in the containment cell, if appropriate, or transfer to a permitted treatment, storage, or disposal facility.

Sampling and analysis of wash water samples will be used to monitor the effectiveness of decontamination of the walls and pads at the bulk waste staging area and Sprung™ structures, the treatment pad, and the equipment; and to verify the presence or absence of hazardous waste constituents. Sampling and analysis of surface soil will be used to monitor the decontamination of the containerized waste staging area and treated waste staging areas and to verify the presence or absence of hazardous waste constituents. As discussed above, samples of clean wash-down solution will be collected prior to decontamination, and baseline surface soil samples and baseline asphaltic concrete samples will be collected prior to CAMU operations. These baseline samples will be TCLP-analyzed for hazardous constituents of concern, and will serve as background data for decontamination verification. These results will be compared to samples of the used wash-down solutions, surface soil samples, or
asphaltic concrete samples, which will be TCLP-analyzed for the same hazardous constituents of concern. The presence of statistically significant concentrations of hazardous constituents in the used wash water, surface soil, asphaltic concrete in comparison with background will be determined using methods defined in Chapter 9, Sampling Plan, Volume II, “Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods,” SW-846 (EPA, 1986).

Successful decontamination of the waste staging areas and treatment pad and of the equipment, and achievement of closure performance standards occurs when:

- Hazardous constituents are not detected in the used wash water or hazardous constituent concentrations in used wash water samples are equal to or less than the background concentrations as defined by concentrations in samples of unused wash water

- Hazardous constituent concentrations in the soil samples or asphaltic concrete samples are equal to or less than the background concentrations as defined by concentrations in baseline soil or baseline asphaltic concrete samples

- Hazardous constituent concentrations in the underlying soil at the containerized waste staging area are equal to or less than background concentrations as defined by concentrations in baseline soil samples

- The top 2 inches of surface soil has been removed from the treated waste staging area and hazardous constituent concentrations in the underlying soil are equal to or less than background concentrations as defined by concentrations in baseline soil samples.

4.4 Phase IV—Closure Certification and Survey Plat

An independent, registered professional engineer will be present to verify that closure activities follow the approved plan. Upon completion of closure, letters certifying that the CAMU has been closed according to the approved plan will be prepared. Each original letter will be dated and signed by the engineer and will be stamped by the engineer with his or her professional seal. Letters will also be signed by the facility owner and operators. Original letters will be submitted by the DOE to the EPA Regional Administrator and the Secretary of the NMED. Copies will be maintained at the DOE offices and at SNL/NM. In addition, SNL/NM will prepare a final closure report describing the closure activities performed (e.g., hazardous waste surveys; decontamination activities, including a summary of the results of any confirmatory sampling; and emplacement of the containment cell final cover) and any variances from the approved closure
plan and the reasons for the variances. SNL/NM will provide this report with the closure certification letter within 180 days of closure.

No later than the submission of the certification of closure of the CAMU, SNL/NM will submit to the local zoning authority (i.e., the Bernalillo County Zoning, Building, and Planning Commission, 600 2nd Street, N.W., Albuquerque, NM) and to the EPA Regional Administrator, a survey plat indicating the location and dimensions of the containment cell with respect to permanently surveyed benchmarks. This plat will be prepared and certified by a professional land surveyor. The plat will be filed with the local zoning authority and contain a prominently displayed note which states SNL/NM’s obligation to restrict disturbance of the containment cell.

4.5 Containment Cell Final Cover

At the end of the containment cell’s operational period, a final cover will be placed over the containment cell to minimize water infiltration. The containment cell will be monitored during the postclosure care period as described in Section 7.0. At the end of the containment cell’s operational period, a final cover system will be placed over the cell to minimize water infiltration. The cover will be positioned over the entire area of the containment cell and will extend to the perimeter swale, which will encircle the containment cell. The final cover system design incorporates a capillary barrier and vegetation cover for primary hydraulic control. A high-density polyethylene (HDPE) liner positioned at the base of the final cover system will provide reinforced hydraulic control. The components of the final cover system, as shown on Figure 4-1, are as follows:

- Topsoil with gravel mulch surface treatment
- Native soil blend with a steel mesh, animal-intrusion barrier
- Filter sand
- Pea gravel
- Bedding sand, and
- Textured 60-mil HDPE.

The topsoil with gravel mulch will be developed from topsoil stockpiled during containment cell excavation. The purpose of the topsoil and native soil blend layers is to provide growing media for the vegetation cover, which has been specified as desert plant seed mixtures. This will enhance evapotranspiration and thus reduce infiltration. A steel mesh barrier within the native soil blend layer will prevent burrowing animal intrusion yet will maintain root accessibility to soils below the mesh. The steel mesh will be galvanized to prevent oxidation and eventual
Figure 4-1
Side View of Final Cover System

- Native Top Soil with Gravel Mulch Surface Treatment
- Steel Mesh at 18" from Surface
- Native Soil Blend
- Filter Sand
- Pea Gravel
- Bedding Sand
- Textured 60-Mil High-Density Polyethylene
- Waste
degradation. A capillary barrier, comprised of the filter sand layer and the pea gravel layer, will be located beneath the native soil blend. Because capillary pressure in a soil matrix is inversely proportional to the effective pore size (i.e., the smaller the pore size, the higher the capillary pressure), the downward migration of percolating water will be suspended when it arrives at the fine/coarse-grained soil interface. Therefore, as long as the downward force of percolating flow (i.e., gravity-induced head) is less than the capillary force in the native soil blend above, the capillary break technology will halt infiltrating water.

The downward and outward slope of the final cover will aid lateral flow of percolating water. The sand layer beneath the native soil blend should encourage lateral diversion of percolating water and reduce migration of fines into the pea gravel layer. The integrity of the final cover system was analyzed based on a 25-year, 24-hour (i.e., 2.48 inches/day) design basis rainfall event. The results of the design analysis, including modeling, demonstrated that moisture would not penetrate beyond the pea gravel layer. The HDPE liner is included in the design as an additional measure of protection. Based on modeling and SNL/NM studies, infiltration of the filter sand into the pea gravel layer is typically only about one inch; therefore, geotextile will not be needed between the filter sand and pea gravel layers. The bedding sand layer beneath the pea gravel layer will provide cushion protection to the underlying HDPE liner. The HDPE liner will be placed over the waste, buttress soil, and extended slope, and will be keyed into an anchor trench located inside the perimeter swale’s inner edge. The uppermost 2 to 3 feet of waste (or clean fill material if required to make up 100 percent capacity) will conform to the following minimum gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>50–100</td>
</tr>
<tr>
<td>No. 200</td>
<td>10–30</td>
</tr>
</tbody>
</table>

In addition, the waste (or clean fill) material will be free from deleterious materials (e.g., roots, grass, other vegetable matter, clay lumps, rocks) and will have a plasticity index of not greater than 15 as determined by American Society for Testing and Materials (ASTM) Standard D 4318. This will ensure a suitable foundation material for the HDPE liner.
In addition to the gravel mulch/vegetation cover, engineering controls will be applied to prevent/minimize erosion losses. These include slope control, surface runoff control, and perimeter flow control. The crown of the cover will slope north, south, east, and west at a 3-percent grade. Transition slopes will range from 8.1:1 to 3:1. This design facilitates the low profile mounding and gentle slopes that will enhance wind and precipitation erosional resistance.

The following sections provide additional information regarding materials properties, installation procedures, and construction quality assurance (QA); water balance modeling; and vegetation selection, application, and maintenance for the final cover system.

4.5.1 Materials Properties, Installation Procedures, and Construction QA for Final Cover System Components

Topsoil Layer
Topsoil for the final cover may be comprised of existing surface soil stripped from the containment cell area during CAMU construction, other SNL/NM surface soils, and/or off-site surface soils with properties similar to the soils in the vicinity of the CAMU. Topsoils will be free of any admixtures of subsoil, foreign matter, objects larger than two inches in any dimension, toxic substances, and any material or substance that may be harmful to plant growth. This soil is to be excavated, stockpiled, and eventually reused as the top six inches of the final cover system.

A minimum 6-inch-thick layer of topsoil will be placed over the entire extent of the final cover system surface. The topsoil layer will provide a suitable seedbed for enhanced germination of the vegetative layer seeds. The fill will be placed in lifts not to exceed 8 inches in thickness and compacted to 85 percent of maximum dry density per ASTM D 1557. QA personnel will perform visual inspection of the topsoil material to verify acceptability for use in construction and ensure that the material is free from deleterious substances (e.g., rubble, trash, organic matter).

Native Soil Blend Layer
The native soil blend, which is between the top soil and capillary barrier layers, will be determined based on laboratory testing including grain size distribution and Modified Proctor tests. It will be free of organic matter, topsoil, rubble, trash, and deleterious substances. Material specifications for the native soil blend include the following minimum gradation requirements:
## Sieve Size

(Square Openings)

<table>
<thead>
<tr>
<th></th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 200</td>
<td>20-50</td>
</tr>
</tbody>
</table>

The minimum 30-inch-thick lift of native soil blend will be placed above the bedding sand layer in lifts not to exceed 6 inches in thickness. The native soil blend layer will be compacted to 85 percent of maximum dry density per ASTM D 1557. This will facilitate root penetration into this layer. During layer filling operations, a continuous layer of wire mesh will be integrated into the native soil blend layer. This mesh will be positioned approximately 18 inches below the final cover system finished grade.

QA testing of the native soil blend will include laboratory and field testing. Laboratory testing will be performed to document its engineering properties and to verify the acceptability of the material for use in construction. The laboratory tests will include determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557, and grain size analysis in accordance with ASTM D 422.

To determine whether construction performance meets design requirements, field testing of in situ portions of the compacted native soil will be performed. The field tests will include determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing will be performed at a minimum frequency of one test per approximately 500 cubic yards. Holes resulting from nuclear gauge testing will be backfilled and hand tamped.

### Filter Sand/Pea Gravel Layers

As stated previously, the filter sand and pea gravel layers comprise the capillary barrier. The sand used as filter material on top of the pea gravel layer will be comprised of a clean, well-graded sand. Minimum gradation requirements for the filter sand include:
The pea gravel layer, which will be located beneath the filter sand in the capillary barrier, will be comprised of a coarse aggregate. Minimum gradation requirements for the pea gravel include:

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-5</td>
</tr>
</tbody>
</table>

A minimum 6-inch-thick lift of pea gravel will be placed above the bedding sand layer. The pea gravel layer will be blanketeted by an approximately 4-inch-thick lift of filter sand material. Pea gravel and filter sand fill material will be placed in 6- to 8-inches-thick lifts. The pea gravel layer will be compacted to achieve a minimum acceptable relative density as determined by the QA Engineer. The pea gravel and filter sand placement methods and conformance of the lifts to desired thicknesses will be confirmed by the QA Engineer during construction. No overlying materials will be placed on the bedding until approved by the QA Engineer.

Laboratory tests of the filter sand will be performed to document the engineering properties and to verify the acceptability of the material for use in construction. The laboratory tests will include determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 for approximately each 2,000 cubic yards of the filter sand, or more often if there is a change of material, and grain size analysis in accordance with ASTM D 422, performed on each sample subjected to the full Modified Proctor Test (minimum of one per approximately 2,000 cubic yards), or when a change in material is noted by QA personnel.

To determine whether construction performance meets design requirements, field testing of in situ portions of the filter sand and pea gravel layers (i.e., the capillary barrier) will be performed.
Field tests of the filter sand will include determination of the in situ density and moisture content by nuclear methods performed in accordance with ASTM D 1557 at a minimum frequency of one per approximately 500 cubic yards, or when a change in material is noted, and in situ density tests on the pea gravel will be performed in accordance with ASTM D 1586 at a minimum frequency of five per acre per lift, or when a change in material is noted.

**Bedding Sand Layer**

The sand used as bedding material beneath the pea gravel layer will be comprised of a clean, well-graded sand. The gradation requirements for the bedding sand are identical to those described previously for the filter sand layer.

A minimum 8-inch-thick layer of compacted bedding sand will be placed over the HDPE final cover system geomembrane. Bedding fill material will consist of bedding/filter sand and will be placed in a 10- to 12-inches-thick lift and compacted to 90 percent of maximum dry density per ASTM D 1557. The compaction of the bedding sand and conformance of the lift to the desired thickness will be confirmed by the QA Engineer during construction. QA testing of the bedding sand material is identical to that described previously for the filter sand.

**60-mil HDPE Layer**

The flexible membrane liner for the final cover will consist of new, first-quality product. Texturing will be required on both sides of the liner for the final cover. The liner will meet the following minimum general specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>60 mils</td>
</tr>
<tr>
<td>Density</td>
<td>0.94 grams per cubic centimeter</td>
</tr>
<tr>
<td>Tensile Strength (at break)</td>
<td>300 pounds per inch-width</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>50 pounds</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>90 pounds</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>2 percent</td>
</tr>
</tbody>
</table>

Installation of the HDPE geomembrane liner will be performed in accordance with the manufacturer's specifications. Panels will be placed such that the long axis of the panel is positioned directly downslope, regardless of location on fill materials. Seams will be constructed as per the manufacturer's recommendations. The QA Engineer will inspect each geomembrane.
panel for damage prior to seaming. Seams will be made by overlapping adjacent sheets approximately four inches for hot wedge welding and three inches for extrusion welding. In general, seams will be oriented parallel to the line of maximum slope (i.e., oriented down and not across slope).

Both destructive and nondestructive seam testing will be performed on the geomembrane liner. Test strips will be conducted to estimate the quality of the production field seams including equipment and operator proficiency. Destructive testing will be accomplished by cutting out and removing a portion of the completed production seam and then further cutting the sample into appropriately sized test specimens. All field seams will be nondestructively tested over their full length using a vacuum test unit, air pressure testing, or other QA-approved method where applicable.

4.5.2 Water Balance Modeling

Water balance modeling was performed to quantify the expected performance of the proposed cover system. The EPA's Hydrologic Evaluation of Landfill Performance (HELP) model (EPA, 1994) is not capable of adequately simulating capillary barrier technology because it does not model unsaturated flow. However, it does contain sufficient and accepted databases of meteoric and climatological data. Therefore, the two-dimensional, unsaturated flow model TRACER3D (Travis, 1984) coupled with applicable components and databases from the HELP model were used to simulate the processes occurring in the proposed cover system.

Not withstanding substantial degradation effects and/or degradation of system components, conventional RCRA Subtitle C cover systems are designed so that modeling indicates no percolation of infiltrating water into the waste. Therefore, comparative evaluation of the capillary barrier technology with these more conventional covers mandates that the capillary barrier cover be designed to the same performance goal. The approach taken here is to demonstrate via modeling that the proposed cover system is expected to produce no percolation, and thus will perform at least as well as any other design. Additionally, inherent to this design is natural durability in the Albuquerque climate (e.g., no relatively wet compacted clay layer is included in this cover design).

The estimate of percolation from the cover system was developed using a two-step process: first, the HELP model was used to generate infiltration and evapotranspiration (ET) data; and second,
the HELP data were input along with unsaturated flow parameter estimates into TRACER3D. Perculation and moisture content were then generated from the TRACER3D model.

Using the HELP model, near-surface processes such as snowmelt, runoff, and ET were generated for each day in a one-hundred year simulation. The five consecutive years that resulted in the most precipitation for the Albuquerque climate were selected from the 100-year simulation as input for TRACER3D. The input generated was a daily infiltration term, I, as indicated below.

\[ I = \text{rain} + \text{snowmelt} - \text{runoff} - \text{interception} \]

ET was also derived from the HELP simulations. The daily 'I' and 'ET' terms were then written to an output file formatted for input to the TRACER3D code.

The output generated using HELP and unsaturated flow parameters were then input into TRACER3D to simulate the flow through the cover. Infiltration was modeled as a source term at the top of the cover. The ET term was distributed throughout the cover to the evaporative zone depth using the algorithm described in the HELP engineering manual.

A one- and two-dimensional geometry were modeled using a 3 percent slope. Results, for most cases, indicated that the capillary barrier does not permit any percolation, and there is no need to rely on lateral drainage. In cases where the initial conditions are extreme (high antecedent moisture content), one-dimensional simulations yield unsatisfactory results. Incorporating lateral drainage in a two-dimensional geometry remedies these results by accounting for lateral diversion imposed by grading.

Because the simulated performance of the cover system indicates no appreciable water is expected to contact the HDPE liner, the HDPE liner was not included in these simulations. Therefore, the HDPE liner is considered a completely redundant feature to this design.

Four different materials were included in the simulations: native topsoil, native soil blend, sand, and pea gravel. The functions of van Genuchten (1980) were assumed to describe the relationship between the hydraulic conductivity, suction head, and volumetric water content for each material. Table 4-1 gives the hydraulic properties of the cover materials.
Table 4-1
Hydraulic Properties of Cover Materials

<table>
<thead>
<tr>
<th>Cover Layer</th>
<th>$K_s$ (cm/s)</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\alpha$ (1/cm)</th>
<th>$N$</th>
<th>Thickness (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native topsoil</td>
<td>1.7E-3</td>
<td>0.44</td>
<td>0.04</td>
<td>0.03</td>
<td>1.32</td>
<td>15.24</td>
</tr>
<tr>
<td>Native soil blend</td>
<td>1.4E-4</td>
<td>0.442</td>
<td>0.077</td>
<td>0.015</td>
<td>2.03</td>
<td>76.20</td>
</tr>
<tr>
<td>Filter sand</td>
<td>2.1E-2</td>
<td>0.39</td>
<td>0.031</td>
<td>0.038</td>
<td>4.95</td>
<td>10.16</td>
</tr>
<tr>
<td>Pea gravel</td>
<td>10</td>
<td>0.42</td>
<td>0.005</td>
<td>4.93</td>
<td>2.19</td>
<td>25.40</td>
</tr>
</tbody>
</table>

$\alpha$ = Inverse of air entry pressure.

$\theta_r$ = In situ moisture content.

$\theta_s$ = Saturated water content.

$K_s$ = Saturated hydraulic conductivity.

$N$ = Slope of van Genuchten Model.

cm = Centimeters.

cm/s = Centimeters per second.

The saturated and hydraulic water content $\theta$ are denoted by the subscripts s and r, respectively; $\alpha$ and $N$ are fitting parameters; and $K_s$ is the saturated hydraulic conductivity. These parameters were estimated from a range of references including conventional laboratory measurements, field infiltration tests performed at SNL/NM TA-III, and referenced scientific journals.

Eight one-dimensional simulations were conducted using the cover system described above. The evaporative depth, quality of vegetation, leaf area index (LAI), and initial saturation were varied. The baseline case assumes good vegetation, an LAI of 1.2, an evaporative zone depth of 36 inches, and an initial saturation of 20 percent. The rationale for the baseline values is based on the proposed cover construction and operational/maintenance program, which will promote a good stand of grass. A 3-foot-deep evaporative zone depth is reasonable considering grass in a dry climate. Additionally, an initial saturation of 20 percent corresponds to an approximate 8-percent moisture content, a reasonable value for semiarid climate soils. Table 4-2 provides a summary of the simulations and input variables.
Table 4-2
One-Dimensional Cover System Modeling Results

<table>
<thead>
<tr>
<th>Evaporative Zone Depth</th>
<th>Vegetation</th>
<th>LAI</th>
<th>Initial Saturation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 in.</td>
<td>Good</td>
<td>1.2</td>
<td>20%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>36 in.</td>
<td>Poor</td>
<td>0.5</td>
<td>20%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>18 in.</td>
<td>Good</td>
<td>1.2</td>
<td>20%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>18 in.</td>
<td>Poor</td>
<td>0.5</td>
<td>20%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>18 in.</td>
<td>Bare</td>
<td>0.0</td>
<td>20%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>36 in.</td>
<td>Good</td>
<td>1.2</td>
<td>70%</td>
<td>Breakthrough, 4.6 cm into capillary barrier</td>
</tr>
<tr>
<td>18 in.</td>
<td>Bare</td>
<td>0.0</td>
<td>70%</td>
<td>Breakthrough, 6.5 cm into capillary barrier</td>
</tr>
<tr>
<td>18 in.</td>
<td>Bare</td>
<td>0.0</td>
<td>50%</td>
<td>No breakthrough</td>
</tr>
</tbody>
</table>

in. = Inches.
LAI = Leaf area index.

Investigation into the extreme cases that failed in the one-dimensional analysis required the use of a two-dimensional model that incorporated lateral diversion. These simulations incorporated the grade of the proposed cover. In the two-dimensional simulations, the sand layer directly above the pea gravel layer can laterally divert/drain water that accumulates.

Table 4-3 summarizes the variable input and results from the two-dimensional modeling. Results indicate that even under extreme conditions, the proposed cover system is expected to yield no net percolation into the waste.

Table 4-3
Two-Dimensional Cover System Modeling Results

<table>
<thead>
<tr>
<th>Evaporative Zone Depth</th>
<th>Vegetation</th>
<th>LAI</th>
<th>Initial Saturation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 in.</td>
<td>Good</td>
<td>1.2</td>
<td>70%</td>
<td>No breakthrough</td>
</tr>
<tr>
<td>18 in.</td>
<td>Bare</td>
<td>0.0</td>
<td>70%</td>
<td>No breakthrough</td>
</tr>
</tbody>
</table>

in. = Inches.
LAI = Leaf area index.

Modeling results indicate that the capillary barrier approach proposed will sufficiently impede the downward flow of percolating water. Even under extreme conditions (i.e., initial saturation of
70 percent), the cover exhibited no infiltration when simulated with a two-dimensional model. Model results in conjunction with the HDPE liner, which was not considered in the modeling, indicate that the proposed cover design will meet the design performance standards (i.e., zero infiltration through the cap).

4.5.3 Vegetation Selection, Application, and Maintenance for Final Cover System

Selection of the most desirable plant species determines the depth of natural soil needed over the cover system. Root penetration of these species provides the effective depth that transpiration can function in controlling soil moisture. Typically, in a semiarid setting, it is desirable to limit the vertical extent of moisture penetration, while attempting to elevate the near-surface moisture to support plant growth. A gravel mulch surface treatment, consisting of at least a thin (nominal 1-inch-thick) gravel layer will be used to armor the cover surface, effectively reducing the effects of erosion and maintaining moisture for seedlings. Gravel mulch surface treatments have been shown to provide more near-surface soil moisture.

Root penetration of the liner system can cause preferential flow paths for infiltrating water. The cover system is designed to protect against root invasion by use of vegetation with shallower roots, emplacement of approximately 30 inches of native soil, and inclusion of the capillary barrier which will limit the movement of moisture and thus the depth of root invasion. Operation and maintenance procedures will also be used to limit the growth of deep tap-root plants.

Based on seeding methodologies developed at SNL/NM, seed application by range land drilling (as near as possible to parallel with land contours) in conjunction with a gravel mulch surface treatment will provide adequate and cost-effective seed application. Desert plant seed mixtures are specified.

In addition to the gravel mulch and vegetative cover, engineering controls will be applied to prevent/minimize erosion losses. These include slope control, surface runoff control, and perimeter flow control. The crown of the cover slopes to the north, south, east, and west at a 3 percent grade, and the slope travel length is approximately 90 feet. Transition slopes range between 13 and 18 feet long with slopes ranging from 8.1:1 to 3:1 (horizontal to vertical). This design facilitates the low profile mounding and gentle slopes that will enhance wind and precipitation erosional resistance.
Based on the Universal Soil Loss Equation (USLE), it is estimated that the cover configuration will satisfactorily withstand erosional forces. The USLE incorporates factors which reflect the response of expected soil types, vegetative cover integrity and plant species, and cover configuration (i.e., slope length and angle) to estimate expected soil loss. It is expected that between 0.01 tons per acre per year (T/a/yr) and 0.1 T/a/yr of soil will erode from the cover. The EPA uses a standard of 2 T/a/yr; thus, these values are acceptable.

Slope stability analysis of the final cover system was performed using hand calculation for static conditions and using the computer model STABL5M for a 3:1 slope for dynamic analysis. Factors of safety for each liner component interface were calculated. Interface friction angles for the cover components are based on vendor information and on independent test results, where available. Friction angles for the native soil layers are based on geotechnical data obtained from the CAMU site and the specified gradations for the soil layers.

Slope stability modeling on the final cover system resulted in factors of safety of 2.8 for static conditions (including vehicle load surcharge) and 1.87 for dynamic conditions (earthquake). These factors of safety are considered acceptable with regard to cover system slope stability.

From an operational/maintenance aspect, the cover is likely to develop bare spots, relatively free of vegetation, due to lack of soil nutrients or soil moisture. This is typical of settings where surface soils have been taken from one location and placed at a new location. During the initial monitoring period following construction, soil moisture and nutrient analysis will be performed on bare spots to determine appropriate initial remedial measures. Scheduled eradication of deep tap root plants will aid in controlling plant root invasion. Additional maintenance activities are identified in Section 7.5 of this closure plan.

5.0 **Sampling Strategies and Sampling Locations**

Sampling will be performed on surface areas suspected of being contaminated (location-biased samples), as evidenced by stains and discolorations (if any), and by using a systematic stratified-random sampling approach. Sampling will be conducted in randomly selected square-foot areas. Separate samples will be collected from pads and walls in each waste staging area. Separate samples will be collected for each type of analysis (e.g., metals and volatiles). Field-blank samples will be collected from each area. The potential constituents of concern (Section 3.0) are expected to remain attached to the soil or debris staged at the CAMU, as any leaching should have occurred at the point of original generation of the waste; therefore, no leaching of potential
constituents of concern is expected from the soil or debris to the asphaltic concrete or concrete pads. Leaching of constituents from the asphaltic pad to the soil or debris will be considered.

Based on waste management practices at the CAMU, if there are no recorded incidents of spills or releases of hazardous waste or hazardous waste constituents to the environment, there is no potential for soil or surface contamination outside the waste staging area. However, if the decision to conduct soil sampling is made based on the hazardous waste survey results, this closure plan will be amended to include a soil sampling strategy. Procedures for locating sampling points and wipe-sample collection are detailed below.

5.1 Procedures for Determining Sampling Locations
Prior to beginning sampling activities, all required access clearances will be obtained, security access procedures will be completed, and all required materials and equipment will be staged on site.

5.1.1. Location-Biased Sample Locations
Location-biased sampling points will be selected based on the following steps.

1) The pad areas and walls will be visually inspected for signs of discoloration or stains.

2) The location and dimensions of any discolored areas will be recorded on the field documentation forms.

3) One sample will be collected from each discolored area following the procedures outlined in the SAP. Filter-wipe samples will be collected from the pads and wall surfaces at the bulk waste staging area, the SprungTM structures, and treatment pad. Surface soil samples will be collected from the containerized waste staging area and treated waste staging area.

4) The samples will be placed in appropriate, labeled sample containers as specified in the SAP.

5) Separate samples (i.e., wipe or surface soil) are required for each analysis suite (sample preparation at the laboratory utilizes the entire jar contents, consequently multiple analyses cannot be completed from a single sample jar). If required, a sample will be collected from an adjacent square-foot area and placed in a clean wide-mouth jar for the next analytical parameter. For example, one jar may contain samples for explosives analysis and a second jar may contain samples for metals analysis. Sample jars from the same sampling point will have identical sample identification numbers, but unique fraction numbers.
6) Collect wipe samples from 1 to 4 square feet each, or surface soil samples from the 0 to 6 inch depth interval, and place in the respective sample jars for each analytical test as is necessary to completely cover the stained area. Do not overwipe any surface areas.

7) Carefully sketch and record all identification numbers, observations, and measurements of the areas sampled on the field documentation forms.

### 5.1.2 Locating Random Sampling Points

For the purposes of random sampling, the areas of investigation will be stratified into distinct surfaces such as pads and walls at each hazardous remediation waste management area.

The procedural steps for locating sampling points on flat surfaces are listed below and illustrated in Figures 5-1 and 5-2. It is anticipated that site conditions may differ somewhat from the idealized methods described below. Therefore, it is of the utmost importance that field sampling personnel make field sketches and document how and why any modifications were made to the procedures listed below to accommodate site-specific situations. The sample location scheme listed below is recommended by Berry and Baker (1968) and described in Gilbert (1987):

1) Measure the dimensions of the area of investigation.

2) Sketch, to scale, the area under investigation. Sampling grids and sample locations will first be located on the sketch plan and then transferred to the area of investigation by measuring from delineated reference points. Masking tape or chalk could be used to transfer markings to the test surfaces so they can be removed at the close of the project.

3) Locate and mark the area of investigation center by finding the intersection of the diagonals.

4) Measure 5 feet out from center in each direction (parallel to the walls, if any) to delineate a 100 square foot grid element. The grid interval should be 10 feet in each direction and be centered on the area of investigation.

5) Construct additional 10 foot by 10 foot squares adjacent to, and aligned with, the center grid element until the entire area of investigation is covered.

6) Depending on how the outer grid elements fall in relation to other potentially contaminated surfaces, use professional judgment to either allow the outer grid elements to overlap beyond the other surface (some grid elements will be unavailable for sampling) or redimension the perimeter area into 100 square-foot (or less) rectangles. If the perimeter is redimensioned, this area should be considered separately for random selection of sampling plots.
a. Locate surface center and delineate center grid element

b. Delineate adjacent grid elements to cover the surface. Identify grid elements A through O, beginning with the upper left and continuing by rows

Figure 5-1
Idealized Procedure to Lay Out 100 Square-Foot Grid Element on a Surface
(After Berry and Baker, 1968; in Gilbert, 1987)
<table>
<thead>
<tr>
<th>Grid</th>
<th>X-Coordinate</th>
<th>Y-Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$X_a$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>B</td>
<td>$X_a$</td>
<td>$Y_b$</td>
</tr>
<tr>
<td>C</td>
<td>$X_a, Y_c$</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>$X_d, Y_a$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>E</td>
<td>$X_d, Y_b$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>F</td>
<td>$X_d, Y_c$</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>$X_g, Y_a$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>H</td>
<td>$X_g, Y_b$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>I</td>
<td>$X_g, Y_c$</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>$X_j, Y_a$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>K</td>
<td>$X_j, Y_b$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>L</td>
<td>$X_j, Y_c$</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>$X_m, Y_a$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>N</td>
<td>$X_m, Y_b$</td>
<td>$Y_a$</td>
</tr>
<tr>
<td>O</td>
<td>$X_m, Y_c$</td>
<td></td>
</tr>
</tbody>
</table>

Indicates a coordinate determined by random number draw, uncircled coordinates determined from adjacent row or column grid elements.

Figure 5-2
Assignment of Sampling Area Coordinates by Drawing Random Numbers for the First Row and Column
(After Berry and Baker, 1968; in Gilbert 1987)
7) Assign letter designations to each grid element (Elements A, B, C, ...X, etc.). Beginning with the upper left, complete the row moving to the right. Move down one grid row and designate left to right.

8) For the first, upper-left grid element (designated A), generate two random numbers (for \( x, y \) coordinates) between 1 and 10 corresponding to the square-foot areas available for sampling. The square foot so located is the first sampling location. Sampling for additional analysis parameters will be from adjacent square-foot areas and so indicated on the field sketch.

9) Retain the \( x \)-coordinate of grid element A, and generate new random \( y \)-coordinates for the remaining grids in the row to the right. These coordinate pairs designate the sampling points for the remaining grid elements on the first row.

10) Next, retain the \( y \)-coordinate of grid element A, and generate a new \( x \)-coordinate for each grid elements in a column perpendicular to the first row along the left border. These coordinate pairs designate the sampling plots for the remaining grid elements down the second row (column).

11) Sampling coordinates have now been determined for the perpendicular border row (top) and column (left) of grid elements. Select the grid element adjacent to the intersection of the so designated row and columns. For sampling, use the \( x \)-coordinate from the grid element adjacent to the left in the same row, and the \( y \)-coordinate from the adjacent grid element above in the same row (column). Fill in sampling coordinates for the remaining grid elements from the adjacent row and column grid elements in a similar manner.

12) For irregular 100 square-foot rectangular grid elements that may have been designated along the area of investigation perimeter, generate random \( x, y \) coordinates that fall on available sampling areas for each irregular rectangle.

### 5.2 Sampling Procedures

RCRA closure sampling procedures (e.g., sample collection and equipment, sample preservation, analytical holding times, waste and contaminated materials disposal) will be specified in the SAP (to be submitted as a closure plan modification (see Section 4.2)).

### 5.3 Sample Custody and Documentation

Samples will be properly handled to maintain sample integrity from the time of collection until analysis is performed. Sample management and custody requirements (e.g., field operations requirements, sample labeling, sample collection logs, analysis request and chain of custody records, custody seals, sample storage and shipping) for RCRA closure of the CAMU will be specified in the SAP.
5.4 **Laboratory Operations and Analytical Procedures**

An approved analytical laboratory under contract to SNL/NM will be used to provide the analytical services associated with RCRA closure samples. Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures. Analytical procedures will follow established laboratory standard operating procedures based on the referenced EPA method. Requested analyses will be determined based on a review of potential constituents of concern managed in specific areas of the CAMU and will be specified in the SAP.

5.5 **Data Reduction, Validation, and Reporting**

Data reduction, validation, and reporting requirements will be specified in the SAP.

5.6 **Quality Control**

QC requirements for sample collection and analysis will be specified in the SAP.

6.0 **Sampling and Analysis Plan for the Treated Waste Staging Areas**

Sampling and analysis of the two treated waste staging areas will be conducted. The treated waste staging areas will consist of prepared compacted soil, as shown on the cross-section for a compacted dirt road on Figure 3-1. This section summarizes the general sampling strategy (see Section 5.0) and procedures that will be used for closure activities. Because the specific contaminant constituents of the treated remediation waste are not fully known, this SAP addresses anticipated contamination which may be present. Specific analytical requirements will be based on characterization data for treated waste temporarily stored on the pads. Sample results will be compared to site-specific baseline and site-wide background data. If the sample results are less than the compared values, the pads will be considered free of contamination.

6.1 **Sampling and Analytical Procedures**

Chemical analyses will be performed for total RCRA metals using EPA SW-846 method 6010/7000 series. The chemical data will be compared to site-wide background data and/or site-specific baseline data. Baseline data will include data collected from the treated waste staging area prior to compaction. All soil sample analyses will be performed either by the SNL/NM ER Chemical Laboratory or by an SNL/NM approved off-site laboratory for confirmation. Due to the anticipated treatment effectiveness and the arid region environment, organic analyses are not
anticipated; however, if treated waste characterization data show organic constituents to be present in sufficient concentrations, additional analyses may be conducted.

For each treated waste staging area, samples will be collected on a grid spacing not to exceed 50 ft. (See Figures 6-1 and 6-2). Two samples will be collected at each sample location; one surface soil sample (0 to 6 inches) and one sample at a depth of 2 feet. If spills have occurred the grid spacing will be reduced to 10 ft for the area encompassing the spill location. Table 6-1 lists procedures which may be used in support of this SAP. These procedures comply with current sampling and analysis guidance documents, relevant SNL/NM field operating procedures (FOP) and administrative operating procedures (AOP), the SNL/NM Environmental Restoration Project Program Implementation Plan, and SW-846 procedures.

6.2 Soil Sample Collection
Soil sampling will be conducted according to this SAP and may follow FOP 94-52 (Spade and Scoop Method for Collection of Soil Samples) and FOP 94-54 (Surface Sediment/Soil Sampling). FOP 94-52 will be followed when shallow soil samples (0 to 6 inches are collected). FOP 94-54 provides additional information on sample collection, metals, and sample collection techniques.

6.3 Sample Handling and Documentation
Procedures and documentation required to track sample possession from the time of collection to the time of analysis (e.g., chain-of-custody) will be followed. These procedures also describe how this documentation will be maintained. A discussion of appropriate sample containers, how they are sealed and tagged, and preservation and holding times are included.

FOP 94-34 describes the procedures for field sample management and custody. AOP 96-16 provides administrative guidance for the Sample Management Office. FOP 94-34 contains a sample analysis request and chain-of-custody form. This form contains the following information: sample number, sample fraction, sample identification or sample location detail, sample depth, site number, date/time collected, sample matrix, container type and volume, preservative, sample collection method, sample type, and parameter and method requested.
Figure 6-1
Assignment of Sampling Area Coordinates for the Treated Waste
Staging Area East of the Soil Washing Area

Grid Element  X-Coordinate  Y-Coordinate
A     31          33
B     31          5
C     31          16
D     12          33
E     12          5
F     12          16
G     30          33
H     30          5
I     30          16

Note: Random samples will be collected on a 10 foot by 10 foot grid in areas of suspected or obvious contamination. Coordinates are measured from the northwest corner of each grid element.

X Indicates a coordinate determined by random number draw. Uncircled coordinates determined from adjacent row or column grid elements.
## Figure 6-2
Assignment of Sampling Area Coordinates for the Treated Waste Staging Area East of the Thermal Desorption Area

<table>
<thead>
<tr>
<th>Grid Element</th>
<th>X-Coordinate</th>
<th>Y-Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>B</td>
<td>26</td>
<td>31</td>
</tr>
<tr>
<td>C</td>
<td>34</td>
<td>25</td>
</tr>
<tr>
<td>D</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>E</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>F</td>
<td>12</td>
<td>31</td>
</tr>
<tr>
<td>G</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>H</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>I</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>J</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>K</td>
<td>49</td>
<td>7</td>
</tr>
<tr>
<td>L</td>
<td>49</td>
<td>8</td>
</tr>
<tr>
<td>M</td>
<td>49</td>
<td>3</td>
</tr>
<tr>
<td>N</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>O</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>P</td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Random samples will be collected on a 10-foot by 10-foot grid in areas of suspected or obvious contamination. Coordinates for grid elements P thru U were generated as a separate set from grid elements A thru O because of the extreme difference in sizes of the elements of the 2 sets. Coordinates are measured from the northwest corner of each grid element.
Table 6-1
Applicable SNL/NM Administrative and Field Operating Procedures

<table>
<thead>
<tr>
<th>Number</th>
<th>Administrative and Field Operating Procedure Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOP 94-22</td>
<td>Sample Management Office User’s Guide</td>
</tr>
<tr>
<td>AOP 94-24</td>
<td>System and Performance Audits</td>
</tr>
<tr>
<td>AOP 94-25</td>
<td>Deficiency Reporting</td>
</tr>
<tr>
<td>AOP 95-14</td>
<td>Preparing Sampling and Analysis Plans, Site-Specific Sampling Plans and Field Operating Procedures</td>
</tr>
<tr>
<td>FOP 94-21</td>
<td>Shallow Soil Gas Sampling</td>
</tr>
<tr>
<td>FOP 94-25</td>
<td>Documentation of Field Activities</td>
</tr>
<tr>
<td>FOP 94-26</td>
<td>General Equipment Decontamination</td>
</tr>
<tr>
<td>FOP 94-34</td>
<td>Field Sample Management and Custody</td>
</tr>
<tr>
<td>FOP 94-52</td>
<td>Spade and Scoop Method for Collection of Soil Samples</td>
</tr>
<tr>
<td>FOP 94-54</td>
<td>Surface Sediment/Soil Sampling</td>
</tr>
<tr>
<td>FOP 94-57</td>
<td>Decontamination Drilling and Other Field Equipment</td>
</tr>
<tr>
<td>FOP 94-68</td>
<td>Field Change Control</td>
</tr>
<tr>
<td>FOP 94-69</td>
<td>Personnel Decontamination (Level D, C, and B Protection)</td>
</tr>
<tr>
<td>FOP 95-23</td>
<td>Shallow Subsurface Drilling and Soil Sampling using Mechanized Hydraulic Augers or the Geoprobe® Soil Core Sampler</td>
</tr>
<tr>
<td>FOP 96-01</td>
<td>Chip, Wipe, and Sweep Sampling for Waste Characterization</td>
</tr>
<tr>
<td>FOP 96-02</td>
<td>Intrusive Sampling of Building Materials for Waste Characterization</td>
</tr>
</tbody>
</table>

AOP = Administrative Operating Procedure
FOP = Field Operating Procedure

6.4 Analytical Procedures
The ER Chemistry Laboratory or an approved analytical laboratory under contract to the Sample Management Office will be used to provide the analytical services. Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures. Analytical procedures will follow established laboratory standard operating procedures based on the referenced EPA method. Requested analyses will be determined based on a review of potential constituents of concern managed on the two treated waste staging areas but will include at a minimum total RCRA metals.

6.5 Field and Laboratory Quality Assurance/Quality Control
Field and laboratory quality assurance (QA) samples will be collected per OP requirements and may include duplicate samples, trip blank samples, field blanks, equipment rinsate blanks and matrix spike samples.
Samples will be submitted to the ER Chemistry Laboratory or an analytical laboratory under contract to the Sample Management Office which meets the QA/QC requirements of SW-846 and the procedures defined in QAP 95-01 (Quality Assurance Plan for the SNL/NM Sample Management Office).

7.0 Closure Schedule—40 CFR §§264.112(b)(6) and (d) and 264.113

The proposed closure schedule and additional closure information is presented below for the CAMU waste staging areas, treatment pad, and containment cell.

CAMU closure activities will commence on or before the expiration date of the CAMU operating permit. Table 7-1 presents the proposed schedule for completion of closure activities. Closure of the CAMU is expected to take up to 180 days. If unforeseen circumstances impact this schedule during closure, a closure plan modification will be requested in accordance with 40 CFR §264.112(c)(3).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notify the U.S Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) of intent to close</td>
<td>Day -45</td>
</tr>
<tr>
<td>Begin application of the data quality objective process</td>
<td>Day 0</td>
</tr>
<tr>
<td>Begin containment cell final cover installation</td>
<td>Day 0</td>
</tr>
<tr>
<td>Remove any remaining hazardous remediation waste from the facility</td>
<td>Day 10</td>
</tr>
<tr>
<td>Conduct hazardous remediation waste survey</td>
<td>Day 30</td>
</tr>
<tr>
<td>Conduct decontamination procedures, if necessary</td>
<td>Day 90</td>
</tr>
<tr>
<td>Verify decontamination, if necessary</td>
<td>Day 140</td>
</tr>
<tr>
<td>Complete containment cell final cover installation</td>
<td>Day 140</td>
</tr>
<tr>
<td>Certify closure</td>
<td>Day 170</td>
</tr>
<tr>
<td>Complete final closure</td>
<td>Day 180</td>
</tr>
<tr>
<td>Submit closure certification letter to the EPA and NMED</td>
<td>Day 240</td>
</tr>
</tbody>
</table>

*aSome activities may be accomplished concurrently.*
8.0 Postclosure Care—40 CFR §§264.117 through 264.120 and 264.552(e)(4)(iv)

This chapter constitutes the postclosure plan for the CAMU and documents how SNL/NM will comply with the postclosure requirements contained in 40 CFR §§264.117 through 264.120. The postclosure plan details the procedures necessary to protect human health and the environment, including monitoring and maintenance activities, and the frequency with which such activities shall be performed to ensure the final cover and the waste containment cell maintain their integrity. SNL/NM will conduct the following activities to achieve these goals:

- Maintain the integrity and effectiveness of the final cover by making repairs as necessary to correct the effects of settling, subsidence, erosion, plant or animal intrusion, or other events that compromise the final cover.
- Continue to operate the leachate collection and removal system (LCRS) until leachate is no longer detected.
- Maintain and monitor the VZMS and comply with all other applicable leak detection system requirements.
- Protect and maintain surveyed benchmarks.

8.1 Point of Contact Concerning Facility During Postclosure Care—40 CFR §§264.118(b)(3) and 264.118(c)

After final closure has been certified, SNL/NM will maintain the approved postclosure plan during the remainder of the postclosure period, and will be the point of contact during the postclosure care period. The contact person for SNL/NM is:

Mr. Fran Nimick  
Sandia National Laboratories  
P.O. Box 5800  
M/S 1147  
Albuquerque, New Mexico  87185-5800  
(505) 284-2577

8.2 Amendment of the Postclosure Care Plan—40 CFR §264.118(d)

If it is necessary for SNL/NM to amend the postclosure plan, a permit modification will be requested in writing from the Regional Administrator. The request will include a copy of the amended postclosure plan for the Regional Administrator’s review. At any time during the active life of the CAMU or during the postclosure care period, SNL/NM may submit a written notification or request to the Regional Administrator for a permit modification to amend the
postclosure plan. SNL/NM will submit a written request for a permit modification to the Regional Administrator to authorize a change in the approved postclosure plan whenever:

- Changes in operating plans or facility design affect the approved postclosure plan, or
- There is a change in the expected year of final closure, or
- Events which occur during the active life of the facility, including partial and final closures, affect the approved postclosure plan.

SNL/NM will submit the written request for a permit modification at least 60 days prior to the proposed change in facility design or operation, or no later than 60 days after an unexpected event has occurred that has affected the postclosure plan. If the Regional Administrator requests modifications to the postclosure plan due to any of the conditions or events listed above, SNL/NM will submit a modified plan no later than 60 days after the Regional Administrator’s request.

8.3 Postclosure Notices—40 CFR §264.119

Within 60 days of certification of closure of the CAMU, SNL/NM will submit to the local zoning authority, NMED, DOE, and the Regional Administrator a record of the type, location, and quantity of hazardous wastes disposed of within the containment cell. The notices and information supplied to these authorities will ensure the following two conditions are met:

- The notices will be filed in such a way in State and Federal records that, in perpetuity, any potential purchaser conducting a title search of the property will be notified that:
  - The land has been used to manage hazardous wastes
  - The land use is restricted under 40 CFR, Part 264, Subpart G (§§264.110–264.120)
  - The survey plat and the record of the type, location, and quantity of hazardous wastes disposed of within the CAMU are filed with the local zoning authority, NMED, DOE, and the Regional Administrator.

- SNL/NM will submit a certification to the Regional Administrator indicating that the above title records/deed restrictions have been filed. A copy of the document in which the title record/deed restriction are made will be included with the SNL/NM certification.
8.4 Monitoring Activities and Frequencies—40 CFR §264.118(b)(1)
The CAMU systems associated with the containment cell that will require monitoring during the postclosure care period include: 1) the final cover, 2) drainage diversions, 3) the LCRS, 4) the VZMS, and 5) the perimeter security fence. Monitoring of these systems will be performed quarterly for a period of 30 years from certification of closure. The monitoring routines for each subsystem are detailed below. Additional monitoring activities (e.g., increased frequency, groundwater monitoring) may be conducted only in the event of failure (i.e., a component(s) failing to perform as designed) of the final cover system, the LCRS, the HDPE liner, the geosynthetic clay liner, and/or the VZMS. In the very unlikely event of a catastrophic failure of all these systems, contingency measures would include remediation using the VZMS access tubes and/or groundwater monitoring. A discussion of these measures is contained in Section 1.0 of Appendix E.

8.4.1 Final Cover Monitoring
The final cover will be inspected on a monthly basis until a native vegetative cover is established and following rain events that exceed the 25-year, 24-hour event (i.e., approximately 2.5 inches of water), as measured at a 10-meter weather station located approximately 200–300 feet east-southeast of the CAMU. The cover may develop bare spots (i.e., areas relatively free of vegetation) because of a lack of soil nutrients or soil moisture. This is typical of settings where surface soils have been taken from one location and placed at a new location. Mixing the soil profiles during this activity sometimes results in spatial heterogeneity of the soils, and deficient areas may require soil amendments. During the initial monthly monitoring period following final cover construction, soil moisture and nutrient analysis will be performed on bare spots to determine the appropriate soil improvement measures. It is anticipated that normal succession processes will continue once native flora have established over the cover.

Once native flora have been fully established on the entire cover, inspections will be reduced to a quarterly basis and following rain events in excess of the 25-year, 24-hour storm event. A plant biologist will inspect and inventory the flora populating the cover on an annual basis and recommend soil augmentations and re-seeding as necessary. The presence of deep tap root plants will be of particular concern. Although research has not yet quantified the effect of root invasion into capillary barriers, it is assumed to have a negative effect. However, since the capillary barrier will preclude movement of moisture into the gravel layer, root penetration of the gravel is not anticipated. Scheduled eradication of deep tap-root plants, will aid in controlling plant root invasion. Cover inspections will also note settlement; soil moisture and nutrient content; desiccation/cracking, animal intrusion; erosion of the cover soils; areas with no vegetation; and any other conditions that may reduce the cover's integrity.
8.4.2 Storm Water Diversion Structures Monitoring
Storm water run-on diversion measures will be designed to be capable of controlling a 25-year, 24-hour storm event. During postclosure, the function of storm water diversion structures associated with the containment cell will be to prevent run-on and run-off from eroding the final cover. The two storm water diversion structures associated with the containment cell are the site diversion ditch and the final cover perimeter swale. Storm water control at the CAMU will be separated into two components: 1) run-on from outside the CAMU boundaries, and 2) runoff from within the CAMU boundaries. Storm water run-on will be prevented from entering the containment cell by diversion at the perimeter of the CAMU where run-on will be directed toward existing surface-water drainage features. Within the CAMU, storm water will be directed to the perimeter drainage by sloping the site to the west and south to match the original grade. Runoff from the final cover of the containment cell will be diverted via a drainage swale surrounding the containment cell to the perimeter drainage. The structures will be inspected quarterly and after rain events in excess of the 25-year, 24-hour storm event to verify structure integrity.

8.4.3 LCRS Monitoring
Very little leachate is expected within the leachate collection system following closure because waste placed in the cell will be dry and the final cover will prevent percolation of meteoric water through the waste. Liquids collecting in the sump will be automatically detected and pumped to the surface leachate collection tank. Following site closure, the pump will be removed and inspected annually to ensure proper operation. The system plumbing will be inspected for possible areas prone to leakage.

8.4.4 Vadose Zone Monitoring
SNL/NM installed a VZMS to satisfy the ground water monitoring requirements at the containment cell. The VZMS has the ability to detect releases much earlier and at levels that are orders of magnitude less than those detected in conventional groundwater monitoring systems.

Baseline Vadose Zone Monitoring
The baseline for VZMS measurements will be established during the period immediately after installation until shortly after final closure of the CAMU containment cell. As soon as possible after installation of the VSA, but before construction of the PSL, subliner wicking layer, or containment cell liner, all VSA instrumentation collectors and sensors must be tested for proper operation. After installation of the PSL and compaction of the PSL access tube trenches, but before construction of the subliner wicking layer or containment cell liner, the access tubes and VSA components must again be tested for proper operation. The CSS will be tested for proper
operation after construction. To provide a proper baseline for future data interpretation and to confirm viability of sensors throughout the containment cell construction process, all VSA and PSL components should be monitored daily for the first week after beginning construction of the subliner wicking layer. The CSS components should be monitored for the first week after they are constructed. Monitoring should continue on a weekly basis for the first month thereafter, then on a monthly basis until closure of the containment cell. After final closure, the VSA, PSL, and CSS sensors should be monitored on a weekly basis for at least six weeks or until results establish that essentially steady-state moisture and temperature conditions exist in the monitored media. This monitoring sequence will establish a sufficient database for characterizing nonleak conditions in the vadose zone below the containment cell, allow for adequate training and experience for monitoring personnel, and verify the viability and proper operation of sensors. After this initial sequence, monitoring will continue on a quarterly basis, for a period of three years, at which time the frequency of monitoring will be reevaluated and renegotiated.

**Quarterly Vadose Zone Detection Monitoring:** Upon closure of the CAMU there will be limited leachate production from inside the containment cell for the following reasons: 1) no liquid wastes or sludges will be placed in the containment cell; 2) rain or melt water, if any, will be removed from the containment cell prior to placement of the final cover, and 3) the final cover will allow no percolation of meteoric water into the waste containment cell. Due to the limited leachate production associated with the containment cell, normally scheduled vadose zone monitoring will be conducted on a quarterly basis. The primary monitoring in the PSL subsystem will involve measuring soil moisture content in each access tube with the neutron probe on an annual basis. The neutron probe utilized will have a sensitivity of ±0.2 percent and precision of 0.1 to 1.0 percent. Unexplained moisture increases above 4 percent over the initial moisture value may suggest a release from the containment cell and will trigger a verification sampling phase, which is described below. The soil moisture and temperature components of the VSA will be monitored quarterly.

The CSS boreholes will be monitored quarterly for soil moisture content changes with the neutron probe. The CSS boreholes will also be sampled for vapors to detect releases from the sanitary sewer line and/or the Chemical Waste Landfill that could approach the containment cell. Because lateral soil vapor movement rates in the vadose zone are relatively low, sampling will be performed on an annual basis.

**Verification Sampling Methods:** Verification sampling in the PSL subsystem will be conducted annually. In addition, verification sampling will be performed if monitoring with the neutron probe suggests leakage from the containment cell. Sampling will involve moisture/soil gas/liquid
sampling and laboratory analyses. This sampling will be accomplished by the deployment of an everting flexible membrane (e.g., SEAMIST™ membrane or equivalent) placed into the access tube. The membrane can be manufactured to incorporate absorbent pads and passive (activated carbon) gas samplers. The absorbent pads and carbon gas samples can be retrieved and sent to a laboratory for liquid and volatile organic compounds extraction and analysis.

Vapor sampling via the sampling ports located in the VSA will occur annually and on an as-needed basis if soil moisture measurements (both from PSL access tube neutron probe moisture results and VSA time domain reflectometry results) indicate a potential leak or potential condensation buildup. Results generated by this subsystem component will be used to identify the origin of moisture buildup beneath the liner system (i.e., from containment cell leakage or as a result of movement from outside the containment cell).

8.4.5 Security Fence Monitoring
On a quarterly basis the fence and gates will be inspected. The inspection will document the condition of the fence and note maintenance that is required including but not limited to: removal of excessive accumulations of wind blown plants and debris, and condition of the fence wires, posts, and gates.

8.5 Maintenance Activities and Frequencies—40 CFR §264.118(b)(2)
Maintenance activities will be performed on a regularly scheduled basis to maintain the integrity of the waste containment cell. To achieve this objective, maintenance activities will be performed on the final cover, the surface water drainage diversion structures, the LCRS, the site perimeter security fence, and the VZMS, as described in the following sections.

8.5.1 Final Cover Maintenance
Maintenance will be performed as needed, based on the results of final cover system monitoring inspections (Section 8.4.1). Maintenance will restore the final cover to a condition that meets or exceeds the original design. Based on inspections by the plant biologist(s) the following activities will be conducted: deep tap-root plant eradication, repair of cover system due to effects of settlement, animal intrusion, erosion and or wind deposition of sediments. Augmentation of the soil will be conducted as necessary based on native flora growth on the cover.
8.5.2 **Drainage Diversion Structures Maintenance**

Maintenance will be performed as needed, based on the storm water diversion system monitoring inspections (Sections 8.4.2). At least once a year, excessive erosion of the channels or side-walls will be repaired and any siltation and debris inhibiting flow will be removed.

8.5.3 **LCRS Maintenance**

Very little leachate is expected within the LCRS following closure because only dry waste will be placed in the cell and the final cover will prevent percolation of meteoric water through the waste. On an annual basis the submersible pneumatic pump in the LCRS sump will be removed and maintenance will be performed. The LCRS surge tank and plumbing will be maintained as necessary based on the results of monitoring inspections (Section 8.4.3).

8.5.4 **VZMS Maintenance**

During regularly scheduled sampling, any required maintenance will be noted and carried out. In general, the PSL may be susceptible to false-positive detection caused by in-pipe moisture buildup. To reduce in-pipe condensation, access tube use and operations will consider the following:

- Using tight-fitting compression seals at daylight ends of access tubes
- Reducing, to the extent practical, air circulation in the tube during humid summer-time periods
- Placing removable, closed-cell foam insulation to 4 feet below top of casing in access tubes.

These measures will reduce temperature gradients and air moisture invasion into the pipes and the resulting potential for moisture accumulation. If moisture buildup does become an issue, air-desiccants can be used to lower humidity in the access tubes. The VSA subsystem will assist in discerning if moisture increases in the PSL are a false-positive detection or an actual release.

General maintenance of these systems will include keeping the protective casing painted and well marked, keeping buried electronic instruments calibrated and assuring all systems are well protected from the weather. Items requiring service will be noted during sampling.

8.5.5 **Security Fence Maintenance**

On an annual basis the fence and gates will be maintained. Maintenance may include but is not be limited to: removal of excessive accumulations of wind blown plants and debris, repair of broken wire sections, repair to posts and repair and oiling of gates and locks.
8.6 Certification of Completion of Postclosure—40 CFR §264.120

Within 60 days of the end of the postclosure care period for the CAMU, SNL/NM will submit to the Regional Administrator, NMED and to DOE by registered mail, a certification that the postclosure care period for the CAMU was performed in accordance with the specifications of the approved postclosure plan. The certification will be signed by SNL/NM and an independent registered professional engineer. Documentation supporting the independent registered professional engineer’s certification of completion of postclosure will be furnished to the Regional Administrator upon request. In addition, SNL/NM will prepare a final postclosure report detailing postclosure activities performed and any variances from the approved postclosure plan and the reasons for the variances. This postclosure report will be provided within 180 days of the end of the postclosure care period.

9.0 Financial Assurance and Liability Requirements

Federal facilities, including SNL/NM, are exempt from financial assurance requirements pursuant to 40 CFR §264.140(c).

10.0 Potential for Exposure

The CAMU will be operated, maintained, and closed in a manner that will ensure protection of human health and the environment in accordance with 40 CFR §264.552(c)(2). The CAMU is located in a remote area of TA III within the boundaries of KAFB. Hazardous remediation waste will be removed from the waste staging areas and the treatment pad at closure. These areas will be decontaminated and/or the pads and any associated structures will be removed and managed as hazardous waste, as necessary and appropriate, thus ensuring clean closure. Although waste will remain in place only at the containment cell, the potential for exposure is highly unlikely for the following reasons:

- Only solid waste forms will be emplaced in the proposed containment cell
- All waste emplaced in the proposed containment cell will meet negotiated treatment standards, resulting in extremely low or nondetectable concentrations of hazardous constituents
- Engineered barriers will prevent migration of liquids from entering the proposed containment cell and prevent precipitation events from migrating outside the proposed containment cell.

See Section 3.1.6 of the Class III Permit Modification Request for the Management of Hazardous Remediation Waste at the CAMU, for more information on the potential for exposure.
11.0 References


EPA, see U.S. Environmental Protection Agency.


APPENDIX E

PROPOSED ALTERNATIVE TO GROUNDWATER MONITORING FOR THE CORRECTIVE ACTION MANAGEMENT UNIT TECHNICAL AREA III SANDIA NATIONAL LABORATORIES/NEW MEXICO ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
PROPOSED ALTERNATIVE TO GROUNDWATER MONITORING FOR THE CORRECTIVE ACTION MANAGEMENT UNIT
TECHNICAL AREA III
SANDIA NATIONAL LABORATORIES/NEW MEXICO
ENVIRONMENTAL RESTORATION PROJECT

FINAL

SEPTEMBER 1997
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## List of Abbreviations/Acronyms

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<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<td>CAMU</td>
<td>Corrective action management unit</td>
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<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>CSS</td>
<td>CWL and Sanitary Sewer Line</td>
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<td>CWL</td>
<td>Chemical Waste Landfill</td>
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<td>ER</td>
<td>Environmental Restoration</td>
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<td>GCL</td>
<td>Geosynthetic clay liner</td>
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<td>HDPE</td>
<td>High-density polyethylene</td>
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<td>KAFB</td>
<td>Kirtland Air Force Base</td>
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<td>LCRS</td>
<td>Leachate collection and removal system</td>
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<td>mCi</td>
<td>Millicurie</td>
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<td>PSL</td>
<td>Primary subliner</td>
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<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
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<td>QA</td>
<td>Quality assurance</td>
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<td>SNL/NM</td>
<td>Sandia National Laboratories/New Mexico</td>
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<td>TA</td>
<td>Technical Area</td>
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<td>TDR</td>
<td>Time-domain reflectometry</td>
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<td>VCP</td>
<td>Vitrified clay pipe</td>
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<td>VSA</td>
<td>Vertical sensor array</td>
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<td>VZMS</td>
<td>Vadose zone monitoring system</td>
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<td>°F</td>
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1.0 Introduction

The Environmental Restoration (ER) Project at Sandia National Laboratories/New Mexico (SNL/NM) requests that an area at the facility be designated as a corrective action management unit (CAMU). The CAMU designation will enable SNL/NM to expedite corrective action remedies pursuant to the Code of Federal Regulations, Title 40 (40 CFR), Part 264, Subpart F, §264.101. The proposed CAMU will be located at ER Site 107 within Technical Area (TA) III at SNL/NM and will consist of hazardous remediation waste staging areas, a treatment area, and a containment cell.

Regulations in 40 CFR §264.552(e)(3)(ii) require that groundwater monitoring associated with a CAMU be sufficient to detect and subsequently characterize releases of hazardous constituents to groundwater that may occur from areas of the CAMU in which wastes will remain in place after closure of the CAMU. The ER Project at SNL/NM plans for the wastes to remain in place in the containment cell after closure of the proposed CAMU.

This document presents information to support a proposed alternative to meeting the groundwater monitoring requirements for the proposed CAMU at SNL/NM; it is not a request for a waiver from monitoring requirements. The environmental conditions at the proposed CAMU location, the proposed operational practices that will be implemented, and the engineered systems incorporated into the containment cell design that, together, support this Proposed Alternative to Groundwater Monitoring, include:

- Arid climate with less than 9 inches per year precipitation
- Depth to groundwater of approximately 485 feet
- Insufficient infiltration at the site for migration of liquids to groundwater
- Nearest water-production well field is approximately 4.5 miles away
- No liquid-bearing wastes placed in containment cell
- Engineered barriers
- A vadose zone monitoring system (VZMS).

Because monitoring is essential to help protect human health and the environment, monitoring will be performed at the proposed containment cell. SNL/NM’s Proposed Alternative to Groundwater Monitoring is vadose zone monitoring, which is a superior system for detecting and subsequently characterizing potential leaks of hazardous remediation wastes from the...
proposed containment cell. The function of the VZMS, which utilizes innovative technology, is the same as a groundwater monitoring system. Advantages of the VZMS include:

- More rigorous and useful results
- Capability to provide real-time data on containment cell performance
- More timely leak detection than is possible with a typical groundwater monitoring system
- Ability to detect a leak that is orders of magnitude less in volume than a leak required for detection via groundwater monitoring
- Ability to help remediate or contain a potential leak
- Ability to differentiate between contaminant sources.

Groundwater monitoring for the Chemical Waste Landfill (CWL), located in the southeast corner of TA III, has shown that contaminants from the CWL have reached groundwater. Because the CWL is upgradient from the proposed containment cell, groundwater monitoring for the containment cell would not provide useful information (i.e., it would not be possible to determine if the contaminant source is the CWL or the proposed containment cell). The more rigorous alternative of vadose zone monitoring is an important advantage of the VZMS because it will provide useful monitoring data.

Elements of containment cell design and operation and of site characteristics also support this Proposed Alternative to Groundwater Monitoring. As discussed in detail in Section 4.1, the proposed containment cell is designed with numerous engineered barriers. A liner system is incorporated into the design, and includes bottom liner and sidewall liner components, which will greatly minimize the possibility of leaks (e.g., in the liquid or vapor phase) from the containment cell to the vadose zone and, subsequently, to groundwater. At final closure, the containment cell will be capped to prevent precipitation from infiltrating the cell. The final cover system design, detailed in Section 4.3, incorporates a capillary barrier and a vegetation cover for primary hydraulic control, and a liner at the base of the final cover system will provide reinforced hydraulic control. When the final cover system is in place, storm water
run-off will be directed away from the containment cell area. No liquid-bearing wastes will be placed into the containment cell; thus, the probability of hazardous remediation waste leaks (liquid or vapor phase) from the containment cell is minimized.

Finally, in the unlikely event that a substantial leak of hazardous remediation wastes from the proposed containment cell did occur, site characteristics will minimize the probability of contaminant migration through the vadose zone to groundwater. Vadose zone characteristics at the site include low gravimetric moisture content (1.0 to 1.6 percent at 48 feet below ground surface) and low saturated hydraulic conductivity (7.0 x 10^{-6} to 7.9 x 10^{-5} feet per second at 48 feet below ground surface) (AEE, 1996). Unsaturated hydraulic conductivity values are typically in the range of 2.8 x 10^{-7} feet per day (1 x 10^{-10} centimeters per second) or lower. (Note: the hydraulic conductivity values in this report were taken verbatim from the various documents cited and were not converted to a single unit of measure. Attachment E-1 of this appendix presents a table which correlates the various hydraulic conductivity values presented throughout this report, and includes applicable references and comments for these values.) Depth to groundwater at the proposed CAMU is approximately 485 feet. As discussed in Section 5.1, the average annual precipitation in the area is approximately 9 inches, the average annual evapotranspiration is 95 percent, and the calculated infiltration rate is -0.3 inches per year. The distance to the nearest downgradient water-production well field is approximately 4.5 miles north-northwest.

Together, engineered barriers included in the containment cell design, CAMU operation procedures, and the hydrogeologic characteristics of the proposed CAMU site will greatly minimize the potential for leachate containing hazardous remediation wastes to be generated in and migrate from the containment cell. The VZMS beneath the containment cell will provide early detection and characterization of potential leaks (liquid or vapor phase) long before migration to groundwater could occur, and may be used to facilitate remediation or containment of any potential leaks. The only conditions that would result in the need to install groundwater monitoring wells would be catastrophic failure (i.e., a component[s] failing to perform as designed) of all the redundant lines of defense built into the proposed CAMU containment cell and its operations. This would require failure of the final cover system, the leachate collection and removal system (LCRS), the high-density polyethylene (HDPE) liner beneath the containment cell, the geosynthetic clay liner (GCL) beneath the
HDPE liner, and the VZMS, as well as emplacement of wastes that have not been treated to approved standards or emplacement of liquid-bearing wastes in the cell.

If a leak occurs, the VZMS access tube(s) in the affected area could potentially be used to remediate the release. The first step in this process would be to intentionally burst (i.e., perforate) the pipe(s) and then place a screen inside the pipe(s). A variety of remediation technologies could then be used depending on the type of leak. These could include soil vapor extraction, bioremediation, grout injection, or fluid extraction. The other components of the VZMS would continue to be used to monitor for leaks and to monitor the remediation.

The CAMU was designed with redundant systems to be protective of the environment. Remediation was not expected to be necessary. Therefore, adaptability of the VZMS for remediation purposes was not a primary design criteria but a potential added benefit of the VZMS design. However, should the catastrophic failures described above occur and if remediation is not possible, groundwater monitoring wells will be installed in accordance with applicable Resource Conservation and Recovery Act requirements.

2.0 Regional Setting

This section provides an overview of the regional environmental setting in the Albuquerque Basin area. Discussions of regional geology, climatology, surface water hydrology, vadose zone characteristics, and groundwater hydrology are presented below.

2.1 Geology

SNL/NM is located in central New Mexico along the east-central edge of the Albuquerque Basin, one of a north-south-trending line of basins that make up the Rio Grande rift (Figure 2-1). On the east and west, the basin is bounded by uplifted fault blocks. The Sandia, Manzanita, and Manzano Mountains are uplifted on the eastern boundary. The west side of the basin is bounded by the Lucero uplift, with the Ladron Mountains on the south side and little physiographic relief on the northwest side of the basin. The basin is approximately 100 miles long and 20 to 40 miles wide (Figure 2-1).
Proposed Alternative to Groundwater Monitoring at the CAMU

Figure 2-1
Location of Albuquerque Basin and Major Faults in Relation to Kirtland Air Force Base (KAFB) and Sandia National Laboratories/New Mexico (SNL/NM)
The geology of the eastern section of the Albuquerque Basin shows evidence of major faulting. These faults include the Hubbell Springs, Sandia, and Tijeras faults (Figure 2-1). The Hubbell Springs and Sandia faults are a set of north-south trending faults that form a series of down-to-the-west blocks (SAIC, 1985; Machette, 1982; Grant, 1981; Kelley, 1977). The Tijeras fault zone extends from SNL/NM to the northeast through Tijeras Canyon, where it separates the Sandia and Manzanita Mountains. The fault zone consists of several subparallel faults that have near-vertical dips and exhibit evidence of normal and left-lateral displacement (Maynard et al., 1991; Lisenbee et al., 1979).

Within the boundaries of Kirtland Air Force Base (KAFB), the Albuquerque Basin rocks are Precambrian to Holocene in age. Precambrian granite is present in the Sandia, Manzano, Los Piños, and Ladron Mountains, and Pennsylvanian limestones, sandstones, shales, and conglomerates of the Madera and Sandia Formations locally overlie thin Mississippian limestones and shales (Kelley, 1977). The majority of the Albuquerque Basin is composed of poorly consolidated sediments eroded from the surrounding highlands following faulting and structural changes that occurred 11.2 to 5.3 million years ago (SNL/NM, 1994). The upper part of the basin fill within KAFB is comprised of the Ceja Member of the Tertiary Santa Fe Group, which is a complex sequence of gravel, sand, silt, clay, and caliche deposits. The Santa Fe sediments thin toward the edges of the basin and are truncated at the bounding uplifts. The Middle Red and Zia Members of the Santa Fe Group underlie the Ceja Member (Kelley, 1977); their total thickness is unknown, although gravity and aeromagnetic mapping indicate that these rocks extend about 15,000 feet below ground surface (SNL/NM, 1996a). Quaternary and Holocene deposits, which include alluvium, landslide deposits, eolian deposits, caliche, and gravel pediments, also comprise Albuquerque Basin sediments within KAFB (Kelley, 1977).

2.2 Climatology

The Albuquerque area has an arid climate characterized by low precipitation (approximately 9 inches per year) (SNL/NM, 1994), high evapotranspiration, wide temperature extremes, frequent drying winds, occasional heavy rain showers (usually of short duration and often with erosive effects), and an erratic, seasonal distribution of precipitation. Most precipitation occurs as thunderstorms during late summer to early autumn; some snow also falls in winter. The average annual temperature in Albuquerque is 56 degrees Fahrenheit (°F) (SNL/NM,
1996a). The average daytime summer temperature is approximately 90°F and the average daily winter temperature is approximately 50°F.

2.3 Surface Water Hydrology
The Rio Grande, flowing north to south, is the major surface hydrologic feature in the Albuquerque Basin. Located approximately 8 miles west of the proposed CAMU, it is the closest perennial surface water to the site.

2.4 Vadose Zone Characteristics
The vadose zone is an important part of the hydrologic system in the KAFB area. It is generally comprised of valley fill deposits, which consist primarily of unconsolidated and semi-consolidated sands, gravels, silts, and clays of the Santa Fe Group. The valley fill deposits also include poorly consolidated clastics associated with modern alluvial fans overlying the Santa Fe. The vadose zone thickness in the SNL/NM and KAFB area appears to be strongly controlled by the Sandia, Hubbell Springs, and Tijeras fault system. Water levels recorded in regional monitoring wells (SNL/NM, 1993) indicate that the vadose zone is typically 300 to 500 feet thick west of the fault system, where the proposed CAMU is located, and 50 to 140 feet thick east of the fault system. The regional area recharge rate outside of the arroyos is estimated to be less than 5 percent of the total annual precipitation (SNL/NM, 1994), and the recharge estimate across the SNL/NM and KAFB region ranges from 0.05 to 0.66 inches per year (SNL/NM, 1996b).

2.5 Groundwater Hydrology
The major aquifer in the Albuquerque Basin is within the Santa Fe Group. Depth to groundwater in the basin ranges from 5 feet near the Rio Grande to more than 1,400 feet near the edges of the basin (Anderholm, 1988). On the east side of the basin, the Sandia and Manzano Mountains act as recharge zones for deep, regional saturated flow.

Three different hydrogeologic regions have been identified on KAFB. The regions are influenced by two very different geologic environments separated by an assemblage of fault systems (SNL/NM, 1994). Region 1 encompasses essentially the entire western half of KAFB, including the proposed CAMU, with depth to groundwater in excess of 400 feet and with unconfined and partially confined aquifers composed of basin-fill deposits. Region 3
comprises a large area on the east side of KAFB in the foothills and canyons of the Manzano Mountains. Region 3 is characterized by shallow unconfined groundwater with fractured rock hydrology. Region 2 represents the transition region between Regions 1 and 3, and is characterized by a system of steeply dipping normal faults and associated complex groundwater flow.

3.0 Proposed CAMU Setting
This section provides information on proposed CAMU environmental setting. The facility location and the site-specific geology, surface water hydrology, vadose zone characteristics, and groundwater hydrology are discussed below.

3.1 Facility Location
SNL/NM is located immediately south of Albuquerque, New Mexico, in Bernalillo County. SNL/NM facilities are within the boundaries of KAFB and include five designated TAs (Figure 3-1). The proposed location for the CAMU is within ER Site 107, which is located northwest of the CWL in the southeast corner of TA III. TA III is located in the southwest portion of KAFB (Figure 3-1). The proposed CAMU is approximately 1.0 mile west of the nearest mapped fault.

3.2 Geology
The Santa Fe Group sediments underlying the proposed CAMU are a heterogeneous sequence of unconsolidated to semi-consolidated valley fill deposits (Hawley and Haase, 1992; Lozinsky, 1988). The sediments are composed primarily of cobbles, gravels, sands, silts, and clays of alluvial and fluvial origin. These sediments are locally cemented by caliche. The very-fine to fine sand and silt matrix in these sediments is characterized by interbedded lenses and sheets of gravel, sand, silt, silty clay, and clay, representing a medial to distal piedmont-slope alluvial fan with possible alluvial fan distributary channels. Basin-fill alluvial fans of the Santa Fe Group consist of channel, debris flow, flood plain, and eolian deposits. Sands and gravels in the alluvial fan facies contain a mixture of limestone, quartz, granitic, and metamorphic clasts. The Santa Fe Group is overlain in places by Pliocene Ortiz gravel deposits and Rio Grande fluvial deposits. According to geophysical logs from the CWL, located just southeast of the proposed CAMU, the overall trend of sediments down to about
Figure 3-1
Sandia National Laboratories/New Mexico Technical Areas (TA) and the Corrective Action Management Unit (CAMU) in Relation to KAFB
500 feet below ground surface shows a coarsing-upward pattern (SNL/NM, 1991; SNL/NM, 1990).

A soils investigation adjacent to ER Site 107 used a 4 to 5-foot-deep trench that exposed a moderately developed soil at the surface underlain by two buried soils that are dominated by the accumulation of secondary calcium carbonate (SNL/NM, 1995). The upper buried soil extends between depths of 9 and 39 inches and contains three horizons that have a moderate amount of calcium carbonate accumulation. The moderate accumulation of calcium carbonate in these horizons shows that the depth of substantial leaching from meteoric waters (rainfall and snowfall) over the past several thousand to tens of thousands of years has been less than about 40 inches. The lower buried soil consists of a well-developed calcic horizon that extends from the 39-inch depth to at least 60 inches. This virtually cemented horizon is known colloquially as a “caliche” and is dominated by the accumulation of secondary pedogenic calcium carbonate.

The proposed CAMU is covered with vegetation typical of the surrounding area. Sagebrush, tumbleweed, ragweed, and other grasses are the predominant vegetation in the area and are typical of this portion of New Mexico.

3.3 **Surface Water Hydrology**

There are no perennial streams in the immediate SNL/NM and KAFB area. The ground surface near the proposed CAMU has a gentle westward slope of about 2 percent, and surface-water drainage is generally west toward the Rio Grande. Surface water in the vicinity of the proposed CAMU is primarily in the form of sheet flow draining into small arroyos and carried by natural and artificial flow paths (SNL/NM, 1996a). These flow paths then drain into two primary arroyos, Tijeras Arroyo and Arroyo del Coyote, located approximately 4 and 3.5 miles north of the proposed CAMU, respectively. The U.S. Army Corps of Engineers (1979) have identified Tijeras Arroyo and Arroyo del Coyote as within the 100-year floodplain, but these channels remain undeveloped (SNL/NM, 1996a). These arroyos flow intermittently during heavy thunderstorms and spring snow melts. Smaller arroyos are also present in the vicinity, including an unnamed arroyo located approximately 500 feet north of the proposed CAMU. This arroyo drains west toward the Rio Grande.
Storm water run-on will be prevented from entering the proposed CAMU by an engineered
diversion at the perimeter of the site, where run-on will be directed toward existing surface-
water drainage features. Storm water run-on diversion measures are designed to be capable of
controlling a 25-year, 24-hour storm event. Consequently, the potential for flooding at the
proposed CAMU is extremely small.

3.4 Vadose Zone Characteristics
Data from monitoring wells at the nearby CWL indicate that the depth to groundwater in the
vicinity of the proposed CAMU is approximately 485 feet. Consequently, liquid infiltration at
the proposed CAMU must travel 485 feet through the vadose zone before reaching
groundwater.

A geotechnical study conducted at the proposed containment cell location yielded data on
gravimetric moisture content and saturated hydraulic conductivity (AEE, 1996). Soil samples
collected from two boreholes (Boreholes 1 and 2) drilled to a depth of 48 feet yielded
gravimetric moisture contents of 1.6 and 1.0 percent, respectively, at the 48-foot depth.
Overall, the gravimetric moisture content in both boreholes decreased with increased depth
from 4.1 to 1.6 percent at Borehole 1, and from 5.4 to 1.0 percent at Borehole 2. Based on
the gravimetric moisture contents, there is extremely low potential for hazardous remediation
waste to migrate through the vadose zone at the proposed CAMU to the uppermost aquifer.
Saturated hydraulic conductivity data from the same boreholes and depths were $7.0 \times 10^{-6}$ and
$7.9 \times 10^{-5}$ feet per second, respectively. These gravimetric moisture content and saturated
hydraulic conductivity data support the conclusion that infiltration rates in the area are
extremely low. Although the data include saturated conductivity values, it is highly unlikely
that saturated flow conditions will ever exist. The unsaturated hydraulic conductivity is
actually much lower, typically in the range of $3.2 \times 10^{-12}$ feet per second ($2.8 \times 10^{-7}$ feet per
day) or lower (SNL/NM, 1996c).

Slug tests on monitoring wells at the north end of TA III were conducted between October
1994 and February 1995 (SNL/NM, 1996b). The average hydraulic conductivities for these
well tests ranged from $4.0 \times 10^{-7}$ to $2.75 \times 10^{-5}$ feet per second. Accuracy of hydraulic
conductivity estimates using slug test data is dependent on well efficiency, which is the ratio
of the actual rate at which water will enter a well for a given drawdown divided by the
maximum theoretical rate for that same drawdown. Because drilling and well completion can lead to development of a lower permeability region near a borehole wall, well efficiency is typically reduced. Hence, hydraulic conductivity estimates from slug test data may be lower than the actual hydraulic conductivity of the formation.

### 3.5 Groundwater Hydrology

The aquifer in the area of the proposed CAMU is located within the Santa Fe Group at a depth of approximately 485 feet. The aquifer is generally composed of interbedded clays, silts, and sands with typical hydraulic conductivity values of $6.9 \times 10^{-2}$ feet per day (SNL/NM, 1995). The aquifer in the region of the proposed CAMU is unconfined to partially confined.

Several major well fields have been developed in the regional aquifer to support the city of Albuquerque, KAFB, and surrounding areas. The closest well field is located approximately 4.5 miles north-northwest and downgradient of the proposed CAMU, and the closest downgradient water-supply well is KAFB-4.

The natural direction of groundwater flow in the SNL/NM area is generally southwest toward the Rio Grande (Bjorklund and Maxwell, 1961). However, water-production wells have impacted the natural gradient (Kues, 1987; Reeder et al., 1967). Pumping has produced a cone of depression in the northwest portion of KAFB and the resulting groundwater flow direction trends more toward the northwest. Based on water-level data in CWL monitoring wells, groundwater appears to flow toward the northwest at a rate of approximately 2 feet per year (SNL/NM, 1993; SNL/NM, 1992). The northwesterly flow of groundwater at the CWL has not changed since monitoring began in 1989. However, there is evidence of a general decline in the water table elevation of approximately 0.85 feet per year (SNL/NM, 1995).
4.0 CAMU Containment Cell

The proposed containment cell design consists of engineered barriers and incorporates a liner system, a vadose zone monitoring system, and a final cover system. A description of each of these design elements is provided in this section.

4.1 Containment Cell Description

The proposed containment cell is designed to accommodate approximately 1 million cubic feet of treated waste. The containment cell, which will measure approximately 200 feet wide by 300 feet long, will include an engineered liner system and a VZMS. At the end of its operational period, the containment cell will be capped with a final cover system.

The engineered liner system is designed to prevent leachate migration from the containment cell to adjacent geologic materials, surface water, or groundwater during CAMU operations and during the post-closure care period. The liner system includes bottom liner and sidewall liner components that will be chemically resistant to the waste and to potentially generated leachate. The bottom liner components of the liner system, shown on Figure 4-1, include the following in descending order:

- A minimum 18-inch-thick protective cover
- An LCRS
- A smooth 60-mil HDPE geomembrane
- A GCL.

A protective cover consisting of native, on-site soil will provide protection of the underlying liner system prior to and during placement of hazardous remediation wastes into the proposed containment cell. The LCRS will function to collect and withdraw leachate from the containment cell during operations and during the post-closure care period. The LCRS will consist of a geocomposite, which is geotextile bonded to a geonet. The geotextile will separate the overlying protective cover and the geonet; it will also prevent clogging of the geonet drainage layer. This separation will ensure the proper performance of the collection layer of the LCRS throughout the containment cell’s operating and post-closure care periods. The geocomposite has open uniform channels that will collect and transfer leachate at a 2-percent double inward slope to a centralized leachate collection trench, which then slopes at
Figure 4-1
Side View of Bottom and Sidewall Liner Components
l percent to a collection sump. A collection pipe in the centrally located trench will be placed on bedding/haunching material along the bottom of the trench and covered by subrounded drain rock, which will provide both support to the piping and additional capacity in the trench and sump. A geotextile wrap will surround the drain rock and will protect adjacent liner materials from puncture. A riser pipe will extend from the shallow end of the LCRS trench, up the sidewall trench, and daylight at the surface to provide an LCRS cleanout capability. At the deeper end of the LCRS trench, a sump containing a riser access pipe will transfer leachate in the containment cell to a surface leachate collection tank. A smooth 60-mil HDPE geomembrane below the LCRS will act as the initial barrier for preventing leachate migration out of the containment cell; in addition, the sump will be lined with additional HDPE geomembrane. HDPE is weather- and chemical-resistant and is highly puncture resistant. A GCL will underlie the HDPE geomembranes and will function as a leachate barrier layer in the event that the overlying HDPE geomembranes fail. The GCL will consist of nonwoven geotextile outer layers needle-punched through an inner layer of low-permeability sodium bentonite.

The sidewall liner components of the liner system, shown on Figure 4-1, include the following in descending order:

- A protective cover sheet of smooth 60-mil HDPE placed only on the side slopes over the LCRS trenches
- A smooth 60-mil HDPE geomembrane
- A GCL over prepared subgrade.

The protective cover sheet will protect the underlying geotextile wrap surrounding the drain rock from ultraviolet degradation and from clogging due to windblown dust and dirt. This cover sheet will be placed only on the side slopes over the LCRS trenches. For the sidewall liner, the HDPE geomembrane will provide the initial barrier for the prevention of leachate migration out of the containment cell. The GCL for the sidewall liner is the same as that of the bottom liner. Prepared subgrade will be below and in direct contact with the sidewall liner GCL. The subgrade will be compacted so that it will not rut or deform under the weight of installation equipment.
4.2 Vadose Zone Monitoring System

The VZMS is capable of providing real-time information on the proposed containment cell performance, allow early detection of leaks from the containment cell, and to detect small magnitude leaks. In addition, the VZMS may be used to remediate potential leaks and to differentiate between a potential leak from the proposed containment cell from other contaminant sources. Together, these features of the VZMS will provide monitoring capabilities that are at least equivalent to and generally better than a groundwater monitoring system.

The VZMS will consist of three subsystems, as follows:

- The Primary Subliner (PSL) Monitoring Subsystem
- The Vertical Sensor Array (VSA) Monitoring Subsystem
- The CWL and Sanitary Sewer Line (CSS) Monitoring Subsystem.

The three subsystems, shown on Figure 4-2, have been designed to be used in an integrated fashion to achieve a high probability of detecting "real" leakage from the containment cell (low false negative rate) and to avoid false detections caused by environmental factors beyond the control of the proposed CAMU operation (low false positive rate). The design allows for detection monitoring and, if a leak is suspected, for additional activities to effectively determine whether a leak has actually occurred and, if so, to determine the general character and magnitude of the leak. The design includes features that will allow identification of a situation where in situ condensation buildup, moisture increases from a nearby sanitary sewer, and/or organic vapors from a nearby inactive landfill have resulted in false indication of containment cell leakage.

The PSL monitoring subsystem will be located beneath the bottom of the containment cell liner system (i.e., within 5 feet) for early leak-detection capability. Five subhorizontal access tubes will permit monitoring of moisture content beneath the containment cell by neutron probes. Should an unexplained increase in moisture content suggest a leak through the liner, a flexible everting membrane containing soil-water and soil-gas sampiers can be deployed through the access tubes to ascertain the type or source of moisture.
Figure 4-2
Plan View of Vadose Zone Monitoring System
The VSA monitoring subsystem will also be located beneath the containment cell liner system and will consist of 11 vertical, instrumented boreholes positioned beneath the liner subgrade. These boreholes will not penetrate the containment cell or the liner system. Analysis of data from these sensors, positioned at 5 and 15 feet below the containment cell, will suggest whether any moisture increases sensed by the PSL monitoring subsystem originate from leakage through the containment cell liner or result from moisture migration through the native media driven by temperature or other gradients. Active soil-gas samplers will aid determination of infiltrate composition and source(s).

The CSS monitoring subsystem will be located between the containment cell and the CWL and sanitary sewer line. It will allow detection and identification of volatile organic compounds migrating from the CWL toward the proposed containment cell as well as leakage from the sanitary sewer line. The CSS monitoring subsystem will consist of 6 vertical boreholes capable of being monitored with the neutron probe and/or used as soil-vapor sampling points.

The VZMS includes soil-gas monitoring capabilities in both the VSA and the CSS monitoring subsystems. These capabilities (e.g., for volatile and semivolatile organic compounds) will be available at any time. Soil-gas sampling is also available by deploying soil-gas samplers into the PSL monitoring subsystem access tubes, if needed. The soil-gas sampling capability will serve three purposes:

- Monitoring soil-gas composition beneath the proposed containment cell
- Monitoring for potential leaks from the sanitary sewer line adjacent to the proposed containment cell
- Monitoring for the CWL vapor plume that currently exists in the vicinity of the proposed containment cell.

At a worst-case leak location (i.e., at a point farthest from a PSL access tube), a point leak as small as 600 gallons will cause a moisture-content increase of approximately 4 percent over antecedent conditions at one or both of the adjacent access tubes. Reliable detection of this increase in moisture (probability greater than 95 percent) will be accomplished with the
neutron probe/access tube PSL monitoring subsystem. It is estimated that a leak volume of tens of thousands of gallons is required to impact groundwater under the extreme scenario of preferential aqueous flow through more than 470 feet of normally matrix-dominated, unsaturated flow regime.

An issue of equal importance to leak volume sensitivity is the time required to detect a potential leak from a breach in the containment cell liner. A geotechnical site investigation performed at the proposed CAMU indicates that soil moistures in the vadose zone beneath the cell range up to about 5 percent. The SNL/NM ER Hydrology Laboratory conducted tests and modeling on similar media that indicate an unsaturated hydraulic conductivity at a more conductive soil moisture content of 10 percent is on the order $1.0 \times 10^{-10}$ centimeters per second ($1.0 \times 10^{-4}$ feet per year). Non-preferential unsaturated aqueous transport through the approximate 470-foot vadose zone at this conductivity would take over one million years. Environmental tracer studies at SNL/NM suggest that the travel time to reach groundwater via a combination of aqueous and nonaqueous (i.e., vapor phase) transport is approximately 8,800 years (SNL/NM, 1996b; SNL/NM, 1995). Leakage migration through groundwater to a monitoring well would add additional years and dispersion might well result in no detection. Worst-case detection time by the VZMS of aqueous unsaturated leakage is approximately 600 days, or approximately four orders of magnitude less than the minimum time required by a groundwater monitoring system.

4.2.1 Primary Subliner Monitoring Subsystem

The PSL monitoring subsystem will be the primary monitoring system of the VZMS, and will incorporate subhorizontal access tubes as opposed to point-specific buried instrumentation. The PSL subsystem is designed to allow operation in a phased approach consisting of a detection/monitoring phase followed, if necessary, by an assessment and confirmation/rejection phase. Detection of increased moisture content over antecedent conditions will be the primary indicator that leakage, potentially involving organic or inorganic hazardous remediation wastes, may have occurred. Assessment and confirmation/rejection of a leak will include employment of more active measures, including the sampling and analysis of pore fluids.

The subhorizontal access tubes will be constructed in trenches below the containment cell excavation and will be oriented parallel to the long axis of the containment cell. One of these
access tubes will be located immediately beneath the LCRS axial trench, which is the most likely location for a leak to occur. The spacing of the access tubes is designed to take advantage of the expected three-dimensional spreading or wicking of moisture that would occur both within the engineered wicking layer and through the native vadose zone materials immediately below the bottom liner GCL.

The access tubes will be located in trenches 5 feet below the containment cell bottom liner, with horizontal spacing at 17- to 27-feet. Numerical modeling has indicated that this horizontal spacing will be sufficient for reliable detection of aqueous leakage from the containment cell. The trenches will be backfilled with engineered wicking-layer and capillary-barrier media to facilitate transport of moisture to the access tubes. The access tubes will daylight at each end of the containment cell and will be integrated with the final cover system. Figures 4-3 and 4-4 present engineering details on the access tubes.

The PSL access tubes will consist of high strength vitrified clay pipe (VCP), providing sufficient porosity for moisture detection and liquid and vapor sampling, thus eliminating the need for holes or screens. Vitrified clay was selected based on service life, resistance to crushing, sufficient porosity, and material compatibility in regards to sensor operation. The PSL access tubes will have a nominal 6-inch inside diameter circular cross-section and will attach to the riser pipes with sweeping elbows having angles of approximately 22 to 23 degrees to allow unobstructed access for the neutron probes. In addition, the access tubes will have a nominal 1.25-inch wall thickness to accommodate sampling using the flexible everting membranes system. The flexible everting membrane sampling system has been proven to operate successfully in tubes up to 800 feet long.

The initial pipe bedding layer will be placed and compacted to 95 percent density as determined by the American Society for Testing and Materials (ASTM) Standard D 1557. After installation of the pipe on the bedding layer, placement and compaction of the haunching layer will begin. Trench backfill will be placed in individual lifts not to exceed 8-inches compacted thickness. The containment cell bottom will then be blanketed with a minimum 12-inch lift of compacted wicking soil placed over the HDPE-covered containment cell excavation bottom. A 3-foot long by 5-inch diameter mandrel will be pulled through the VCP to ensure sensors will pass.
Quality Assurance (QA) personnel will be present during construction of the VZMS and will perform visual observations and inspections to ensure proper installation of the PSL monitoring subsystem. The VCP for the access tubes will be tested for bearing, absorption, hydrostatic pressure, and acid resistance per ASTM C 301 prior to installation. After installation of the PSL and compaction of the PSL access tube trenches, but before construction of the subliner wicking layer or the containment cell liner, the access tubes will be tested for proper operation. After placement of the wicking layer, moisture-density tests will be performed in accordance with ASTM D 1557. Any repairs necessary during installation of the PSL monitoring subsystem will be performed under the direction of QA personnel.

The PSL neutron probe to be used to monitor moisture content beneath the cell will operate effectively within the vitrified clay pipe access tubes. The probes are not installed in the access tubes, but are manually moved through the tubes during monitoring events. These probes measure neutrons returned to a detector from a neutron source. A decrease in neutrons detected is a function of hydrogen ion concentrations in the subsurface, which can then be related to moisture content. Although the purpose of the neutron probe is to monitor moisture content, the PSL system is designed to sample for organic vapor through the deployment of a flexible membrane within the horizontal access tubes. Sampling may be performed at any time or if a leak or vapors are suspected in the system. The probe’s response is a function of hydrogen atom concentrations which can be used to monitor increases in humidity, water vapor, or concentrations of hydrocarbon vapors. However, because there are more hydrogen atoms in liquids than in vapors, the probes will detect soil moisture increases more readily than vapor phase increases. Calibration of the neutron probes will be conducted and documented upon installation.

In the very unlikely event that the containment cell liner allows significant leakage, the access tube system offers the potential for remediation of leaks or at least arresting contaminant migration prior to more intensive corrective action, if necessary. For potential remediation, or for arresting contaminant migration, the access tube in the affected area could undergo intentional pipe bursting (perforating) and screen insertion followed by remediation or migration barrier technologies such as soil vapor extraction, bioremediation, fluid (e.g., grout)
injection, or fluid extraction. If leaks are detected, the access tubes may be used to create a temporary barrier to vertical migration or to collect and remove leaked fluids.

Measures will be taken to reduce the potential for false-positive detection caused by in-pipe moisture buildup. To reduce in-pipe condensation, access tube utilization and operations will incorporate one or more of the following:

- Using tight-fitting compression seals at daylight ends of access tubes
- Reducing, to the extent practical, air circulation in the tube during humid summer-time periods
- Placing removable, closed-cell foam insulation to 4 feet below top of casing in access tubes.

These measures will reduce temperature gradients and air moisture invasion into the pipes and the resulting potential for moisture accumulation. If moisture buildup becomes an issue, air desiccants may be used to lower humidity in the access tubes. Desiccants will be used primarily to remove water condensation that may be present in the uppermost extensions of the riser pipes. Use of desiccants in these areas of the riser pipes, however, will not effect the moisture measuring capabilities of the neutron probes in the horizontal portion of the access tubes.

4.2.2 **Vertical Sensor Array Monitoring Subsystem**

Experience at other arid location landfills has found that sources of false-positive moisture increases below landfills are sometimes external to the landfill. Factors that may contribute to a moisture buildup below a lined landfill from external sources include soil moisture content gradients, vertical temperature gradients, and vertical soil-gas concentration gradients. Increases in soil-moisture content from in situ sediment or in-pipe moisture buildup are other examples of false-positive indications. The VSA monitoring subsystem will provide three-dimensional information on subliner moisture content, temperature, and soil-gas gradients to reduce the potential for false-positive indications. Although the VSA monitoring subsystem is not intended as a primary tool for leak detection, it will provide data that may be used to
distinguish between moisture content increases derived from leachate leakage and increases derived from external sources.

The VSA monitoring subsystem will consist of 11 vertical boreholes strategically located within the proposed containment cell, including one beneath the LCRS sump, which is the most likely location for a leak to occur. Experience has shown that this number of boreholes will provide sufficient soil-moisture detection coverage at a reasonable cost. All boreholes will contain a sampling point at 5 feet and a sampling point at 15 feet below the containment cell liner. Each sampling point will contain the following three components: a time-domain reflectometry (TDR) soil-moisture content probe; a temperature sensor; and an active soil-gas sampler in a coarse-sand pack. The VSA monitoring subsystem will also provide a reduced-sensitivity backup to the PSL monitoring subsystem. Instrumentation cabling and tubing will be ducted to the surface outside of the containment cell liner perimeter. Figures 4-5 and 4-6 present engineering details of the VSA monitoring subsystem.

Drilling of the VSA boreholes will be advanced by the hollow-stem or continuous-flight auger method without the use of drilling fluids or mud. Care will be taken to minimize disturbance to the native soil materials and borehole walls during drilling, and especially during sensor array installation. The borehole will be maintained open for the sensor installation. Beneath the containment cell bottom, conduits will be excavated for the VSA instrumentation leads and soil-gas collection piping to exit the subsurface without compromising the PSL monitoring subsystem and containment cell bottom liner. Upon installation of the leads and soil-gas conduit, raceways will be backfilled to the containment cell excavation surface. Sensor packs will be installed to the required depths. Splices of coaxial cable, wires, and tubing will not be allowed. Installation will include surface assembly of instrument packs with an operations check to assure that all systems are functioning properly before being installed in the borehole.

QA personnel will be present during construction of the VZMS and will perform visual observations and inspection to ensure proper installation of the VSA monitoring subsystem. QA personnel will check sensors and materials for proper construction and operation prior to installation. After installation of the VSA (but before construction of the PSL, subliner wicking layer, or containment cell liner), VSA instrumentation collectors and sensors will be
tested for proper operation. Any repairs necessary during installation will be performed under the direction of QA personnel.

The TDR moisture content measuring package will consist of the following equipment or equivalent: SNL/NM ER Project Hydrology Laboratory 6-3-516 TDR (or similar) moisture probes with coaxial cables, a Tektronix 1502B (or similar) cable tester, computer interface software, and a notebook computer to collect and store data. To promote accurate measurement of soil moisture in the vadose zone below the containment cell, TDR probes will be inserted in native material (at the 15-foot-deep sampling point) or compacted backfill of native material to duplicate the native material effective pore size (at the 5-foot-deep sampling point). To eliminate preferential flowpaths, the boreholes will be filled between sampling points with a uniform mixture of native materials (90 percent) and powdered bentonite (10 percent). During installation of the VSA boreholes, soil samples will be collected at approximately 5 and 15 feet and analyzed for initial volumetric moisture content in order to properly calibrate the TDR probes. No splices will be allowed in the TDR cable.

The temperature sampling package will be the following or equivalent: 20 AWG Type T (or similar) duplex insulated copper/constantan wires welded with a TIGTech, Inc. (Lexington, Massachusetts) Model 116 SRL (or similar) thermocouple welder. A voltage proportional to the surrounding temperature is generated at the juncture of the two dissimilar metals and measured and stored by a Campbell 21X (or similar) datalogger. The thermistor junction will be encased in epoxy to prevent corrosion of the bimetal junction and ensure stable measurement over time. No splices will be allowed in the thermistor wire.

The soil-gas sampling package will consist of nominal 2-inch-diameter and 6-inch-long, end-capped and slotted polyvinyl chloride (PVC) screen at the sampling location connected to the ground surface by 1/4-inch-inside-diameter Teflon™ tubing. The tubing will connect to the screen at a hose barb tapped into the upper cap. To keep soil particles from clogging the tubing, the PVC screen will be factory-machine slotted with a standard slot width of approximately 0.020 inch (20 slot).

The VSA and CSS subsystems are designed to allow for extraction of in-situ soil gas with sampling of the soil-gas stream for analytical laboratory analysis. As designed, a consistent
approach to soil-gas sampling and analysis can be applied to each subsystem. The target analyte group is volatile organic compounds, particularly including chemicals that are known to be present in some SNL/NM ER site soils and debris that will eventually be treated and contained at the CAMU.

During installation of the VSA boreholes, soil samples will be collected at depths of approximately 5 and 15 feet and analyzed in order to properly calibrate the TDR probes. The thermistors will be calibrated and measured by data logger systems. The installation/function of the monitoring probes will be subject to SNL/NM QA procedures, and data logging system will follow QA procedures to be provided by the manufacturer. The monitoring probes are nonretrievable once they are successfully installed; therefore, repairs cannot be performed on these components. The VSA system is designed to be a secondary mode of detection for the PSL monitoring subsystem and has eleven borings to be redundant in case of breakdown.

4.2.3 CWL and Sanitary Sewer Line Monitoring Subsystem

The CSS monitoring subsystem will be located east of the proposed containment cell. Six vertical boreholes will be placed between the containment cell and the CWL and sanitary sewer line. Based on experience, the six boreholes will allow potential CWL and sanitary sewer line false-positive indications to be distinguished at a reasonable cost. Each vertical borehole will contain a gas-sampling port and will be suitable for neutron soil moisture content monitoring. The CSS monitoring subsystem will be able to detect organic vapors migrating from sources in the CWL northwest through the vadose zone towards the proposed containment cell location. In addition, it will be able to detect leaks from the sanitary sewer line, thereby avoiding a false positive from the PSL monitoring subsystem.

All six boreholes will be constructed to a depth of approximately 20 feet and spaced approximately 100 feet apart. The bottom six inches of each borehole will consist of a steel drive point that is either threaded or welded to a two-foot section of 0.010 (10 slot) galvanized steel screen. The remaining length of each borehole will be constructed of nominal 2-inch-diameter galvanized steel. Installation will initially involve a nominal 6-inch-diameter borehole to be augered from the ground surface to a depth of approximately 10 feet. The galvanized steel drive point, screen, and riser will then be driven into the ground an additional 10 feet for a total depth of approximately 20 feet.
The neutron soil moisture probe, gas sampling port, and instrumentation for the CSS monitoring subsystem will be similar to the VSA subsystem. The primary moisture sensor will be a neutron moisture probe similar to the Troxler Electronic Laboratories Model 4350 Soil Moisture-Density Probe owned by the SNL/NM ER Project. The Troxler probe uses a 10.0-millicurie (mCi) americium-241:beryllium neutron source for moisture content measurement and an 8.0-mCi cesium-137 gamma source for soil density measurement. The probe is self-contained and includes radioactive sources, detectors, and data storage and interpretation capabilities. The probes are not installed in the boreholes, but are manually lowered into the boreholes during monitoring events. The gas-sampling port consists of the slotted-drive point at the bottom of the borehole. A vacuum is attached to the casing, and any organic vapors enter the drive point and move up through the casing to be collected. Figure 4-5 presents engineering details of the CSS monitoring subsystem.

QA personnel will be present during construction of the VZMS and will perform visual observations and inspections to ensure proper installation of the CSS monitoring subsystem. During well-point installation, inspections will be performed to assure that the drive point does not deviate unacceptably from vertical. In the event installation is unsuccessful due to a subsurface obstruction, QA personnel will designate an alternate location for the borehole. Similarly if the galvanized steel drive point cannot be driven 10 feet due to the density of the soils, the initially augered 10-foot-deep borehole will be extended downward as necessary. The CSS will be tested for proper operation immediately after construction.

4.2.4 Proposed Monitoring Frequency
The monitoring frequency to be implemented at the CAMU will vary depending on the operational status of the containment cell. Initial startup, active cell conditions, and closure will influence the frequency at which the VZMS is operated. The PSL, VSA, and CSS subsystems are equipped to monitor for soil moisture content increases and the presence of soil gases (e.g., volatile and semivolatile organic compounds). Sampling and analysis plans for these subsystems are included in this appendix as Attachments E-2, E-3, and E-4. The proposed frequency to be employed to monitor these parameters is as follows:
Table 4-1

Monitoring Frequency, Parameters, and Methods for the Vadose Zone Monitoring System

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Monitoring Frequency</th>
<th>Monitoring System</th>
<th>Monitoring Parameter</th>
<th>Monitoring Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week after construction of each subsystem</td>
<td>Daily</td>
<td>PSL</td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VSA</td>
<td>Soil moisture content</td>
<td>TDR probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSS</td>
<td>Temperature</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Weekly</td>
<td>PSL</td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VSA</td>
<td>Soil moisture content</td>
<td>TDR probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSS</td>
<td>Temperature</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>Monthly</td>
<td>PSL</td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VSA</td>
<td>Soil moisture content</td>
<td>TDR probe</td>
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<td></td>
<td>CSS</td>
<td>Temperature</td>
<td>Temperature sensor</td>
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<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>1st six weeks after closure (or until steady-state readings are obtained)</td>
<td>Weekly</td>
<td>PSL</td>
<td>Moisture content</td>
<td>Neutron probe</td>
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<tr>
<td></td>
<td></td>
<td>VSA</td>
<td>Soil moisture content</td>
<td>TDR probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSS</td>
<td>Temperature</td>
<td>Temperature sensor</td>
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<tr>
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<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
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<td></td>
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<td></td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Remaining post-closure period</td>
<td>Quarterly for first three years, then subject to renegotiation&lt;sup&gt;2&lt;/sup&gt;</td>
<td>PSL</td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VSA</td>
<td>Soil moisture content</td>
<td>TDR probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSS</td>
<td>Temperature</td>
<td>Temperature sensor</td>
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<tr>
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<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
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<td></td>
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<td></td>
<td>Moisture content</td>
<td>Neutron probe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Active soil gas</td>
<td>Method TO-14&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Due to the uncertainty of actual contaminant constituents to be managed in the containment cell, active soil gas sampling will be conducted using EPA Method TO-14. The analyte list for soil gas monitoring is contained in Attachment E-5.

<sup>2</sup> Active soil gas sampling will be conducted annually unless increased soil moisture is detected, in which case active soil gas sampling will be conducted on a quarterly basis until steady-state conditions are reached.
4.3 Final Cover System
At the end of the containment cell’s operational period, a final cover system will be placed over the cell to minimize water infiltration. The cover will be positioned over the entire area of the containment cell and will extend to the perimeter swale, which will encircle the containment cell. The final cover system design incorporates a capillary barrier and vegetation cover for primary hydraulic control. An HDPE liner positioned at the base of the final cover system will provide reinforced hydraulic control. The components of the final cover system, as shown on Figure 4-7, are as follows:

- Topsoil with gravel mulch surface treatment
- Native soil blend with a steel mesh, animal-intrusion barrier
- Filter sand
- Pea gravel
- Bedding sand
- Textured 60-mil HDPE.

The topsoil with gravel mulch will be developed from topsoil stockpiled during containment cell excavation. The purpose of the topsoil and native soil blend layers is to provide growing media for the vegetation cover, which has been specified as desert plant seed mixtures. This will enhance evapotranspiration and thus reduce infiltration. A steel mesh barrier within the native soil blend layer will prevent burrowing animal intrusion yet will maintain root accessibility to soils below the mesh. The steel mesh will be galvanized to prevent oxidation and eventual degradation. A capillary barrier, comprised of the filter sand layer and the pea gravel layer, will be located beneath the native soil blend. Because capillary pressure in a soil matrix is inversely proportional to the effective pore size (i.e., the smaller the pore size, the higher the capillary pressure), the downward migration of percolating water will be suspended when it arrives at the fine/coarse-grained soil interface. Therefore, as long as the downward force of percolating flow (i.e., gravity-induced head) is less than the capillary force in the native soil blend above, the capillary break technology will halt infiltrating water.
Figure 4-7
Side View of Final Cover System

- Native Top Soil With Gravel Mulch Surface Treatment
- 6 inches
- 30 inches
- Steel Mesh at 18" from Surface
- Native Soil Blend
- 4 inches
- Filter Sand
- Pea Gravel
- 6 inches
- Bedding Sand
- 8 inches
- Textured 60-Mil High-Density Polyethylene
- Waste
The downward and outward slope of the final cover will aid lateral flow of percolating water. The sand layer beneath the native soil blend should encourage lateral diversion of percolating water and reduce migration of fines into the pea gravel layer. Based on modeling and SNL/NM studies, infiltration of the filter sand into the pea gravel layer is typically only about one inch; therefore, geotextile will not be needed between the filter sand and pea gravel layers. The sand layer beneath the pea gravel layer will provide cushion protection to the underlying HDPE liner. The HDPE liner will be placed over the waste, buttress soil, and extended slope, and will be keyed into an anchor trench located inside the perimeter swale’s inner edge.

In addition to the gravel mulch/vegetation cover, engineering controls will be applied to prevent/minimize erosion losses. These include slope control, surface runoff control, and perimeter flow control. The crown of the cover will slope north, south, east, and west at a 3-percent grade. Transition slopes will range from 8.1:1 to 3:1 (horizontal:vertical). This design facilitates the low profile mounding and gentle slopes that will enhance wind and precipitation erosional resistance.

5.0 Potential For Migration

The potential for migration of hazardous remediation wastes from the proposed containment cell through the vadose zone to groundwater is presented in this section. Three scenarios are examined: the potential migration due to precipitation; the potential migration due to containment cell leakage; and the potential for vapor phase migration.

5.1 Potential Migration Due to Precipitation

As discussed in Section 2.2, the Albuquerque area has an arid climate characterized by low precipitation, high evapotranspiration, frequent drying winds, and an erratic seasonal distribution of precipitation. As a result, the arid environment at the proposed CAMU minimizes the potential for migration due to precipitation.

Several design features of the proposed containment cell final cover system will help to prevent precipitation from entering the containment cell and, thus, will further minimize the potential for migration due to precipitation. The primary hydraulic control of the low
permeability final cover system will be provided by vegetation cover and a capillary barrier, and reinforced hydraulic control will be provided by an HDPE liner at the base of the final cover system. (The proposed containment cell cover system is described in detail in Section 4.3.)

Site drainage plans combined with containment cell design features will also help to minimize the potential for migration due to precipitation. Storm water run-on will be diverted from the proposed CAMU at its perimeter and directed toward existing surface water drainage features. At the proposed containment cell, storm water run-off will be diverted from the containment cell via a drainage swale that will surround the cell perimeter. During operations, the containment cell will be open, and accumulated storm water will be captured by the LCRS. Upon closure, a final cover system will be placed over the containment cell. The cover will be gently crowned and sloped to direct storm water away from the containment cell area and, thus, minimize infiltration and potential leachate generation.

Potential migration of hazardous remediation wastes due to infiltration of precipitation at the proposed containment cell may be computed using a water-balance equation provided in the U.S. Environmental Protection Agency Manual SW-921 (EPA, 1981).

The equation is as follows:

\[ I = P - ET - R, \]

where

- \( I \) = Infiltration
- \( P \) = Precipitation
- \( ET \) = Evapotranspiration
- \( R \) = Runoff.

Average annual precipitation in the Albuquerque area is approximately 9 inches (SNL, 1994), and the average annual evapotranspiration is 95 percent of the annual rainfall (8 inches), or 7.6 inches (SNL/NM, 1996a). A conservative calculation of the maximum run-off due to a 24-hour, 100-year precipitation event ranges from 1.7 to 2.2 inches, using the Soil Conservation Service curve number method (USDA, 1973) (Attachment E-6 of this appendix). Although the containment cell final cover system is designed with a 95 percent gravel mulch/vegetation cover, the conservative run-off values above are based on the closed
containment cell final cover system having a soil surface with only 20 to 40 percent vegetative cover.

From the above values for precipitation, evapotranspiration, and run-off, a conservative scenario for annual average infiltration at the proposed CAMU is:

\[
I = P - ET - R \\
I = 9 \text{ inches} - 7.6 \text{ inches} - 1.7 \text{ inches} \\
I = -0.3 \text{ inches.}
\]

The conclusion that annual average infiltration is essentially zero is also supported by geotechnical data. SNL/NM geotechnical laboratory data from samples collected at depths of 46 to 48 feet at the proposed containment cell site indicate gravimetric moisture contents of 1.6 and 1.0 percent at Boreholes 1 and 2, respectively, and saturated hydraulic conductivities ranging from \(7.0 \times 10^{-6}\) to \(7.9 \times 10^{-5}\) feet per second (AEE, 1996). Extremely low infiltration is also indicated by a 1995 soils investigation, which showed the depth of substantial leaching from meteoric waters over the past several thousand to tens of thousands of years has been less than about 40 inches (SNL/NM, 1995).

5.2 Potential Migration Due to Containment Cell Leakage

Several lines of defense are built into the proposed containment cell design and associated operational practices to protect the environment from any potential leaks of hazardous remediation wastes from the containment cell. Both a bottom liner component and a sidewall liner component are incorporated into the designed liner system for the proposed containment cell, as detailed in Section 4.1. The bottom liner component will consist of a protective cover of native on-site soil, a LCRS, a smooth 60-mil HDPE geomembrane, and a GCL. The bottom liner component will be constructed over the PSL and VSA monitoring subsystems of the VZMS. (The proposed containment cell VZMS is described in detail in Section 4.2) The sidewall liner components will consist of a protective cover sheet of smooth 60-mil HDPE over the sidewall LCRS trenches, a smooth 60-mil HDPE geomembrane, and a GCL over prepared subgrade. Operational practices will require that soil and debris wastes to be placed in the proposed containment cell be treated to meet negotiated treatment standards prior to emplacement, and no liquid-bearing wastes will be placed into the containment cell.
Therefore, there is little opportunity for a liquid waste leak to occur. Together, the design features and the operational practices will greatly minimize the possibility of leaks from the proposed containment cell to the vadose zone and, subsequently, to groundwater.

The LCRS incorporated into the design for the bottom liner component of the proposed containment cell liner system will be used to routinely monitor and withdraw leachate from the containment cell during the operational period and during the post-closure care period. The LCRS will be used to detect, collect, and remove leachate that accumulates above the HDPE geomembranes. The HDPE geomembranes provide the first barrier to prevent migration from the containment cell.

The LCRS design capacity is based on the amount of precipitation from a 25-year, 24-hour storm event that could occur during the operational period of the proposed containment cell. For the Albuquerque area, the rainfall amount during a 25-year, 24-hour storm event is 2.5 inches (City of Albuquerque, 1993); this value was used to calculate the maximum volume of leachate that could potentially be generated during the operating period of the proposed containment cell. Based on an open containment cell, the maximum leachate volume generated during the design storm event is estimated to be 7,128 cubic feet per day. Upon closure of the containment cell, the volume of leachate that could potentially be generated will, of course, be greatly diminished because the final cover system will be in place.

The GCL component of the containment cell provides the second barrier to prevent migration from the containment cell. It will underlie the HDPE geomembranes and will function as a leachate barrier layer in the event that the HDPE geomembranes fail. The 1/4-inch-thick GCL will have a maximum hydraulic conductivity of $2.8 \times 10^{-6}$ feet per day ($1 \times 10^{-9}$ centimeters per second). This value is two orders of magnitude less than the maximum hydraulic conductivity of $2.8 \times 10^{-4}$ feet per day ($1 \times 10^{-7}$ centimeters per second) typically required for 3-foot-thick compacted soil material.

The VZMS beneath the bottom liner system of the proposed containment cell will be capable of early detection of any potential leak from the cell. In addition, the VZMS will be capable of detecting a leak that is orders of magnitude less in volume than one required for detection.
with a conventional groundwater monitoring system. The VZMS provides an important line of defense to prevent migration due to a containment cell leak.

For the purpose of evaluating potential migration of liquids due to a containment cell leak, a worst-case scenario is examined. In this scenario, it is assumed that the LCRS, the HDPE geomembrane, the sump and its additional HDPE geomembrane, and the VZMS have failed, and containment of the open cell is provided only by the GCL. Leakage, in terms of infiltration through the GCL, may be calculated from the Darcy flow equation (Davis and DeWiest, 1966):

\[
Q = KA(dh/dl), \text{ where} \\
Q = \text{Flow rate} \\
K = \text{Saturated hydraulic conductivity} \\
A = \text{Cross-sectional area} \\
dh = \text{Change in hydraulic head} \\
dl = \text{Distance dissipating active head.}
\]

According to the design specifications discussed above, the K of the GCL will be 2.8 x 10^{-6} feet per day. As stated previously, the maximum leachate volume that would be generated during a 25-year, 24-hour storm event is 7,128 cubic feet. The cross-sectional or surface area (A), when multiplied by the change in hydraulic head (dh), becomes volume (V), which can be substituted into the Darcy flow equation. The distance over which the hydraulic head is absorbed (dl) is the thickness of the GCL, which is 114 inches (0.02 feet). Assuming a constant head is maintained, the rate of leakage through the sump area at the bottom of the containment cell becomes:

\[
Q = KA(dh/dl) = KV/dl \\
Q = (2.8 \times 10^{-6} \text{ feet per day})(7,128 \text{ cubic feet})/(0.02 \text{ feet}) \\
Q = 1.0 \text{ cubic foot per day.}
\]

The total volume of leachate leaking through the base of the containment cell in one day becomes:
\[ V_L = Q(t) = (1.0 \text{ cubic feet per day})(7.48 \text{ gallons per cubic feet}) = 7.48 \text{ gallons per day}. \]

As demonstrated above, the potential for migration of liquids to groundwater due to a containment cell leak is insignificant, especially considering the arid regional climate and the distance to groundwater (approximately 485 feet) at the proposed CAMU site. Even assuming catastrophic and simultaneous failure of the LCRS, the HDPE geomembranes, the sump, and the VZMS and extreme conditions of a 25-year, 24-hour storm event while the containment cell is open, less than 8 gallons of leachate would potentially leak through the base of the cell in one day.

### 5.3 Potential for Vapor Phase Migration

The potential for vapor phase migration as a result of a leak from the proposed containment cell is highly unlikely for the following reasons.

- Only solid waste forms will be emplaced in the proposed containment cell. Liquid waste will not be accepted.

- All waste emplaced in the proposed containment cell will meet negotiated treatment standards, resulting in extremely low or nondetectable concentrations of hazardous constituents.

- Engineered barriers and the VZMS will prevent migration of contaminants from the proposed containment cell to groundwater.

Although contamination from the CWL has impacted groundwater via vapor phase migration, waste management practices and waste acceptance criteria at the proposed containment cell will be far more stringent than those at the time of the CWL operations. Thus, the potential for vapor phase migration of contamination from the proposed containment cell is greatly minimized.
6.0 Summary

As presented in this Proposed Alternative to Groundwater Monitoring, the proposed
containment cell at ER Site 107 within TA III at SNL/NM has extremely low potential for
impacting groundwater in the uppermost aquifer. Only infiltration through the final cover and
failure of the liner, leachate collection and removal, and vadose zone monitoring systems
followed by migration through approximately 485 feet of Santa Fe Group sediments could
potentially impact local groundwater.

The environmental conditions at the proposed containment cell, the proposed operational
practices that will be implemented, and the engineered systems incorporated into the
containment cell design all support this Proposed Alternative to Groundwater Monitoring. In
summary, these elements include:

- Arid climate with less than 9 inches per year precipitation
- Depth to groundwater of approximately 485 feet
- Insufficient infiltration at the site for migration of liquids to groundwater
- Nearest water-production well is approximately 4.5 miles away
- No liquid-bearing wastes placed in containment cell
- Engineered barriers
- A VZMS.

Monitoring is essential to help protect human health and the environment. SNL/NM intends
to conduct monitoring by using vadose zone monitoring instead of groundwater monitoring; a
waiver from monitoring requirements is not requested.

The VZMS element of the proposed containment cell has been designed to meet the intent of
40 CFR §264.552(e)(3)(ii), which requires that monitoring be sufficient to detect and
characterize releases of hazardous constituents to groundwater that may occur from areas of
the CAMU in which wastes will remain in place (i.e., the containment cell) after closure of
the CAMU. The proactive VZMS is a superior system for detection and subsequent
characterization of potential leaks from the containment cell. The function of the VZMS is
the same as for a groundwater monitoring system. The advantages of the VZMS over a
typical groundwater monitoring system include:
- More rigorous and useful results
- Provision of real-time data on containment cell performance
- More timely leak detection
- Ability to detect smaller volume leaks
- Ability to help remediate or contain a potential leak before substantial migration occurs
- Ability to differentiate a leak from the proposed containment cell from other contaminant sources.

Groundwater monitoring at the CWL, located southeast of the proposed containment cell in TA III, has shown that contaminants from the CWL have reached groundwater. Because the CWL is upgradient from the proposed containment cell, groundwater monitoring for the containment cell would not provide useful information because contaminants derived from the CAMU could not be differentiated from contaminants derived from the CWL. The more rigorous alternative of vadose zone monitoring is, therefore, another important advantage of the VZMS because it will provide useful monitoring data.

Additional important design elements of the proposed containment cell will greatly minimize the possibility of leaks (liquid or vapor phase) from the cell to the vadose zone and, subsequently, to groundwater. The containment cell liner system will consist of bottom liner and sidewall liner components. The HDPE geomembranes and the GCL of the bottom and sidewall liner components will provide the first and second barriers, respectively, to prevent migration from the containment cell. The containment cell bottom liner component will also incorporate a LCRS, which will be used to routinely monitor and withdraw leachate from the containment cell during the operational period and during the post-closure care period. The final design element of the containment cell is the final cover system, which will be constructed upon closure of the cell to prevent precipitation from entering the cell and, thus, further minimize the possibility of infiltration, leachate generation, and subsequent leakage from the cell. Components of the low permeability final cover system that will provide hydraulic control include a vegetation cover, a capillary barrier, and an HDPE liner. The
final cover system will also be gently crowned and sloped to direct storm water away from the containment cell area and further minimize infiltration and potential leachate generation.

Proposed operational practices will also serve to minimize the potential for migration from the containment cell. No liquid-bearing wastes will be placed in the containment cell; therefore, the potential for hazardous remediation waste leachate generation and subsequent leakage (liquid or vapor phase) from the cell is minimized.

Finally, in the highly unlikely event that a substantial leak of hazardous remediation wastes from the proposed containment cell should occur, environmental conditions at the site will minimize the possibility of contaminant migration through the vadose zone to the groundwater. The arid climate is characterized by low rainfall and high evapotranspiration. In addition, vadose zone characteristics (e.g., low gravimetric moisture content, low saturated hydraulic conductivity, low unsaturated hydraulic conductivity, and low volumetric moisture content values) will preclude substantial migration of leachate to groundwater at a depth of 485 feet.
7.0 Certification Statement

I, Earl Morse, a Certified Professional Geologist, certified by the American Institute of Professional Geologists, do hereby certify that, in my best professional opinion, the geologic and hydrologic contents of this document are correct and that the proposed operational practices meet the intent of controlling migration of liquids from the proposed CAMU containment cell that could impact local groundwater resources.

Respectfully,

IT Corporation

Signature of Professional Geologist
Earl Morse

Name of Professional Geologist

Date
9-17-97

Certificate Number
7946
I, P. Scott Den-Baars, a Registered Professional Engineer, certified by the New Mexico State Board of Registration for Professional Engineers and Surveyors, do hereby certify that, in my best professional opinion, the engineering design contents of this document are correct and that the proposed CAMU containment cell design (which includes the VZMS) and the operational practices meet the intent of groundwater monitoring requirements and that the VZMS is capable of detecting and mitigating leaks with the potential to reach groundwater. This engineering certification was prepared in accordance with generally accepted professional engineering principles and practice. These services have been performed with the care and skill ordinarily exercised by members of the profession practicing under similar conditions at the same time, and in the same or similar locality. We make no other warranty either expressed or implied.

Respectfully,

IT Corporation

Signature of Professional Engineer
P. Scott Den-Baars

Name of Professional Engineer

Date
10653/December 31, 1997

Certificate Number/Expiration Date
8.0 References

AEE, see AGRA Earth & Environmental, Inc.


COE, see U.S. Army Corps of Engineers.


EPA, see U.S. Environmental Protection Agency.


SAIC, see Science Applications International Corporation.


SNL/NM, see Sandia National Laboratories/New Mexico.


USDA, see U.S. Department of Agriculture.


ATTACHMENT E-1

Hydraulic Conductivity Values
Table E-1
Hydraulic Conductivity Values

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<th>$K$ (ft/yr)</th>
<th>$K$ (cm/s)</th>
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bold = value(s) cited in text
K = hydraulic conductivity
ft/s = feet per second
ft/d = feet per day
ft/yr = feet per year
cm/s = centimeters per second
bgs = below ground surface
SNL/NM = Sandia National Laboratories/New Mexico
TA-III = Technical Area III
NA = not applicable
GCL = geosynthetic clay liner
ATTACHMENT E-2

Sampling and Analysis Plan for the CWL and Sanitary Sewer Line Monitoring System
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1.0 Introduction

Sampling and analysis of the Chemical Waste Landfill (CWL) and Sanitary Sewer Line (CSS) monitoring system will be conducted to detect and identify potential migration of volatile organic compounds (VOC) from the CWL toward the containment cell as well as potential leakage from the sanitary sewer line. This Sampling and Analysis Plan (SAP) summarizes the general monitoring and sampling strategy and procedures for the CSS that will be used during and after containment cell activities.

The CSS is one of three vadose zone monitoring systems associated with the containment cell. The CSS along with the Primary Subliner (PSL) and Vertical Sensor Array (VSA) monitoring systems have been designed to be used in an integrated fashion to achieve a high probability of detecting leakage from the containment cell. As such, the results from monitoring of the CSS will be evaluated with the results from the other two monitoring systems to determine if there is a leak, and if so, the general character and magnitude of the leak. If a leak is confirmed, a remedial action plan will be prepared to address corrective action.

1.1 CSS Monitoring System Description

The CSS monitoring system is located east of the containment cell between the containment cell and the north-south oriented sanitary sewer line and includes a total of six vertical boreholes spaced 100 feet apart. Each vertical borehole is constructed to a depth of 20 feet. The bottom six inches of each borehole consists of a steel drive point that is connected to a two-foot section of 0.010 inch (10 slot) galvanized steel screen. The remaining length of each borehole is nominal 2-inch-diameter galvanized steel. Each borehole contains a gas-sampling port (drive point and screen) and will be used for neutron soil moisture content monitoring. The system serves the following purposes:

- Detect organic vapors migrating northwest through the vadose zone from sources in the CWL toward the containment cell; and
- Detect releases from the sanitary sewer line (thereby avoiding a false positive from the PSL subsystem). Potential releases from the sanitary sewer line will
be of an aqueous nature and will contain nitrates and perhaps phosphates and sulfates. VOCs are not anticipated to originate from the sanitary sewer line.

2.0 Monitoring and Sampling Strategy

The baseline for the CSS measurements will be established during the period immediately after installation until shortly after final closure of the containment cell. To provide a proper baseline for future data interpretation and to confirm viability of sensors throughout the containment cell construction process, the CSS monitoring points will be monitored daily for moisture content for the first week after being constructed. Monitoring will continue on a weekly basis for the first month thereafter, then on a monthly basis until closure of the containment cell. After final closure, the CSS will be monitored on a weekly basis for at least six weeks until results establish that essentially steady-state moisture conditions exist. This monitoring sequence will establish a sufficient database for characterizing non-leak conditions in the vadose zone beside the containment cell, allow for adequate training and experience for monitoring personnel, and verify the viability and proper operation of the system.

2.1 Monitoring Methods

The CSS monitoring points will be monitored for soil moisture changes with the neutron probe on a quarterly basis. The probes are not installed in the monitoring points, but are manually lowered into the monitoring points during monitoring events. The data stored in the probe will then be downloaded into a personal computer, combined with the results from the other two vadose zone monitoring subsystems (PSL and VSA), and evaluated.

The primary moisture sensor will be a neutron moisture probe similar to the Troxler Electronic Laboratories Model 4350 soil moisture-density probe owned by the SNL/NM ER Project. The Troxler probe uses a 10.0-millicurie (mCi) americium-241:beryllium neutron source for moisture content measurement and an 8.0-mCi cesium-137 gamma source for soil density measurement. The probe is self-contained and includes radioactive sources, detectors, and data storage and interpretation capabilities.
2.2 **Sampling Methods**

The CSS monitoring points will be sampled for soil gas to detect releases from the CWL and sanitary sewer line that could potentially migrate toward the containment cell. This sampling will be performed on a quarterly basis in accordance with SNL/NM Field Operating Procedure (FOP) 94-21 "Shallow Soil Gas Sampling".

The sampling process involves attaching a sample line (polyethylene tubing or equivalent) to the 2-way swagelock valve at the top of each CSS monitoring point. The monitoring point will be evacuated prior to sampling, such that the soil gas representative of the vadose zone soil gas has completely displaced the internal volume of the monitoring point and sampling line. This will be accomplished by connecting an air compressor/vacuum pump to the sampling line and operating the pump for such a duration that at least three (3) dead volumes have been removed. Sampling will be conducted immediately after monitoring point evacuation by connecting a Summa™ canister to the sampling line and opening the isolation valve, causing soil gas in the monitoring point and sampling line to be drawn into the canister. The full details of this sampling procedure are contained in FOP 94-21, which is included in Appendix G of this permit modification request.

2.3 **Analytical Procedures**

The ER Chemistry Laboratory or an approved analytical laboratory under contract to the Sample Management Office will be used to provide the analytical services. Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures. Analytical procedures will follow established laboratory standard operating procedures based on the referenced EPA method (i.e., TO-14). Active soil gas sampling will be conducted for selected volatile organic compounds (VOC) included in EPA Method TO-14 to provide a proper baseline for the system.

Chemical analyses will be performed using EPA Method TO-14 and any applicable SW-846 methods. All sample analyses will be performed either by the SNL/NM ER Chemical Laboratory or by an SNL/NM approved off-site laboratory.
2.4 Field and Laboratory Quality Assurance/Quality Control

Table 2-1 lists procedures which may be used in support of this SAP. These procedures comply with current sampling and analysis guidance documents, relevant SNL/NM FOP and Administrative Operating Procedures (AOP), the SNL/NM Environmental Restoration Project Program Implementation Plan, and SW-846 procedures.

![Table 2-1](image)

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<thead>
<tr>
<th>Number</th>
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<tr>
<td>AOP 94-22</td>
<td>Sample Management Office User’s Guide</td>
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<td>AOP 94-24</td>
<td>System and Performance Audits</td>
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<td>FOP 94-57</td>
<td>Decontamination Drilling and Other Field Equipment</td>
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<tr>
<td>FOP 94-68</td>
<td>Field Change Control</td>
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<td>FOP 94-69</td>
<td>Personnel Decontamination (Level D, C, and B Protection)</td>
</tr>
</tbody>
</table>

AOP  Administrative Operating Procedure  
FOP  Field Operating Procedure

Field and laboratory quality assurance (QA) samples will be collected per AOP requirements and may include duplicate samples, trip blank samples, field blanks, equipment rinsate blanks and matrix spike samples.
Samples will be submitted to the ER Chemistry Laboratory or an analytical laboratory under contract to the Sample Management Office which meets the QA/QC requirements of SW-846 and the procedures defined in QAP 95-01 (Quality Assurance Plan for the SNL/NM Sample Management Office).

2.4.1 Neutron Probe Calibration and QA/QC

This section describes the calibration and QA/QC procedures to be used for the neutron probe associated with this monitoring system. The Troxler® Electronic Laboratories Model 4350 soil moisture-density probe is a geophysical means of measuring soil moisture content. Briefly, a neutron probe uses the absorption of emitted neutrons to calculate soil moisture content. The assumption is made that the hydrogen in soil moisture is the dominant absorber of the emitted neutrons. In the CAMU soils, this may not be an accurate assumption. The following calibration and QA/QC checks are therefore required:

1. **Troxler® Electronic Laboratories Model 4350 Soil Moisture-Density Probe QA/QC**

   The Model 4350 probe, probe shield, system interface, computer, and software program are operated in accordance with the User’s Guide (Troxler, no date). The standard count measures the proper function of the gauge electronics and also compensates for the source decay. This measurement should be performed daily as described in the User’s Guide (Troxler, no date).

   Software loading and operation, QA/QC, probe parameter set-up, data uploading and display, data reduction, and trouble shooting procedures are performed as described in the User’s Guide (Troxler, no date).

2. **Troxler® Electronic Laboratories Model 4350 Soil Moisture-Density Probe Calibration**

   Calibration of the Troxler® Electronic Laboratories Model 4350 soil moisture-density probe is performed in a controlled environment that duplicates as close as possible the *in situ* characteristics at the field measuring location. The calibration setup is shown in Figure 1.
The probe is inserted into the access tube and count readings are taken as the soil moisture content in the repacked native soil is varied. The resulting count/soil moisture content relationship is used to develop a calibration curve for the instrument. Actual soil moisture contents can be determined as described in Klute, 1986, by mass weighing of the entire test apparatus, or with the aid of a previously calibrated TDR system.

2.5 References


ATTACHMENT E-3

Sampling and Analysis Plan for the Primary Subliner Monitoring System
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2.4 Field and Laboratory Quality Assurance/Quality Control .... 7
  2.4.1 Neutron Probe Calibration and QA/QC ..................... 9
2.5 References ......................................................... 10
1.0 Introduction

Sampling and analysis of the Primary Subliner (PSL) monitoring system will be conducted to verify containment cell integrity and performance. The objective is to provide early detection of failure in containment. This Sampling and Analysis Plan (SAP) summarizes the general monitoring and sampling strategy and procedures for the PSL that will be used during containment cell disposal operations and during post-closure.

The PSL is one of three vadose zone monitoring systems associated with the containment cell. The PSL along with the Vertical Sensor Array (VSA) and CWL and Sanitary Sewer Line (CSS) monitoring systems have been designed to be used in an integrated fashion to achieve a high probability of detecting leakage from the containment cell. As such, the results from monitoring of the PSL will be evaluated with the results from the other two monitoring systems to determine if there is a leak, and if so, the general character and magnitude of the leak. If a leak is confirmed, a remedial action plan will be prepared to address corrective action.

1.1 PSL Monitoring System Description

The PSL is the primary monitoring system based on the use of subhorizontal access tubes that utilize detection instrumentation deployed down access tubes during monitoring events. The PSL consists of five access tubes including one tube located immediately beneath the leachate collection and removal system axial trench. The spacing of the access tubes ranging between approximately 20 and 30 feet is designed to take advantage of the expected three-dimensional spreading or wicking of moisture that would occur (should a leak occur) both within the engineered wicking layer and through the native vadose zone materials. The access tubes are located 4 feet below the cell liner (GCL component) and will be constructed of thick-walled (1¾-inch) high-strength vitrified clay pipe (VCP) with nominal 6-inch inside diameter circular cross section. The access tubes will daylight on the north and south sides of the containment cell.

The PSL is designed to allow operation in a phased approach consisting of a detection/monitoring phase followed, if necessary, by an assessment and confirmation/rejection phase. Detection of increased moisture content over antecedent conditions will be the primary indicator that leakage may have occurred. Assessment and confirmation/rejection of the
release will include employment of more active measures, including the sampling and analysis of pore fluids by deployment of the flexible liner underground technologies (Flute™) (formerly Seamist) liner (or equivalent). Analysis of the pore fluids will indicate if the moisture originated from a leak in the containment cell or from external sources.

2.0 Monitoring and Sampling Strategy

The baseline for the PSL measurements will be established during the period immediately after installation until shortly after final closure of the containment cell. To provide a proper baseline for future data interpretation and to confirm viability of sensors throughout the containment cell construction process, the PSL access tubes will be monitored daily for moisture content for the first week after beginning construction of the sub-liner wicking layer. Monitoring will continue on a weekly basis for the first month thereafter, then on a monthly basis until closure of the containment cell. After final closure, the PSL access tubes will be monitored on a weekly basis for at least six weeks until results establish that essentially steady-state moisture conditions exist. This monitoring sequence will establish a sufficient database for characterizing non-leak conditions in the vadose zone below the containment cell, allow for adequate training and experience for monitoring personnel, and verify the viability and proper operation of the system.

2.1 Monitoring Methods

The primary monitoring in the PSL subsystem will involve measuring soil moisture content in each access tube with the neutron probe on a quarterly basis, after the baseline has been established. Unexplained moisture increases above approximately 3 to 4 percent over the initial value (neutron probe sensitivity is ±2 percent and precision is 0.1 to 1.0 percent) that might suggest a leak from the containment cell will trigger a secondary assessment and confirmation/rejection phase, which is described under sampling methods below.

The primary moisture sensor will be a neutron moisture probe similar to the Troxler Electronic Laboratories Model 4350 soil moisture-density probe owned by the SNL/NM ER Project. The Troxler probe uses a 10.0-Millicurie (mCi) americium-241:beryllium neutron source for moisture content measurement and an 8.0-mCi cesium-137 gamma source for soil density measurement. The probe is self-contained and includes radioactive sources, detectors, and data storage and interpretation capabilities.
With the Mt. Sopris cable-and-winches system available at SNL/NM, the Troxler probe can be configured to move through access tubes while automatically recording moisture and density. All measurements are stored in the probe's internal memory until downloaded into a computer for analysis.

A six millimeter static nylon accessory cord will be placed inside each access tube at the time of tube construction. This cord will extend the length of the access tubes and will be used to pull the Mt. Sopris logging-winches cable through the access tubes prior to being attached to the Troxler neutron probe. The Mt. Sopris cable-and-winches system will then pull the neutron probe through the access tubes when monitoring. When the survey is complete, the neutron probe will be removed and the cable-and-winches system will be used to pull the static cord back through the tube. The Flute™ liner can also be used to move the Troxler probe through the access tubes and therefore represents a backup system in the event of a malfunction of the cable-and-winches system.

Following moisture logging in the access tubes using the neutron probe, the stored moisture content data will be transferred from the neutron probe to a personal computer for evaluation.

### 2.2 Sampling Methods

Sampling in the PSL subsystem will only be conducted if monitoring with the neutron probe suggests leakage from the containment cell. This sampling will be conducted to determine if the moisture contains constituents known to have been placed into the containment cell. This will be accomplished by comparing the analytical results from this sampling with the characterization data from the treated waste placed into the cell. The data will also be compared to background data initially collected during the construction of the wicking layer. During construction, the wicking materials will be saturated, drained, and the effluent sampled for background concentrations.

Sampling of the PSL will involve moisture/passive soil gas/liquid sampling and laboratory analyses. The sampling will be accomplished by the deployment of an everting flexible membrane (e.g., Flute™ membrane or equivalent) placed into the access tube. Detailed procedures for deployment of the membrane will be supplied by the manufacturer of the technology based on the site-specific application requirements.
The Flute™ membrane technology pertinent to the PSL will be manufactured with external tabs allowing incorporation of absorbent pads and passive gas samplers (e.g., Goresorber™) based on the location of a suspected leak, as determined using the data from the three vadose zone monitoring subsystems (PSL, VSA, and CSS). Absorbent pads and other devices can be attached to the liner at SNL/NM in a protected area, allowing 400 to 500 feet of roll-out space. The membrane liner will then be brought to the access tubes in a deflated, rolled up state with the absorbent pads and passive gas samplers already attached. The Flute™ membrane technology relies on air pressure to deploy and maintain placement of the liner in the hole. Initial deployment utilizes a pressurized deployment canister purchased with the liner. As the liner is pressurized, it will unroll into the access tube and place the absorbent pads and passive gas samplers against the inside of the access tube at the predetermined locations. Once deployed, the liner is kept inflated using pressurized air (e.g., 1 psi gauge) supplied by an air pump using a solar-charged, rechargeable battery or other portable means. The membrane liner will remain in the access tubes for two to three weeks to allow absorption of enough liquid/vapors for analysis. At the end of this period, the membrane liner will be deflated and removed from the access tube. Once removed, the liner will be unrolled to allow access to the samplers, which will be retrieved and sent to a laboratory for extraction and analysis as described in analytical procedures below.

The primary indicator of potential leakage will be moisture. Analysis of the constituents in the moisture compared to the constituents known to be present in the containment cell, and to the background data for the wicking layer, will indicate if a leak has occurred. As described above, absorbent pads will be used to sample the liquid within the PSL access tubes. The absorbers are made of a synthetic material approximately 1/8 inch in thickness. A wide variety of absorber materials are available. Some are hydrophilic, others are hydrophobic. The length of the absorber depends upon the application. The absorber is attached at its axial ends by four tabs on each end. The tabs are built onto the liner. The new absorber is attached to the liner while protected by a high-density polyethylene covering. As the liner is inverted, the covering is left behind and the absorber is encapsulated in the inverted liner. The absorbers evert from the interior of the inverted liner to a position between the liner and the hole wall. The liner pressure forces the absorber firmly against the wall of the hole. The absorber is often monitored with a wire pair embedded in the liner wall. The resistance of the absorber is monitored as it wicks up water from the hole wall. When the absorption process...
has achieved an asymptotic approach to steady state, the absorber is removed by inverting the liner.

As the liner is inverted, the absorber is carried to the protected interior of the inverted liner so as to avoid any contact with another portion of the hole wall. The inverted liner is wound onto the reel in the retrieval canister, carrying the absorbers with it.

The absorbers are removed by evert ing the liner in a protected area, usually upon a sheet of plastic. As the absorber first appears at the eversion end of the liner, the attaching tabs are clipped to release the absorber. The liner eversion is continued to extend the absorber (inside out) into a plastic Ziplock™ bag. When the other end of the absorber appears, the absorber is cut from the tabs with a scissors, dropping the absorber into the bag. The bag is quickly sealed. The normal time of exposure to the air is about 5 seconds before the bag is closed. The bag is enclosed in a second bag to reduce the possible vapor loss.

The vadose zone monitoring system was designed to utilize the VSA for soil gas characterization. The placement of passive gas samplers (e.g., Goresorber™) in the access tubes utilizing the membrane liner will provide additional data regarding soil gas character. The Goresorber™ analyses will provide meaningful data regarding the type and relative abundance of a variety of constituents. The results present the mass of the specific constituents per mass of absorbent and therefore will indicate relative concentrations (low, medium, high). The Goresorber™ module consists of long (approximately 120 centimeters) hollow Gore-Tex™ membrane cord containing three separate granular Tenax-Ta™ sorbent packs positioned at one end. Tenax-Ta™ is a material that has a strong affinity for a broad range of organic compounds, independent of sample moisture. The Gore-Tex™ membrane, which also serves as a wrapping for each pack, is an expanded polytetrafluoroethylene transparent to gasses while preventing direct contact of the sorbent with solid or aqueous matrices. Thus, during deployment in the field, the sorbent is both wrapped and sheathed in an inert, hydrophobic, microporous membrane, allowing only for the penetration of vapors. The modules will be left in place for a period of two to three weeks at which time the module will be retrieved and sent to the laboratory for extraction and analysis.
2.3 Analytical Procedures

The ER Chemistry Laboratory or an approved analytical laboratory under contract to the Sample Management Office will be used to provide the analytical services. Analysis of the Goresorber™ will be performed at the W.L. Gore and Associates’ Screening Module Laboratory. Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures. Analytical procedures will follow established laboratory standard operating procedures based on the referenced EPA method.

Chemical analyses will be performed using EPA SW-846 methods for liquid samples, and the EPA TO-14 method for the soil gas samples. Analyses will be conducted for selected volatile organic compounds (VOC) included in EPA Method TO-14 plus any additional VOCs known to have been placed in the containment cell. All liquid sample analyses will be performed either by the SNL/NM ER Chemical Laboratory or by an SNL/NM approved off-site laboratory.

2.4 Field and Laboratory Quality Assurance/Quality Control

Table 2-1 lists procedures which may be used in support of this SAP. These procedures comply with current sampling and analysis guidance documents, relevant SNL/NM Field Operating Procedures (FOP) and Administrative Operating Procedures (AOP), the SNL/NM Environmental Restoration Project Program Implementation Plan, and SW-846 procedures.
Table 2-1

Applicable SNL/NM Administrative and Field Operating Procedures

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<tr>
<td>AOP 94-22</td>
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<td>AOP 95-14</td>
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<tr>
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<td>Documentation of Field Activities</td>
</tr>
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<td>FOP 94-26</td>
<td>General Equipment Decontamination</td>
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<td>FOP 94-34</td>
<td>Field Sample Management and Custody</td>
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<td>FOP 94-57</td>
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<td>Field Change Control</td>
</tr>
<tr>
<td>FOP 94-69</td>
<td>Personnel Decontamination (Level D, C, and B Protection)</td>
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</tbody>
</table>

AOP  Administrative Operating Procedure  
FOP  Field Operating Procedure  

Field and laboratory quality assurance (QA) samples will be collected per OP requirements and may include duplicate samples, trip blank samples, field blanks, equipment rinsate blanks and matrix spike samples.

Samples will be submitted to the ER Chemistry Laboratory or an analytical laboratory under contract to the Sample Management Office which meets the QA/QC requirements of SW-846 and the procedures defined in QAP 95-01 (Quality Assurance Plan for the SNL/NM Sample Management Office).
2.4.1 Neutron Probe Calibration and QA/QC

The Troxler® Electronic Laboratories Model 4350 soil moisture-density probe is a geophysical means of measuring soil moisture content. Briefly, a neutron probe uses the absorption of emitted neutrons to calculate soil moisture content. The assumption is made that the hydrogen in soil moisture is the dominant absorber of the emitted neutrons. In the CAMU soils, this may not be an accurate assumption. The following calibration and QA/QC checks are therefore required.

1. **Troxler® Electronic Laboratories Model 4350 Soil Moisture-Density Probe QA/QC**

   The Model 4350 probe, probe shield, system interface, computer, and software program are operated in accordance with the User's Guide (Troxler, no date). The standard count measures the proper function of the gauge electronics and also compensates for the source decay. This measurement should be performed daily as described in the User's Guide (Troxler, no date).

   Software loading and operation, QA/QC, probe parameter set-up, data uploading and display, data reduction, and trouble shooting procedures are performed as described in the User's Guide (Troxler, no date).

2. **Troxler® Electronic Laboratories Model 4350 Soil Moisture-Density Probe Calibration**

   Calibration of the Troxler® Electronic Laboratories Model 4350 soil moisture-density probe is performed in a controlled environment that duplicates as close as possible the *in situ* characteristics at the field measuring location. The calibration setup is shown in Figure 1.

   The probe is inserted into the access tube and count readings are taken as the soil moisture content in the repacked native soil is varied. The resulting count/soil moisture content relationship is used to develop a calibration curve for the instrument. Actual soil moisture contents can be determined as described in Klute, 1986, by mass weighing of the entire test apparatus, or with the aid of a previously calibrated TDR system.
Figure 1.
**Troxler® Electronic Laboratories Model 4350 Soil Moisture-Density Probe Calibration Setup.**

2.5 **References**


ATTACHMENT E-4

Sampling and Analysis Plan for the Vertical Sensor Array Monitoring System
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1.0 Introduction

Sampling and analysis of the Vertical Sensor Array (VSA) monitoring system will be conducted to verify containment cell integrity and performance. The objective is to provide a means of distinguishing between moisture content increases derived from leachate leakage and increases derived from external sources. This Sampling and Analysis Plan (SAP) summarizes the general monitoring and sampling strategy and procedures for the VSA that will be used during and after containment cell activities.

The VSA is one of three vadose zone monitoring systems associated with the containment cell. The VSA along with the Primary Subliner (PSL) and CWL and Sanitary Sewer Line (CSS) monitoring systems have been designed to be used in an integrated fashion to achieve a high probability of detecting leakage from the containment cell. As such, the results from monitoring of the PSL will be evaluated with the results from the other two monitoring systems to determine if there is a leak, and if so, the general character and magnitude of the leak. If a leak is confirmed, a remedial action plan will be prepared to address corrective action.

1.1 VSA Monitoring System Description

The VSA monitoring subsystem is located under the containment cell liner system and consists of 11 vertical, instrumented boreholes positioned beneath the liner subgrade. These boreholes do not penetrate the containment cell or the liner system. Analysis of data from these sensors will suggest whether any moisture increases sensed by the PSL monitoring subsystem originate from leakage through the containment cell liner or result from moisture migration through the native media driven by temperature or other gradients. Soil gas samplers will aid determination of infiltrate composition and source(s).

Each VSA borehole contains two sampling points, at 5 and 15 feet below the cell liner. Each sampling point contains a time domain reflectometry (TDR) soil moisture content probe, a temperature sensor, and a soil gas sampler embedded in either native material or repacked native material. The VSA will also provide a reduced-sensitivity back-up to the primary containment cell leak monitoring subsystem. Instrumentation cabling and tubing will be ducted in 1.5-inch PVC conduit to the surface outside of the cell liner perimeter. The cabling and tubing daylight will be protected by a 23- by 23- by 12-inch steel flush-mounted box at
the ground surface. Once disposal operations are completed and the final containment cell cover is constructed, the PVC conduit will be extended through the cover to daylight in a 12-inch diameter flush-mounted steel box at the surface of the cover. The older box will be filled with grout as a moisture barrier.

The TDR moisture content measuring package will consist of the following equipment or equivalent: SNL/NM ER Project Hydrology Laboratory 6-3-516 TDR moisture probes with coaxial cables, a Tektronix 1502b cable tester, computer interface software, and a notebook computer to collect and store data. To promote accurate measurement of soil moistures in the vadose zone below the containment cell, TDR probes will be inserted in native material (15-foot-deep sampling point) or compacted backfill of native material to duplicate the native material effective pore size (at the 5-foot-deep sampling point). To eliminate preferential flowpaths, the boreholes will be filled between sampling points with a uniform mixture of native materials (90 percent) and powdered bentonite (10 percent). During installation of the VSA boreholes, soil samples will be collected at 5 and 15 feet and analyzed for initial volumetric moisture content in order to properly calibrate the TDR probes. No splices are allowed in the TDR cable.

The temperature sampling package will be the following or equivalent: 20 AWG Type T duplex insulated copper/constantan wire welded with a Tigtech, Inc. (Lexington, Massachusetts) Model 116 SRL thermocouple welder. A voltage proportional to the surrounding temperature is generated at the juncture of the two dissimilar metals and measured and stored by a Campbell 21x (or similar) datalogger. The thermistor junction will be encased in epoxy to prevent corrosion of the bimetal junction and ensure stable measurement over time. No splices are allowed in the thermistor wire.

The soil gas sampling package will consist of nominal 2-inch-diameter and 6-inch-long, end-capped and slotted PVC screen at the sampling location connected to the ground surface by 1/4-inch-inside-diameter (ID) Teflon™ tubing. The tubing will connect to the screen at a hose barb tapped into the upper cap. To keep soil particles from clogging the tubing, the PVC screen will be factory machine slotted with a standard slot width of approximately 0.020 inch (20 slot).
The neutron probe comes complete with calibration, operation, diagnostic, data storage, and data retrieval software. The TDR moisture sampling package will use public domain control and data acquisition software. The temperature probe system will use Campbell Scientific, Inc., operation software or the equivalent.

2.0 Monitoring and Sampling Strategy

The baseline for the VSA measurements will be established during the period immediately after installation until shortly after final closure of the containment cell. As soon as possible after installation of the VSA (but before construction of the PSL, subliner wicking layer, or containment cell liner), all VSA instrumentation collectors and sensors will be tested for proper operation. After installation of the PSL and compaction of the PSL access tube trenches, but before construction of the subliner wicking layer or containment cell liner, the VSA components will again be tested for proper operation. To provide a proper baseline for future data interpretation and to confirm viability of sensors throughout the containment cell construction process, all VSA components will be monitored daily for the first week after beginning construction of the subliner wicking layer. Monitoring will continue on a weekly basis for the first month thereafter, then on a monthly basis until closure of the containment cell. After final closure, the VSA sensors will be monitored on a weekly basis for at least six weeks until results establish that essentially steady-state moisture and temperature conditions exist in the monitored media. This monitoring sequence will establish a sufficient database for characterizing non-leak conditions in the vadose zone below the containment cell, allow for adequate training and experience for monitoring personnel, and verify the viability and proper operation of sensors.

2.1 Monitoring Methods

The soil moisture and temperature components of the VSA will be monitored quarterly using the data acquisition system to store and upload the data. Baseline establishment is discussed above in Section 2.0.

2.2 Sampling Methods

Soil gas sampling via the sampling ports located in the VSA will occur quarterly or if soil moisture measurements (both from PSL access tube neutron probe moisture results and VSA gradients), and moisture changes measured by the VSA subsystem will be interpreted by
qualified personnel to distinguish the origin of moisture buildup beneath the liner system as originating from containment cell leakage or from sources outside the containment cell.

The TDR moisture sampling package will include TDR moisture probes with coaxial cabling, a signal generator (Tektronix 1502b), and a data acquisition system consisting of a PC and appropriate software (SNL/NM ER Hydrology Laboratory SM-SC PC-based control and data acquisition software or equivalent). Because of the relatively infrequent recommended sampling interval, and the synchronous manual collection of gas samples, a manual system composed of a single signal generator and laptop PC for data acquisition will be used. When a soil moisture measurement is needed, the signal generator and data acquisition system is connected to the coaxial cable of an individual TDR probe, and a reading is taken. A laptop PC with an 80486 chip or greater central processing unit, a 3.5 inch floppy drive, a 200 megabyte (or greater) hard drive, and 12 megabytes (or more) of ram will be used.

The temperature sampling package will include the thermistors, wire, and a datalogger. Campbell Scientific Graphterm™ software will be used to facilitate datalogger operation and data retrieval.

### 2.3 Analytical Procedures

The ER Chemistry Laboratory or an approved analytical laboratory under contract to the Sample Management Office will be used to provide the analytical services. Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures. Analytical procedures will follow established laboratory standard operating procedures based on the referenced EPA method. Active soil gas sampling will be conducted for selected volatile organic compounds (VOC) included in EPA Method TO-14 to provide a proper baseline for the system.

Chemical analyses will be performed using EPA Method TO-14 and any applicable SW-846 methods. All sample analyses will be performed either by the SNL/NM ER Chemical Laboratory or by an SNL/NM approved off-site laboratory.
2.4 Field and Laboratory Quality Assurance/Quality Control

Table 2-1 lists procedures which may be used in support of this SAP. These procedures comply with current sampling and analysis guidance documents, relevant SNL/NM Field Operating Procedures (FOP) and Administrative Operating Procedures (AOP), the SNL/NM Environmental Restoration Project Program Implementation Plan, and SW-846 procedures.

Table 2-1

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
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<td>Sample Management Office User’s Guide</td>
</tr>
<tr>
<td>AOP 94-24</td>
<td>System and Performance Audits</td>
</tr>
<tr>
<td>AOP 94-25</td>
<td>Deficiency Reporting</td>
</tr>
<tr>
<td>AOP 95-14</td>
<td>Preparing Sampling and Analysis Plans, Site-Specific Sampling Plans and Field Operating Procedures</td>
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<td>FOP 94-25</td>
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<td>General Equipment Decontamination</td>
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<td>Field Sample Management and Custody</td>
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<td>Decontamination Drilling and Other Field Equipment</td>
</tr>
<tr>
<td>FOP 94-68</td>
<td>Field Change Control</td>
</tr>
<tr>
<td>FOP 94-69</td>
<td>Personnel Decontamination (Level D, C, and B Protection)</td>
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</table>

AOP  Administrative Operating Procedure  
FOP  Field Operating Procedure

Field and laboratory quality assurance (QA) samples will be collected per OP requirements and may include duplicate samples, trip blank samples, field blanks, equipment rinsate blanks and matrix spike samples.
Samples will be submitted to the ER Chemistry Laboratory or an analytical laboratory under contract to the Sample Management Office which meets the QA/QC requirements of SW-846 and the procedures defined in QAP 95-01 (Quality Assurance Plan for the SNL/NM Sample Management Office).

2.4.1 *Time Domain Reflectometry Calibration and QA/QC*

This section describes the calibration and QA/QC procedures associated with the time domain reflectometry (TDR) monitoring technique. TDR is a geophysical means of measuring *in situ* soil moisture content. The TDR system consists of a controlling PC and software, a signal generator (Tektronics 1502b), and a coaxial cable and probe assembly. Briefly, the PC software keys the Tektronics 1502b to send a signal through the coaxial cable to the emplaced probe. The reflected signal is then received in digital form by the PC, the reflected signal shape dimensions are reduced to soil dialectric, and the soil dialectric converted, with the aid of a calibration curve, into soil moisture content. This process assumes that the soil dialectric is essentially a product of soil moisture content. In all soils, this is not strictly the case, and soil mineral content may be a significant contributor to soil dialectric, especially in the ignimbritic and/or arid soils encountered at the CAMU. The following calibrations and QA/QC checks are therefore required.

1. **TDR Probe and Coaxial Cable Assembly**
   
The probe and coaxial cable assembly requires no calibration or QA/QC.

2. **PC Software Calibration and QA/QC**
   
The Tektronics software requires no calibration or testing other than to ensure the proper transfer of instructions to and data from the Tektronics 1502b signal generator. Signal delivery to the Tektronics 1502b is simply tested by using the PC/software to initiate signal generation, and checking that the Tektronics 1502b displays the desired signal magnitude, location, and detail. Confirmation of proper data reception is best accomplished by first ensuring that the same signal seen on the Tektronics 1502b display is seen on the PC screen. The data file generating the PC display can then be imported into a graphics-capable software program such as Microsoft Excel or Sigmaplot to confirm that the dimensions seen on the PC screen and the Tektronics 1502b are identical to those stored in the data file.
3. **Tektronics 1502b**

The Tektronics 1502b signal generator itself is operated and calibrated according to the Tektronics 1502b Operator's Manual. Prior to installation, the following checks must be performed in relation to the Tektronics 1502b/TDR probe combination. To prevent loss of the critical "probe start" and "probe end" points on the reflected signal (see Figure 1), the system must be tested in native soils, at approximate *in situ* bulk density, and over the range of possible soil moisture contents and conductivity.

![Typical Tektronics 1502b Screen Display of the TDR Probe](image)

**Figure 1.**

*Typical Tektronics 1502b Screen Display of the TDR Probe, Used to Derive Soil Moisture Content. The Critical Points That Must Appear Unambiguously on the Screen are the Start and End Points of the Probe.*

Optimal Tektronics 1502b settings must be found that present the start and end points of the TDR probe. Because the proper settings are a function of probe type, soil content, soil moisture, and soil solution conductivity, it is necessary to test the Tektronics 1502b/TDR
probe combination over the possible ranges of contributing parameters. This is best accomplished by testing the Tektronics 1502b/TDR probe in a controlled environment where all the parameters may be varied. For the particular CAMU environment, native soils sufficient to fill an open container can be gathered, repacked to the *in situ* bulk density, and used to both calibrate and QA/QC TDR response (Figure 2).

![TDR Testing Setup](image)

**Figure 2.**
TDR Testing Setup.

The fifteen sampling points inside the 1’ x 3’ x 5’ test box can be used to obtain a statistically sufficient calibration curve based on the expected range of soil moisture contents. A simple procedure randomly picks three soil moisture sampling points in the test plot for each of five equally spaced moisture contents in the desired calibration range. Each of the soil sample moisture contents (“x” in Figure 2 above) is compared to the average soil moisture content measured by the four TDR probes immediately surrounding the soil sample.
"y" in Figure 2 above). No soil sampling location is reused. This method allows three soil moisture content comparisons between actual and TDR measurements at each of five points along the calibration curve. Actual soil moisture content measurements are performed as described in Klute, 1986.

Soil moisture content can be easily varied over its expected range by first fully saturating the test soil, then taking measurements as the test soil dries. Preliminary TDR measurements based on standard empirical calibration curves are sufficient for picking the five measurement comparison points over a desired range. Because the test soil is well-mixed and repacked, homogeneity should not present a significant problem. The depth of the actual soil sample should be at least two-thirds the length of the TDR probe (Figure 3). Soil moisture content measurement is integrated over the length of the TDR probe, with the greatest sensitivity in the first two-thirds of the probe (Knight, 1992). During the calibration procedure, Tektronics 1502b settings can be determined that ensure the reflected signal is presented with sufficient detail to allow precise measurement of soil moisture content while not omitting critical dimensions.

Once the calibration curve and optimal Tektronics 1502b settings have been established, data reduction and derivation of soil moisture content may be easily accomplished with a commercially available software program such as Microsoft Excel. During normal field TDR measurement of soil moisture content, at least ten percent of the actual waveforms should be checked by a qualified individual to ensure that the complete waveforms are being captured. Erroneous measurements can be generated from incomplete waveforms. In addition, data reduction and moisture content algorithms should be checked for at least ten percent of all measurements to ensure proper calculations. Further information may be obtained from Klute (1986, ppg. 999 to 1004), Knight (1992), Kachanoski (1992), Dasberg and Hopmans (1992), and Topp (1980).
Figure 3.
Soil Moisture Content Conformation Sample Depth in Relation to TDR Probe Length.
2.5 References


ATTACHMENT E-5

Monitoring System Analytes Using EPA Method TO-14
Monitoring System Analytes Using EPA Method TO-14

Acetone
Acetonitrile
Acrolein
Acrylonitrile
Benzene
Bromomethane
2-butanone
Carbon tetrachloride
Chlorobenzene
Chloroethene
Chloroform
Chloromethane
Chlorotoluene
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
Dichlorodifluoroethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
1,4-dioxane
Ethanol
Ethyl acetate

Ethyl benzene
Ethylene dibromide
Hexachlorobutadiene
Isopropanol
Methanol
Methyl ethyl ketone
Methyl methacrylate
4-methyl-2-pentanone
Methylene chloride
Styrene
1,1,2,2-tetrachloroethane
Tetrachloroethene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
Trichlorotrifluoroethane
1,1,2-trichlorotrifluoroethene
(freon 113)
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
Toluene
Trichloroethene
Vinyl chloride
Vinyl acetate
m,p-xylene
o-xylene

ATTACHMENT E-6

Estimation of Runoff at the Sandia National Laboratories/New Mexico Technical Area III for the 24-Hour 100-Year Precipitation Event
ATTACHMENT E-6

Estimation of Runoff at the Sandia National Laboratories/New Mexico Technical Area III for the 24-Hour 100-Year Precipitation Event

A calculation of runoff (R) is required to estimate potential infiltration (I) at the proposed Corrective Action Management Unit (CAMU) in Technical Area (TA) III at Sandia National Laboratories/New Mexico (SNL/NM). Infiltration is computed using a water-balance equation provided in the U.S. Environmental Protection Agency Manual SW-921 (1981). The water-balance equation is I = P - ET - R (Infiltration = Precipitation - Evapotranspiration - Runoff). The method used to calculate R for the above equation is provided in the U.S. Department of Agriculture, Soil Conservation Service, "Peak Rates of Discharge for Small Watersheds," Chapter 2, Engineering Field Manual for Conservation Practices, revised for New Mexico 10/73, updated 2/85. To calculate R, the following information is required:

(a) Soil and Hydrologic Group (from Table 2-1 of Soil Conservation Service [SCS] report)
(b) Cover Complex and Density in Percent (from Figure 2-1 of SCS report)
(c) CN (from Figure 2-1 of SCS report)
(d) Area (i.e., percent of area comprised of each hydrologic group/cover complex, if more than one)

A copy of the appropriate tables, figures, and exhibits from the SCS report are included with this attachment.

For (a) above, the soil at TA III is comprised of Tijeras Gravelly Fine Sandy Loam and Madurez Loamy Fine Sand (from Hacker, L.W., 1977). From Table 2-1 of the SCS report, these soils correspond to Hydrologic Group "B."

For (b) above, the cover complex from Figure 2-1 of the SCS report that best describes the specified vegetative cover is "Herbaceous."

A 95 percent gravel mulch/vegetation cover is included in the design for the final cover system at the proposed CAMU containment cell. However, to calculate R, conservative values of both 20 percent and 40 percent vegetation cover are assumed here.

For (c) above, the CN from Figure 2-1 of the SCS report for a conservative 20 percent cover density is 79. The CN from Figure 2-1 of the SCS report for a conservative 40 percent cover density is 73.

For (d) above, all of the soil for the proposed containment cell final cover system corresponds to Hydrologic Group B and all of the cover complex will be Herbaceous. Therefore, the value for (d) is 100 percent.
The CN for 20 percent cover density is \( (c)(d) = (79)(1.00) = 79 \). The CN for 40 percent cover density is \( (c)(d) = (73)(1.00) = 73 \). 

To determine \( R \), Figure 2-5 of the SCS report requires a value for rainfall in inches. From Exhibit 2-2, p. 16, of the SCS report, a conservative value for rainfall during a 24-hour, 100-year precipitation event at the proposed CAMU site is 4.2 inches.

From Figure 2-5, for \( CN = 79 \), \( R = 2.2 \) inches. For \( CN = 73 \), \( R = 1.7 \) inches. Therefore, a conservative estimate of maximum runoff due to a 24-hour, 100-year precipitation event at the proposed CAMU site ranges from 1.7 to 2.2 inches.
PEAK RATES OF DISCHARGE
FOR SMALL WATERSHEDS

CHAPTER 2
(REvised 10/73 FOR NEW MEXICO)
(UPDATED 2/85)
ENGINEERING FIELD MANUAL
FOR
CONSERVATION PRACTICES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TABLE 2-1
HYDROLOGIC GROUPS OF NEW MEXICO SOILS,
UPDATED JUNE 1983

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Desert Brush: Brush, weed, and grass mixtures with brush as the predominant element. Some typical plants are - Mesquite, Creosote, Yucca, Saltbrush, etc. This area is typical of lower elevations of desert and semi-desert areas.

Herbaceous: Grass, weed, brush mixtures with brush as the minor element. Some typical plants are - Grass, Tumble, Broom, Snake, Sagebrush, Saltbrush, Mesquite, Yucca, etc. This area is typical of lower elevations of desert and semi-desert areas.

Mountain Brush: Mountain brush mixtures of Oak, Mountain Mahogany, Apache Plume, Rabbit Brush, Stump Brush, Sage, Cliff Rose, Snowy, etc. Mountain Brush is typical of intermediate elevations and generally higher annual rainfall than Desert Brush and Herbaceous areas.

Juniper - Grass: These areas are mixed with varying amounts of junipers, pine, grass, and cholla cover, or may be predominantly of one species. Grass cover is generally heavier than desert grasses due to higher annual precipitation. Juniper-Grass is typical of mountain slopes and plateaus of intermediate elevations.

Ponderosa Pine: These are forest lands typical of higher elevations where the principal cover is timber.
APPENDIX F

QUALITY ASSURANCE PLAN
FOR THE
CAMU CONTAINMENT CELL

FINAL

SEPTEMBER 1997
QUALITY ASSURANCE PLAN FOR THE CAMU CONTAINMENT CELL

Prepared by:
IT Corporation
5301 Central Avenue, N.E., Suite 700
Albuquerque, New Mexico 87108

Under contract to:
Sandia National Laboratory/New Mexico
Albuquerque, New Mexico 87108
Contract No. AM-0098

Project No. 765491

June 1996
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Attachment A - Inspection Checklists
Attachment B - Specifications
1.0 Introduction

This document presents the overall program controls of the Quality Assurance for the CAMU Containment Cell Plan to be used for the construction of the Sandia National Laboratories (SNL)/New Mexico (NM) Hazardous Waste Corrective Action Management Unit (CAMU) containment cell. It should be recognized that the management of construction quality involves using scientific and engineering principles and practices to verify that the containment cell and associated liner system, final cover system, and leachate collection and removal system to be constructed meet or exceed design criteria, plans, and specifications. This management activity begins prior to construction, continues throughout construction, and ends when the completed facility is accepted by the SNL/NM.

1.1 Concept and Objectives of the QA Plan

The governing purpose for the QA Plan is to verify that the CAMU containment cell is constructed as designed. To verify proper construction, the following objectives must be met:

• Guidelines and requirements in construction drawings and specifications are followed.

• Inspection and verification testing throughout construction to verify that design features are implemented as intended.

• Evaluation of variances to the design and their effects upon system performance.

• Complete documentation demonstrating that the design has been implemented and that performance requirements have been met.

In meeting these objectives, the following are defined as part of the QA Plan:

• Quality-related qualifications, responsibilities, and authorities of personnel.

• Controls for the procurement of services and materials.

• Direction for necessary inspections and verification testing during construction so that execution of the design documents can be confirmed. Acceptance criteria for the inspections and testing are also included.

• Provision for continuity throughout construction so that the work progresses as an organized, planned sequence of events which allows revision and change.
Direction for the preparation and maintenance of records so that it can be demonstrated that the construction was performed in accordance with design requirements.

An audit system will be established to provide evaluation of the implementation of the construction drawings and specifications, the QA program, and work areas and activities including materials and workmanship.

1.2 Basis of the QA Plan
The following sources have been used as guidance in the preparation of the QA Plan:

- New Mexico Administrative Code Title 20, Chapter 4, Part 1, Subpart V.
- Manufacturer supplied installation guidelines.

1.3 Presentation of the QA Plan
The QA Plan contains general direction for the control of construction activities, such as the definition of organizational responsibilities and authorities, QA personnel qualifications, and specific technical information, such as execution guidance and verification tests to be performed throughout construction.

Inspection checklists have been developed for use by QA personnel to document the inspection and verification requirements in the QA Plan. These checklists will be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A. Specifications for individual components of the liner system, leachate collection and removal system, and final cover system are included in Attachment B.

Whenever possible, nationally recognized test methods such as those published by the American Society for Testing and Materials (ASTM) and the Geosynthetic Research Institute Standards will be utilized. In general, recognized standards will be cited only by reference.
and not included verbatim. If a test method is not a nationally recognized standard, the test method will be defined, including criteria for acceptability.
2.0 Responsibility and Authority

The principal organizations involved in construction of the SNL/NM CAMU and associated facilities include:

- U.S. Environmental Protection Agency (EPA) (Permitting Agency)
- New Mexico Environment Department (NMED) (Review Agency)
- Department of Energy (DOE) (Owner)
- SNL/NM (Operator)
- IT Corporation (Design Engineer)
- IT Corporation (QA Contractor)
- Construction Contractor (to be determined).

The areas of responsibility and lines of authority are delineated in the following sections such that the lines of communication are established to effectively implement the QA Plan. An organization chart for the project during the facility construction is shown in Figure 2-1.

2.1 Permitting Agency

The permitting agency, EPA, has the authority to issue a permit for the construction and operation of the CAMU facility. It is the responsibility of the permitting agency to review the Owner's site-specific QA Plan for compliance with the agency's regulations. The NMED has the responsibility to review all QA documentation during or after construction of the facility to confirm the approved plan was followed and that the facility was constructed as specified in the design.

2.2 Owner

SNL/NM will have responsibility and authority for operation of the facility. This responsibility includes complying with the requirements of the EPA/NMED in order to obtain approval of the CAMU permit application and assuring the permitting agency, by the submission of the QA documentation, that the facility was constructed as specified in the design. SNL/NM has the authority to select and dismiss the organizations in charge of QA and construction activities. The Owner also has the authority to accept or reject design plans and specifications, the QA Plan, reports and recommendations of the QA Engineer, and the materials and workmanship of the Construction Contractor. In addition, the Owner will have a Construction Representative (Sandia Construction Representative [SCR]) on site to coordinate and oversee all construction-related activities.
Permitting Agency
ENVIRONMENTAL PROTECTION AGENCY
REGION VI

Permittee
(DOE/SNL/NM)

Sandia
Construction
Representative

Design Engineer
IT Corporation

Construction
Contractor

Earth Work
Subcontractor

Geosynthetics
Installation
Subcontractor

Other Specialty
Subcontractor

QA
Contractor
IT Corporation

QA
Engineer

QA Certifying
Engineer

Testing
Laboratory

Inspection Personnel

Figure 2-1
Organization Chart, SNL/NM CAMU
2.2.1 **Sandia Construction Representative (SCR) (Owner/Representative)**
The SCR (i.e., Owner/Representative) will report directly to SNL/NM and has the following responsibilities:

- Overall coordination of construction activities
- Overseeing implementation of this QA Plan
- Notification to Design Engineer, QA Contractor, and Construction Contractor of nonconformances observed
- Approval of changes and notification of other personnel, as appropriate, for the changes
- Verification that inspections and verification tests performed by the QA Contractor are conducted at required intervals and in accordance with this plan
- Review the results of inspections, as-built drawings, and field and laboratory verification testing
- Preparation of audits and surveillance reports for submission to the Operator
- Authority to stop work if conditions adverse to quality are persistent and must be corrected before proceeding
- Maintenance of construction documents and records after transfer from the QA Contractor.

2.3 **Design Engineer**
The Design Engineer's primary responsibility is to design and specify a facility that fulfills the operational needs of the Owner and the performance requirements of the permitting agency. Design activities may not end until the facility is completed. Revisions to the design may be required if unexpected site conditions are encountered or changes in construction methodology occur that could adversely affect facility performance. The QA program provides assurance that these unexpected changes or conditions will be detected, documented, and addressed during construction.

Additional responsibility and authority include formulating and implementing the QA Plan, periodic review of QA documentation, modifying construction site activity, and specifying specific corrective measures in cases where deviation from the specified design or failure to meet design criteria, plans, and specifications is detected by QA personnel.
2.4 Construction Contractor
It is the responsibility of the Construction Contractor to construct the CAMU in strict accordance with the design criteria, specifications, construction drawings, and QA Plan using the necessary construction procedures and techniques.

2.5 QA Contractor
The overall responsibility of the QA Contractor is to perform those activities specified in the QA Plan (e.g., inspection, sampling, documentation). At a minimum, the QA Contractor shall include a QA Engineer and the necessary supporting QA inspection personnel. Specific responsibilities and authority of the QA Contractor’s personnel are defined clearly in the QA Plan and in the associated contractual agreements with the Owner.

2.5.1 QA Engineer
Specific responsibilities of the QA Engineer include, but are not limited to, the following:

- Reviewing design criteria, specifications, and construction drawings for clarity and completeness so that the QA Plan can be implemented
- Educating QA inspection personnel on QA requirements and procedures
- Scheduling and coordinating QA inspection activities
- Directing and supporting the QA Inspectors in performing observations and tests by:
  - Confirming that regular calibration of testing equipment is properly conducted and recorded
  - Confirming that the testing equipment (e.g., nuclear density gauge), personnel, and procedures do not change over time or making sure that changes do not adversely impact the inspection process
  - Confirming that the test data are accurately recorded and maintained (This may involve selecting reported results and backtracking them to the original observation and test data sheets.)
  - Verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted
- Maintaining QA-related documents, including but not limited to the QA Plan, field notes, meeting notes, test results, and miscellaneous reports
• Providing the SCR recommendations and reports on the inspection results including:

- Review and interpretation of data sheets, as-built drawings, and reports
- Identification of work that shall be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval
- Verification that corrective measures are implemented

• Reporting of nonconformances to the SCR

• Reporting to the SCR activities which are adverse to overall quality

• Documenting nonconformances

2.5.2 QA Inspection Personnel
Day-to-day inspections and field verification tests will be provided by the QA Inspectors. Their role is critical to successful demonstration of construction procedures and required documentation. Their major responsibilities include:

• Performing independent on-site inspection of the work in progress to assess compliance with the facility design criteria, specifications, and construction drawings

• Inspect delivery tickets and manufacturers quality control (QC) reports to verify that liner materials meet construction specifications

• Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the QA Plan

• Collecting samples in the field for subsequent verification testing by on-site or off-site laboratories

• Reporting to the QA Engineer results of all inspections including work that is not of acceptable quality or that fails to meet the specified design

• Reporting of nonconformances as appropriate to the construction foremen, superintendents, or manager if correction can be made during the normal course of work
• Reporting of nonconformances to the QA Engineer if correction cannot be readily achieved to the satisfaction of the QA Inspector, so that resolution can be accomplished by the QA Engineer.

• Reporting to the QA Engineer any activities which are adverse to overall quality and any nonconformances which are recurring.

• Documenting nonconformances.

• Reporting to the QA Engineer changes in the construction drawings and specifications.

• Documentation of inspection and verification testing activities through the completion of specified forms and daily logs.

2.5.3 QA Certifying Engineer
The QA Certifying Engineer is responsible for certifying to the Owner and EPA/NMED that, in his or her opinion, the facility has been constructed in accordance with plans and specifications, and QA document approved by the permitting agency. The certification statement is normally accompanied by a final QA report that contains all the appropriate documentation, including daily observation reports, sampling locations, test results, drawings of record or sketches, and other relevant data. The QA Certifying Engineer may be the QA Engineer or someone else in the QA Engineer’s organization who is a registered professional engineer with experience and competency in certifying like installations.

2.6 Testing Laboratory
Many QA tests are performed by commercial laboratories. The testing laboratory shall have its own internal QC plan to verify that laboratory procedures conform to the appropriate ASTM standards or other applicable testing standards. The testing laboratory is responsible for ensuring that tests are performed in accordance with applicable methods and standards, internal QC procedures are followed, sample chain-of-custody records are maintained, and data are effectively reported. The testing laboratory must be willing to allow the Owner, Design Engineer, QA Engineer, or EPA/NMED to observe the sample preparation, testing procedures, or record-keeping procedures, if they so desire. The Owner, Design Engineer, or QA Engineer, or EPA/NMED may request that they be allowed to observe some or all tests on a particular job at any time, either announced or unannounced. The testing laboratory personnel must be willing to accommodate such a request, but the observer shall not interfere with the testing or slow the testing process.
3.0 Personnel Qualifications

The key individuals involved in QA and their minimum recommended qualifications are listed in Table 3.1.

Table 3.1
Recommended Personnel Qualifications

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<th>Minimum Recommended Qualifications</th>
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<tr>
<td>Design Engineer</td>
<td>Registered professional engineer</td>
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<tr>
<td>Sandia Construction Representative</td>
<td>Designated by the owner with knowledge of the project, its plans, specifications and QC/QA documents</td>
</tr>
<tr>
<td>QA Engineer</td>
<td>Employed by an organization that operates separately from the Construction Contractor and Owner; registered professional engineer</td>
</tr>
<tr>
<td>QA Inspectors</td>
<td>Employed by an organization that operates separately from the Construction Contractor and the Owner and experienced in performing the appropriate field tests and making observations during construction activities</td>
</tr>
<tr>
<td>QA Certifying Engineer</td>
<td>Employed by an organization that operates separately from the Construction Contractor and Owner; registered professional engineer in the state of New Mexico</td>
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4.0 Project Communications

Communication between QA program participants is crucial. Required reporting to program participants is necessary so that activities can be reviewed and work can proceed. Communications in the form of construction documents, inspection reports, audit reports, verification test results, and daily logs must be timely so that reviews and evaluations can take place.

Throughout this plan, required report preparation and the individuals responsible for distribution, review, and approval are cited.

4.1 Meetings
Meetings shall be held throughout the course of construction. Progress meetings will be held at the request of the SCR and include, as appropriate, members of the Design Engineer personnel, members of the Construction Contractor(s) personnel (including subcontractors), and the QA personnel. Progress meetings will be documented in the form of meeting notes prepared by the QA personnel. These notes will be maintained in the on-site construction and/or QA records system. Following are discussions of three specific meeting formats.

4.1.1 Preconstruction Meeting
Prior to the start of construction of the CAMU facility, a Preconstruction Meeting will be held to review and acquaint personnel with the requirements of the QA Program, construction drawings, and specifications. The meeting will be led by the SCR and the QA Engineer. Attendance at the meeting should include: the Design Engineer’s field engineer, QA Inspectors, and Construction Contractor(s) including but not limited to surveyor, construction manager, superintendents, and foreman. Meeting notes will be prepared by the QA personnel and maintained in the on-site records system. Subcontractor personnel will attend the meeting as applicable to their scope of work. If subcontractors come on site after construction begins (such as the lining installation subcontractor) and the preconstruction meeting has been held, the SCR and QA Engineer will meet with the subcontractors to review appropriate activities of their work and document these meetings.

The preconstruction meeting should present the following:

- Schedule
• Safety plan
• Documents pertinent to each group’s activities during construction
• Construction organization
• Review requirements of the construction drawings and specifications
• Responsibilities and authority of specific personnel such as the QA Inspectors and the SCR
• Review requirements of the QA Program
• Inspection and verification testing methods, frequencies, and acceptance criteria
• A review of required documentation and operation of the on-site records system
• A discussion of the procedure for resolution of nonconformances and the responsibility of all personnel to bring attention to nonconformances
• A discussion of the procedure for change to construction drawings and specifications and the means for review and approval.

4.1.2 Progress Meetings
A progress meeting will be held periodically at the work site. At a minimum, the meeting will be attended by the SCR, the Design Engineer, the Construction Contractor, and the QA personnel.

The purpose of the meeting is to:

• Review the activities and accomplishments
• Review the work location and activities for the week
• Identify the Contractor’s personnel and equipment assignments for the week
• Discuss any potential construction problems.

This meeting will be documented by a member of the QA personnel.

4.1.3 Quality Resolution Meeting
Special meetings may be called by the Design Engineer, SCR, or the QA Engineer to discuss activities adverse to construction quality and define resolution. It is intended that these
meetings be called to discuss quality problems which cannot be readily resolved and which are ongoing or recurring.

The meeting should:

- Define and discuss the quality-related problem
- Review solutions
- Implement a plan to resolve the quality-related problem.

Resolution will be approved by the Design Engineer and/or the SCR as appropriate. Meeting notes will be prepared by the QA Contractor.
5.0 Observations, Inspection Activities, and Tests—Liner System

The liner system for the SNL/NM CAMU containment cell is composed of two liners (i.e., a geomembrane liner and a lower geosynthetic clay liner [GCL]) and a leachate collection and removal system.

The bottom liner system consists of the following components in descending order:

- Protective cover: 18-inch thick protective cover consisting of native on-site soil
- Leachate collection and removal system: Geocomposite drainage layer consisting of a geonet with a nonwoven geotextile bonded to the upper surface with drainage to a collection sump
- Geomembrane: 60-mil smooth high density polyethylene (HDPE) liner
- GCL

The Vadose Zone Monitoring System (VZMS) includes components which are not part of the liner system but are addressed within this document to ensure QA. These components include:

- Wicking soil
- Geomembrane: 60-mil smooth HDPE
- Prepared subgrade.

5.1 Earthwork

This section specifies the observations, inspections and tests necessary to control, verify, and document that the earthwork for the containment cell conforms to the plans and specifications.

Earthwork activities include:

- Excavation and subgrade preparation
- Capillary break and wicking material placement
- Embankment construction
- Protective soil cover placement
- Anchor trench construction.
In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists will be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

5.1.1 Excavation and Subgrade Preparation
Excavation includes the excavation of the containment cell to final grades as specified in the construction plans. The subgrade will provide a structurally stable foundation for the overlying liner system and waste.

5.1.1.1 Observations and Inspections—Excavation and Subgrade
QA personnel will continuously perform the following observations and inspections prior to and during containment cell excavation and subgrade preparation:

- Observe clearing and grubbing of the containment cell area to verify complete removal of all trees, shrubbery, grass, roots, and other vegetation or rubbish.

- Observe that surveying is performed for final excavation grades prior to placement of the liner system. Verify that containment cell base grades and sidewall slopes conform to construction drawings. The results of the survey shall be retained for future use to prepare as-built drawings.

- Observe that excavated material suitable for backfill is stockpiled at the specified location. Conduct visual classification of excavated soils in accordance with ASTM D 2488.

- Inspect subgrade to verify that all loose or soft zones have been excavated and replaced with suitable backfill material.

- Inspect subgrade to verify that it is free of all rocks greater than 0.5 inch in any dimension, roots, debris, and standing water.

- Observe coverage and number of passes made by compaction equipment.

5.1.1.2 Laboratory Tests—Subgrade
Laboratory tests of the subgrade shall be performed to document the engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:
• Determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 at a minimum frequency of 1 per acre, or more often if there is a change of material.

5.1.1.3 Field Tests—Subgrade
In addition to performing the required observations and inspections, QA personnel shall perform the following field tests required by the earthwork specifications:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of five per acre per lift. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

5.1.2 Wicking Material
Wicking soil will be placed in the vadose zone monitoring trenches and above the geomembrane over the entire cell floor in a 10-to-12-inch compacted lift.

5.1.2.1 Acceptance and Conformance Testing
The QA officer shall see that conformance test samples are obtained from stockpiled soils. These samples shall be sent to the QA laboratory for testing. The conformance test results should then be sent to the QA Engineer for review and acceptance prior to the installation of these materials. Any lots failing conformance testing shall be rejected.

Following testing of the materials, the QA Engineer shall:

• Verify that grain size analysis is performed in accordance with ASTM D 422.

• Verify that the fill materials conform to the quality and gradations according to the specifications.

• Verify that a pressure-plate soil moisture retention test is performed on candidate wicking materials to determine wicking parameters as detailed in VZMS specifications.

5.1.2.2 Storage and Handling
QA personnel shall verify the following storage conditions:

• The fill materials shall be stored in an area where the ponding of water will not occur.
5.1.2.3 Observations and Inspections—Placement

A personnel shall observe and verify the following:

• Inspect the fill materials to be used to verify that they meet construction specifications.

• Observe that fill material is placed to the lift thickness as shown on the construction drawings.

• Observe that fill materials are placed in such a manner as to prevent damage to the underlying geomembrane.

5.1.2.4 Laboratory Tests—Wicking Material

Laboratory tests of wicking materials shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

• Determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 for each lift of wicking material, or more often if there is a change of material.

• Grain size analysis in accordance with ASTM D 422, performed on each sample subjected to the full Modified Proctor Test, or when a change in material is noticed by QA personnel.


5.1.2.5 Field Tests—Wicking Material

To determine whether construction performance meets project requirements, field testing of in situ portions of the fill material shall be performed. Fill placed at densities and/or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests on the wicking material include the following:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of five tests per lift.
and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

5.1.3 Embankment and Protective Soil Cover Construction
Embankments will be constructed around the perimeter of the containment cell in order to prevent precipitation run-on into the containment cell or anchor trenches. The protective soil cover consists of 18 inches of native soil obtained from on-site excavated materials.

5.1.3.1 Laboratory Tests—Embankment and Protective Soil Cover
Laboratory tests of fill materials including embankments and protective soil cover shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 for each 2,000 cubic yards of protective soil cover and embankment fill, or more often if there is a change of material. A minimum of one test shall be performed per borrow area or stockpile prior to its use as fill to determine the moisture-density curve.

- Grain size analysis in accordance with ASTM D 422, performed on each sample subjected to the full Modified Proctor Test (minimum of one per 2,000 cubic yards), or when a change in material is noticed by QA personnel.

5.1.3.2 Observations and Inspections—Embankment and Protective Soil Cover
QA personnel will continuously perform the following observations and inspections during the construction of the embankment and placement of the protective soil cover:

- Inspect the materials to be used for the construction of embankments and the protective soil cover. The fill materials will be obtained from on-site excavated material. The excavated materials shall be comprised of native granular materials as specified in the construction specifications. Visual inspections of the excavated materials shall be made by QA personnel to detect the presence of organic matter, rubble, trash, and deleterious material. Irreducible material in excess of 0.5-inch in any dimension shall be removed.

- Observe coverage and number of passes made by compaction equipment.

- Inspect individual and final lift thickness.
• Observe the method of installation of the protective soil cover to prevent damage to the underlying geosynthetic liner materials.

5.1.3.3 Field Tests—Embankments and Protective Soil Cover
To determine whether construction performance meets project requirements, field testing of in situ portions of the embankments and protective soil cover shall be performed. Fill placed at densities and/or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of one test per 500 cubic yards. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled in accordance with the specifications and hand tamped.

5.1.4 Anchor Trench Construction
Anchor trenches will be constructed at the perimeter of the containment cell in order to immobilize the geosynthetic liner system components. The primary anchor trench will contain the GCL and the geomembrane liner. The secondary anchor trench will contain the geomembrane and the geotextile wrap for the final cover system. Information regarding the secondary anchor trench is presented in Section 6.1.4.

5.1.4.1 Observations and Inspections—Anchor Trenches
QA personnel shall perform the following observations and inspections of the anchor trenches following construction, prior to placement of geosynthetics within the trenches, and backfilling:

• Inspect anchor trench corners to verify that they are slightly rounded so as to avoid sharp bends in the geosynthetics.

• Inspect anchor trench dimensions to verify conformance with construction drawings and specifications.

• Observe that the anchor trench is free of ponded water or softening of the adjacent soils while the trench is open.
• Observe that backfilling is accomplished with approved backfill soil as indicated in the specifications and that care is taken during placement and compaction so as not to damage the underlying geosynthetics.

5.1.4.2 Laboratory Tests—Anchor Trench
Laboratory tests of the anchor trench backfill shall be performed to document the engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

• Determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 for each 1,000 feet of anchor trench, or more often if there is a change of material.

5.1.4.3 Field Tests—Anchor Trenches
To determine whether construction performance meets project requirements, field testing of in situ portions of the anchor trench backfill shall be performed. Fill placed at densities and/or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of once every 100 feet along the length of the trench. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled in accordance with the specifications and hand tamped.

5.2 Geosynthetics
This section specifies the observations, inspections, and tests necessary to control, verify, and document that the installation of geosynthetics within the liner system conforms to the drawings and specifications.

The bottom liner system consists of the following geosynthetic components in ascending order:

• 60-mil, black-surfaced, HDPE geomembrane (the geomembrane is placed below the wicking material for the VZMS)
• GCL
  60-mil, black-surfaced, HDPE geomembrane
• Geotextile wrap (The geotextile wrap is located within the leachate collection trench.)
• Geocomposite (i.e., geotextile/geonet).

The sidewall liner system consists of the following geosynthetic components in ascending order:
  • GCL
  • 60-mil, black-surfaced, HDPE geomembrane.

Because the geosynthetics in the bottom and sidewall liner systems are constructed of like materials, the tests and inspections to verify construction performance are the same. Accordingly, the tests and inspections for the geosynthetic components of the bottom and sidewall liner system may be divided into the following categories:
  • GCL
  • Geomembrane
  • Geocomposite
  • Geotextile wrap.

5.2.1 Geosynthetic Clay Liner
The GCL will be placed directly above the prepared wicking materials in the floor of the cell and over the prepared side slopes. The GCL will underlie the geomembrane and will function as a leachate barrier layer in the event that the overlying HDPE geomembrane fails. The GCL consists of nonwoven geotextile outer layers needle-punched through an inner layer of low-permeability sodium bentonite.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.
5.2.1.1 Acceptance

Upon delivery of the GCL rolls to the field site, the QA Engineer shall:

- Inspect delivery tickets and GCL manufacturer’s QC reports to verify that the GCL meets construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.

- Verify that QC certificates have been provided for all rolls and visually inspect each roll for damage.

5.2.1.2 Storage and Handling

Storage of GCLs at the site shall be avoided due to the potential for absorbing moisture and accidental damage. If storage is required at the site for a short period of time (i.e., days or a few weeks) GCLs shall be stored in delivery trailers unhitched from delivery vehicles. Alternatively, if storage within delivery trailers is not possible, GCLs may be stored with the following considerations:

- Handling and storage of GCLs shall be in accordance with ASTM D 4873.

- Handling of rolls of GCLs shall be done in a competent manner such that damage does not occur to the product nor to its protective wrapping.

- Lifting the rolls requires a minimum 3-inch outside diameter steel pipe with a wall thickness, capable of supporting the roll to prevent deformation. The pipe is inserted through the roll’s cardboard core, and heavy duty slings or end caps are attached to each end of the pipe. The pipe is then fastened to a spreader bar. The assembly can be lifted by crane, back hoe, end loader or other suitable piece of equipment.

- Rolls shall be adequately covered to protect them from moisture and ultraviolet light.

- The location of temporary field storage shall not be in areas where water can accumulate. The rolls shall be stored elevated off the ground while providing support to the entire GCL roll length.

- Any rolls that come in contact with moisture while in storage, shall be set aside to await examination by the QA Engineer. Damaged rolls shall be set aside and examined to determine the suitability of the liner for use.

- The rolls shall not be stacked so high as to cause thinning of the product at points of contact.
5.2.1.3 Observations and Inspections—Placement

The installation contractor shall remove the protective wrapping from the rolls to be deployed only after the underlying wicking material has been approved by the QA Engineer. QA personnel shall be present at all times during the placement and covering of the GCL.

QA personnel shall observe and verify that the following procedures are adhered to during GCL placement:

- The installer shall take the necessary precautions to protect the wicking material underlying the GCL. Construction equipment may be used to deploy the GCL, however, precautions shall be exercised to verify that rutting of the wicking material in excess of 1 inch is avoided.

- During placement, care must be taken not to entrap fugitive clay, stones, or sand in or beneath the GCL that could damage the overlying geomembrane or hamper subsequent seaming of the materials.

- On the side slopes, the GCL shall be secured at the top and then unrolled so as to keep the material free of wrinkles and folds.

- Trimming of the GCL shall be done with great care such that fugitive clay particles do not come in contact with drainage materials such as geonets, geotextiles, or aggregate drainage materials.

- The deployed GCL shall be visually inspected to verify that no potentially harmful objects are present (e.g., stones, cutting blades, small tools, sandbags, etc.).

5.2.1.4 Observations and Inspections—Joining

Joining of the GCLs shall be accomplished by overlapping and placing additional bentonite between overlaps.

QA personnel shall observe and verify that the procedures stated below are followed during GCL joining:

- Adjacent GCL sheets shall overlap each other according to match lines on the bottom sheet. This match line is typically 10 inches from the edge of the sheet.

- The same bentonite used in the GCL shall be placed between the sheets at the overlap region to verify the seal. The bentonite, in a dry state, shall be added using a line spreader or line chalker at a rate of 1/4 lb per linear foot of seam.
• Transverse overlaps at the ends of rolls shall be a minimum of 12 inches in length.

• No horizontal seams on side slopes shall be allowed.

• On the side slopes, seams shall be shingled in a down direction such that water flows across the seam from the top sheet to the bottom sheet.

• When the liner is a cut to fit in small areas, corners, or around details, adjacent panels shall overlap a minimum of 6 inches, with bentonite added in the overlap region.

5.2.1.5 Observations and Inspections—Repairs
Holes, tears, or rips in the GCL made during transportation, handling, placement, or anytime before covering the GCL shall be repaired by patching.

QA personnel shall observe and verify that the following procedures are adhered to during GCL repair:

• Any patch used for repair of a tear or rip in the geotextile shall be done using the same material as the damaged geotextile or other geotextile approved by the QA Engineer.

• The size of the geotextile patch must extend at least 12 inches beyond any portion of the damaged geotextile.

• If bentonite particles are lost from within the GCL or if the bentonite has shifted, the patch shall consist of the full GCL product. It shall extend at least 12 inches beyond the extent of the damage at all locations. Procedures for placement of additional bentonite in overlap seaming shall be used for patching.

• Care shall be taken in using a GCL patch since fugitive bentonite particles can infiltrate drainage materials or hinder subsequent geomembrane seaming activities.

• Patches on side slopes shall be minimized. GCL panels that require patching shall be moved and used on the floor of the containment cell whenever possible.

• Areas that are inadvertently exposed to standing water or excess precipitation and allowed to hydrate prior to being covered, shall be examined by the QA Engineer. If the engineer and installer determine that the GCL has hydrated and that the bentonite would displace under expected load, the GCL must be removed and replaced.
• Any GCL material exposed to hydrocarbon fuels, chemicals, pesticides, leachates, or other such liquids during installation, shall be cut out, removed, and disposed of away from any components of the liner presently under construction.

5.2.1.6 Observations and Inspections—Covering

The layer of material placed above the deployed GCL will be a 60-mil HDPE geomembrane. The GCL shall be covered before any rainfall or snow event occurs to preclude premature hydration of the GCL.

QA personnel shall observe and verify that the following procedures are adhered to in covering the GCL:

• The GCL shall not be covered before observation and approval by the QA Engineer. This requires close coordination between the installation crew and the QA personnel.

• The GCL shall be covered with the geomembrane as soon as possible. Only install as much GCL as can be anchored, inspected, and covered in the same day or before precipitation occurs.

• The overlying geomembrane shall be deployed such that the underlying GCL is not damaged.

• Both the underlying and the newly deployed materials shall be inspected to verify that they are not damaged.

• When construction and installation is halted at the end of the day, the leading edge of the GCL shall be folded back under the geomembrane such that the geomembrane extends beyond the GCL a minimum of two feet. The leading edge of the geomembrane shall then be weighted with sandbags or suitable ballast to safeguard against wind uplift and the flow of runoff under the liner.

5.2.2 Geomembrane Liners

The HDPE geomembrane liners will be placed on the prepared subgrade on the bottom of the containment cell, directly over the GCL on the floor and sidewalls of the containment cell and over the previously placed geomembrane in the sump area. The liners consist of a 60-mil, smooth, HDPE geomembrane.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the
QA Engineer. These checklists will document the QA process throughout construction. These checklists are included in Attachment A.

5.2.2.1 Acceptance
Upon delivery of the geomembrane rolls to the field site, the QA Engineer shall:

- Inspect delivery tickets and the manufacturer's QC reports to verify that the geomembrane rolls meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.
- Verify that QC certificates have been provided for all rolls and visually inspect each roll for damage.

5.2.2.2 Storage and Handling
Storage of geomembrane rolls at the site shall be in an area where standing water cannot accumulate and accidental damage will not occur. Geomembranes may be stored with the following considerations:

- Unloading and handling of rolls shall be such that no damage will occur to the geomembrane. Pushing, sliding, or dragging of rolls will not be permitted.
- The storage area ground surface shall be cleared of all stones and rough objects prior to use.
- Temporary storage of the rolls shall not be more than five rolls high so that crushing of the core or flattening of the rolls does not occur.
- Outdoor storage of rolls shall not exceed six months. For storage periods longer than six months, the rolls shall be covered.

5.2.2.3 Observations and Inspections—Placement
QA personnel shall be present at all times during the placement and covering of the geomembranes.

QA personnel shall observe and verify that the following procedures are adhered to during placement where appropriate:

- The underlying GCL or geomembrane shall have all folds, wrinkles and other undulations removed prior to placement of the geomembrane.
• The underlying material shall be inspected and cleaned of debris prior to placement of the geomembrane.

• Care and planning shall be taken to unroll the geomembrane at its intended and final position.

• Construction equipment shall not be operated directly on the underlying GCL or the geomembrane. In cases where rolls must be moved over the previously placed GCL or geomembrane, the materials shall be moved by hand or by using small lifting units on pneumatic tires. Tire pressures shall be limited to a maximum value of 6 pounds per square inch.

• The installer shall take the necessary precautions to protect the prepared subgrade underlying the geomembrane. Construction equipment may be used to deploy the geomembrane, however, precautions shall be exercised to verify that rutting of the subgrade in excess of 1 inch is avoided.

• The geomembrane shall have adequate slack such that it does not lift up off of the substrate material at any location. The final seaming of the geomembrane and backfilling of the anchor trench shall be done during the coldest part of the day.

• Excessive slack that may cause creases or folds in the geomembrane shall not be allowed.

• Temporary tack welds shall not interfere with the primary seaming method or with the ability to perform subsequent destructive seam tests.

• The geomembranes shall not be unrolled when the sheet temperature is below 32°F or above 122°F.

• The geomembrane shall have adequate temporary anchorage (i.e., sandbags or tires) to prevent uplift by winds.

• Geomembrane rolls which have been displaced or damaged by wind shall be rejected and/or repaired as recommended by the QA Engineer. Rejected materials must be removed from the site.

5.2.2.4 Observations and Inspections—Seaming
Seaming of the geomembranes will be accomplished by hot wedge or extrusion welding.

QA personnel shall observe and verify that the following procedures are adhered to during seaming activities:
• Seaming shall not take place during precipitation, blowing dust, or high winds.

• The area to be seamed shall be free of moisture, dust, or foreign material of any kind.

• Only the manufacturer's approved seaming equipment and products shall be used for all seams.

• No horizontal seams on the side slopes shall be allowed.

• "Fish mouths" and wrinkles shall not be allowed to occur at seams.

• The rolls shall be overlapped a minimum of 4 inches for hot wedge welding and 3 inches for extrusion welding.

• Seaming shall extend into the anchor trench a minimum of one foot.

5.2.2.5 Test Strips and Trial Seams
Test strips shall be conducted to estimate the quality of the production field seams including equipment and operator proficiency. The QA Engineer shall have the option of requesting test strips of any field seaming crew or device at anytime. QA personnel shall observe all trial seam procedures and tests.

The following testing procedures shall be followed:

• Test strips shall be made in sufficient lengths, as a single continuous seam, for required testing purposes.

• Test strips shall be made every four hours. Additionally, they shall be made whenever personnel or equipment are changed, when climatic conditions reflect wide changes in geomembrane temperature, or when other conditions occur that could affect seam quality.

• Test strips shall be approximately 3-feet long by 1-foot wide for extrusion welds and 6-feet long by 1-foot wide for hot wedge welds with the seam centered lengthwise. Overlaps will be representative of production seams.

• Destructive testing on the trial seams shall begin as soon as the seam cools.

• The cut specimens shall be randomly selected by QA personnel and tested in both peel and shear using a field tensiometer supplied by the QA contractor.
• A new test strip shall be fabricated if any of the test specimens fail. If additional specimens fail, the seaming apparatus and seamer shall not be accepted and will not be used for seaming until the deficiencies are corrected and successful trial welds are achieved.

• If the specimens pass, seaming operations can move directly to production seams.

5.2.2.6 Destructive Test Methods for Seams
Destructive testing shall be accomplished by cutting out and removing a portion of the completed production seam and then further cutting the sample into appropriately sized test specimens. The QA Engineer shall select the sampling location where test specimens shall be cut from the seam. QA personnel shall witness all seam sample cutting and all field tests and verify that proper identification and details accompany the test results.

Details required in QA documents include:

• Date and time
• Ambient temperature
• Identification of seaming unit, group or machine
• Name of master seamer
• Welding apparatus temperature and pressure, or chemical type and mixture
• Pass or fail description
• A copy of the report shall be attached to the remaining portion of the sample.

QA personnel shall observe and verify that the following procedures are adhered to during destructive testing:

• When cutting samples from the geomembrane, only an upward hook blade shall be used.

• Holes in the geomembrane resulting from seam sampling shall be repaired immediately in accordance with the repair procedures.

• Samples shall be adequately numbered and marked with permanent identification.

• A 28-inch long sample shall be taken from the seam and cut into two individual 14-inch samples. Individual samples go to the QA Contractor and the Owner. The QA Contractor shall cut the sample into five shear and five peel test specimens and shall conduct the appropriate tests immediately. The remaining sample shall be archived by the Owner.
• The sample width perpendicular to the seam shall be 12 inches with the seam centrally located within this dimension.

• Seam samples shall be taken at fixed increments along the total length of the seams. Increments shall be 250 feet. This value may be applied either directly to the record drawing during layout of the seams, or to each seaming crew as they progress during the work period.

• This increment shall be held regardless of the location upon which it falls. Exceptions to avoid sumps, connections, protrusions, etc. may be made with the approval of the QA Engineer.

• Field testing of individual specimens shall be completed using an electric or hand tensiometer.

• Shear tests shall be conducted in accordance with ASTM D 4437. Seam shear efficiencies shall be at least 95 percent of the specified minimum yield strength of the geomembrane.

• Peel tests shall be conducted in accordance with ASTM D 4437. Seam peel efficiencies shall be at least 62 percent of the specified minimum yield strength of the geomembrane. Frontward and backward peel tests shall be performed.

• Only one failure out of the five tested specimens per test type (i.e., shear or peel) is allowable. If the failure number is larger, two additional samples shall be taken, one on each side of the original sample each spaced 10 feet from it. If either one of these samples fail, the iterative process of sampling every 10 feet is repeated until passing test results are observed. The entire seam between the two successful test samples shall be questioned, and the QA Engineer may elect to have the contractor cap strip the entire seam or if the seam is made with a thermal fusion method, to extrude a fillet weld over the outer seam edge.

• Verbal laboratory test results to verify field results shall be required within 24 hours after the laboratory receives the samples. The test results shall be directed to the QA Engineer. The QA Engineer will then inform the SCR of the results and make appropriate recommendations.

• Each repair of a patched seam where a test sample had been removed shall be verified by nondestructive testing.

5.2.2.7 Nondestructive Test Methods for Seams
All field seams will be nondestructively tested over their full length using a vacuum test unit, air pressure testing, or other QA approved method where applicable. Nondestructive testing is
meant to verify the continuity of field seams and not to quantify seam strength. QA personnel shall observe all nondestructive testing procedures.

QA personnel shall observe and verify that the following procedures are adhered to during nondestructive testing:

- Nondestructive testing shall be conducted as the seaming work progresses or as soon as a suitable length of seam is available.
- Nondestructive testing shall be required for 100 percent of the field seams. The QA Engineer may approve an alternative test method for seams occurring in sumps and at pipe penetrations.
- Dual seam air pressure tests shall be in accordance with GRI GM-6.
- The location, data, test number, name of test person, and outcome of tests shall be recorded.
- In the event of failed nondestructive tests, the failed area shall be repaired by extrusion welding.
- The SCR shall be informed of any deficiencies.

5.2.2.8 Observations and Inspections—Repairs

Holes, tears, or rips in the geomembrane made during transportation, handling, placement, testing, or while covering the geomembrane shall be repaired. Depending upon the type of repair needed, several acceptable procedures exist and shall be approved prior to initiating the repair.

Repair procedures available include:

- Patching
- Buffing and re-welding
- Spot welding or seaming
- Capping
- Topping.

QA personnel shall observe and verify that the following procedures are adhered to during geomembrane repairs:
• Surfaces to be repaired shall be abraded no more than one hour prior to the repair.

• All surfaces shall be clean and dry.

• All equipment for repairs shall be approved by the QA Engineer.

• All patches or caps shall extend at least six inches beyond the affected area, and all corners of patches will be rounded with a radius of at least three inches.

• Each repair shall be non-destructively tested using the methods described in Section 5.2.2.7.

• A failed test indicates that the repair shall be redone and re-tested until a passing test result is obtained.

5.2.3 Geocomposite
The geocomposite will be placed directly over the upper 60-mil HDPE geomembrane on the floor of the cell. The geocomposite will consist of a geonet with a nonwoven geotextile bonded to the upper side. The geotextile will function as a barrier to the 18-inch protective soil layer overlying the geocomposite. The geonet will function as a drainage layer.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will document the QA process throughout construction. These checklists are included in Attachment A.

5.2.3.1 Acceptance
Upon delivery of the geocomposite rolls to the field site, the QA Engineer shall:

• Inspect delivery tickets and the manufacturer’s QC reports to verify that the geocomposite rolls meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.

• Verify that QC certificates have been provided for all rolls and visually inspect each roll for damage.

5.2.3.2 Storage and Handling
The following storage and handling considerations shall be adhered to:
• Storage and handling shall be done in accordance with ASTM D 4873.

• Handling of the rolls shall be done in a competent manner such that damage does not occur to the geocomposite or protective covering.

• Rolls shall be adequately covered to protect them from ultraviolet light.

• The location of the field storage shall not be in areas where water can accumulate. The rolls shall be elevated off the ground so as not to form a dam creating the ponding of water.

• The rolls shall be stacked in such a way that the cores are not crushed nor the geocomposite or protective covering damaged.

• Outdoor storage of rolls shall not exceed six months. For storage longer than six months a temporary cover shall be placed over the rolls.

5.2.3.3 Observations and Inspections—Placement

The installation contractor shall remove the protective wrapping from the rolls to be deployed only after the underlying geomembrane has been inspected and approved by the QA Engineer. QA personnel shall be present at all times during the placement and covering of the geocomposite.

QA personnel shall observe and verify that the following procedures are adhered to during geocomposite placement:

• Precautions shall be taken to protect the underlying geomembrane upon which the geocomposite will be placed. Construction equipment shall not ride directly on the underlying geomembrane or the geocomposite. Deployment of the geocomposite will be either by hand or by use of a low ground contact pressure vehicle (i.e., less than 6 pounds per square inch).

• The geocomposite shall be placed so as to channel flow to the LCRS trench.

• During placement, care must be taken not to entrap, either within or beneath the geocomposite, stones, excessive dust, or moisture that could damage the underlying geomembrane, cause clogging of drains or filters, or hamper subsequent joining.

• Trimming of the geocomposite shall be performed using only an upward hook blade.
• A visual examination of the deployed geocomposite shall be carried out to verify that no potentially harmful objects (i.e., stones, sharp objects, small tools, sandbags, etc.) are present.

5.2.3.4 Observations and Inspections—Joining
Joining of the adjacent geocomposite rolls will be accomplished by overlapping and securing the overlaps.

QA personnel shall observe and verify that the following procedures are adhered to during geocomposite joining:

• When joining the geocomposite rolls side-by-side, the geonet shall be joined together using plastic fasteners (i.e., cable ties) or polymer braids at approximately 5-foot intervals. The geotextile portion shall be overlapped a minimum of 3 inches and sewn or secured with duct or double-sided tape or as recommended by the QA Engineer.

• When joining the geocomposite rolls end-to-end, the roll ends shall be overlapped a minimum of 12 inches and tied every 6 inches across the width of the roll. The geotextile overlap shall be sewn or secured with duct or double-sided tape or as recommended by the QA Engineer.

5.2.3.5 Observations and Inspections—Repairs
Holes, tears, or rips in the geocomposite made during transportation, handling, placement, or covering of the geocomposite shall be repaired by patching using the same type of material, geotextile and/or geonet as applicable.

QA personnel shall observe and verify that the following procedures are adhered to during geocomposite repair:

• Holes or tears in the drainage cores shall be repaired by placing a patch of the same type of material over the damaged area. The patch shall extend at least 4 inches beyond the edges of the hole or tear.

• Holes or tears in the geotextile shall be repaired using a patch of the same type of polymeric material. The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.

• The geotextile patch shall be sewn in place by hand or machine so as not to accidentally shift out of position before or during covering operations.
• The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired.

• The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.

• QA personnel shall inspect all patches.

5.2.3.6 Observations and Inspections—Covering
The material placed above the deployed geocomposite shall be an 18-inch layer of protective soil.

QA personnel shall observe and verify that the following procedures are adhered to while covering the geocomposite:

• The core of the drainage geocomposite shall be kept free of soil, dust, and accumulated debris during covering activities.

• Placement of the protective soil layer over the geocomposite shall not shift the position of nor damage the geocomposite.

5.2.4 Geotextile Wrap
The geotextile shall be installed around the drain aggregate in the leachate collection trenches. The trenches will be lined with an HDPE geomembrane. The geotextile wrap shall function as a separator and cushion between the aggregate and the geomembrane liner and the aggregate and the overlying geocomposite.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

5.2.4.1 Acceptance
Upon delivery of the rolls of geotextiles to the field site, the QA Engineer shall:

• Inspect delivery tickets and the manufacturer’s QC reports to verify that the geotextile rolls meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.
• Verify that QC certificates have been provided for all rolls and visually inspect each roll for damage.

5.2.4.2 Storage and Handling
The following procedures shall be adhered to during storage and handling of the geotextile:

• Handling of rolls shall be done in a competent manner such that damage does not occur to the geotextile nor to its protective wrapping. In this regard ASTM D 4873 shall be referenced and followed.

• Rolls shall be adequately covered to protect them from ultraviolet light.

• The location of field storage shall not be in areas where water can accumulate. The rolls shall be elevated off of the ground so as not to form a dam creating the ponding of water.

• The rolls shall be stacked in such a way that the cores are not crushed nor the geotextile or protective covering damaged.

• Outdoor storage of rolls shall not exceed manufacturers recommendations or longer than six months, whichever is less. For storage periods longer than six months, a cover shall be placed over the rolls.

5.2.4.3 Observations and Inspections—Placement
The installation contractor shall remove the protective wrapping from the rolls to be deployed only after the underlying surface has been inspected and approved by the QA Engineer. QA personnel shall be present at all times during the handling, deployment, placement of aggregate and piping, and during the joining of the geotextile.

QA personnel shall observe and verify that the following procedures are adhered to during the placement of the geotextile wrap:

• Precautions shall be taken to protect the underlying geomembrane upon which the geotextile will be placed. Deployment of the geotextile will be either by hand or by use of a low ground contact pressure vehicle.

• During placement, care shall be taken not to entrap, either within or beneath the geotextile, stones or excessive dust that could damage the underlying geomembrane or cause clogging of drains or filters.

• Trimming of the geotextile shall be performed using only an upward hook.
5.2.4.4 Observations and Inspections—Seaming
QA personnel shall observe and verify that the following overlap and seaming procedures are adhered to:

- No end-to-end seams shall be allowed on side slopes.
- All geotextile roll edges (i.e., end-to-end in the cell floor and those brought together over the aggregate) shall have a minimum overlap of 12 inches and shall be sewn.
- Heat seaming of geotextiles shall not be permitted.

5.2.4.5 Observations and Inspections—Repairs
Holes, or tears, in geotextiles made during handling, placement, or while backfilling the aggregate shall be repaired by patching.

QA personnel shall observe and verify that the following procedures are adhered to:

- The patch material used for repair of a hole or tear shall be the same type of polymeric material as the damaged geotextile.
- The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.
- The patch shall be sewn in place by hand or machine so as not to accidentally shift out of position or be moved during backfilling or covering operations.
- The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.
- QA personnel shall inspect all patches.

5.2.4.6 Observations and Inspections—Backfilling
Subrounded, 3/4 inch drain aggregate, a leachate collection and removal pipe system, and 1/4 inch pipe bedding shall be installed within the geotextile wrap. All components shall be installed such that the geotextile is not shifted from its intended position or damaged, and the underlying geomembrane is not exposed or damaged.
Additional QA guidelines for the placement of leachate collection and removal components are presented in Section 5.3 of this document.

5.3 Leachate Collection and Removal System

This section specifies the observations, inspections, and tests necessary to control, verify, and document that the installation of the leachate collection and removal system conforms to the drawings and specifications. The leachate collection and removal system shall be centrally located from south to north within the containment cell.

The leachate collection and removal system consists of the following components:

- Leachate collection trenches
- Geocomposite
- Geotextile wrap
- Submersible pump
- Leachate collection, discharge, transfer, riser, and clean-out pipe
- Pipe bedding, drain aggregate, and bentonite/soil backfill.

The appropriate QA guidelines and controls for the construction of the leachate collection trenches are presented in Section 5.1.1 of this document. The appropriate QA guidelines and controls for the installation of the geocomposite and the geotextile wrap are presented in Section 5.2.3 and Section 5.2.4, respectfully. The QA guidelines and controls for the remaining components will be presented in the following sections.

5.3.1 Piping

PVC pipe shall be installed within the collection trenches in the floor and sidewalls of the containment cell and at the surface of the containment cell. The PVC pipe will function as the leachate collection, discharge, transfer, and clean-out lines, and as the submersible pump riser pipe.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.
5.3.1.1 Acceptance
Upon delivery of the pipe, the QA Engineer shall:

- Inspect delivery tickets and the manufacturer's QC reports to verify that the piping meets construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.
- Verify that QC certificates have been provided for all pallets and visually inspect the pipes for damage.
- Inspect the pipe for diameter, thickness, and perforation as per specifications.
- Verify that all pipe openings and nozzles are adequately protected by cover/caps or screw-in plugs.

5.3.1.2 Storage and Handling
Pipe and piping appurtenances shall be stored in an area and in such a manner as not to cause undo damage to the materials.

QA personnel shall observe and verify that the following procedures are adhered to:

- The location of field storage shall be in areas where water cannot accumulate. The pallets shall be on level ground and oriented so as not to form a dam creating the ponding of water.
- The pallets shall not be stacked more than three high.
- Outdoor storage of plastic pipe shall not be longer than 12 months. For storage periods longer than 12 months a temporary covering shall be placed over the pipes.

5.3.1.3 Observations and Inspections—Placement
All piping, valves, and fittings shall be installed in accordance with the specifications, drawings, and codes. Pipe in the floor of the cell, along the one percent slope, shall be placed on the prepared pipe bedding surface. The interior of all piping and appurtenances shall be free from all dirt, excess water, and other foreign material as the pipe laying progresses and shall be left clean at completion.

Prior to placing the bedding and the pipe the QA Engineer shall verify the following:
• The bedding beneath and around the pipe shall be Class IA, IB or II according to ASTM D 2321 and shall meet the gradation requirements set forth in the specifications.

• Pipe fittings shall be in accordance with the specific pipe manufacturer’s recommendations.

Additionally, the QA Engineer shall verify that field testing and inspections of piping, valves, and fittings are performed in accordance with the specifications.

5.3.2 **Pipe Bedding, Drain Aggregate, and Bentonite/Soil Backfill**

A layer of pipe bedding material shall be placed within the geotextile wrap in the leachate collection trenches. The pipe bedding material shall be placed directly beneath the piping in the floor of the cell along the one percent slope. Pipe bedding shall not be placed in the sump area. The drain aggregate shall be placed throughout the leachate collection trenches, over and around the piping. The bentonite/soil mix is to be backfilled around the piping existing the surface of the containment cell.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will document the QA process throughout construction. These checklists are included in Attachment A.

5.3.2.1 **Acceptance and Conformance Testing**

Upon delivery of the fill materials, the QA officer shall see that conformance test samples are obtained. These samples shall be sent to the QA laboratory for testing. The conformance test results should then be sent to the QA Engineer for review and acceptance prior to the installation of these materials. Any lots failing conformance testing shall be rejected.

Following the delivery of the materials, the QA Engineer shall:

• Inspect delivery tickets to verify that the fill materials meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.

• Verify that grain size analysis is performed in accordance with ASTM D 422.
• Verify that the bedding material and drain aggregate consists of Class IA, IB, or II according to ASTM D 2321, and conforms to the quality and gradations according to the specifications.

• Verify that the bentonite consists of high swelling, sodium montmorillonite, and conforms to density and gradations according to the specifications.

5.3.2.2 Storage and Handling
QA personnel shall verify the following storage conditions:

• The aggregate, bedding, and bentonite materials shall be stored in an area where the ponding of water will not occur.

5.3.2.3 Observations and Inspections—Placement
QA personnel shall observe and verify the following:

• All fill materials shall be placed to the lines and grades as shown on the construction drawings.

• All materials shall be placed in such a manner as to prevent damage to the piping and underlying synthetic materials.

• The bedding material shall be laid and compacted in 6-inch maximum layers.

• The bedding material shall be compacted to a relative density of 90 percent in accordance with ASTM D 4254.

• The bedding material shall be laid with a minimum thickness below the bottom of the pipe of 4 inches and shall extend half-way up the sides of the pipe.

• Approved fill material shall be mixed with 20 percent by weight bentonite.

• The bentonite/soil mix shall be laid and compacted in 6-inch maximum layers at the top of slope around each LCRS pipe as shown on construction drawings.

• The bentonite/soil mix shall be compacted to a relative density of 90 percent in accordance with ASTM D 4254.

5.3.2.4 Laboratory Testing of Fill Materials
Laboratory tests of fill materials (i.e., bedding, drain aggregate, bentonite, and bentonite/soil mix) shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.
The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation (established moisture density curve) in accordance with ASTM D 1557 for each batch of bedding and bentonite/soil mix, or more often if there is a change in material.

- Grain size analysis for all fill materials in accordance with ASTM D 422, performed at a minimum frequency of one per 500 cubic yards, or when a change in material is noticed by QA personnel.

- Determination of liquid limit, plastic limit, and plasticity index for the bentonite and bentonite/soil mix in accordance with ASTM D 4318 (Atterburg Limits). These tests shall be performed at a minimum frequency of one per batch, or when a change of material is noticed.

5.3.2.5 Field Tests-Pipe Bedding and Bentonite/Soil Backfill

To determine whether construction performance meets project requirements, field testing of in situ portions of the pipe bedding and bentonite/soil backfill shall be performed. Fill placed at densities and/or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

- Determination of the pipe bedding and bentonite/soil mix in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of one test per batch. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.
6.0 Observations, Inspection Activities, and Tests—Final Cover System

The final cover system design for the SNL/NM CAMU containment cell incorporates a capillary barrier and vegetation cover for primary hydraulic control. A HDPE geomembrane positioned at the base of the cover system will provide reinforced hydraulic control. The layers of the cover system in descending order are as follows:

- Topsoil (i.e., gravel mulch)
- Compacted native soil blend
- Geotextile wrap
- Filter sand
- Pea gravel
- Bedding sand
- HDPE geomembrane
- Native and treated waste soil foundation.

6.1 Earthwork

This section specifies the observations, inspections and tests necessary to control, verify, and document that the earthwork for the cover system conforms to the plans and specifications.

Earthwork activities include:

- Containment cell perimeter preparation
- Foundation preparation construction
- Compacted native soil and top soil placement
- Anchor trench construction.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

6.1.1 Containment Cell Perimeter Preparation

The cover system shall extend beyond the outer dimensions of the containment cell as shown on the construction drawings. Appropriately, the surface around the perimeter of the cell shall be prepared and graded to provide a functional subgrade for the cover system.
6.1.1.1 Observations and Inspections—Containment Cell Perimeter
QA personnel will perform the following observations and inspections prior to and during the preparation of the containment cell perimeter:

- Observe that surveying is performed for final grades prior to placement of the foundation. Verify that base grades and slopes conform to construction drawings. The results of the survey shall be retained for future use to prepare as-built drawings.
- Inspect the perimeter to verify that all loose or soft zones have been excavated and replaced with suitable backfill material.
- Observe coverage and number of passes made by compaction equipment.

6.1.1.2 Laboratory Tests—Containment Cell Perimeter
Laboratory tests of perimeter materials shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 at a minimum frequency of one per acre per lift, or more often if there is a change of material.

6.1.1.3 Field Tests—Containment Cell Perimeter
In addition to performing the required observations and inspections, QA personnel shall perform the following field tests as required by the earthwork specifications:

- Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of five per acre per lift. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

6.1.2 Foundation Construction
The foundation of the cover system will be comprised of two materials occurring in distinct areas. The foundation above the cell will consist of the compacted waste backfill (i.e., treated soil). The foundation around the perimeter of the cell will consist of compacted native soil obtained from on-site excavated materials. The perimeter foundation will be constructed in
order to achieve a stable and functional slope from the waste, near the edge of the cell, to the surrounding natural grade.

6.1.2.1 Laboratory Tests—Foundation Fill Materials
Laboratory tests of fill materials shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 for each 2,000 cubic yards of the foundation fill, or more often if there is a change of material.
- Grain size analysis in accordance with ASTM D 422, performed at a minimum frequency of one per 2,000 cubic yards, or when a change in material is noticed.

6.1.2.2 Observations and Inspections—Foundation
QA personnel will continuously perform the following observations and inspections during the construction of the foundation:

- Inspect the materials to be used for the construction of the foundation. The fill materials will be obtained from on-site excavated material. The excavated materials shall be comprised of native granular materials as specified in the construction specifications and treated-soil waste backfill. Visual inspections of the excavated materials shall be made by QA personnel to detect the presence of organic matter, rubble, trash, and deleterious material. Irreducible material in excess of 0.5 inch in diameter shall be removed from all perimeter foundation backfill and from waste backfill to be placed in the upper 2 feet of the cell.
- Observe coverage and number of passes made by compaction equipment.
- Verify that only hand compactors are used around pipe penetrations.
- Inspect individual and final lift thickness.
- Verify lines and grades of the completed foundation.

6.1.2.3 Field Tests—Foundation
To determine whether construction performance meets project requirements, field testing of in situ portions of the foundation shall be performed. Fill placed at densities and/or moisture
contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

- Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of one test per 500 cubic yards. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

6.1.3 Compacted Native Soil and Top Soil Placement

A 30-inch layer of compacted native soil will be placed between the capillary barrier and the 6-inch top soil layer. In order to prevent burrowing-animal intrusions, a galvanized wire mesh will be installed within the compacted soil layer as shown on the construction drawings.

6.1.3.1 Laboratory Tests—Compacted Native Soil

Laboratory tests of fill materials shall be performed to document their engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 for each 2,000 cubic yards of fill, or more often if there is a change of material.

- Grain size analysis in accordance with ASTM D 422, performed on each sample subjected to the full Modified Proctor Test (minimum of one per 2,000 cubic yards), or when a change in material is noticed by QA personnel.

6.1.3.2 Observations and Inspections—Compacted Native Soil and Top Soil

QA personnel will continuously perform the following observations and inspections during construction:

- Inspect the materials to be used for construction. The fill materials will be obtained from on-site excavated material. The excavated materials shall be comprised of native granular materials as specified in the construction specifications. Visual inspections of the excavated materials shall be made by QA personnel to detect the presence of organic matter, rubble, trash, and deleterious material.
• Observe coverage and number of passes made by compaction equipment.
• Verify that only hand compactors are used around pipe penetrations.
• Inspect individual and final lift thickness.
• Verify lines and grade after each layer has been completed.

6.1.3.3 Field Tests—Compacted Native Soil
To determine whether construction performance meets project requirements, field testing of in situ portions of the compacted native soil shall be performed. Fill placed at densities or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of one test per 500 cubic yards. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

6.1.4 Anchor Trench Construction
Anchor trenches will be constructed at the perimeter of the cover system in order to immobilize the geosynthetic components (i.e., the geomembrane and the geotextile wrap).

6.1.4.1 Observations and Inspections—Anchor Trenches
QA personnel shall perform the following observations and inspections of the anchor trenches following construction and prior to placement of geosynthetics within the trenches.

• Inspect anchor trench corners to verify that they are slightly rounded so as to avoid sharp bends in the geosynthetics.

• Inspect anchor trench dimensions to verify conformance with construction drawings and specifications.

• Observe that the anchor trench is adequately drained to prevent ponding of water or softening of the adjacent soils while the trench is open.
• Observe that backfilling is accomplished with approved backfill soil in accordance with the specifications and that care is taken during placement and compaction so as not to damage the underlying geosynthetics.

6.1.4.2 Laboratory Tests—Anchor Trenches
Laboratory tests of the anchor trench backfill shall be performed to document the engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

• Determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 for each 1,000 feet of anchor trench, or more often if there is a change of material.

6.1.4.3 Field Tests—Anchor Trenches
To determine whether construction performance meets project requirements, field testing of in situ portions of the anchor trench backfill shall be performed. Fill placed at densities or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.

The field tests include the following:

• Determination of the soil in-place density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of once every 100 feet along the length of the trench. Plot and check all field density test locations and elevations. All holes resulting from nuclear gauge testing shall be backfilled and hand tamped.

6.2 Geosynthetics
This section specifies the observations, inspections, and tests necessary to control, verify, and document that the installation of geosynthetics within the cover system conforms to the drawings and specifications. The geosynthetics to be incorporated into the cover system includes a geomembrane and a geotextile wrap.

6.2.1 Geomembrane
The geomembrane will be placed directly onto the treated-soil waste and the compacted native soil foundation. The geomembrane will underlie the capillary barrier layer and will function
as the hydraulic barrier layer. The geomembrane consists of a 60-mil, two-sided textured black HDPE liner.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

### 6.2.1.1 Acceptance
Acceptance and conformance testing of geomembranes is addressed in Section 5.2.2.1.

### 6.2.1.2 Storage and Handling
Storage and handling of geomembranes is addressed in Section 5.2.2.2.

### 6.2.1.3 Observations and Inspections—Placement
QA personnel shall be present at all times during the placement and covering of the geomembrane.

QA personnel shall observe and verify that the following procedures are adhered to during placement:

- The geomembrane shall be placed only after the subgrade has been approved by the QA Engineer.
- Care and planning shall be taken to unroll the geomembrane at its intended and final position.
- Construction equipment shall not ride directly on the geomembrane.
- The geomembrane shall have adequate slack such that it does not lift up off of the substrate material at any location.
- Excessive slack that may cause creases or folds in the geomembrane shall not be allowed.
- Temporary tack welds shall not interfere with the primary seaming method or with the ability to perform subsequent destructive seam tests.
• The geomembranes shall not be unrolled when the sheet temperature is below 32°F or above 122°F.
• The geomembrane shall have adequate temporary anchorage (i.e., sandbags or tires) to prevent uplift by winds.
• Geomembrane rolls which have been displaced or damaged by wind shall be rejected and/or repaired as recommended by the QA Engineer and approved by SCR.

6.2.1.4 Observations and Inspections—Seaming
Seaming of the geomembranes will be accomplished by hot wedge or extrusion welding.

QA personnel shall observe and verify that the following procedures are adhered to during seaming activities:

• Seaming shall not take place during precipitation, blowing dust, or high winds.
• The area to be seamed shall be free of moisture, dust, or foreign material of any kind.
• Only the manufacturer's approved seaming equipment and products shall be used for all seams.
• "Fish mouths" and wrinkles shall not be allowed to occur at seams.
• The rolls shall be overlapped approximately 4 inches for hot wedge welding and 3 inches for extrusion welding.
• Seaming shall extend into the anchor trench a minimum of one foot.

6.2.1.5 Test Strips and Trial Seams
Test strips and trial seams for geomembranes are addressed in Section 5.2.2.5.

6.2.1.6 Destructive Test Methods for Seams
Destructive testing of geomembrane seams is addressed in Section 5.2.2.6.

6.2.1.7 Nondestructive Test Methods for Seams
Nondestructive testing of geomembrane seams is addressed in Section 5.2.2.7.
6.2.1.8 Observations and Inspections—Repairs
Activities related to repairs of geomembranes is addressed in Section 5.2.2.8.

6.2.2 Geotextile Wrap
The geotextile will be installed over the capillary barrier around the perimeter of the cover system. The geotextile wrap shall function as stabilization for the capillary barrier on the side slopes.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

6.2.2.1 Acceptance
Acceptance of geotextiles is addressed in Section 5.2.4.1.

6.2.2.2 Storage and Handling
Storage and handling of geotextiles is addressed in Section 5.2.4.2.

6.2.2.3 Observations and Inspections—Placement
The installation contractor shall remove the protective wrapping from the rolls to be deployed only after the underlying surface has been inspected and approved by the QA Engineer. QA personnel shall be present at all times during the deployment and subsequent covering of the geotextile.

QA personnel shall observe and verify that the following procedures are adhered to during the placement of the geotextile wrap:

- Precautions shall be taken not to displace the underlying capillary barrier layer upon which the geotextile will be placed.
- Deployment of the geotextile will be either by hand or by use of a low ground contact pressure vehicle (less than 6 pounds per square inch).
6.2.2.4 Observations and Inspections—Seaming
QA personnel shall observe and verify that the following overlap and seaming procedures are adhered to:

- All geotextile roll edges shall have a minimum overlap of 12 inches and shall be sewn.
- The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.
- Heat seaming of geotextiles shall not be permitted.

6.2.2.5 Observations and Inspections—Repairs
Holes, or tears, in geotextiles made during handling, placement, or while backfilling the overlying soil layer shall be repaired by patching.

QA personnel shall observe and verify that the following procedures are adhered to:

- The patch material used for repair of a hole or tear shall be the same type of polymeric material as the damaged geotextile.
- The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.
- The patch shall be sewn in place by hand or machine so as not to accidentally shift out of position or be moved during backfilling or covering operations.
- The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired.
- The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.
- QA personnel shall inspect all patches.

6.2.2.6 Observations and Inspections—Backfilling
A layer of native soil will be placed over the geotextile wrap. Care shall be exercised during the placement of the soil so as not to damage the geotextile.
Additional QA guidelines for the placement of the overlying soil is presented in Section 6.1.3 of this Plan.

6.3 Capillary Barrier
This section specifies the observations, inspections, and tests necessary to control, verify, and document that the installation of the capillary barrier within the cover system conforms to the drawings and specifications.

The capillary barrier consists of the following materials in ascending order:

- 8-inch bedding sand layer
- 6-inch pea gravel layer
- 4-inch filter sand layer.

The 8-inch layer of bedding sand will be placed directly over the GCL. The 6-inch layer of pea gravel and the 4-inch layer of filter sand will be placed in succeeding layers thereafter.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

6.3.1 Acceptance and Conformance Testing
Upon delivery of the fill materials, the QA officer shall see that conformance test samples are obtained. These samples shall be sent to the QA laboratory for testing. The conformance test results should then be sent to the QA Engineer for review and acceptance prior to the installation of these materials. Any lots failing conformance testing shall be rejected.

Following the delivery of the materials, the QA Engineer shall:

- Inspect delivery tickets to verify that the fill materials meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.
- Verify that grain size analysis is performed in accordance with ASTM D 422.
- Verify that the fill materials conform to the quality and gradations according to the specifications.
6.3.2 Storage and Handling
QA personnel shall verify the following storage conditions:

- The fill materials shall be stored in an area where the ponding of water will not occur.

6.3.3 Observations and Inspections—Placement
QA personnel shall observe and verify the following:

- Inspect the fill materials to be used to verify that they meet construction specifications.
- Observe that fill materials are placed to the lines and grades as shown on the construction drawings.
- Observe that fill materials are placed in such a manner as to prevent damage to the underlying geomembrane or pipe penetrations.
- Verify lines and grades of completed layers.

6.3.4 Laboratory Tests—Capillary Barrier
Laboratory tests of bedding/filter sand shall be performed to document the engineering properties and to verify the acceptability of the material for use in construction.

The laboratory tests shall include the following:

- Determination of the Modified Proctor moisture-density relation in accordance with ASTM D 1557 for each 2,000 cubic yards of the bedding/filter sand, or more often if there is a change of material.
- Grain size analysis in accordance with ASTM D 422, performed on each sample subjected to the full Modified Proctor Test (minimum of one per 2,000 cubic yards), or when a change in material is noticed by QA personnel.

6.3.5 Field Tests—Capillary Barrier
To determine whether construction performance meets project requirements, field testing of in situ portions of the capillary barrier shall be performed. Fill placed at densities and/or moisture contents not conforming to the specifications shall be removed and replaced or reworked to conform to the specifications.
QA personnel shall verify the following:

- Determination of the in situ density and moisture content by nuclear methods of the bedding/filter sand performed in accordance with ASTM D 1557 at a minimum frequency of one per 500 cubic yards, or when a change in material is noticed. Plot and check all field density test locations and elevations.

- In situ density tests on the pea gravel shall be performed in accordance with ASTM D 1586 at a minimum frequency of five per acre per lift, or when a change in material is noticed. Plot and check all field density test locations and elevations.

### 6.4 Vegetative Layer

The vegetative layer will be incorporated into the top soil and will function to protect the cover system from the effects of wind and water erosion.

In order to verify proper QA, inspection checklists have been developed for use by QA personnel. Checklists shall be completed and signed by QA Inspectors and reviewed by the QA Engineer. These checklists will become part of the final construction report, documenting the QA process throughout construction. These checklists are included in Attachment A.

#### 6.4.1 Acceptance

Following the delivery of the materials, the QA Engineer shall:

- Inspect delivery tickets to verify that the materials meet construction specifications and that the measurements of properties by the manufacturer are consistent with construction specifications.

#### 6.4.2 Storage and Handling

QA personnel shall verify the following storage conditions:

- All materials shall be stored in an area where the ponding of water will not occur.

#### 6.4.2.1 Observations and Inspections—Vegetative Layer

QA personnel will perform the following observations and inspections during the construction of the vegetative layer:

- Inspect the materials to be used for the vegetative layer.
• Verify that applications take place during favorable weather conditions (i.e., low winds, no precipitation).

• Verify that the appropriate application method is used.

• Observe and verify that the application rate of soil additives and seed are in accordance with the specifications.

• Survey lines and grade of the completed cover.
7.0 Nonconformance

Nonconforming items and activities are those which do not meet the construction drawings and specifications, procurement document criteria, approved work procedures, or the QA Program.

Nonconformances may be detected and identified by:

- QA personnel—during construction operations by field inspections and verification testing
- Laboratory personnel—during the preparation for and performance of laboratory testing, and calibration of equipment
- SCR—during the performance of audits, surveillances, and other quality assurance activities.

Each nonconformance affecting quality shall be documented by the personnel identifying or originating it. For this purpose, the results of calibration and laboratory analysis quality control tests, audit reports, inspection reports, or an internal memorandum or letter can be used as appropriate. This documentation shall be compiled by the QA Engineer and documented in a Nonconformance and Corrective Action Report and submitted to the SCR.

This report shall, when necessary, include:

- Description of nonconformance
- Identification of individual(s) identifying or originating the nonconformance
- Method(s) for completing corrective action and corrective action taken
- Required approval signatures for the corrective action
- Schedule for completing corrective action and corrective action taken
- Responsible individuals for correcting the nonconformance and verifying satisfactory resolution

Documentation shall be available to the Owner, SCR, Design Engineer, Construction Contractor, QA Contractor, and/or subcontractor(s), as necessary.
It is the responsibility of the QA personnel to notify the appropriate personnel of the nonconformance. In addition, the SCR should be notified as soon as practical of nonconformances which could impact the results of the work.

Completion of corrective actions for nonconformances should be verified by QA personnel as part of future activities.

Any recurring nonconformance should be evaluated by the SCR, Design Engineer, QA Contractor, and/or laboratory to determine its cause and appropriate changes instituted to prevent future recurrence. When such an evaluation is performed, the results shall be documented.
8.0 **Documentation**

Documentation of compliance with the requirements of the construction specifications during all phases of containment cell construction will consist of records prepared by QA personnel, the independent testing laboratory, the Construction Contractor, and subcontractors.

8.1 **Daily Summary Report**

Whenever there is any construction activity, a daily summary report will be prepared. Other records required will depend on the specific work being performed that day.

The daily summary report prepared by the QA Engineer, or under the direct supervision of the QA Engineer, will contain:

- The date
- A summary of the weather conditions
- A summary of locations where construction is occurring
- A list of personnel on the project
- A summary of any meetings held and attendees
- A description of all materials used and references or results of testing and documentation
- The certificates for calibration and recalibration of test equipment
- The daily inspection checklists from each QA Inspector.

8.2 **Inspection Checklists**

Inspection checklists (see Attachment A) will be reviewed by the QA Engineer and submitted to the SCR, to document inspections performed.

At a minimum, each inspection checklist will contain the following information:

- The date and time of inspection
- The location
- Weather conditions
- The type of inspection
• The procedure used (e.g., ASTM method)
• Test data
• The results of the activity
• Personnel involved in the inspection and sampling activities
• The signature of the inspector.

8.3 Nonconformance and Corrective Action Reports
Whenever any material or workmanship does not meet the requirements of the construction specifications or has an obvious defect, the appropriate personnel will be notified and a Nonconformance and Corrective Action Report will be completed by the QA Engineer. Additional information on nonconformance, corrective action, and the documentation thereof is present in Section 7.0 of this Plan.

8.4 Testing Reporting
Reports of all field and laboratory testing will be submitted to the QA Engineer and SCR.

8.4.1 Field Testing Data
The soils technicians will submit reports of all field tests and retests to the QA Engineer and SCR as soon as possible upon completion of the required tests.

The reports may include, but are not limited to, the following:

• Date of the test and date submitted
• Location of test
• Weather
• Test method (ASTM or approved)
• Wet weight, moisture content, and dry weight of field sample (if required)
• Description of soil
• Ratio of field dry density to maximum lab dry density expressed as a percent (if required)
• Comments concerning the field density passing or failing the specified compaction
• Comments about results.
QA Inspectors will record field testing data on the inspection checklists or approved forms. Also recorded will be an indication that the following items are acceptable or not acceptable and comments as needed:

- Date
- Location
- Weather
- Roll markings
- Shipping protection
- Placement of the geomembrane
- Field seam samples (lab results and field results)
  - Sheer strength
  - Peel adhesion
- Air pressure test
  - Pressure
  - Length
  - Results
- Vacuum Box
- Penetrations
  - Location
  - Vacuum box
- Anchors
  - Location
  - Depth
  - Compaction
  - Liner properly placed
- Repairs
- Rolls installed per approved layout plan.

8.4.2 Laboratory Testing Data

The independent testing laboratory will submit data reports of all laboratory tests to the QA Engineer as soon as possible upon completion of the tests. The reports will include, but not be limited to, the following:

- Date of the test and date submitted
- Identification and description of sample tested
- Test method (ASTM or approved)
- Results of test.
8.4.3 **Data Reports**
Test data from laboratory testing of soils or geosynthetics will be reported by the independent testing laboratory using its customary reporting format and forms. Field test data will be reported on daily inspection checklists approved by the QA Engineer.

8.5 **Photographic Reporting**
Any photographs used to document the progress and acceptability of the landfill construction may be incorporated into the daily summary report and the acceptance report.

Each photo will be identified individually and within a photograph log with the following information:

- The date, time, location, and direction of the photograph
- The roll and photograph number
- The name of the photographer
- The signature of the photographer.

8.6 **As-Built Drawings**
All records prepared by the QA Contractor shall be retained in the on-site record system to provide documentation of how a unit was constructed. Final as-built drawings shall be prepared by the QA Contractor utilizing this information and retained by the Owner as a permanent record of the final configuration and dimensions of unit features (e.g., subgrade, geosynthetic liner systems, leachate collection and removal system, and final cover system). As-built drawings must be reviewed and approved by the QA Engineer and the SCRs.

8.7 **Acceptance of Completed Components**
Upon completion of the construction of the liner system and final cover, the QA Engineer will prepare an acceptance report to submit to the Owner. The acceptance report shall be submitted before the structure is placed into service.

The acceptance report shall contain the following:

- A certification by the QA Engineer that the construction has been prepared and constructed in accordance with the construction specifications
- As-built drawings
- All daily summary reports.
8.8 Final Documentation

When construction of the CAMU has been completed and the final inspection shows that all punchlist items have been resolved, a final report will be prepared to submit to EPA and NMED.

The final report will be certified as correct by the QA Engineer and will contain the following:

- Daily summary reports
- Daily inspection checklists
- Nonconformance and corrective action reports
- Field testing results
- QC data from manufacturers or fabricators
- Laboratory testing results
- Photographs
- As-built drawings
- Internal QA memoranda or reports with data interpretation or analyses
- Design changes.

8.9 Document Control

During construction of the CAMU, this QA Plan will be maintained by IT under a document control procedure to provide for convenient replacement of pages. The revision status will be indicated on each page. A control scheme will be designed and implemented to organize and index all QA documents so a reviewer can identify and retrieve original inspection reports or data sheets for any completed work.

8.10 Storage of Records

During construction of the CAMU, the QA Engineer will be responsible for storage of all QA documents such as:

- Design drawings
- Construction specifications
- QA Plan
- Inspection checklists (originals)
- Field testing data reports (originals)
- Laboratory testing data reports (originals).
Duplicate copies will be kept at another location as a safeguard for the information if the originals are damaged. Once construction is complete, the originals will be transferred to a storage location.
ATTACHMENT A

INSPECTION CHECKLISTS

The checklists in this Attachment are provided to indicate the checks to be made for inspection. The format of the inspection checklists may be modified by the resident engineer. However, the revised form must include all checks and information contained in the original form.
## List of Forms

<table>
<thead>
<tr>
<th>Title</th>
<th>Form No.</th>
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<tbody>
<tr>
<td><strong>RECEIVING INSPECTION</strong></td>
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<tr>
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<td>Wicking Material Laboratory Test Verification (Field Office Form)</td>
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<td>Field Moisture/Density Test Results (Field Form)</td>
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RI-01
RECEIVING INSPECTION
GEOSYNTHETIC CLAY LINER
GEOMEMBRANE
GEOCOMPOSITE
GEOTEXTILE WRAP

ONE FORM FOR EACH TRUCK LOAD OR DELIVERY

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<td>• Is the material properly stored?</td>
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<td>• Is the storage area free of water and/or moisture?</td>
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NOTES:
RI-02
RECEIVING INSPECTION
PVC PIPE

ONE FORM FOR EACH TRUCK LOAD OR DELIVERY

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- Have delivery tickets and QC certificates been provided for all piping received?
- Does the material description match the construction specifications?
- Is the pipe diameter, thickness, and perforations as per specifications?
- Is the material free of damage?
- Is the material acceptable for use?

Checks after unloading:

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- Is the material free of damage?
- Is the material properly stored?
- Is the storage area free of water and/or moisture?
- Are all pipe openings and nozzles protected with covers or caps?

NOTES:
RI-03
RECEIVING INSPECTION
DRAIN AGGREGATE/PIPE BEDDING/BENTONITE-SOIL/ CAPILLARY BARRIER/WICKING MATERIAL

ONE FORM FOR EACH TRUCK LOAD OR DELIVERY

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<td>• Is the storage area free of water and/or moisture?</td>
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<td>• Have all QC samples been collected as required?</td>
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<tr>
<td>• Has sample documentation been completed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Has a pressure-plate soil moisture retention test been performed on candidate wicking materials?</td>
<td></td>
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</tr>
</tbody>
</table>

NOTES:
RI-04
RECEIVING INSPECTION
VEGETATIVE LAYER

ONE FORM FOR EACH TRUCK LOAD OR DELIVERY

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Project No.</th>
<th>Received by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inspected by</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Delivery Slip No.</th>
<th>Transporter/Supplier</th>
<th>Storage Location</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Number of Rolls Delivered</th>
<th>Approximate Qty.</th>
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</table>

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Manufacturer's designation</th>
<th>Material</th>
</tr>
</thead>
<tbody>
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</table>

(Provide explanatory notes if the answer to any of the following questions is “no.” Include any remedial steps required.)

<table>
<thead>
<tr>
<th>Checks before unloading:</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>• Have seed certifications been received from supplier prior to delivery?</td>
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<tr>
<td>• Have delivery tickets been provided for all material received?</td>
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<tr>
<td>• Does the material description match the construction specifications?</td>
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<tr>
<td>• Is the material acceptable for use?</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Checks after unloading:</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>• Is the storage area free of water and/or moisture?</td>
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</tbody>
</table>

NOTES:

A-5
TI-01
TESTING INSPECTION
SUBGRADE/EMBANKMENT/PROTECTIVE SOIL COVER/ANCHOR TRENCH FILL/
PIPE BEDDING/BENTONITE-SOIL/CONTAINMENT CELL PERIMETER/
COVER SYSTEM FOUNDATION/CAPILLARY BARRIER/
NATIVE SOIL/TOP SOIL
LABORATORY TEST VERIFICATION
(FIELD OFFICE FORM)

Project Name
Project No.
Weather

Date
Inspected by

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

YES/NO 
NOTE NO.

• Has the relationship between moisture content and density been analyzed by Modified Proctor test as required?
• Has a grain size analysis been performed (as required)?
• Has the liquid limit, plastic limit, and plasticity index been determined for the bentonite and bentonite-soil mix?

NOTES:
TI-02
TESTING INSPECTION
WICKING MATERIALS
LABORATORY TEST VERIFICATION
(FIELD OFFICE FORM)

Project Name
Project No.
Weather

Date
Inspected by

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Has the relationship between moisture content and density been analyzed by Modified Proctor test as required?
- Has a grain size analysis been performed?
- Have van Genuchten parameters been determined by performing a pressure-plate soil moisture retention test?

NOTES:

YES/NO	NOTE NO.
**TI-03**
**TESTING INSPECTION**
**SUBGRADE/EMBANKMENT/ANCHOR TRENCHES/PROTECTIVE SOIL COVER/PIPE BEDDING/ BENTONITE-SOIL/CONTAINMENT CELL PERIMETER/ COVER SYSTEM FOUNDATION/CAPILLARY BARRIER/NATIVE SOIL/ TOP SOIL/WICK'ING MATERIAL**

**FIELD TESTS**
**(FIELD FORM)**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
</tr>
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<tbody>
<tr>
<td>Project No.</td>
<td></td>
<td></td>
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<tr>
<td>Borrow Area</td>
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</tbody>
</table>

**Compaction Equipment**

**Soil description**

**Weather**

**Volume and Location of Material Placed during Shift**

**Surface area and location covered during shift**

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

<table>
<thead>
<tr>
<th>YES/NO</th>
<th>NOTE NO.</th>
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<tbody>
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</table>

- Have in situ soil nuclear density and moisture content tests been performed? 
- Have field density test locations and elevations been plotted and checked? 
- Have the results of the in situ density and moisture content tests been recorded on form TI-04 "Field Moisture/Density Test Results"? 
- Have all holes from the soil nuclear density tests been backfilled with like material and hand tamped?

**NOTES:**
Project Name: 
Project No.: 
Borrow Area: 
Type of Construction: (structural fill, protective soil layer) 
Maximum Dry Density (pcf) 
Optimum Moisture: 

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Approximate Location</th>
<th>In Situ Dry Density (pcf)</th>
<th>Percent Compaction</th>
<th>In Situ Water Content (Wc) (%)</th>
<th>Percent Wc Variation</th>
<th>Soil Description</th>
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</thead>
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</table>
CI-01
CONSTRUCTION INSPECTION
EXCAVATION/SUBGRADE/CONTAINMENT CELL PERIMETER
(FIELD FORM)

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

Project Name ____________________________ Date ____________________________
Project No. ______________________________ Inspected by ________________________
Borrow Area _____________________________ Max Dry Density (pcf) ________________
Opt. Moisture (%) __________________________

Compaction equipment ____________________________________________________________
Soil description _________________________________________________________________
Weather ________________________________________________________________
Volume and location of material placed during shift _________________________________
Surface area and location covered during shift _______________________________________

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

• Have all trees, shrubbery, grass, roots, and other vegetation been completely cleared and grubbed from the containment cell area? YES/NO NOTE NO.
• Has the containment cell been surveyed for final excavation grades, to verify that the containment cell base and sidewall slopes conform to the construction drawings? YES/NO NOTE NO.
• Has the cell perimeter been surveyed for final grades prior to placement of the cover system foundation? YES/NO NOTE NO.
• Has the excavated material, potentially suitable for backfill, been visually classified in accordance with ASTM D2488? YES/NO NOTE NO.
• Has the excavated material that has been determined to be suitable for backfill been stockpiled? YES/NO NOTE NO.
• Has the subgrade or cell perimeter, as applicable, been inspected to ensure that all loose or soft zones have been excavated and replaced with suitable backfill material? YES/NO NOTE NO.
• Has the subgrade been inspected to ensure that it is free of all rocks greater than 0.5 inch in diameter? YES/NO NOTE NO.
• Has the number of passes and the coverage of the compaction equipment been documented? YES/NO NOTE NO.

NOTES:
# Construction Inspection

## Anchor Trenches

### (Field Form)

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<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
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<th>Project No.</th>
<th>Inspected by</th>
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</table>

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Max. Dry Density (pcf)</th>
<th>Opt. Moisture (%)</th>
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</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>Volume and location of material during shift</th>
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<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface area and location covered during shift</th>
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</tbody>
</table>

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

1. Have the trench dimensions been verified with the construction drawings and specifications?
   - YES/NO
   - NOTE NO.

2. Are the trenches adequately drained to prevent standing water and softening of the adjacent soils?
   - YES/NO
   - NOTE NO.

3. Has approved soil been used during backfilling?
   - YES/NO
   - NOTE NO.

4. Has care been taken during placement and compaction of backfill so as not to damage the underlying geosynthetics?
   - YES/NO
   - NOTE NO.

## Notes:

---

A-11
CI-03
CONSTRUCTION INSPECTION
EMBANKMENT/PROTECTIVE SOIL COVER/Cover SYSTEM FOUNDATION/
NATIVE SOIL/TOP SOIL
(FIELD FORM)

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

Project Name
Project No.
Borrow Area

Date
Inspected by

Compaction equipment
Soil Description
Weather
Volume and location of material placed during shift
Surface area and location covered during shift

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

YES/NO NOTE NO.

• Is the soil free of irreducible material?
• Is the soil reasonably free of any visible organic matter, deleterious substance, or frozen material?
• Is the surface of the area to be filled acceptable (not desiccated or excessively wet)?
• Have all the soil property tests as specified been performed for fill material?
• Does the soil contain irreducible material greater than 1/2 inch in any dimension?
• Is organic material or odor present?
• Is the soil placed so as to prevent damage to the underlying material?
• As applicable, is the material placed in such a manner to prevent wrinkles in the synthetic materials from folding over?
• Have the fill materials been placed per the construction specifications and drawings?
• Has the number of passes and the coverage of compaction equipment been documented?
• Have only hand compactors been used around pipe connections?
• Have individual and final lift thickness been checked?
• Have lines and grade been surveyed after each layer has been completed (if appropriate)?

NOTES:

A-12
CI-04  
CONSTRUCTION INSPECTION  
CAPILLARY BARRIER AND WICKING MATERIAL  
(FIELD FORM)  

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrow Area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compaction equipment  
Soil Description  
Weather  
Volume and location of material placed during shift  
Surface area and location covered during shift  

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Is the fill material placed so as to prevent damage to the underlying material?  
- Have lines and grade been surveyed after each layer has been completed (if appropriate)?  
- Have the materials been placed to the lines and grades specified on the construction drawings?

<table>
<thead>
<tr>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
</table>

NOTES:
## CI-05
### CONSTRUCTION INSPECTION
#### VEGETATIVE LAYER
##### (FIELD FORM)

**ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
<th>Max Dry Density (pcf)</th>
<th>Opt. Moisture (%)</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**Compaction equipment**

**Soil description**

**Weather**

**Volume and location of material placed during shift**

**Surface area and location covered during shift**

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Is the weather favorable (i.e., low winds, no precipitation)?
- Have the proper types and quantities of soil additives and seed been applied?
- Has the hydroseed application rate been verified, coverage sufficient?
- Have the final lines and grades been surveyed?

<table>
<thead>
<tr>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**NOTES:**

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A-14
CI-06
CONSTRUCTION INSPECTION
PVC PIPE
(FIELD FORM)

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

Project Name ___________________________  Date ___________________________
Project No. _____________________________  Inspected by ___________________________
Weather ________________________________
Location of pipe installed ____________________________

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

YES/NO  NOTE NO.

• Is the pipe installed in a manner that prevents damage to underlying materials? ________ ________

• Is the pipe free of dirt and debris? ________ ________

• Is the pipe properly joined (no solvent used)? ________ ________

• Are the layout and location of the pipe installed in accordance with drawings? ________ ________

NOTES:

A-15
<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>DATE</th>
<th>WEATHER</th>
<th>PROJECT NUMBER</th>
<th>INSPECTOR</th>
<th>PANEL NUMBER</th>
<th>ROLL NUMBER</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
</tr>
<tr>
<td>Are all personnel wearing shoes that do not damage the liner?</td>
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<tr>
<td>Does the method used to unroll the panel prevent damage to the liner or underlying materials?</td>
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<tr>
<td>Is the liner uniform in appearance and free from defects?</td>
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<tr>
<td>Have all defects been marked and assigned a unique I.D. number?</td>
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<tr>
<td>Is the anchor trench constructed according to the dimensions shown on the drawings?</td>
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<tr>
<td>Is the liner properly placed in the anchor trench and adequately anchored?</td>
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<tr>
<td>Is the trench reasonably free of debris prior to placing the backfill?</td>
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<tr>
<td>Are sand bags being properly used to prevent movement or uplift of liner?</td>
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<tr>
<td>Are sand bags of adequate strength and tied properly to prevent breakage and spillage?</td>
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<tr>
<td>Are the liners installed in accordance with the approved liners layout plan?</td>
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**NOTES:**
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<th>5</th>
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</thead>
<tbody>
<tr>
<td><strong>YES/NO</strong></td>
<td><strong>NOTE NO.</strong></td>
<td><strong>YES/NO</strong></td>
<td><strong>NOTE NO.</strong></td>
<td><strong>YES/NO</strong></td>
</tr>
</tbody>
</table>

- Are adjacent GCL sheets overlapped a minimum of 10' from the edge of the sheet?
- Has the proper amount of granular bentonite been applied between the GCL sheets at the overlap regions?
- Are the traverse overlaps at the end of the rolls a minimum of 12" in length?
- In areas where the GCL is cut to fit do panels overlap a minimum of 6" and is bentonite added to the overlap region?
- Are there horizontal seams on the side slopes?

**NOTES:**
CONSTRUCTION INSPECTION
GEOSYNTHETIC CLAY LINER REPAIR
(FIELD FORM)

ONE FORM FOR EACH REPAIR MADE

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
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</table>

Weather

Surface area and location of repair shift

Description of damage needing repair

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

<table>
<thead>
<tr>
<th>Question</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the geotextile used for patch material the same as the damaged geotextile?</td>
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<tr>
<td>Does the patch extend a minimum of 12&quot; beyond any portion of the damaged area?</td>
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<tr>
<td>If the area requiring repair is on a side slope, can the repaired GCL panel be moved and used on the floor of the containment cell?</td>
<td></td>
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<tr>
<td>If the damage was the result of exposure to hydrocarbon fuels, chemicals, pesticides, leachates, or other such liquids has the damaged area been removed and disposed of away from other components of the liner system?</td>
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</tbody>
</table>

NOTES:
CI-10
CONSTRUCTION INSPECTION
GEOSYNTHETIC CLAY LINER COVERING
(FIELD FORM)

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

Project Name __________________________ Date __________________________
Project No. ___________________________ Inspected by ______________________
Borrow Area __________________________

Compaction equipment ______________________________________________________
Soil Description ____________________________________________________________
Weather ____________________________________________________________________
Volume and location of material placed during shift _________________________________
Surface area and location covered during shift ___________________________________

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

• Has the GCL been inspected by the QA engineer? YES/NO NOTE NO.
• Is the 60-mil HDPE geomembrane free of defects? YES/NO NOTE NO.
• Has the GCL been covered by end of shift (or day)? YES/NO NOTE NO.
• Is the GCL free of stress due to the overlying geomembrane? YES/NO NOTE NO.
• Has the leading edge of the GCL been folded back under the geomembrane as required at the end of each shift (or day)? YES/NO NOTE NO.

NOTES:
## CONSTRUCTION INSPECTION

**GEOMEMBRANE LINER PLACEMENT (FIELD FORM)**

**ONE FORM EVERY FIVE PANELS**

<table>
<thead>
<tr>
<th>PANEL NUMBER</th>
<th>ROLL NUMBER</th>
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<tbody>
<tr>
<td>A-20</td>
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</tbody>
</table>

- Are all personnel wearing shoes that do not damage the liner? YES/NO
- No construction vehicles of any type shall be allowed to move directly on the geomembrane. YES/NO
- Is the liner subgrade free from debris (irreducible material greater than 1/2" in any dimension) or protrusions (if applicable)? YES/NO
- Is the underlying GCL free of all folds, wrinkles, and debris (if applicable)? YES/NO
- Is the geomembrane free of excessive slack that may cause creases or folds? YES/NO
- Does the method used to unroll the panel prevent damage to the liner or underlying materials? YES/NO
- Is the liner uniform in appearance and free from defects? YES/NO
- Have all defects been marked and assigned a unique I.D. number? YES/NO
- Is the liner properly placed in the anchor trench and adequately anchored? YES/NO
- Is the trench reasonably free of debris prior to placing the backfill? YES/NO
- Are sand bags being properly used to prevent movement or uplift of liner? YES/NO
<table>
<thead>
<tr>
<th>PANEL NUMBER</th>
<th>ROLL NUMBER</th>
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</thead>
<tbody>
<tr>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
</tr>
</tbody>
</table>

*Are sand bags of adequate strength and tied properly to prevent breakage and spillage?*

*Are the liners installed in accordance with the approved panel layout plan?*

**NOTES:**
## CONSTRUCTION INSPECTION
**GEOMEMBRANE LINER SEAM WELDING**
*(FIELD FORM)*

<table>
<thead>
<tr>
<th>PANEL NUMBER(s)</th>
<th>ROLL NUMBER(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1  2  3  4  5

<table>
<thead>
<tr>
<th>Has the roll identification number been marked on the roll?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Has an as-built layout been prepared?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are the weather conditions appropriate for seaming?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is the area to be seamed free of moisture, dust, or foreign material?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is the correct amount of overlap being used for the type of seam being made?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is proper seaming/equipment being used?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Have defects been assigned a unique identification number?</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTES:

---

A-22
## Construction Inspection

**GEOMEMBRANE LINER DESTRUCTIVE TESTING SAMPLE COLLECTION**

*(FIELD FORM)*

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Number</td>
<td>Time</td>
</tr>
<tr>
<td>Seam Number</td>
<td>Inspected by</td>
</tr>
<tr>
<td>Weather</td>
<td>Name of Master Seamer</td>
</tr>
<tr>
<td>Seaming Unit/Group</td>
<td>Seaming Machine I.D.</td>
</tr>
<tr>
<td>Welding Apparatus</td>
<td>Pressure (If applicable)</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
</tbody>
</table>

-Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.-(If applicable)-

<table>
<thead>
<tr>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
CI-14
CONSTRUCTION INSPECTION
GEOMEMBRANE LINER DESTRUCTIVE TESTING
LABORATORY TEST VERIFICATION
(FIELD OFFICE FORM)

Project Name ___________________________
Project Number ___________________________
 Seam Number ___________________________

Date ___________________________
Inspected by ___________________________
Sample Numbers ___________________________

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Have the laboratory test results been received within the time allotted? YES/NO __________  NOTE NO. __________
- Have the test results been reviewed by the QA Engineer? YES/NO __________  NOTE NO. __________
- Were all required tests performed? YES/NO __________  NOTE NO. __________
- Do the test results meet construction/design specifications? YES/NO __________  NOTE NO. __________
- Have all the required notifications been made regarding test results? YES/NO __________  NOTE NO. __________

NOTES:
# Construction Inspection

**Geomembrane Liner - Nondestructive Testing (Air Pressure Test)**

*Field Form*

**ONE FORM PER SEAM**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Project No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seam No.</th>
<th>Seam Length</th>
<th>Inspector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Field Test</th>
<th>Test Personnel ID</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Checks to Be Made Prior to Testing

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes/No</th>
<th>Note No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can the air pump generate and sustain a pressure of approximately 30 psi?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the test device equipped with a rubber hose, fittings, connections, and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sharp hollow needles or equivalent?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Checks to Be Made During Testing

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes/No</th>
<th>Note No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are both ends of the seam to be tested sealed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have pressure gases been installed at both the ends of the seam?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the pressure loss 5 psi or less?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have all the defects detected been marked on the panel and recorded on the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>following table?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After repairing all defects, have defects been successfully retested?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record gage pressures after pressures stabilizes and at beginning of testing period.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record gage pressure at end of test.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record difference in gage pressures.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Retest

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes/No</th>
<th>Note No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>After a successfully retest of a repair, has the inspector initiated and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dated the repair on the panel and recorded it on the following table?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Defect ID

<table>
<thead>
<tr>
<th>Defect ID</th>
<th>Type of Repair/Date</th>
<th>Type of Retest</th>
<th>Date</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes/No</th>
<th>Note No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the seam 100 percent tested?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have the total number of defects been marked on the end of the seam?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have all defects been repaired and successfully retested?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a seam sample required for testing? (Minimum one sample per 500 feet of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>seam length required. Include details on the following table.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seam Sample</th>
<th>Roll ID</th>
<th>Date Sampled</th>
<th>Date</th>
<th>Patched</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

---
**CONSTRUCTION INSPECTION**
**GEOMEMBRANE LINER REPAIR**
*(FIELD FORM)*

**ONE FORM FOR EACH REPAIR MADE**

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Weather</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Surface area and location of repair**

**Description of damage needing repair**

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

<table>
<thead>
<tr>
<th>Question</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the area requiring repair been prepared as required and is it clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and dry?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the repair equipment been approved?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the patch material extend a minimum of 6&quot; beyond the affected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>area and are all corners of the patch material rounded as required?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the repaired area been non-destructively tested by the appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>methods?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the repair passed all required testing?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
### CI-17
CONSTRUCTION INSPECTION
GEOCOMPOSITE PLACEMENT AND JOINING
(FIELD FORM)

**ONE FORM EVERY FIVE PANELS**

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>DATE</th>
<th>WEATHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROJECT NUMBER</th>
<th>INSPECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PANEL NUMBER</th>
<th>ROLL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GEOCOMPOSITE PLACEMENT AND JOINING

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
<td>NOTE NO.</td>
<td>YES/NO</td>
</tr>
</tbody>
</table>

- Is the geocomposite installed in a manner that prevents damage to the underlying material?  
- Is the geocomposite installed over a clean membrane?  
- Is the geocomposite free from dirt and debris?  
- Is the geotextile portion of the geocomposite overlapped a minimum of 3" from the edge of the sheet and sewn or secured with tape as recommended by the QA engineer?  
- Are the traverse overlaps at the end of the rolls a minimum of 12" in length?

### NOTES:

---

---
CI-18
CONSTRUCTION INSPECTION
GEOCOMPOSITE REPAIR
(FIELD FORM)

ONE FORM FOR EACH REPAIR MADE

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Project No.</th>
<th>Weather</th>
<th>Date</th>
<th>Inspected by</th>
</tr>
</thead>
</table>

Surface area and location of repair

Description of damage needing repair

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

<table>
<thead>
<tr>
<th>Question</th>
<th>YES/NO</th>
<th>NOTE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the geocomposite used for patch material the same as the damaged geocomposite?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the geocomposite patch extend a minimum of 4&quot; beyond any portion of the damaged area?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the geotextile used for patch material the same as the damaged geotextile?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the geotextile patch extend a minimum of 12&quot; beyond any portion of the damaged area?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the thread used to sew the geotextile of contrasting color and does it have chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
CI-19
CONSTRUCTION INSPECTION
GEOTEXTILE WRAP PLACEMENT AND SEAMING
(FIELD FORM)

ONE FORM PER SHIFT WHEN THIS WORK IS BEING DONE

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Inspected by</th>
<th>Weather</th>
<th>Surface area location covered during shift</th>
</tr>
</thead>
</table>

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Is the geotextile installed in manner that prevents damage to underlying materials? □ □
  - The geotextile has been deployed by hand or by use of a low ground pressure vehicle? □ □
- Is the geotextile free from defects, dirt, and debris? □ □
- Are edges of adjacent sheets of geotextile overlapped per specification requirements? □ □
- No end-to-end seams have been made on side slopes? □ □
- Have all geotextiles roll edges been overlapped a minimum of 12" and sewn? □ □
- Have the proper tools for cutting the geotextile been used? □ □
- Is the seaming of geotextiles in accordance with the specifications? □ □

NOTES:
CI-20
CONSTRUCTION INSPECTION
GEOTEXTILE WRAP REPAIR
(FIELD FORM)

ONE FORM FOR EACH REPAIR MADE

Project Name ___________________________ Date ___________________________
Project No. _____________________________ Inspected by _______________________
Weather ________________________________

Surface area and location of repair _____________________________________________

Description of damage needing repair __________________________________________

 ____________________________________________

(Provide explanatory notes if the answer to any of the following questions is "no." Include any remedial steps required.)

- Is the geotextile used for patch material the same as the damaged geotextile? _______________ NOTE NO. __________
- Does the geotextile patch extend a minimum of 12" beyond any portion of the damaged area? _______________ NOTE NO. __________
- All patches have been sewn in place by hand or machine? _______________ NOTE NO. __________
- Is the thread used to sew the geotextile of contrasting color and does it have chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself? _______________ NOTE NO. __________
- The patch has been inspected by a QA personnel? _______________ NOTE NO. __________

NOTES:________

A-30
ATTACHMENT B
SPECIFICATIONS
Construction Contract Specifications for the Corrective Action Management Unit

This attachment includes specifications which further describe the design of the Corrective Action Management Unit (CAMU) at Sandia National Laboratories/New Mexico (SNL/NM). The specifications included are either SNL/NM standard specifications or are special specifications which have been developed specifically for the CAMU at SNL/NM. It should be noted, however, that SNL/NM construction procurement allows "or equal" materials and inspection services, provided that these are reviewed by the construction representative and are determined to be of equal quality and meet the intent of the specifications.

SNL/NM Standard Specifications

02200 Earthwork
02730 Sanitary Sewer Systems

Special Specifications

02010 Earthwork for Containment Cell
02020 Geosynthetic Clay Liner for Containment Cell
02030 Flexible Geomembranes for Containment Cell
02040 Geocomposite for Containment Cell
02050 Geotextile Wrap for Containment Cell Collection Trench
02060 Leachate Collection and Removal System
13501 Piping Systems for Vadose Zone Monitoring System
13600 Earthwork for Final Cover System
13602 Seeding for Final Cover System
13700 Geomembrane Liner for Final Cover and Vadose Zone Monitoring Systems
SNL/NM Standard Specification

Section 02200

Earthwork
STANDARD SPECIFICATION
SECTION 02200
EARTHWORK

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1.04 Submittals ................................................................................. 3
1.05 Quality Assurance ...................................................................... 4
1.06 Project Conditions ..................................................................... 4

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September 29, 1995

02200-1
EARTHWORK
STANDARD SPECIFICATION
SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Earthwork includes, but is not limited to clearing, preparing, grading, excavating, filling, backfilling and compacting of soils as necessary to accomplish finished construction as indicated on the drawings.

B. Excavation for Mechanical/Electrical Work: Excavation and backfill required in conjunction with underground mechanical and electrical utilities and buried mechanical and electrical appurtenances is included as work of this section.

C. Related Section: Refer to Division 3, Section "Cast-In-Place Concrete" for general excavation requirements.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)
   C131  Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   C136  Method for Sieve Analysis of Fine and Coarse Aggregates
   D1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
   D4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table
   D4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density

B. Code of Federal Regulations (CFR)
   Title 29 Part 1926.650 Safety and Health Regulations for Construction
1.03 Definitions

A. **Borrow**: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

B. **Drainage Fill**: Course of washed granular materials supporting slab-on-grade, placed to cut off upward capillary flow of pore water.

C. **Excavation**: The removal of material encountered to subgrade elevations and the reuse or disposal of material removed.

D. **Structures**: Building, footing, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

E. **Subgrade**: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil material.

F. **Unauthorized Excavation**: Removing materials beyond indicated subgrade elevations or dimensions without direction by the Sandia Delegated Representative (SDR).

G. **Utilities**: On site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

H. **Flowable Concrete Backfill**: Controlled low-strength flowable backfill with no less than 6 inch (152 mm) slump and no more than 10 inch (254 mm) slump.

I. **Subbase Course**: The layer placed between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.

J. **Base Course**: The layer placed between the subbase and surface pavement in a paving system.

1.04 Submittals

A. **General**: Submit the following items in accordance with Conditions of Contract and Division 1, Section "Descriptive Submittals."

B. **Product Data**: Submit product data for the following materials and items. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

Each type of plastic warning tape.

C. **Test Reports**: Submit test reports required under Quality Assurance as well as the following:

1. Laboratory analysis of each soil material proposed for fill and backfill from on-site and borrow sources.

2. One "Optimum Moisture - Maximum Density Curve" for each soil material.
3. Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

D. Traffic Plan: Contractor shall submit a proposed traffic plan prior to start of construction if required in the Contract documents. Traffic plan shall consist of the following:

1. How street(s) will be flagged and barricaded.
2. How street will be maintained.
3. Placement and size of steel plates to be used.
4. Duration of street closure.

1.05 QUALITY ASSURANCE

Sandia National Laboratories (SNL) will engage a soil testing and inspection service for quality control testing during earthwork operations. Should initial tests of Contractor's work indicate noncompliance with the specification, the Contractor shall make corrections as directed. Retesting required to determine compliance with this specification shall be performed by an approved testing laboratory at the Contractor's expense.

1.06 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, notify the SDR. Do not interrupt existing utilities without following the Standard Facilities Engineering procedures for utility outage. Provide a minimum of 2 weeks' notice when practical, and await notice to proceed before interrupting any utilities.

3. Known Utilities: Type and location of known existing utilities and obstructions which are shown on the drawings are approximate, but are based on the best information available. Protect these and other utilities which are made known to General Contractor prior to excavation. Determine exact location of all known utilities by performing exploratory hand excavation to expose the utility. Hand excavate at least 5 feet (1.5 m) each side of the indicated location unless the utility is located sooner. Remainder of excavation shall be completed only after the SDR has approved location of known utilities. When electrified utilities are to be removed, safety precautions specified under the procedure for unknown utilities shall be adhered to.

If movement of traffic or public safety makes it necessary to backfill an exploratory excavation after the utility has been located, a suitable marker shall be installed to permanently mark the location.

C. Unknown Utilities: In the event that unidentified conduits, concrete encased ducts or pipes are encountered that must be removed, all work on that part of the job will stop until the SDR is contacted and resumption of work is authorized.
D. **Underground Telephone Cable:** Where an underground telephone cable is shown on the Contract drawings, NO excavation is to be attempted in that vicinity until the line is properly located and staked by the Air Force Communications Service (AFCS). If an unknown cable is identified as a telephone cable during excavation, all excavation is to cease until the AFCS identifies and properly stakes the cable locations in the vicinity of the excavation. (For assistance call 844-8411)

E. **Use of Explosives:** The use of explosives is not permitted.

F. **Protection of Persons and Property:** Flag and barricade open excavations occurring as part of this work. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1. Contractor shall be responsible for protection of personnel and property in the work area for the duration of the Contract.

2. Keep excavation free of water from any source at all times. Provide and operate pumps if necessary. Remove water from site in manner to avoid damage to adjoining property.

G. **Pollution Control:** Use water sprinkling, temporary enclosures, and other suitable methods to limit amount of dust and dirt rising and scattering in the air to lowest practicable level.

1. Comply with governing regulations pertaining to environmental protection. Obtain digging permit from the SDR and earth disturbance notification from City of Albuquerque, when required in the Contract, prior to beginning any earthwork.

2. Clean adjacent structures and improvements of dust, dirt, and debris caused by earthworking operations, as directed by the SDR. Return adjacent areas to conditions existing prior to the start of the work.

H. **Street Crossings:** Excavations shall be conducted in a manner so as to cause the least interruption of traffic. Maintain half the width of the street open at all times unless prior approval from the SDR has been given to close the street. Request to close a street must be presented in writing to the SDR at least 2 weeks prior to the requested closing date.

**PART 2 - PRODUCTS**

2.01 **SOIL MATERIALS**

A. **General:** Unless otherwise noted on the Contract documents, the existing site soils shall be used for fill and backfill materials. If the on-site soils are found by laboratory test to be unsuitable for fill and backfill material, contact the SDR for direction.

Any additional fill material used must conform with the applicable requirements of this section.
B. **Structural Fill**: Structural fill shall consist of a controlled fill placed in areas indicated on the drawings.

1. Structural fill material shall consist of soils that conform to the following physical characteristics:

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inch (152 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>50 - 100</td>
</tr>
<tr>
<td>No. 200 (600 μm)</td>
<td>10 - 30</td>
</tr>
</tbody>
</table>

2. The plasticity index of material, as determined in accordance with ASTM D4318 shall not exceed 15.

3. The fill material shall be free from roots, grass, other vegetable matter, clay lumps, rocks larger than 6 inches (152 mm), or other deleterious materials. Stripped top soil shall not be used in structural fill.

C. **Retaining Wall Backfill**: Retaining wall backfill material shall be free-draining and conform to fill quality requirements as follows:

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing by Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch (19.1 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>30 - 80</td>
</tr>
<tr>
<td>No. 200 (600 μm)</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

The material should have a plasticity index of less than 5 when tested in accordance with ASTM D4318.

D. **Granular Base**

1. Granular base shall meet the following grading requirements as determined in accordance with ASTM C136.

<table>
<thead>
<tr>
<th>Sieve Size (Square Openings)</th>
<th>Percent Passing by Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (25 mm)</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch (19.1 mm)</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>30 - 60</td>
</tr>
<tr>
<td>No. 200 (600 μm)</td>
<td>3 - 10</td>
</tr>
</tbody>
</table>

2. The granular base shall have a plasticity index of no greater than 3 when tested in accordance with ASTM D4318. The coarse aggregate shall have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM C131), of no greater than 5%. Reconstituted asphalt base course is allowable when meeting these gradations.
2 02 ACCESSORIES

Detectable Warning Tape: Provide a polyethylene film detectable warning tape manufactured for marking and identifying underground utilities. Tape shall be 6 inches (152 mm) wide and a minimum metallic foil core of 0.5 mils (0.013 mm) and shall be reinforced consisting of 9.0 mil (0.23 mm) total thickness. Letters shall be black in color and 1 inch (25 mm) minimum in size.

A. Color Codes:
   1. Electric - Red
   2. Gas - Yellow
   3. Water - Blue
   4. Steam - Yellow
   5. Sewer - Green
   6. Telephone - Orange

B. Text: The lettering shall be repeated continuously for the full length of the tape as follows:

   CAUTION  CAUTION  CAUTION  
   BURIED (UTILITY TYPE) LINE BELOW

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost and excessive drying or wetting. Provide protective insulating materials as necessary.

C. Protection of Personnel: Flag and barricade open excavations occurring as part of this work.

D. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water run-off or airborne dust to adjacent properties and walkways.

3.02 CLEARING AND GRUBBING

A. General: Clearing and grubbing will be required for all areas indicated on the drawings to be excavated, improved on or which fill is to be constructed. All cleared and grubbed materials, including trash, shall be deposited at the Kirtland Air Force Base Landfill or as directed by the SDR.

B. Clearing and Grubbing: Clearing shall consist of removal and disposal of trees, shrubbery and other vegetation as well as brush and rubbish within the areas to be improved and constructed upon.

02200-7
EARTHWORK
C. **Grass and Topsoil**: Grass, grass roots and incidental topsoil shall not be left beneath fill area, nor shall this material be used as fill or backfill material.

### 3 03 EXCAVATION

**A. General**: Excavate to contours, shapes, dimensions and elevations required for the work indicated on the drawings, extend sufficiently to permit form placing, inspection and removal. Undercutting is prohibited.

1. Earth excavation shall consist of excavation and removal of suitable soils for use as structural fill as well as satisfactory disposal of all vegetation, debris and deleterious materials encountered within area to be graded or in a borrow area, or any combination thereof.

2. Excavated areas shall be continuously maintained in a manner so that surfaces shall be smooth and have sufficient slope to allow water to drain from surface.

3. All existing man-made fill shall be removed in its entirety.

4. Width of excavations shall be to dimensions indicated on drawings, with additional space allowed as required for erection and stripping of forms, and inspection of related work.

**B. Unauthorized excavation** consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the SDR. Unauthorized excavation, as well as remedial work directed by the SDR, shall be at Contractor's expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Flowable concrete fill (2000 psi minimum (14 MPa)) may be used to bring elevations to proper position, when acceptable to the SDR.

2. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classifications, unless otherwise directed by the SDR.

**C. Additional Excavation**: When excavation has reached required subgrade elevations, notify the SDR who will make an inspection of conditions.

1. If unsuitable bearing materials are encountered at required subgrade elevations, immediately notify the SDR for direction.

2. Removal of unsuitable material and its replacement shall be as directed by the SDR.

**D. Stability of Excavations**: Slope sides of excavations where possible in accordance with OSHA 1926.650. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

Shore all vertical cuts greater than 5 feet (1.5 m) in depth.

02200-8
EARTHWORK
E. **Dewatering**: Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

F. **Storage of Soil Materials**: Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials at a location on site as directed by the SDR. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.

G. **Excavation for Structures**: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot (30.5 mm) and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of service, other construction, and for inspection.

H. **Excavation for Pavements**: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.

I. **Excavation for Utility Trenches**: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide minimum 6 inch (152 mm) clearance on both sides of pipe or conduit.

   1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.

   2. Where rock is encountered, carry excavation 6 inches (152 mm) below specified elevation and backfill with a 6 inch (152 mm) layer of crushed stone, gravel, or sand prior to pipe installation.

   3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

   4. Do not backfill trenches until tests and inspections have been made and backfilling authorized by the SDR. Use care in backfilling to avoid damage or displacement of pipe systems.

   5. For grade dependent utilities, the entire length of trench between manholes or terminations shall be opened prior to placement of pipe. If existing utilities conflict with the new line, adjust the grade accordingly at the direction of the SDR.

   6. As-built any changes found or made and return to SNL before job completion.

J. **Cold Weather Protection**: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (1.66 degrees C).

3.04 **BACKFILL AND FILL**

A. **General**: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below:

   1. In excavations, use satisfactory excavated or borrow material.
2. Under building slabs, use granular base material, or as noted on drawing.

3. Behind retaining walls, use retaining wall backfill material.

4. Flowable concrete backfill may be used in lieu of soil when the ability to compact is affected by conditions such as safety or tight conditions.

B. Backfill excavation as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

2. Inspection, testing, approval, recording locations and as-builting of underground utilities.


4. Removal of temporary shoring and bracing, and backfilling of voids with satisfactory materials.

5. Removal of trash and debris from excavation.

6. Installing permanent or temporary horizontal bracing at horizontally supported walls.

C. Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than one vertical to four horizontal so that fill material will bond with existing surface.

Prior to placement of fill, notify the SDR who will make an inspection of conditions to verify satisfactory removal of unsatisfactory materials.

D. Placement and Compaction: Place backfill and fill materials in layers not more than 8 inches (203 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches (152 mm) loose depth for material compacted by hand-operated tampers.

1. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Place backfill and fill materials evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.

E. Utility Trench Backfill: Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
1. Backfill trenches with concrete where trench excavations pass under column or wall footings. Concrete shall fill from the bottom of the trench to the bottom of the footing and extend the full width of the trench to 18 inches (457 mm) beyond the edge(s) of the footing.

2. Provide 4-inch (102 mm) thick concrete base slab support for piping or conduit less than 30 inches (762 mm) below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches (102 mm) of concrete before backfilling or placing roadway subbase.

3. Install continuous detectable warning tape at all utility trenches as they are backfilled. Locate the tape approximately 36 inches (914 mm) above the utility line, but not less than 12 inches (305 mm) below grade. Install it directly above and parallel to the utility line with the printed side up. Take necessary precautions to avoid distorting or misplacing the tape when backfilling.

When backfilling gas utility trenches, follow these procedures: Install an electrically conductive 12 gage (0.0808 inch) (2.052 mm) copper wire with the pipe. This wire and all its underground connections shall be insulated to prevent corrosion. This wire shall be placed above the pipe with a 12 inch (305 mm) layer of backfill separating it from the top of the pipe. A detectable warning tape shall then be covered with 18 inches (457 mm) of backfill minimum and an additional detectable warning tape shall be placed a minimum of 12 inches (305 mm) below finish grade. (Minimum gas pipe depth is 48 inches (1.2 m)).

3.05 COMPACTION

A. General: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils) determined in accordance with ASTM D1557 and not less than the following percentages of relative density, determined in accordance with ASTM D4253 and D4254, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

1. Under Structures, Building Slabs, Steps, Pavement And Curb And Gutter: Compact the top 12 inches (305 mm) below subgrade and each layer of backfill or fill material at 95 percent maximum dry density unless otherwise indicated on the drawings. (Exception: Utility trenches under pavements; compact the top 6 inches (152 mm) at 95 percent maximum dry density and each layer of backfill or fill material below subgrade at 90 percent maximum dry density unless otherwise indicated on the drawings.) Where the native soil is cohesionless, compact top 12 inches (305 mm) to a minimum relative density of 72 percent.

2. Under Lawn or Unpaved Areas: Compact the top 6 inches (152 mm) below subgrade and each layer of backfill or fill material at 85 percent maximum dry density for clayey soils (more than 35 percent passing No. 200 sieve) and 90 percent relative density for all other soils.
3 Under Walkways: Compact the top 6 inches (152 mm) below subgrade and each layer of backfill or fill material at 90 percent maximum dry density for clayey material or 90 percent relative density for all other material.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations. Remove and replace, or scuff and air dry, soil material that is too wet to permit compaction to specified density.

3.06 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot (30.5 mm) above or below required subgrade elevations.

2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1/2 inch (12.7 mm) above or below required subgrade elevation.

3. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2 inch (12.7 mm) above or 1 inch (25 mm) below required subgrade elevation.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch (12.7 mm) when tested with a 10 foot (3 m) straightedge.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.07 BUILDING SLAB DRAINAGE COURSE

Drainage course consists of placement of 6 inch (152 mm) thickness of granular base material over subgrade surface to support concrete building slabs.

3.08 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.09 DISPOSAL OF EXCESS AND WASTE MATERIAL

Transport excess excavated material to designated soil storage areas on Kirtland Air Force Base. Waste areas will generally be within 2 miles (3 km) of project site. Stockpile soil or spread as directed by the SDR.

3.10 RECORD DRAWINGS

The Contractor shall supply one red-lined set of as-built drawings which identify the actual location of utility lines installed and the horizontal location and depth of all existing lines encountered during construction. Utilities shall be dimensioned from the nearest permanent structure.

END OF SECTION
SNL/NM Standard Specification

Section 02730

Sanitary Sewer Systems
PART 1 - GENERAL
1.01 Description Of Work
1.02 Submittals
1.03 Quality Assurance

PART 2 - PRODUCTS
2.01 Pipe And Fittings
2.02 Joints
2.03 Cleanouts
2.04 Services

PART 3 - EXECUTION
3.01 Pipe Laying
3.02 Cleanouts
3.03 Septic Systems
3.04 Cleaning
3.05 Location Of Water And Sewer Lines
3.06 Inspection
3.07 Testing For Leakage
STANDARD SPECIFICATION
SECTION 02730
SANITARY SEWER SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK
A. This section shall apply to the materials and operations required for the installation of exterior sanitary sewer systems.
B. The extent of the work is indicated on the contract drawings.
C. Related Sections: Refer to the following sections for related work:
   1. Division 2, Section "Earthwork".
   2. Division 2, Section "Sewer Manholes".
   3. Division 3, Section "Cast-in-Place Concrete".

1.02 SUBMITTALS
Submit Material Safety Data Sheets (MSDS) for joint compounds as required.

1.03 QUALITY ASSURANCE
A. The materials and practices comprising the work shall conform to this and other referenced standard specifications and codes.
B. All materials used shall not contain any asbestos fibers.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS
Pipe and fitting materials shall be polyvinyl chloride (PVC), unless otherwise indicated as ductile iron or vitrified clay on the contract drawings. Each pipe and fitting shall be marked with a permanent label which allows identification of class and type of material. In addition, pipe shall conform to the following requirements:
2.02 JOINTS

Joint materials shall be furnished with the sewer pipe. Gaskets shall be stored in accordance with ASTM C 443. In addition, the joints shall conform to the following requirements:

A. **Vitrified clay pipe** bell and spigot joints shall conform to ASTM C 425. Each joint shall receive an application of furan-based cement mortar according to manufacturer's instructions.

B. **Cast-iron pipe** hub and spigot joints shall have neoprene compression gaskets and shall conform to ASTM 564.

C. **Ductile iron pipe** for sewer shall have push-on rubber gasket joints and shall conform to AWWA C111.

D. For **PVC**, refer to ASTM D 2321 and ASTM F 794 for pipe laying and joining of pipe guidelines.

1. All joints will be assembled in accordance with manufacturer's published recommendations. If a lubricant is required to facilitate assembly, it shall have no detrimental effect on the gasket or on the pipe when subjected to extended exposure. Proper jointing may be verified by rotation of the spigot by hand or with a strap wrench. If unusual joining resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint components and repeat the assembly steps. Note that fitting bells may permit less insertion depth than pipe bells. When mechanical equipment is used to assemble joints, care should be taken to prevent overinsertion.
2. Solvent cement joints shall be limited to 4" and 6" diameter sanitary sewer service lines. The solvent cement shall be compatible to the pipe manufacturer's product and shall conform to the requirements as specified in ASTM D 2564 for PVC pipe and ASTM D 2235 for ABS pipe.

2.03 CLEANOUTS

Cleanouts shall be constructed according to the standard details and conform to the following materials requirements:

A. **Top**: Iron ferrule with countersunk brass screw plug.

B. **Riser**: Cast-iron, service weight, hub and spigot pipe and fittings for DI and VCP sewer lines.

C. **Riser** for PVC lines shall be PVC Schedule 40 pipe conforming to ASTM D 2665 - cast-iron soil pipe (service weight), or ABS Schedule 40 sewer pipe conforming to ASTM D 2661. Only PVC or ABS shall be used when connecting to flexible pipe.

D. **Wye or double-wye fitting** on building sewer shall be of the same material as the building sewer.

E. **Collar**: Cast-in-place reinforced concrete shall conform to the requirements of Division 3, Section “Cast-in-Place Concrete”.

2.04 SERVICES

A. **Sanitary sewer service** lines shall be installed at all locations shown on the plans.

B. **All fittings** shall be compatible with the service line material.

PART 3 - EXECUTION

3.01 PIPE LAYING

A. **The depth of sewer pipe mains** shall be a minimum of 3 feet from top of finished grade to the top of sewer pipe, unless otherwise indicated on the contract drawings.

B. **Pipe shall be laid** on a smoothly graded, prepared subgrade soil foundation true to alignment and grade as indicated on the applicable contract drawings. Bell holes shall be hand-excavated so that the bottom of the pipe is in continuous contact with the surface of the prepared subgrade material. When joined in the trench, the pipe invert shall form a true and straight line.

C. **Sewer pipe shall be laid** according to the pipe manufacturer's written recommendations or installation handbooks. If conflicts occur between these specifications and the manufacturer's instructions, these specifications shall govern. Vitrified clay pipe shall also be laid in accordance with ASTM C 12 for Class C bedding.
D. Vitrified clay pipe joints shall be made up using furan-based cement mortar. Before joining, the mortar shall be applied in the base of the bell so that when the pipe sections are joined, the joint will be completely filled with mortar, and the excess mortar will be pushed out into the bore of the pipe. A burlap bag, stuffed so that it fits tightly into the bore of the pipe, shall be drawn past the joint to wipe the excess mortar away, leaving a smooth interior surface at the joint.

E. For PVC, the reference mark (a distinct circumferential line) is placed on the pipe's spigot by the manufacturer to indicate the correct depth of spigot penetration into the pipe gasket joint. If the pipe is seated too deeply or too shallowly, the pipe may buckle or separate due to thermal expansion/contraction. Spigot penetration shall be within 1/4" of the manufacturer's recommended mark.

F. PVC pipe connection to manholes: The Contractor shall install an appropriately sized press seal gasket, such as PS-10 by Press Seal Gasket Corporation. Large Diameter Waterstops for Concrete Manhole Adapters by Fernco, or approved equal. The gasket shall be installed per manufacturer's directions.

G. Approved backfill material shall be spaded and tamped into the "haunch" area under each side of the pipe so that all void spaces underneath the pipe are filled with compacted backfill material.

H. Pipe laying shall proceed upstream with the spigot ends pointing in the direction of flow. Pipe shall not be laid in standing water or when trench or weather conditions are deemed unsuitable by the Sandia Delegated Representative (SDR).

I. Approved backfill material shall be placed in the trench along the side of the pipe and compacted by hand up to the top of the pipe. Approved backfill material shall be placed and compacted a minimum of 12" above the top of the pipe.

J. Pipe coupons shall not be left inside the sewer main when the direct-tapping method is used. All pipe coupons shall be returned to the SDR.

3.02 CLEANOUTS

Single and two-way cleanouts shall be constructed at the locations indicated and as detailed on the contract drawings. Cleanouts and extensions to grade shall be constructed on 6" and smaller lines at the minimum spacing and at the locations required by the Uniform Plumbing Code (UPC), Section 406, unless otherwise specified on the contract drawings.

3.03 SEPTIC SYSTEMS

A. Septic systems, including septic tank, distribution box, drain field (or seepage pit), shall comply with UPC requirements. In addition, the following requirements shall be met:

1. Access holes (with covers) shall be extended to grade and furnished with manhole covers.

2. Septic tanks shall be placed on a sand bed (with a minimum thickness of 1") 90° compacted earth per ASTM D 1557.
3. A minimum of six guard posts shall be installed above grade around the septic tank perimeter.

B. The Contractor shall also be required to:

1. Complete the Liquid Waste Disposal (LWD) permit application and pay the application fee.

2. Obtain all necessary State of New Mexico Construction Industries Division (CID) inspections relating to the LWD permit.

3. Complete, as a contract deliverable, the LWD permit application, including the CID endorsement indicating completion of required inspections.

4. Submit the completed LWD permit to the SDR, who will then transmit the documents to the Construction Management Engineer.

5. Have an MS-1, MS-3, MM-1, or MM-98 New Mexico plumbing license.

3.04 CLEANING

A. Prior to laying pipe, each interior pipe section shall be cleaned of all soil and debris.

B. After laying backfill, all interior pipes shall be free of all foreign material such as soil, cement mortar, joint compounds, etc. If large amounts of material have accumulated, the SDR may require flushing of the pipe. If flushing is required, any outlets into existing lines shall be blocked so that no foreign material is discharged into existing lines.

3.05 LOCATION OF WATER AND SEWER LINES

A. Mains: Water and sewer mains running parallel shall be laid at least 10 feet apart horizontally with the water main at a higher elevation than the top of the sewer line. Water and sewer mains shall be laid in separate trenches in all cases. Where water and sewer mains are laid closer than 10 feet or where they are crossing, the bottom of the water main shall be at least 18" higher than the top of the sewer line, otherwise the sewer line shall be of pressure class pipe, or shall be encased in concrete as indicated on the contract drawings, within 10 feet either side of the water main.

B. Service Lines: Water and sewer service lines shall not be laid in the same trench. unless the bottom of the water line, at all points, is at least 12" above the top of the sewer line, and the water line shall be laid on a solid shelf excavated at one side of the common trench. Where water and sewer service lines cross, the water line shall be at least 12" higher than the sewer.

3.06 INSPECTION

A. Upon arrival at the job site, all materials may be inspected for conformance with the requirements of Part 2 of this specification. Any rejected material shall immediately be removed from the job site.
B. When PVC pipe is stored outside and exposed to prolonged periods of sunlight, an obvious discoloration of the pipe can occur. This is an indication of reduced pipe impact strength, and any particular length of pipe that is discolored shall be rejected. All pipe rejected by the SDR shall be removed from the job site.

C. Immediately prior to laying, each pipe section shall be visually inspected for defects or damage. Any damaged or defective pipe section shall not be used. Each pipe section shall be cleaned so that the interior and joining surfaces of the pipe are free of soil and debris.

Vitrified clay pipe shall be inspected for straightness, true circular cross-section, cracks, blister, lumps, pits, broken bell and spigot, and general soundness according to ASTM C 700.

D. After the trench has been backfilled, the DI and VCP pipe shall be inspected for displacement, poor alignment or other defects by illuminating the interior of the pipe using a lamp or mirror. The pipe shall be deemed to be in poor alignment if less than three quarters of the opening at the opposite end of the pipe can be seen by the SDR. Allowable deviations from vertical grade shown on the drawings shall be no more than 3/8" below or above the true grade line. In addition, vertical sags and crowns in the pipe joints shall be no more than 1/4" across any 16 feet of pipe length. Horizontal alignment, as shown on the contract drawings, shall be within 1" of the true line and shall not vary more than 1/2" across any single joint of pipe, unless otherwise shown on the contract drawings. Any sections of pipe found to be defective, damaged or in poor alignment shall be taken up and relaid or replaced at the Contractor's expense.

E. Not less than 30 days after the installation and backfilling of PVC sewers, including any service connections, the Contractor shall, in the presence of the SDR, deflect the pipe with a mandrel (GO-NOGO device). The mandrel shall be hand-pulled. All pipe with deflections in excess of 5% of the base internal diameter, as determined by ASTM D 3034, ASTM F 679, or ASTM F 794, shall be excavated, rerounded, backfilled and retested after an additional period of at least 30 days. Mandrels shall have 9 ribs and be only hand-pulled through the test section. The Contractor shall furnish the mandrels. The length of the minimum radius portion of the mandrel shall not be less than one-third of the nominal diameter of the pipe tested. The pipe shall be flushed and cleaned by the Contractor prior to testing. No flow will be permitted in the pipe while testing for deflections.

1. All expense for trenching, backfill, compaction, paving, and related work that is required because of failure to meet deflection test requirements shall be borne by the Contractor.

2. Acceptance of plastic pipe sewers shall be made only after these deflection test requirements have been met.

3. Minimum Diameters of Mandrels:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Minimum Mandrel Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot;</td>
<td>7.28&quot;</td>
</tr>
<tr>
<td>10&quot;</td>
<td>9.03&quot;</td>
</tr>
<tr>
<td>12&quot;</td>
<td>10.80&quot;</td>
</tr>
</tbody>
</table>

02730-7
SANITARY SEWER SYSTEMS
3.07 TESTING FOR LEAKAGE

A. All sanitary sewer pipes shall be tested for leakage by the low pressure air method or other method submitted by the Contractor and approved by the SDR. The Contractor, at his option, may air test the sanitary sewer line before backfilling to aid the Contractor in checking for any defects. The testing for acceptance and compliance with the contract specifications will be performed after backfilling has been completed. If the line does not meet or exceed the test requirements, the Contractor shall make repairs to the line as necessary, and shall retest the line at no additional cost to Sandia National Laboratories (SNL). All manholes shall be tested separately.

The procedure for conducting an air test shall be as follows:

1. **Clean the pipe section** (manhole to manhole reach of sewer) being tested by propelling a snug-fitting inflated ball, or other adequate method, through the pipe with water. It is important that the pipe be thoroughly wetted if consistent results are to be expected.

2. **Plug all pipe outlets** with pneumatic plugs. The pneumatic plugs shall be able to resist internal testing pressures without requiring external bracing. Give special attention to laterals.

3. **Introduce air** slowly to the section of pipe under evaluation until the internal air pressure is raised to 4.0 psig plus any increase required by a high groundwater level.

4. **Allow the air pressure to stabilize.** Air may be added slowly to maintain a pressure between 3.5 and 4.0 psig for two minutes.

5. **After the stabilization period,** when the pressure reaches exactly 3.5 psig, the stopwatch is started, and when the pressure reaches exactly 2.5 psig the stopwatch is stopped.

6. **If the time required** for a one pound pressure drop is not less than the allowable time for the pipe section under test to lose air, the section shall pass the leakage test.

7. **All persons** conducting an air test must be made aware of the fact that an air test may be dangerous if improperly conducted.

8. **Air Testing Table:** Table 1 will be used to determine the required test duration for the section of line being tested.

B. **Tables**

1. **Explanation of Tables**
   
   a. **Column A** Nominal diameter of pipe (any pipe material)
b. Column E: Minimum duration of air test regardless of length of line segment being tested. (e.g., 250 feet of 8" PVC, test duration 3 min. 47 sec.)

c. Column C: Length of line associated with minimum duration of air test (Column B).

d. Column D: \( L = \text{Length of line in feet; product of computation yields duration of air test (e.g., 250 feet of 12" PVC where ground water is not present (Table 1): test duration } = 1.709 \times 150 = 427.25 \text{ sec. } = 7 \text{ min. 8 sec.} \)

e. Column E: Duration of air test for given incremental lengths of line.

2. Use of Tables: Table 1 is based on an air loss rate of 0.003 cfm/sf of internal surface area. Use for line installations where ground water and subsequent infiltration is not present. In the event that ground water and infiltration is present, Table 2 shall be used.
### Table: 02730-1

**Specification Time Required for Loss of Pressure**

From 1.5 PSIG to 2.5 PSIG for Size and Length of Pipe Indicated for $k=0.003$

<table>
<thead>
<tr>
<th>(A) Pipe Diameter (in)</th>
<th>(B) Minimum Time (Min. sec)</th>
<th>(C) Length for Minimum Time (ft)</th>
<th>(D) Time for Length (sec)</th>
<th>(E) Specification Time for Length (L) Shown (min:sec)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>597</td>
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Table from WPCF Journal, Vol 44, No. 4, April 1972, Ramseier, "Testing New Sewer Pipe Installations", pp. 555-564
**TABLE 02730-2**

**SPECIFICATION TIME REQUIRED FOR 10 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR D=0.8615**

<table>
<thead>
<tr>
<th>(A) Pipe Diameter (in.)</th>
<th>(B) Minimum Time (Min: sec)</th>
<th>(C) Minimum Length for Time (Min: sec)</th>
<th>(D) Time for Length (sec)</th>
<th>(E) Specification Time for Length (L) Shown (min sec)</th>
</tr>
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<tr>
<td></td>
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Table from UNI-B-6-79, "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe", Uni-Bell Plastic Pipe Assoc.
Special Specification

Section 02010

Earthwork for Containment Cell
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

This section describes the earth work necessary for the construction of the containment cell including:

A. Soil material selection and specification.
B. Clearing and grubbing of project area.
C. Excavation of containment cell and trenches, and stockpiling excavated backfill material.
D. Fill and backfill of anchor trenches and protective soil cover.
E. Compaction of subsurface and embankment.
F. Grading.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM C 117, Methods for Materials Finer than 75 Micrometers (No. 200) Sieve in Mineral Aggregate by Washing.
   3. ASTM D 1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ [2,700 kN-m/m]).

PART 2 - MATERIALS AND EQUIPMENT

2.01 SOIL MATERIALS

A. General: Unless otherwise specified, soil materials shall be in accordance with SNL Standards Specification 02200. All materials are subject to approval by the Sandia Construction Representative.

1. Fill material shall be free of organic matter, rubble, trash, and deleterious substances.

2. Frozen soil shall not be used as backfill or fill material.

B. Protective Soil Cover: The soil backfill shall be “clean” on-site native, excavated soil free of organic matter, topsoil, rubble, trash, and deleterious substances. The soil shall meet the following gradation requirements.

PROTECTIVE SOIL COVER

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
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</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>100</td>
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<td>No. 4</td>
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</tr>
<tr>
<td>No. 200</td>
<td>5-30</td>
</tr>
</tbody>
</table>

C. Anchor Trench Fill: Fill shall be on-site native, excavated soil. The particle size shall be less than 1/2-inch.

D. Embankment Fill: Fill shall be on-site native, excavated soil. The particle size shall be less than 1/2-inch. Use non-expansive soil such as gravel, soil, or a combination thereof.

E. Subgrade: The subgrade shall be free of rocks greater than 1/2-inch in any dimension, roots, debris, and standing water.

2.02 EQUIPMENT

A. General: All equipment, tools, and machines used in performance of the earthwork shall be subject to approval prior to commencement of work.
PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING

A. General: Clearing and grubbing shall be in accordance with SNL Standards Specification Section 02200.

3.02 EXCAVATION

A. General: Excavation activities shall be in accordance with SNL Standards Specification, Section 02200.

B. Over-Excavations: Care shall be exercised such that excavations are not carried below the required elevations shown on the construction drawings. If excavations are extended beyond the required excavation, backfilling with suitable structural fill and compacting to the design elevation indicated shall be completed.

C. Dewatering: Surface water shall be prevented from entering excavations and from flooding the project site and surrounding area. Excess water will be removed to prevent soil softening that may effect the stability of the excavated area.

D. Storage of Soil Materials: Excavated material, suitable for backfill and fill material, will be stockpiled at a specified location on site.

3.03 BACKFILL AND FILL

A. General: Backfill and fill activities shall be in accordance with SNL Standards Specification Section 02200.

B. Anchor Trench: Backfill shall be placed in the anchor trench over each underlying liner component extending into the trench or as determined necessary by the Sandia Construction Representative (SCR). Care shall be taken to place and compact the backfill so as not to damage the liner components.

C. Protective Soil Cover: The protective soil cover is to be placed directly above the geocomposite in the floor of the cell and above the access road in the cell.

1. The core of the underlying geocomposite shall be free of soil, dust, and accumulated debris prior to backfilling.

2. The placement of the protective soil layer shall not shift or damage the underlying geocomposite.
3. Placement of the soil cover shall be accomplished by equipment operating on top of the soil cover at all times. Placement shall begin at the base of the access road and proceed west and south until the cell cover is complete. No equipment shall be allowed directly on the geocomposite.

4. Placement of the soil cover shall be installed in multiple lifts with a first lift of 12 inches minimum to result in a compacted thickness of 18 inches in the floor of the cell and 24 inches on the access road.

3.04 COMPACTATION

A. General: Compaction activities shall be in accordance with SNL Standards Specification Section 02200, except that the first lift of the protective soil cover shall be a minimum of 12 inches.

B. Subgrade: The containment cell subgrade shall be compacted to a minimum relative density of not less than 90 percent so as not to rut or deform under the weight of installation equipment. Water shall be added or removed as necessary to produce a suitably firm subgrade.

Should rain cause erosion gullies to form in fill slopes, the slopes shall be reworked by mechanical equipment to restore them to their original lines and grades and compacted. No hand backfilling will be permitted.

C. Embankment: Embankment shall be placed in 6-inch maximum lifts and compacted to a minimum relative density of not less than 90 percent.

D. Anchor Trench: Fill shall be compacted to a minimum relative density of not less than 90 percent.

E. Protective Soil Cover: The protective soil cover shall be placed in a maximum first lift thickness of 12 inches and compacted to a minimum relative density of not less than 90 percent.

3.05 GRADING

A. General: All grading shall be complete in accordance with SNL Standards Specification Section 02200. All earthwork construction shall be controlled to a final horizontal line tolerance of plus or minus 0.5 foot. The vertical elevation tolerance, including embankment toes, shall be plus or minus 0.1 foot. All general grading required to bring grades to proper lines, slopes, and elevations shall be as shown on the drawings. General grading shall be smooth and free from irregular surface changes.

END OF SECTION

02010-4
EARTHWORK FOR CONTAINMENT CELL
Special Specification

Section 02020

Geosynthetic Clay Liner for Containment Cell
SPECIAL SPECIFICATION
SECTION 02020
GEOSYNTHETIC CLAY LINER FOR CONTAINMENT CELL

PART 1 - GENERAL

1.01 DESCRIPTION

This section defines the submittals and special requirements, the product properties, and
the appropriate actions for the care and installation of the geosynthetic clay liner (GCL).

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D 413, Standard Test Methods for Rubber Property—Adhesion to
   Flexible Substrate.

2. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation
   of Geotextiles.

3. ASTM D 4643, Standard Test Method for Determination of Water (Moisture)
   Content of Soil by the Microwave Oven Method.

4. ASTM D 4833, Standard Test Method for Index Puncture Resistance of
   Geotextiles, Geomembranes, and Related Products.


   Conductivity of Saturated Porous Materials Using a Flexible Wall Perimeter.

7. ASTM D 5199, Standard Test Method for Measuring Nominal Thickness of
   Geotextiles and Geomembranes.

8. ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of
   Geotextiles.

9. ASTM D 5321, Standard Test Method for Determining the Coefficient of Soil
   and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct
   Shear Method.

B. Geosynthetic Research Institute Standards


2. GRI GCL-2, Standard Test Method for "Permeability of Geosynthetic Clay Liners (GCLs)."


1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of GCL Materials and Workmanship: The GCL material shall be guaranteed, in writing, by the manufacturer or supplier on a pro-rated basis for a period of 5 years. The guarantee shall be against manufacturing defects in material and workmanship.

B. Experience of Contractor: The Contractor shall have demonstrated his ability to perform this work by having successfully installed, in impoundment or waste management unit structures, a minimum of 1,000,000 square feet of similar-type liners. A list of installations shall be submitted for approval. The list shall include the client name, contact person, telephone, date of installation, size, and type of material installed. In addition, the on-site liner supervisor assigned full time to this work shall have directed the installation of a minimum of 500,000 square feet of similar-type liners in landfill or impoundment structures.

C. Samples and Specifications of Materials: Prior to ordering any materials, four samples (each measuring approximately 8 inches by 10 inches) of the GCL proposed for the work, along with certified physical property values, shall be submitted for approval. In addition, the contractor shall submit the manufacturer's certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values.

The source of all GCL materials shall be selected in advance of use. Test results from samples shall be submitted to the Sandia Construction Representative (SCR) for approval not less than 30 days before the material is required for use.

D. Quality Control (QC) Documents: Prior to commencement of work, the manufacturer or supplier shall submit the manufacturer's QC reports and QC certificates for all GCL rolls.
E. **Shop Drawings:** Shop drawings showing the proposed layout of the deployed GCL rolls shall be submitted for approval prior to starting work. The proposed layout shall show the size, number, and position of all rolls. The scale of the drawing shall not be smaller than 1 inch = 50 feet.

F. **Work Plan:** Prior to commencement of work, the installer shall submit a work plan detailing anticipated method, equipment, manpower, and schedule for placement of the liners. The installer shall furnish the services of a competent, factory-trained, field technical representative to supervise the entire installation of the liners.

**PART 2 - MATERIALS AND EQUIPMENT**

2.01 **GEOSYNTHETIC CLAY LINER**

A. **Manufacturers:** The following have been selected as acceptable manufacturers of the products described herein:

1. Fluid Systems, Inc.

2. Approved Equal

B. **Product Properties:** The GCL shall be a composite containment liner which combines geotextile outer layers with an inner layer of low-permeability sodium bentonite. The geotextile components shall be high quality, chemical resistant, needle punched, non-woven fabrics. The GCL shall meet the following specifications:
# PROPERTIES OF THE GEOSYNTHETIC CLAY LINER

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<tr>
<th>PROPERTY</th>
<th>TEST</th>
<th>STANDARD</th>
<th>UNITS</th>
<th>VALUES</th>
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## COMPONENTS

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<td>maximum</td>
<td>ml</td>
<td>15</td>
</tr>
<tr>
<td>-Confined Swell</td>
<td>GRI GCL 1</td>
<td>minimum</td>
<td>%</td>
<td>350</td>
</tr>
</tbody>
</table>

### NOTES:

1) Typical tensile values given for weakest principle direction.
2) Samples hydrated under a net normal stress of 7.5 psi and observed internally.
3) Water permeability values given correspond to effective stress of 30 psi.
4) Nonwoven cation geotextile is woven reinforced.

## 2.02 EQUIPMENT

All equipment, tools, and machines used in performance of the work shall be subject to approval prior to commencement of work.
PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

Storage and handling of GCLs shall be in accordance with ASTM D 4873. GCLs are packaged in rolls and covered in a protective wrapping.

1. The delivery of the GCL shall be coordinated such that temporary storage of the rolls on site is kept to a minimum. If storage is required, GCL rolls shall be stored in the trailers in which they are delivered or at a location established for temporary storage where the materials can be kept dry.

2. The rolls shall be stored on high flat ground or elevated in an area where water can accumulate.

3. Protective wrapping damaged during handling or storage shall be repaired immediately.

4. The rolls shall be supported along their length and shall not be stacked so high as to cause thinning of the product.

5. Lifting the rolls requires a minimum 3-inch outside diameter steel pipe capable of supporting the roll to be inserted into the center cardboard roll core to minimize deformation.

6. Care shall be taken to minimize moisture pickup, exposure to ultraviolet light, and accidental damage. Damaged rolls shall be set aside and examined to determine the suitability of the liner for use.

3.02 INSTALLATION

A. The GCL will be installed to function as the lower component of the composite liner. The GCL is to be installed directly above the wicking materials on the bottom of the containment cell and over the prepared surface of the sidewalls. The GCL shall be installed in accordance with the previously approved sheet layout plans and shall not deviate from the plans except with the approval of the SCR.

The following are minimum installation specifications. The actual installation of the GCL shall conform to approved manufacturer’s installation guidelines.

1. The installer shall take the necessary precautions to protect the wicking material underlying the GCL. Construction equipment may be used to deploy the GCL; however, precautions shall be exercised to ensure that rutting of the wicking material in excess of 1 inch is avoided.
2. During placement, care shall be taken not to entrap fugitive clay, stones, or sand in or beneath the GCL that could damage the overlying geomembrane or hamper subsequent seaming of the materials.

3. On the side slopes, the rolls shall be secured at the top of the slope and extended down the slope as recommended by the manufacturer. Care shall be taken to minimize folds and wrinkles.

4. The GCL rolls shall be laid with a minimum overlap in accordance with the manufacturer’s recommendations and design considerations. Adjacent GCL sheets shall be overlapped according to match lines on the bottom sheet. Overlap distance is typically 10 inches from the edge of the sheet. An all inclusive 10-inch overlap should provide a minimum 6-inch overlap of bentonite. When the liner is cut to fit in small areas or corners, adjacent panels shall overlap a minimum of 6 inches. Transverse overlaps at the ends of rolls should be a minimum of 12 inches.

5. The same bentonite used in the GCL shall be placed between the sheets at the overlap region to verify the seal. The bentonite, in a dry state, shall be added using a line spreader or line chalker at a rate of 1/4 pound per linear foot of seam.

6. No horizontal seams shall be allowed on side slopes.

7. The edges of deployed rolls shall be secured with sandbags or other adequate ballast to prevent uplift.

8. Trimming or repairing of the GCL shall be done with great care such that fugitive clay particles do not come in contact with drainage materials or hinder subsequent geomembrane seaming activities.

9. Any patch, used for repair of a tear or rip in the geotextile, should be completed using the same materials as the damaged textile or other approved geotextile. If bentonite particles are lost from within the GCL, or if the bentonite has shifted, the patch should consist of the full GCL product. In either case, the patch must extend at least 12 inches beyond any portion of the damage and be sealed using the same bentonite in the overlap region to verify the seal. Patches on side slopes shall be minimized.

10. Patches on side slopes shall be minimized. GCL panels that require patching shall be moved and used on the floor of the containment cell whenever possible.
11. The deployed GCL shall be visually inspected to verify that no potentially harmful objects are present (e.g., stones, cutting blades, small tools, sandbags, etc.).

12. Areas that are inadvertently exposed to standing water or excess precipitation and allowed to hydrate prior to being covered, shall be examined by the SCR. If the SCR determines that the GCL has hydrated and that the bentonite would displace under expected load, the GCL must be removed and replaced.

13. Any GCL material exposed to hydrocarbon fuels, chemicals, pesticides, leachates, or other such liquids during installation, shall be cut out, removed, and disposed of away from any components of the liner presently under construction.

14. Only deploy as much GCL as can be anchored, inspected, and covered at the end of the day, or that can be covered in a reasonably short time in the event of precipitation. Care shall be taken to ensure that precipitation will not accumulate in the anchor trench prior to backfilling.

15. The GCL shall not be covered before inspection by the SCR.

16. Care shall be taken not to damage the GCL during the installation of the overlying geomembrane. Both the GCL and geomembrane shall be inspected to verify they are not damaged.

17. When construction and installation is halted at the end of the day, the leading edge of the GCL shall be folded back under the geomembrane such that the geomembrane extends beyond the GCL a minimum of 2 feet. The leading edge of the geomembrane shall then be weighted with sandbags or suitable ballast to safeguard against wind uplift and precipitation.

END OF SECTION
Special Specification

Section 02030

Flexible Geomembranes for Containment Cell
SPECIAL SPECIFICATION

SECTION 02030

FLEXIBLE GEOMEMBRANES FOR CONTAINMENT CELL

PART 1 - GENERAL

1.01 DESCRIPTION

This section defines the submittals and special requirements, the product properties, and the appropriate actions for the care and installation of the 60-mil high density polyethylene (HDPE) flexible membrane liners.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)


B. Federal Test Method Standard


1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of HDPE Geomembrane Material and Workmanship: The HDPE geomembrane materials shall be guaranteed, in writing, by the manufacturer or supplier for a period of 5 years. The guarantee shall be against manufacturing defects in material and workmanship and against deterioration due to ozone, ultraviolet, or other normal weather aging.

B. Experience of Contractor: The contractor shall have demonstrated his ability to perform this work by having successfully installed, in impoundment or waste management unit structures, a minimum of 1,000,000 square feet of similar-type flexible membranes. A list of installations shall be submitted for approval. The list shall include the client name, contact person, telephone, date of installation, size, and type of material installed. In addition, the on-site liner supervisor assigned full time to this work shall have directed the installation of a minimum of 500,000 square feet of similar-type liner in landfill or impoundment structures.

C. Samples and Specifications of Materials: Prior to ordering any materials, four samples (each measuring approximately 8 inches by 10 inches) of the HDPE geomembrane proposed for the work, along with certified physical property values, shall be submitted for approval. In addition, the contractor shall submit the manufacturer's certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values.

Four samples each of the geomembrane field joints and factory joints (if any) shall be submitted with a complete description of the seaming methods. Pipe boot details and test results, if not field fabricated, shall also be submitted.

The source of all geomembrane materials shall be selected in advance of use. Test results from samples shall be submitted to the Sandia Construction Representative (SCR) for approval not less than 30 days before the material is required for use.

D. Quality Control (QC) Documents: Prior to commencement of work, the manufacturer or supplier shall submit the manufacturer's QC reports and QC certificates for all geomembrane rolls.

E. Shop Drawings: Shop drawings showing the proposed layout of the deployed HDPE rolls shall be submitted for approval prior to starting work. The proposed layout shall show the size, number, and position of all rolls. Locations of field joints and factory joints (if any) shall also be indicated. The scale of the drawing shall not be smaller than 1 inch = 50 feet.
F. **Work Plan**: Prior to commencement of work, the installer shall submit a work plan detailing anticipated method, equipment, manpower, and schedule for placement of the liners. The installer shall furnish the services of a competent, factory-trained, field technical representative to supervise the entire installation of the geomembranes.

**PART 2 - MATERIALS AND EQUIPMENT**

2.01 **HDPE LINER AND PROTECTIVE COVER SHEET**

A. **Manufacturers**: The following have been selected as acceptable manufacturers of the products described herein:

1. GSE Lining Technology, Inc.
2. *error Corporation
3. Approved Equal

B. **Product Properties**: The liner and the protective cover sheet shall consist of new, premium grade geomembranes from virgin polyethylene resin. The geomembranes shall be free of defects such as holes, tears, nodules, blisters, or manufacturing defects that may affect the life or serviceability of the materials. The materials shall have suitable physical and mechanical properties that have been satisfactorily demonstrated by prior use. Each roll shall be labeled to identify thickness, length, and manufacturer's mark number.

HDPE geomembranes will be required as shown below:

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SURFACE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom Liner</td>
<td>Black-Surfaced, Smooth on both sides</td>
</tr>
<tr>
<td>Sidewall Liner</td>
<td>Black-Surfaced, Smooth on both sides</td>
</tr>
<tr>
<td>Sidewall Leachate Collection Trench Protective Cover Sheet</td>
<td>Black-Surfaced, Smooth on both sides</td>
</tr>
</tbody>
</table>

The HDPE geomembranes shall meet the following specifications:
PROPERTIES OF THE BLACK-SURFACED, SMOOTH 60-MIL HDPE LINER

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>UNITS</th>
<th>NOMINAL VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D 751/1593/5199</td>
<td>mils</td>
<td>60</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D 792/1505</td>
<td>g/cc</td>
<td>0.94</td>
</tr>
<tr>
<td>Tensile Properties (each direction):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength at Break</td>
<td>ASTM D 638, Type IV</td>
<td>lb/in-width</td>
<td>300</td>
</tr>
<tr>
<td>Strength at Yield</td>
<td>Dumbell, 2 ipm</td>
<td>lb/in-width</td>
<td>140</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>Gauge lengths per NSF Std. 54</td>
<td>%</td>
<td>800</td>
</tr>
<tr>
<td>Elongation at Yield</td>
<td></td>
<td>%</td>
<td>15</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D 1004</td>
<td>lb</td>
<td>50</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>FTMS 101, Method 2065</td>
<td>lb</td>
<td>90</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D 1603</td>
<td>%</td>
<td>2</td>
</tr>
<tr>
<td>Environmental Stress Crack Resistance</td>
<td>ASTM D 1693, Cond. B</td>
<td>hr</td>
<td>2000</td>
</tr>
<tr>
<td>Tensile Impact Strength</td>
<td>ASTM D 256</td>
<td>ft-lb/in²</td>
<td>381</td>
</tr>
<tr>
<td>Low Temperature Brittleness</td>
<td>ASTM D 746, Cond. B</td>
<td>°F</td>
<td>-120</td>
</tr>
</tbody>
</table>

2.02 WELDING MATERIALS

All welding materials shall be of a type recommended and supplied by the liner manufacturer and shall be delivered in the original sealed containers. Each container shall have an indelible label bearing the brand name, manufacturer's mark number, and complete directions as to proper storage.

2.03 PIPE BOOTS

Piping penetrating the geomembranes shall be sealed to the membrane with pipe boots. The boots shall be steel banded and made of the same material and exhibit the same workmanship as the membrane to which it is sealed.

2.04 EQUIPMENT

All equipment, tools, and machines used in performance of the work shall be subject to approval prior to commencement of work.

02030-4
FLEXIBLE GEOMEMBRANES FOR CONTAINMENT CELL
PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. Rolls of HDPE geomembranes shall be handled such that no damage to the materials will occur.

1. Off-loading shall be performed with cranes or forklifts, and no pushing, sliding, or dragging of the rolls shall be permitted.

2. The rolls shall be stored in an area where standing water can not accumulate and the ground surface shall be cleared of stones and other rough objects that could potentially damage the geomembranes.

3. Geomembrane rolls shall not be stacked so high as to cause crushing of the core or flattening of the rolls. This limit is typically 5 rolls high. The rolls shall be adequately secured such that shifting, abrasion, or other adverse movement does not occur.

4. For storage periods longer than six months, the rolls shall be covered.

3.02 INSTALLATION

A. The HDPE geomembranes will be installed to function as the upper component of the composite liner and as the sidewall leachate collection trench protective cover sheet. Functioning as the liner, the HDPE geomembrane will be installed directly above the GCL on the floor and sidewalls of the cell. Within the sump, a second layer of the HDPE geomembrane will be installed and will extend beyond the sump 5 feet on the north end and 3 feet on all remaining sides. Functioning as the protective cover sheet, the HDPE geomembrane will be installed directly above the leachate collection trench. The geomembranes shall be installed in accordance with the previously approved sheet layout plans and shall not deviate from the plans except with the approval of the SCR.

The following are minimum installation specifications. The actual installation of the geomembranes shall conform to approved manufacturer’s installation guidelines.

1. The underlying GCL shall be inspected and have all folds, wrinkles and debris removed prior to placement of the geomembrane.

2. The geomembranes shall be placed over the underlying GCL by hand or by using small lifting units on pneumatic tires so as not to damage the...
GCL. Tire inflation pressures on pneumatic lifts should be limited to a maximum value of 6 pounds per square inch.

3. Care shall be taken to unroll each geomembrane close to its final position, as repositioning may be difficult and may cause damage to the membrane.

4. On the side slopes, the rolls shall be secured at the top of the slope and extended down the slope as recommended by the manufacturer. Care shall be taken to minimize folds and wrinkles.

5. Geomembranes that have been torn or excessively deformed during installation shall be rejected or repaired.

6. Geomembrane rolls shall not be unrolled in temperatures less than 32°F or above 122°F to avoid cracking and distortion in texture.

7. The geomembrane shall have adequate slack such that it does not lift up off of the substrate material at any location.

8. The geomembranes shall not be installed with excessive slack that would cause the membrane to crease or fold over upon itself.

9. Any shifting required after any geomembrane has been deployed and before the field seaming begins shall be done with a minimal amount of dragging and without disturbing the material beneath the membrane.

10. Sandbags, tires, or other adequate ballast may be used to temporarily anchor the geomembranes to avoid wind damage. Deployed geomembrane rolls that have been displaced or damaged by wind shall be rejected and/or repaired as required by the SCR. Rejected materials must be removed from the site.

11. Temporary tack welds shall not interfere with the primary seaming method or the ability to perform subsequent destructive seam tests.

12. Any membrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be repaired or replaced as directed by the SCR. All patches shall extend a minimum of 6 inches from the affected area.

13. Surfaces to be repaired shall be abraded no more than one hour prior to the repair. Surfaces shall be clean and dry.
14. The final seaming of the geomembrane and backfilling of the anchor trench shall be done during the coldest part of the day. Seaming shall not take place during precipitation, blowing dust, or high winds. The weld area shall be free of all dirt, dust, moisture, or other foreign material prior to seaming.

15. Seaming will be accomplished by the hot wedge method by extrusion welding. Seaming will be completed in accordance with the manufacturer's recommendations and design considerations. Only the manufacturer's approved seaming equipment and products shall be used for all seams.

16. Horizontal seams on slopes shall not be allowed.

17. The rolls shall be overlapped a minimum of 4 inches for hot wedge welding and 3 inches for extrusion welding. The liner panels shall be welded together a minimum of 1 foot into the anchor trench.

18. "Fish mouths" and wrinkles shall not be allowed to occur at seams.

19. All pipe penetrations and anchorage details shall be as recommended by the manufacturer or as shown on the drawings.

20. The nearest seam parallel to the leachate collection trench shall be offset a minimum of 10 feet from the centerline of the trench.

3.03 TESTING

A. Test Strips and Trial Seams: Test strips shall be conducted to estimate the quality of the production field seams including equipment and operator proficiency. The SCR shall have the option of requesting test strips of any field seaming crew or device at anytime. The SCR shall observe all trial seam procedures and tests.

The following testing procedures shall be followed:

1. Test strips shall be made in sufficient lengths, as a single continuous seam, for required testing purposes.

2. Test strips shall be made every four hours. Additionally, they shall be made whenever personnel or equipment are changed, when climatic conditions reflect wide changes in geomembrane temperature, or when other conditions occur that could affect seam quality.
3. Test strips shall be approximately 3-feet long by 1-foot wide for extrusion welds and 6-feet long by 1-foot wide for hot wedge welds with the seam centered lengthwise. Overlaps will be representative of production seams.

4. Destructive testing on the trial seams shall begin as soon as the seam cools.

5. The cut specimens shall be randomly selected by the SCR and tested in both peel and shear using a field tensiometer supplied by the CQA contractor.

6. A new test strip shall be fabricated if any of the test specimens fail. If additional specimens fail, the seaming apparatus and seamer shall not be accepted and will not be used for seaming until the deficiencies are corrected and successful trial welds are achieved.

7. If the specimens pass, seaming operations can move directly to production seams.

B. Destructive Test Methods for Seams: Destructive testing shall be accomplished by cutting out and removing a portion of the completed production seam and then further cutting the sample into appropriately sized test specimens. The SCR shall select the sampling location where test specimens shall be cut from the seam. The SCR shall witness the seam sample cutting and all field tests and verify that proper identification and details accompany the test results.

Details required in COA documents include:

- Date and time
- Ambient temperature
- Identification of seaming unit, group or machine
- Name of master seamer
- Welding apparatus temperature and pressure, or chemical type and mixture
- Pass or fail description
- A copy of the report shall be attached to the remaining portion of the sample.

The SCR shall observe and verify that the following procedures are adhered to during destructive testing:
1. When cutting samples from the geomembrane, only an upward hook blade shall be used.

2. Holes in the geomembrane resulting from seam sampling shall be repaired immediately in accordance with the repair procedures.

3. Samples shall be adequately numbered and marked with permanent identification.

4. A 28-inch long sample shall be taken from the seam and cut into two individual 14-inch samples. Individual samples go to the CQA Contractor and the Owner. The CQA Contractor shall cut the sample into five shear and five peel test specimens and shall conduct the appropriate tests immediately. The remaining sample shall be archived by the Owner.

5. The sample width perpendicular to the seam shall be 12 inches with the seam centrally located within this dimension.

6. Seam samples shall be taken at fixed increments along the total length of the seams. Increments shall be 250 feet. This value may be applied either directly to the record drawing during layout of the seams, or to each seaming crew as they progress during the work period.

7. This increment shall be held regardless of the location upon which it falls. Exceptions to avoid sumps, connections, protrusions, etc. may be made with the approval of the SCR.

8. Field testing of individual specimens shall be completed using an electric or hand tensiometer.

9. Shear tests shall be conducted in accordance with ASTM D 4437. Seam shear efficiencies shall be at least 95 percent of the specified minimum yield strength of the geomembrane.

10. Peel tests shall be conducted in accordance with ASTM D 4437. Seam peel efficiencies shall be at least 62 percent of the specified minimum yield strength of the geomembrane. Frontward and backward peel tests shall be performed.

11. Only one failure out of the five tested specimens per test type (i.e., shear or peel) is allowable. If the failure number is larger, two additional samples shall be taken, one on each side of the original sample each spaced 10 feet from it. If either one of these samples fail, the iterative process of sampling every 10 feet is repeated until passing test results are observed.
The entire seam between the two successful test sample shall be questioned, and the SCR may elect to have the contractor strip the entire seam or if the seam is made with a thermal fusion method, to extrude a fillet weld over the outer seam edge.

12. Verbal laboratory test results to verify field results shall be required within 24 hours after the laboratory receives the samples. The test results shall be directed to the SCR.

13. Each repair of a patched seam where a test sample had been removed shall be verified by nondestructive testing.

C. Nondestructive Test Methods for Seams: All field seams will be nondestructively tested over their full length using a vacuum test unit, air pressure testing, or other CQA approved method where applicable. Nondestructive testing is meant to verify the continuity of field seams and not to quantify seam strength. The SCR shall observe all nondestructive testing procedures.

The SCR shall observe and verify that the following procedures are adhered to during nondestructive testing:

1. Nondestructive testing shall be conducted as the seaming work progresses or as soon as a suitable length of seam is available.

2. Nondestructive testing shall be required for 100 percent of the field seams. The SCR may approve an alternative test method for seams occurring in sumps and at pipe penetrations.

3. Dual seam air pressure tests shall be in accordance with GRI GM-6.

4. The location, data, test number, name of test person, and outcome of tests shall be recorded.

5. In the event of failed nondestructive tests, the failed area shall be repaired by extrusion welding.

6. The SCR shall be informed of any deficiencies.

END OF SECTION
Special Specification

Section 02040

Geocomposite for Containment Cell
SPECIAL SPECIFICATION

SECTION 02040

GEOCOMPOSITE FOR CONTAINMENT CELL

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section defines the submittals and special requirements, product properties, and the appropriate actions for the care and installation of the geocomposite (i.e., the geonet/geotextile composite filter layer).

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)


1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of the Geocomposite Materials and Workmanship: The geocomposite materials shall be guaranteed, in writing, by the manufacturer or supplier for a period of 12 months. The guarantee shall be against defects in material and workmanship.

B. Experience of Contractor: The contractor shall have demonstrated his ability to perform this work by having successfully installed, in impoundment or waste management unit structures, a minimum of 1,000,000 square feet of similar-type materials. A list of installations shall be submitted for approval. The list shall include the client name, contact person, telephone, date of installation, size, and type of material installed. In addition, the on-site supervisor assigned full time to this work shall have directed the installation of a minimum of 500,000 square feet of similar-type material in landfill or impoundment structures.

C. Samples and Specifications of Materials: Prior to ordering any materials, four samples (each measuring approximately 8 inches by 10 inches) of the geocomposite material proposed for the work, along with certified physical property values, shall be submitted for approval. In addition, the contractor shall submit the manufacturer’s certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values.

The source of all materials shall be selected in advance of use. Test results from samples shall be submitted to the Sandia Construction Representative (SCR) for approval not less than 30 days before the material is required for use.

D. Quality Control (QC) Documents: Prior to commencement of work, the manufacturer or supplier shall submit the manufacturer’s QC reports and QC certificates for all geocomposite rolls.

E. Shop Drawings: Shop drawings showing the proposed layout of the deployed geocomposite shall be submitted for approval prior to starting work. The proposed layout shall show the size, number, and position of all rolls. Locations of field joints and factory joints (if any) shall also be indicated. The scale of the drawing shall not be smaller than 1 inch = 50 feet.

F. Work Plan: Prior to commencement of work, the installer shall submit a work plan detailing anticipated method, equipment, manpower, and schedule for placement of the materials.

02040-2
GEOCOMPOSITE FOR CONTAINMENT CELL
PART 2 - MATERIALS AND EQUIPMENT

2.01 GEOCOMPOSITE

A. Manufacturers: The following have been selected as acceptable manufacturers of the products described herein:

1. TENSAR Environmental Systems, Inc.
2. GSE Lining Technology, Inc.
3. Fluid Systems, Inc.
4. Approved Equal

B. Product Properties: The geocomposite shall consist of a geotextile bonded to one side of a geonet. The geocomposite shall have a low compressibility in order to maintain high flow capacity over a wide range of confining pressures. The strength of the bond between the geonet and geotextile shall be greater than the friction developed between the geotextile and the protective soil layer. The geocomposite shall maintain a high flow under long term loading conditions and shall be resistant to biological and chemical degradation normally encountered in a soil environment.

The geocomposite shall be made from geonet and geotextile products that conform to the following specifications:
# Properties of the Geocomposite

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Units</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Capacity</td>
<td>ASTM D 4716</td>
<td>x 10&lt;sup&gt;3&lt;/sup&gt; ft/sec</td>
<td>21</td>
</tr>
<tr>
<td>Gradiant</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Transmissivity @ 500 psf</td>
<td></td>
<td>x 10&lt;sup&gt;3&lt;/sup&gt; ft/sec</td>
<td>16</td>
</tr>
<tr>
<td>Transmissivity @ 10,000 psf</td>
<td></td>
<td>x 10&lt;sup&gt;3&lt;/sup&gt; ft/sec</td>
<td>8.6</td>
</tr>
<tr>
<td>Transmissivity @ 20,000 psf</td>
<td></td>
<td>x 10&lt;sup&gt;3&lt;/sup&gt; ft/sec</td>
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<tr>
<td>Compression @ 20,000 psf</td>
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<td>%</td>
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<td>Aperture Size</td>
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<td>inches</td>
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</tr>
<tr>
<td>Thickness</td>
<td>O.D. Calipered</td>
<td>inches</td>
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</tr>
<tr>
<td>Specific Gravity</td>
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<td>Carbon Black Stabilization</td>
<td>ASTM D 4218</td>
<td>%</td>
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<td>Geotextile</td>
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<tr>
<td>Apparent Open Size</td>
<td>ASTM D 4751</td>
<td>US Std. Sv. Sz.</td>
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<tr>
<td>Permeability</td>
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<tr>
<td>Trapezoidal Tear Strength</td>
<td>ASTM D 4533</td>
<td>lbs</td>
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<tr>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
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<td>115</td>
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<td>Mullen Burst</td>
<td>ASTM D 3786</td>
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</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
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</tr>
<tr>
<td>Weight</td>
<td>ASTM D 5261</td>
<td>oz/ny</td>
<td>7.5</td>
</tr>
<tr>
<td>Composite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laminate Bond Strength</td>
<td>ASTM F 904</td>
<td>g/in</td>
<td>400</td>
</tr>
<tr>
<td>Thickness - Finished Product</td>
<td>O.D. Calipered</td>
<td>in</td>
<td>0.24</td>
</tr>
</tbody>
</table>

**Notes:**
1. Test values are for this core not only.
2. MD-Machine (roll) Direction.
3. Test values are for geotextile prior to bonding process.
4. All test values are nominal unless otherwise indicated.
5. Compression Tests are performed on a 2-inch square sample loaded at 1 mm/min to measure load rate of strain.
6. Inside dimensions in both principal directions are measured by calipers.
7. Outside dimensions in each principal dimension are measured by calipers.
8. Thickness is measured by placing the specimen flat on a comparator base and lowering a round 0.5 Inch diameter flat to contact surface squarely over a function.
9. Geotextile specimens within each roll of finished goods shall be considered acceptable product. The spacing methods shall include, but are not limited to, matching or tear bonding. The finished splice shall maintain the continuity of the filtration function of the geotextile. These methods will be considered viable and acceptable unless otherwise specified.
10. Minimum value of a random 5 samples (MD) average between the polyethylene geotextile and the needle punched geotextile.

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GEOCOMPOSITE FOR CONTAINMENT CELL
2.02 THREAD

Thread required for sewn seams shall be provided by the manufacturer or supplier. The thread shall be a bonded TEX size 210 (i.e., weight in grams of 1 kilometer of thread), 2,000 denier (i.e., weight in grams of 9,000 linear meters of thread), or as recommended by the manufacturer.

2.03 EQUIPMENT

All equipment, tools, and machines used in performance of the work shall be subject to approval prior to commencement of work.

PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. Storage and handling of geocomposites shall be in accordance with ASTM D 4873. The geocomposite materials shall be delivered to the site in rolls, bonded to a core, and covered in a protective wrapping.

1. The rolls shall be handled in a competent manner so as not to damage the geocomposite or protective wrapping.

2. The rolls shall be elevated off the ground and stored in areas where water can not accumulate. The rolls shall be adequately covered to protect them from ultraviolet light.

3. The rolls shall be stacked in such a way that the core is not crushed, the geocomposite is not damaged, and conformance testing is possible.

4. Outdoor storage of the rolls shall not exceed manufacturers recommendations or longer than 6 months, whichever is shorter. For storage longer than 6 months, a temporary cover shall be placed over the rolls.

3.02 INSTALLATION

A. The geocomposite will be installed in the floor of the cell above the HDPE liner and will extend up the sidewalls approximately 3.5 feet. The geocomposite shall consist of a geotextile bonded to one side of a geonet. The geotextile layer will function to prevent soil particles, from the overlying protective soil layer, from infiltrating and clogging the drainage system. The geocomposite shall be installed in accordance with the previously approved sheet layout plans and shall not deviate from the plans except with the approval of the SCR.

02040-5
GEOCOMPOSITE FOR CONTAINMENT CELL
The following are minimum installation specifications. The actual installation of the geocomposite shall conform to approved manufacturer’s installation guidelines.

1. The protective wrapping on the geocomposite rolls shall be removed only after the underlying geomembrane has been properly seamed and its installation documented and approved by the SCR.

2. The necessary precautions shall be taken when installing the geocomposite so as not to damage the underlying geomembrane. Deployment shall be by hand, by use of small lifting units on pneumatic tires, or by use of all-terrain vehicles. Construction equipment shall not ride directly on the underlying geomembrane or the geocomposite.

3. The geocomposite shall be placed so as to channel flow to the leachate collection trench.

4. Care shall be exercised not to entrap fugitive stones or soil, either within or beneath the composite, that may potentially damage the geomembrane or clog the drainage system. To ensure the surface is free of fugitive materials, a visual examination of the underlying geomembrane shall be made and the appropriate preparatory action taken before deployment of the geocomposite.

5. Care shall be taken to minimize folds and wrinkles.

6. Trimming shall be performed using only an upward cutting hook blade.

7. When connecting the geocomposite rolls, the rolls shall be deployed side by side and the geonet joined together using plastic fasteners or polymer braids at approximately 5 foot intervals. The geotextile shall be overlapped a minimum of 3 inches. Geotextile overlaps shall be sewn or secured with duct or double-sided tape.

8. When connecting the geocomposite rolls end-to-end, the material shall be overlapped a minimum of 12 inches and tied every 6 inches across the width of the roll. The geotextile shall be overlapped and sewn or secured with duct or double-sided tape.

9. Holes or tears in the drainage cores shall be repaired by placing a patch of the same type of material over the damaged area. The patch shall extend at least 4 inches beyond the edges of the hole or tear.

10. Holes or tears in the geotextile shall be repaired using a patch of the same type of polymetric material. The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.
11. The geotextile patch shall be sewn in place by hand or machine so as not to accidentally shift out of position before or during covering operations. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired.

12. The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.

13. The core of the geocomposite shall be free of soil and accumulated debris before the protective soil layer is deployed.

14. A visual examination of the deployed geocomposite shall be carried out to verify that no potential harmful objects (i.e., stones, sharp objects, small tools, sand bags, etc.) are present.

15. Placement of the protective soil layer over the geocomposite shall not shift the position of nor damage the geocomposite.

END OF SECTION
Special Specification

Section 02050

Geotextile Wrap for Containment Cell Collection Trench
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section defines the submittals and special requirements, product properties, and the appropriate actions for the care and installation of the geotextile wrap.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)


1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of the Geotextile Materials and Workmanship: The geotextile materials shall be guaranteed, in writing, by the manufacturer or supplier for a period of 12 months. The guarantee shall be against manufacturing defects in material and workmanship.

B. Experience of Contractor: The contractor shall have demonstrated his ability to perform this work by having successfully installed, in impoundment or waste management unit structures, a minimum of 1,000,000 square feet of similar-type materials. A list of installations shall be submitted for approval. The list shall include the client name, contact person, telephone, date of installation, size, and type of material installed. In addition, the on-site supervisor assigned full time to this work shall have directed the installation of a minimum of 500,000 square feet of similar-type material in landfill or impoundment structures.

C. Samples and Specifications of Materials: Prior to ordering any materials, four samples (each measuring approximately 8 inches by 10 inches) of the geotextile material proposed for the work, along with certified physical property values, shall be submitted for approval. In addition, the contractor shall submit the manufacturer's certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values.

The source of all materials shall be selected in advance of use. Test results from samples shall be submitted to the Sandia Construction Representative (SCR) for approval not less than 30 days before the material is required for use.

D. Quality Control (QC) Documents: Prior to commencement of work, the manufacturer or supplier shall submit the manufacturer's QC reports and QC certificates for all geotextile rolls.

E. Shop Drawings: Shop drawings showing the proposed layout of the deployed geotextile shall be submitted for approval prior to starting work. The proposed layout shall show the size, number, and position of all rolls. Locations of field joints and factory joints (if any) shall also be indicated. The scale of the drawing shall not be smaller than 1 inch = 50 feet.

F. Work Plan: Prior to commencement of work, the installer shall submit a work plan detailing anticipated method, equipment, manpower, and schedule for placement of the materials.
PART 2 - MATERIALS AND EQUIPMENT

2.01 GEOTEXTILE

A. Manufacturers: The following have been selected as acceptable manufacturers of the products described herein:

1. TREVIRA Spunbond
2. TENSAR Environmental Systems, Inc.
3. Approved Equal

B. Product Properties: The geotextile shall be a nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester, formed into a stable network by needle punching. The fabric shall be resistant to biological and chemical degradation normally encountered in a soil environment. The fabric shall conform to the following specifications:

<table>
<thead>
<tr>
<th>PHYSICAL PROPERTIES</th>
<th>TEST METHOD</th>
<th>UNITS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric Weight</td>
<td>ASTM D 5261</td>
<td>oz/yd²</td>
<td>4.2</td>
</tr>
<tr>
<td>Fabric Thickness</td>
<td>ASTM D 5199</td>
<td>mils</td>
<td>70</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
<td>lbf</td>
<td>150/125</td>
</tr>
<tr>
<td>Elongation at Failure</td>
<td>ASTM D 4632</td>
<td>%</td>
<td>75/85</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>ASTM D 3786</td>
<td>psi</td>
<td>225</td>
</tr>
<tr>
<td>Coefficient of Normal Permeability (k)</td>
<td>ASTM D 4491</td>
<td>cm/sec</td>
<td>0.45</td>
</tr>
<tr>
<td>Permeability</td>
<td>ASTM D 4491</td>
<td>sec⁻¹</td>
<td>2.5</td>
</tr>
<tr>
<td>Vertical Water Flow</td>
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<td>gpm/ft²</td>
<td>190</td>
</tr>
<tr>
<td>Apparent Open Size</td>
<td>ASTM D 4751</td>
<td>US Standard Sieve Number larger than</td>
<td>70</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>ASTM D 4533</td>
<td>lbf</td>
<td>5550</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833</td>
<td>lbf</td>
<td>65</td>
</tr>
</tbody>
</table>

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GEOTEXTILE WRAP FOR CONTAINMENT CELL COLLECTION TRENCH
2.02 THREAD

Thread required for sewn seams shall be provided by the manufacturer or supplier. The thread shall be a bonded TEX size 210 (i.e., weight in grams of 1 kilometer of thread), 2,000 denier (i.e., weight in grams of 9,000 linear meters of thread), or as recommended by the manufacturer.

2.03 EQUIPMENT

All equipment, tools, and machines used in performance of the work shall be subject to approval prior to commencement of work.

PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

Storage and handling shall be in accordance with ASTM D 4873.

1. The geotextile rolls shall remain wrapped and protected from moisture and UV light prior to being deployed. The rolls shall be handled in a manner that will avoid damaging the materials.

2. The location of field storage shall not be in areas where water can accumulate. The rolls shall be elevated off of the ground so as not to form a dam creating the ponding of water.

3. The rolls shall be stacked in such a way that the cores are not crushed nor the geotextile or protective covering damaged.

4. Outdoor storage of rolls shall not exceed manufacturers recommendations or longer than 6 months, whichever is less. For storage periods longer than 6 months, a temporary cover shall be placed over the rolls.

5. Any geotextile seen to be in a damaged or degraded condition, either before or after placement, shall be removed and replaced.

3.02 INSTALLATION

A. A continuous layer of geotextile shall be used to wrap the drain aggregate in the collection trenches as shown on the construction drawings. The geotextile shall be installed to act as a separator and cushion between the aggregate and synthetic liners. The geotextile shall be installed in accordance with the previously approved sheet layout plans and shall not deviate from the plans except with the approval of the SCR.

GEOTEXTILE WRAP FOR CONTAINMENT CELL COLLECTION TRENCH
The following are minimum installation specifications. The actual installation of the geotextile shall conform to approved manufacturer’s installation guidelines.

1. Precautions shall be taken to protect the underlying geomembrane upon which the geotextile will be placed. Deployment of the geotextile will be either by hand or by use of a low ground contact pressure vehicle.

2. During placement, care shall be taken not to entrap, either within or beneath the geotextile, stones or excessive dust that could damage the underlying geomembrane or cause clogging of drains or filters.

3. Trimming of the geotextile shall be performed using only an upward hook.

4. The geotextile roll edges (i.e., end to end in the cell floor and those brought together over the aggregate) shall have a minimum overlap of 12 inches. All overlaps shall be sewn.

5. Sandbags or tires may be used to temporarily hold the geotextiles in place.

6. Metal wires or any devices that may penetrate or damage the geotextile or synthetic liners are prohibited. Heat seaming shall not be permitted.

    Patch material used for repair of a hole or tear shall be the same type of polymeric material as the damaged geotextile.

8. The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.

9. The patch shall be sewn in place by hand or machine so as not to accidentally shift out of position or be moved during backfilling or covering operations.

10. The thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile itself.

11. Backfilling shall be accomplished such that the geotextile is not shifted from its intended position or damaged, and the underlying geomembrane is not exposed or damaged.

END OF SECTION
Special Specification

Section 02060

Leachate Collection and Removal System
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section defines the submittals and special requirements, materials, material properties, and the appropriate actions necessary to install the leachate collection and removal system.

Necessary materials include:

1. Polyvinyl chloride (PVC) leachate collection, cleanout, transfer, and riser pipe.
2. Nylon discharge tubing.
3. Pipe bedding.
4. Drain aggregate.
5. Bentonite/soil backfill.
7. Nylon pipe insulation.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

4. ASTM D 1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120.


1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of Piping Materials and Workmanship: The piping materials shall be guaranteed in writing by the manufacturer or supplier to be free of defects in material and workmanship for a period of 1 year following the date of acceptance.

B. Samples and Specifications of Materials: The source of all materials shall be selected in advance of use.

1. Contractors shall provide printed information on materials, products, and systems, which show performance characteristics, dimensions, materials of fabrication, and other characteristics necessary to assure conformity with the design requirements.

2. Contractors shall submit the manufacturer’s certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values and that these materials are in accordance with specified requirements.
3. Prior to delivery to the site, sieve analysis results shall be submitted for approval by the Sandia Construction Representative.

PART 2 - MATERIALS

2.01 PVC PIPE AND FITTINGS

A. Manufacturers: The following have been selected as acceptable manufacturers of the products described herein:

1. R&G Sloan

2. Approved equal

B. Product Properties: All PVC materials shall conform to ASTM D 1755. All PVC pipe shall conform to ASTM D 1785 and be of size and diameter as specified herein. All PVC pipe shall be flush threaded unless otherwise noted. All PVC pipe fittings shall be in accordance with ASTM D 3034.

Pipe and fittings shall be the products of one manufacturer and shall conform to the following specifications:

1. Schedule 40, 4-inch diameter PVC pipe shall serve as secondary containment for the nylon tubing leachate discharge line from the surface of the cell to the drain box in the leachate storage area.

2. Schedule 80, 4-inch diameter PVC pipe shall serve as the leachate collection and cleanout lines. The slotted portion of the 4-inch collection pipe shall have four rows of slots, 0.125-inch wide, an outside slot length of 1.75 inches, with 0.5-inch between slots and shall be cut using a 3-inch blade.

3. Schedule 80, 10-inch diameter PVC pipe shall serve as the sump access pipe. The slotted portion of the 10-inch pipe shall have six rows of slots, 0.125-inch wide, an outside slot length of 2.75 inches, with 0.5-inch between slots and shall be cut with a 4-inch blade.

PROPERTIES OF THE SCHEDULE 40 PVC PIPE

<table>
<thead>
<tr>
<th>Nominal Pipe Size (inch)</th>
<th>Outer Diameter (inch)</th>
<th>Average Inner Diameter (inch)</th>
<th>Minimum Wall Thickness (inch)</th>
<th>Nominal Weight (lb/100 ft)</th>
<th>Maximum Work Pressure (psi) at 73°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4.500</td>
<td>4.026</td>
<td>0.237</td>
<td>205.0</td>
<td>220</td>
</tr>
</tbody>
</table>

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LEACHATE COLLECTION AND REMOVAL SYSTEM
PROPERTIES OF THE SCHEDULE 80 PVC PIPE

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Outer Diameter (in.)</th>
<th>Average Inner Diameter (in.)</th>
<th>Minimum Wall Thickness (in.)</th>
<th>Nominal Weight (lbs/100 ft)</th>
<th>Maximum Work Pressure (psi) at 73°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10.750</td>
<td>9.564</td>
<td>0.593</td>
<td>1224.3</td>
<td>NA</td>
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<td>4</td>
<td>4.500</td>
<td>3.826</td>
<td>0.337</td>
<td>284.4</td>
<td>160</td>
</tr>
</tbody>
</table>

2.02 NYLON DISCHARGE TUBE

The nylon tubing shall be 1.25-inch outside diameter and shall serve as the leachate discharge line from the pump through the 10-inch sump access pipe. A 4-inch PVC pipe will serve as secondary containment for the tubing above the surface of the cell.

2.03 BEDDING MATERIAL

The pipe bedding material shall consist of course sand, Class IA, IB, or II according to ASTM D 2321, and conform to the following gradations:

BEDDING MATERIAL

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>&gt;50</td>
</tr>
<tr>
<td>No. 8</td>
<td>75-100</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-3</td>
</tr>
</tbody>
</table>

2.04 DRAIN AGGREGATE

A. The drain aggregate to be placed within the leachate collection trenches shall be clean, durable, subrounded, natural rock fragments, free of organic matter, anhydrite, gypsum, mica, calcareous material, or other deleterious matter. The aggregate shall consist of washed granitic, basic igneous, or quartzitic material. The aggregate shall be Class IA, IB, or II according to ASTM D 2321, and shall meet the following gradations:
DRAIN AGGREGATE MATERIAL

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>80-100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>60-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-50</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-3</td>
</tr>
</tbody>
</table>

2.05 BENTONITE/SOIL BACKFILL

The bentonite/soil mix shall be composed of approved fill material treated with 0 percent by weight of sodium bentonite. The bentonite/soil mix shall conform with lean clay/fat clay (C'v/CL) or clayey sand (SC) classification.

A. Bentonite: The bentonite shall be high swelling, sodium montmorillonite, containing no organic polymers. High swelling is defined as the ability of two grams of bentonite, when mechanically reduced to minus 100 mesh, to swell in water to an apparent volume of 16 cubic centimeters (cc) or more when added a little at a time to 100 cc of distilled water contained in a graduated cylinder. Colloid content shall exceed 70 percent. The process density shall be 70.0 +/- 4.0 pounds per cubic feet. The bentonite particle size shall be as follows:

BENTONITE

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size (Square Openings)</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>97-100</td>
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<tr>
<td>No. 10</td>
<td>15-20</td>
</tr>
<tr>
<td>No. 20</td>
<td>0-1</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1</td>
</tr>
</tbody>
</table>

B. Soil Fill: The fill material shall be obtained from the excavated soils. The soil shall be free of rock, debris, and organic material.
2.06 HEAT TRACE CABLE

A. Manufacturers: The following have been selected as acceptable manufacturers of the products described herein:

1. Roychem/Chemelex, Advanced Technology Sales
2. Chromalox
3. Approved equal.

B. Product Properties: Heat trace cable shall be self regulating 5-watt heater with a maximum temperature of 150°F. Cable shall be supplied with connection and termination kits, ambient-sensing thermostat, "Electric Traced" label, glass tape, and pipe straps.

2.07 NYLON PIPE INSULATION

A. Manufacturers: The following have been selected as acceptable manufacturers of the products described herein:

1. Armstrong, All American Supply, Inc.
2. Approved equal.

B. Product Properties: Nylon pipe insulation shall be 1/2" nominal wall thickness, 3" outer diameter, 2" inner diameter, flexible elastomeric thermal insulation with a thermal conductivity of 0.27 BTU-in/hr-ft²°F at 75°F.

PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. Piping: Pipes and piping appurtenances shall be stored in an area and in such a manner so as not to cause undo damage to the materials. Covers/caps or screw-in plugs shall be utilized on pipe openings, pipe flanges, and nozzles to adequately protect the interior of the piping components from dirt, excess water, and other foreign material. The location of field storage shall be in areas where water cannot accumulate. The pallets shall be on level ground and oriented so as not to form a dam creating the ponding of water. The pallets shall not be stacked more than three high. Outdoor storage of plastic pipe shall not be longer than 12 months. For storage periods longer than 12 months a temporary covering shall be placed over the pipes.
B. **Fill Material**: Fill materials shall be stored in an area where the ponding of water will not occur.

3.02 **INSTALLATION**

The following are minimum installation specifications. The actual installation of the materials shall conform to approved manufacturer installation guidelines and the CQA Plan.

A. **Piping**: The piping shall be installed within the collection trenches located in the floor and side slopes of the containment cell and at the surface of the containment cell as shown on the construction drawings. All pipe installation shall be in accordance with SNL Standards Specification Section 02730.

1. All piping shall be installed true to line and grade and shall be free from cracks or defects.

   The interior of all piping and appurtenances shall be free from all dirt, excess water, and other foreign material as the pipe laying progresses and shall be left clean at completion.

3. All fittings, elbows, couplings, etc., shall be threaded. No adhesive bonding shall be used.

B. **Bedding Material**: The pipe bedding material shall be laid beneath the PVC pipe in the floor of the cell and beneath the buried 4" PVC pipe on the surface.

1. The bedding material shall be placed to the lines and grades as shown on the construction drawings.

2. The bedding material shall be placed in such a manner as to prevent damage to the piping and underlying synthetic materials.

3. The bedding material shall be laid and compacted in 6-inch maximum layers.

4. The bedding material shall be compacted to a relative density of 90 percent in accordance with ASTM D 4254.

5. The bedding material shall be laid with a minimum thickness below the bottom of the pipe of 4 inches and shall extend half-way up the sides of the pipe.

C. **Drain Aggregate**: The drain aggregate shall be placed within the collection trenches and over the PVC piping to the lines and grades as shown on the

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LEACHATE COLLECTION AND REMOVAL SYSTEM
construction drawings. The aggregate shall be placed in such a manner as to prevent damage to the underlying synthetic materials and piping.

D. Bentonite/Soil Backfill: The bentonite/soil mix shall be backfilled around the PVC piping near the surface of the containment cell as shown on the construction drawings.

1. Mixing of the bentonite/soil backfill shall be accomplished using a pugmill.

2. The bentonite/soil mix shall be installed in horizontal layers of 6-inch maximum compacted thickness at the top slope around each pipe penetration as shown on the construction drawings.

3. The material shall be compacted to a relative density of 90 percent in accordance with ASTM D 4254.

4. Each layer of bentonite/soil mix shall bond properly with the succeeding layer. If proper bonding is not possible due to surface smoothness and/or compaction, the existing layer shall be scarified with hand tools to provide a satisfactory surface before the succeeding layer as placed.

E. Inspection

1. After the pipe has been installed and the bedding and drain aggregate placed, the interior of the pipe shall be televised.

2. A color video shall be performed at a speed not greater than 1 foot per second.

3. The SCR shall be present during the video inspection.

4. One high quality VCR tape of the inspection shall be supplied to SNL/NM.

F. Heat Trace Cable: Heat trace cable shall be installed on the 1.25" nylon tubing and on the 2" galvanized leachate discharge piping from the pneumatic pump to the leachate storage tank.

1. Heat trace cable shall be installed in accordance with SNL Electrical Special Specification 16859 and manufacturer’s recommendations.

G. Nylon Pipe Insulation: Pipe insulation shall be installed over the 1.25" nylon tubing from the pneumatic pump to the leachate drain box within the LCRS storage area.
1. Pipe insulation shall be installed in accordance with SNL Standard Specification 15250 and manufacturer's recommendations.

END OF SECTION
Special Specification

Section 13501

Piping Systems for Vadose Zone Monitoring System
PART 1 - GENERAL

1.01 DESCRIPTION

A. Products and protocols associated with construction and installation of the three subsystems of the VZMS including:

1. Primary Sub-Liner (PSL) Monitoring Subsystem.

B. PSL Monitoring Subsystem Specifications including:

1. Vitrified Clay Pipe (VCP) used for sensor and sampling equipment deployment.
2. Polyvinyl Chloride (PVC) plastic pipes to access VCP pipe which traverses under containment cell.

C. VSA Monitoring Subsystem Specifications including:

1. Conduit and tubing materials.
2. Sensor and sampling equipment electronic and operational specifications.

D. The CSS Monitoring Subsystem Specifications including:

1. Conduit and tubing materials.
2. Sensor and sampling equipment electronic and operational specifications.

1.02 REFERENCES

A. Standard SNL/NM Specifications
   1. Standard SNL/NM Specification 02730 Sanitary Sewer
   2. Standard SNL/NM Specification 02200 Earthwork

B. American Society of Testing and Materials
   C425-91 Standard Specifications for Compression Joints for Vitrified Clay Pipe and Fittings
   C700-91 Standard Specifications for VCP Extra Strength, Standard Strength, and Perforated
   C896-87 Standard Definitions of Terms Relating to Clay Products
   D1785 PVC Pipe Conformity Code
   D1784-65T PVC Pipe Strength and Dimension Code
   D5220-92 Neutron Probe Schematics

PART 2 - PRODUCTS

2.01 SENSORS AND ELECTRONICS

   A. All sensors and electronics will be supplied by SNL/NM.

2.02 PIPE

   A. Six-inch inside diameter VCP pipe shall be used for access tube construction. The access tubes shall traverse the containment cell in a north/south orientation. Daylight access will be accommodated at the north and south edges of the containment cell within 12-inch diameter protective shrouds with hinged/locked portals.
B. The VCP will be thick-wall, plain, bisque fired with a three point bearing capacity equal to or greater than 8,470 pounds per linear foot of pipe. This specialty fabricated pipe is available from Superior Clay Pipe Corporation located in Uhrichville, Ohio.

C. The VCP will be tested prior to delivery. The VCP will be tested for bearing, adsorption, hydrostatic pressure, and acid resistance per ASTM C 301. However, a maximum adsorption value will not apply. Destructive bearing strength testing will be conducted at a rate of 5 percent of total pipe lengths required for field installation. The SCR will review and approve the testing process and results prior to delivery.

D. VCP Access Tubes, located beneath the containment cell bottom, will be connected to the surface via PVC riser pipes. Sweeping elbows of PVC pipe will join the riser pipes to the VCP access tubes. Six-inch diameter, Schedule 80 PVC pipe will be used for access tube riser pipe material.

E. Sweeping Elbows will be specially constructed from 6-inch ID Schedule 80 PVC pipe. Access tube riser pipe elbows constructed for the south end of the VZMS PSL will have an angle of 22.2 degrees and a radius of 20' 4". Access tube riser pipe elbows constructed for the north end of the VZMS PSL will have an angle of 23.2 degrees and a radius of 19' 5". Each elbow will be constructed with a flush end for joining at the VCP and a threaded end for coupling to PVC riser pipe.

F. VSA Soil Gas Sampler and Ancillary Equipment: The soil gas sampling package will consist of nominal 2-inch diameter and 6-inch long, end capped and slotted PVC screen at the sampling location connected to the ground surface by 1/4-inch-diameter (ID) Teflon™ tubing. The tubing will connect to the screen at a hose barb tapped into the upper cap. To keep soil particles from clogging the tubing, the PVC screen will be factory machine slotted with a slot width of 0.020 inch (20 slot).

G. CSS Galvanized Steel Pipe will be 2-inch inner diameter 20 feet long. Bottom six inches will consist of steel drive point threaded or welded to a two-foot section of 0.010 (10 slot) galvanized steel screen. Remainder of CSS will be galvanized steel riser pipe and should be threaded onto screen. Top of riser must be threaded to accept removable and replaceable endcap fitted with 2-way brass Swagelok® valve.
2.03 FITTINGS AND JOINTS

A. Fittings from VCP to VCP will be of o-ring compression joint configuration as described in ASTM C 425-91. PVC riser pipe sections will be connected via threaded joints similar to LCRS trench pipe connection.

B. Joining VCP access tubes to PVC riser pipe will be accommodated using a rubber boot and stainless steel hose clamps. At the PVC/VCP junction point the flush pipe ends will be butted together. A rubber boot will be placed over the junction point and stainless steel hose style clamps positioned over the boot at the VCP and PVC pipe. These clamps will be tightened to secure the boot onto each pipe and maintain the pipe end alignment.

C. Coupling holes will be excavated to relieve stress at joint locations along the VCP access tubes in accordance with Section 02200. Specifications for coupling hole configurations will be followed from ASTM C 12-91.

PART 3 - EXECUTION

3.01 VCP PIPE INSTALLATION

A. The initial pipe bedding layer shall be placed and compacted to 95% density as determined by ASTM D-1557. Further definition of the bedding layer and backfill materials is provided in the Special Specification Section 13500 Earthwork for the VZMS.

B. VCP installation shall be in accordance with SNL/NM Standard Specification 02730. Following compaction and before installing pipe sections in the trench, hand excavation will be required at the predetermined locations of the bell-end connections for the VCP to prevent stress concentrations on the bells. A nylon rod shall be placed in the pipe with 15-foot pigtails left at each end.

C. After installation of the pipe on the bedding layer and before placement of the haunching layer, the installation will be inspected by SCR.

D. Following inspection of the pipe installation by the SCR, placement and compaction of the haunching layer may begin. The haunching layer will also consist of the wicking soils blend. The haunching soils shall also be compacted by hand-tamping to 95% density as determined by ASTM D-1557. Extreme care shall be exercised by the contractor during compaction of the haunching soils to prevent damage to the VCP, yet assure adequate lateral pipe support.
E. A 3-foot long by 5-inch diameter mandrel will be pulled through the VCP to ensure sensors will pass.

3.02 VSA INSTRUMENTED BOREHOLE: SENSOR INSTALLATION

A. All sensors and materials will be checked for proper construction and operation prior to installation. The SCR must inspect and approve the operation check prior to installation.

B. The Contractor shall excavate shallow raceways beneath the cell bottom to provide conduits for VSA instrumentation leads and soil gas collection piping to exit the subsurface without compromising the PSL Monitoring Subsystem and cell bottom liner. Raceways shall be constructed as specified on the construction drawing.

C. Upon installation of the leads and soil gas conduit, the raceways will be backfilled to the containment cell excavation surface. The Contractor shall exercise the utmost care when backfilling all portions of the VSA to prevent damage to the system components.

D. All components of the VSA installations shall be checked and verified to be operating properly before installation of any portion of the VZMS PSL subsystem over the VSA. The SCR shall be present during this verification.

E. To promote accurate measurement of soil moisture in the vadose zone below the containment cell, TDR moisture probes will be inserted in native material (15 foot deep sampling point) or compacted backfill of native material to duplicate the native material effective pore size (at the 5 foot deep sampling point). To eliminate preferential flowpaths, the boreholes will be filled between sampling points with a uniform mixture of native materials (90 percent) and WYO-BEN HYDROGEL powdered bentonite (10 percent). During installation of the VSA boreholes, soil samples must be collected by the contractor at 5 and 15 feet and analyzed for initial volumetric moisture content in order to properly calibrate the TDR moisture probes.

3.03 CSS INSTALLATION

A. CSS is installed with a drill rig. A nominal 6-inch diameter borehole is augered from ground surface to 10 feet below ground surface (bgs). The galvanized steel drive point, screen, and riser is driven into the ground from 10 feet to 20 feet bgs per the construction drawing. The annular space around the riser between 10 feet and 2 feet bgs is backfilled with a uniform mixture of

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PIPING SYSTEMS FOR VADOSE ZONE MONITORING SYSTEM
90% native soil materials and 10% w/YO-BEN HYDROGEL powdered bentonite. From 2 feet bgs to the surface, the annular space is sealed with concrete.

B. A 12-inch diameter heavy duty steel protective cover with an 18-inch skirt is installed around the CSS per the construction drawing. The steel protective casing will stick up approximately 6-inches above the ground surface. A concrete pad is installed around the protective cover.

C. The galvanized steel riser pipe must be allowed to stick up above the ground surface approximately 1 to 2 inches per the construction drawing so it will accommodate the neutron probe.

END OF SECTION
Special Specification

Section 13600

Earthwork for Final Cover System
SPECIAL SPECIFICATION

SECTION 13600

EARTHWORK FOR FINAL COVER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes a description of the backfill and fill materials and procedures required to construct the final cover system for the disposal cell.

B. Backfill and fill materials specification will describe bedding, capillary barrier, native soil blends, and topsoil materials used to construct the final cover system.

C. Procedures to construct the final cover system will consist of soil placement and compaction specifications. This includes:

1. Buttressing soil placement around disposal cell perimeter apron between the inside edge of the perimeter swale and the upper edge of the waste.

2. HDPE geomembrane anchor trench excavation and backfill.

3. Bedding layer placement, above the HDPE geomembrane final cover system liner. HDPE geomembrane product and installation specifications are provided in Special Specification Section 13700 Geomembrane Liner for the Final Cover and Vadose Zone Monitoring Systems.

4. Capillary Barrier construction. Heretofore within this specification, the bedding layer for the HDPE geomembrane is referred in context of the Capillary Barrier.

5. Native Soil Blend layer construction above the capillary barrier. This includes the placement of a burrowing animal barrier which consists of a galvanized wire mesh positioned within the Native Soil Blend layer.

6. Topsoil coating
REFERENCES

A. Standard SNL/NM Specifications:
1. Standard SNL/NM Specification 02200 Earthwork
2. Standard SNL/NM Specification 02232 ABC, RABC, CCBC

B. Special Specification 13700 Geomembrane Liner for Final Cover and Vadose Zone Monitoring Systems

C. Documents:
2. Evaluating Cover Systems for Solid and Hazardous Waste Landfills, EPA#SW-867, GPO#055-000-00228-2, 1982
PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. NATIVE SOIL BLENDS:

1. Topsoil: Topsoil is the existing surface soil stripped to a depth of six-inches and consisting of natural, friable soil representative of productive soils in the vicinity. Topsoils shall be free of any admixtures of subsoil, foreign matter, objects larger than two-inches in any dimension, toxic substances, and any material or substance that may be harmful to plant growth. This soil is to be excavated, stockpiled, and eventually refilled as the top six-inches of the final cover system.

2. Native Soil Blend: The native soil blend which is proposed for placement between the top-soil and capillary barrier layers will be determined based on laboratory testing including grain size distribution and proctor tests. It will be free of organic matter, topsoil, rubble, trash, and deleterious substances. Minimum material specifications for this product are described in Specification Section 02200 Earthwork, structural fill, with one exception. The fines (passing the #200 sieve) content should meet or exceed 20% by weight.

B. CAPILLARY BARRIER MATERIALS

1. Filter/Bedding Sand: The sand which will be used as bedding and filter material on the top and bottom of the capillary barrier will be comprised of a well graded clean sand.

2. Pea Stone Aggregate: The pea stone which will be centrally located in the capillary barrier (encased with sand) will be comprised of a coarse aggregate as specified herein.

3. The sand and pea stone shall meet the following gradations:
U.S. STANDARD SIEVE SIZE (SQUARE OPENINGS) PERCENT PASSING (BY WEIGHT)

FILTER/BEDDING SAND
- 3/8 inch: 75-90
- No. 10: 75-85
- No. 40: 25-35
- No. 60: 10-20
- No. 200: 0-5

PEA STONE AGGREGATE
- 1-1/2 inch: 100
- 3/4 inch: 90-100
- 3/8 inch: 0-10
- No. 4: 0-5

C. WIRE MESH FOR PREVENTION OF BURROWING-ANIMAL INTRUSION

1. The wire mesh for prevention of burrowing-animal intrusion will consist of a galvanized, 20 gauge woven steel wire mesh with a maximum opening size of 1/4 inches.

D. ANCHOR TRENCH PACKFILL

1. The anchor trench backfill material will consist of clean on-site native soil free of organics and deleterious materials. Particle size will not exceed the 1/4 inch U.S. Standard sieve size.

PART 3 - EXECUTION

3.01 HDPE GEOMEMBRANE LINER FOUNDATION PREPARATION

A. Waste material complying with structural fill definition SNL/NM specification 02200 Earthwork will be set aside during treatment activities. This material will be placed at the end of waste fill operations.

B. The upper 2 to 3 feet of waste will consist of this sandy material. It will be void of any deleterious materials such as organic matter, highly angular aggregates, debris, etc.
C. Compaction for this upper sandy waste layer will be performed using 3 passes using a vibrating sheepsfoot roller, with compacted lift thicknesses of 8 inches.

3.02 BUTTRESSING SOIL PLACEMENT AND COMPACTION

A. Prior to placement of the HDPE final cover system geomembrane, a wedge of soil will be placed and compacted around the disposal cell perimeter. As depicted in the construction drawings, this wedge will provide more gentle transition slopes between the inside edge of the perimeter swale and the 3:1 to 3% transition slope at the waste mound. Buttress fill material will consist of native soil blend as described above. The fill will be placed in lifts not to exceed 8 inches in thickness and compacted within ±2 percent of optimum moisture content to 95% of maximum dry density per ASTM D-1557.

3.03 HDPE GEOMEMBRANE AND BURROWING-ANIMAL BARRIER WIRE MESH ANCHOR TRENCH

A. Clearing and grubbing of the cell area including the perimeter drainage swale and anchor trench alignment has been specified in other areas of this specification package.

B. Following placement of the buttress soil and prior to placement of the HDPE final cover system geomembrane, a one-foot wide two foot deep anchor trench will be excavated around the disposal cell.

1. General: Excavation activities shall be in accordance with SNL Standards Specification. Section 02200. Voids or depressions beyond the intended grade occurring from the removal of any obstruction shall be backfilled to the intended grade prior to completing additional installation in the affected location.

2. Safety of Excavations: All Occupational Safety and Health Administration standards and all other applicable regulations relative to excavation stability and methods of providing a stable excavation shall be adhered to including local codes and ordinances having jurisdiction. Sides and slopes of excavations shall be maintained in a safe condition until completion of backfilling.

3. Over-Excavations: Excavation dimensions for the HDPE geomembrane anchor trench shall be as delineated on the project drawings and details.
Should sideslope stability be compromised during the construction, the specified trench width shall be maintained in the trench bottom.

4. Runon Prevention/Dewatering: All water shall be prevented from entering the excavations. If required, temporary surface drainage berms may be constructed to prevent overland surface flow from entering the anchor trench. Excess water will be removed to prevent soil softening or instability of the trench walls.

5. Storage of Excavated Materials: Excavated materials, if suitable for structural backfill material per SNL/NM Earthwork Specification 02200, will be stockpiled at the specified location on site.

C. Placement of the HDPE geomembrane is described in Special Specification Section 13700 Geomembrane Liner for Final Cover and Vadose Zone Monitoring Systems.

D. Rolls of the galvanized wire mesh for burrowing-animal intrusion prevention will be positioned in the trench. The mesh will be placed over the HDPE geomembrane such that the remaining roll is positioned between the edge of the trench and the perimeter swale. Seams between rolls will consist of at least 1-foot overlap of the mesh. The overlaps will be tied on 5-foot spacing using string or other material.

E. Backfill material will be placed and compacted to the design grade in accordance with the drawings and details. Care shall be taken to place and compact the backfill so as not to damage the underlying liner components.

F. Anchor trench backfill shall be compacted by hand using walk-behind or hand-held tamping devices. Special care shall be employed to assure that the HDPE geomembrane is not damaged during backfill compaction. The backfill shall be compacted to not less than 90 percent maximum dry density within plus or minus 3 percent of optimum moisture content as determined by ASTM D 1557.

G. The anchor trench shall be excavated to the lines and grades as specified on the construction drawings and details.

3.04 BEDDING SAND PLACEMENT AND COMPACTION

A. Following placement of the HDPE final cover system geomembrane (per Special Specification Section 13700, Geomembrane Liner for Final Cover and Vadose Zone Monitoring Systems), an 8" thick (vertical change in elevation)
A lift of compacted bedding sand will be placed over the HDPE final cover system geomembrane. Bedding fill material will consist of bedding/filter sand materials as described in Part 2, above. The fill will be placed in a 10-12 inches thick lift and compacted to 90% of maximum dry density within + 2 percent of optimum moisture content per ASTM D1557.

1. The sand bedding material will be placed and spread on top of the HDPE geomembrane in a single 8-inch lift. All care shall be taken to prevent damage to the HDPE geomembrane during bedding placement. At no time shall equipment be driven directly on top of the HDPE geomembrane.

2. The compaction of the sand bedding and conformance of the lift to desired thickness will be confirmed by the CQA Engineer during construction. No overlying materials may be placed on the bedding until approved by the SCR.

3.05 CAPILLARY BARRIER PLACEMENT AND COMPACTION

A. A 6-inch thick (vertical change in elevation) lift of pea gravel as described in Part 2, above, will be placed above the bedding sand layer. The pea gravel layer will be blanketed by a 4-inch thick (vertical change in elevation) lift of filter sand material. Pea gravel and filter sand fill material will consist of pea gravel and bedding/filter sand materials as described in Part 2, above. These fill materials will be placed in a 6- to 8-inches thick lifts. The pea gravel layer will be compacted to achieve a relative density of “dense” as determined by the SCR.

1. The pea gravel will be placed in a single 6-inch lift thickness by maintaining excess gravel at the blade and pushing it gradually out onto the bedding sand.

2. Care shall be taken to prevent excess working of the gravel to prevent individual gravel particles from penetrating the sand in a puncture fashion.

3. The placement method and conformance of the lift to desired thickness will be confirmed by the SCR during construction. No overlying materials may be placed on the bedding until approved by the SCR.

4. The filter sand material will be placed and spread on top of the pea gravel to achieve a single 4-inch lift.
5. Care shall be taken to prevent excess working of the filter sand into the gravel during placement.

6. The compaction of the sand bedding and conformance of the lift to desired thickness will be confirmed by the SCR during construction. No overlying materials may be placed on the bedding until approved by the SCR.

3.06 NATIVE SOIL BLEND PLACEMENT AND COMPACTION

A. Typically, a 30-inch thick (vertical change in elevation) lift of native soil blend as described above will be placed above the bedding sand layer. The fill material will consist of native soil blend as described in Part 2. The fill will be placed in lifts not to exceed 6 inches in thickness and compacted to 85% of maximum dry density within ± 3 percent of optimum moisture content per ASTM D1557. This will facilitate root penetration into this layer. During layer filling operations, a continuous layer of wire mesh will be integrated into the Native Soil Blend Layer. This mesh will be positioned at 18-inches below ± 3 inches the Final Cover System finished grade.

1. Materials for mixing Native Soil Blends will be derived from the on-site stockpiles from the cell excavation, and shall meet the requirements of the native soil blend as specified in the materials section of this specification.

2. The Native Soil Blends will be constructed to the thickness and grade specified on the construction drawings.

3. Upon reaching the established grade, the galvanized wire mesh for prevention of burrowing animals will be placed. The acceptable tolerance will be ± 3 inches.

4. No part of the final compacted surface grade may be covered prior to inspection and approval of the installation by the SCR.

5. All required sampling and testing for the work of this section will be the responsibility of the SCR in accordance with the SCR.

6. Retesting of materials that failed to meet construction criteria will be performed at the expense of the contractor.
3.07 **TOP-SOIL PLACEMENT AND CONSTRUCTION**

A. Following completion of the natural soil blend layer, a 6"-thick (vertical change in elevation) layer of topsoil will be blanketed over the entire extent of the final cover system surface. Topsoil will provide a suitable seedbed for enhanced germination of the vegetative layer seeds. The fill will be placed in lifts not to exceed 8 inches in thickness and compacted to 85% of maximum dry density within ± 2 percent of optimum moisture content per ASTM D1557.

3.08 **INSPECTION AND TESTING**

A. All required sampling and testing for the work of this section will be the responsibility of the SCR in accordance with the CQA Plan.

B. Retesting of materials that failed to meet construction criteria will be performed at the expense of the contractor.

**END OF SECTION**
Special Specification

Section 13602

Seeding for Final Cover System
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the description of products and materials used to vegetate the surface of the cover system located vertically above the waste. This excludes the 3:1 slopes between the slope transition line vertically above the edge of waste and the perimeter swale edge.

B. Standard SNL/NM Specification 01562 Dust Control is the basis for this specification and applies to areas not included in the previous section.

1.02 REFERENCES

A. Standard SNL/NM Specifications:


B. Special Specification 13600 Earthwork for Final Cover System

C. Documents:

1. Evaluating Cover Systems for Solid and Hazardous Waste Landfills, EPA#SW-867, GPO#055-000-00228-2, 1982


PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Topsoil per Special Specification Section 13600 Earthwork for Final Cover System

B. Gravel Mulch will consist of a mixture of gravelly aggregates. The gravel mulch shall meet the following gradations:

<table>
<thead>
<tr>
<th>U.S. STANDARD SIEVE SIZE (SQUARE OPENINGS)</th>
<th>PERCENT PASSING (BY WEIGHT)</th>
</tr>
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<td>3 inch</td>
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<td>1 inch</td>
<td>60-80</td>
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<tr>
<td>3/4 inch</td>
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<td>5-60</td>
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<tr>
<td>No. 4</td>
<td>0-10</td>
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<td>No. 10</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>

2.02 SEEDING

A. The following seed mix shall be used for seeding of final grades:

<table>
<thead>
<tr>
<th>Seed Species</th>
<th>Seeding Rate Pure Live Seed (Pounds per Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crested Wheatgrass</td>
<td>6</td>
</tr>
<tr>
<td>Indian Ricegrass</td>
<td>6</td>
</tr>
<tr>
<td>Alkali Sacaton</td>
<td>2</td>
</tr>
<tr>
<td>Sand Dropseed</td>
<td>2</td>
</tr>
<tr>
<td>Four-Wing Saltbrush</td>
<td>2</td>
</tr>
</tbody>
</table>

B. Seed shall be stored in a sealed waterproof containers in a cool, dry location and shall be kept out of direct sunlight until ready for use.

C. The seeding contractor shall furnish the SCR duplicate copies of a statement by the vendor, certifying that each lot of seed has been tested by a recognized

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SEEDING FOR FINAL COVER SYSTEM
laboratory for seed testing within six months of date of delivery. This statement shall include: (1) the name and address of laboratory; (2) date of test; (3) lot number for each kind of seed; (4) results of tests as to name, percentage of purity and of germination, and percentage of weed content (must be less than 5% noxious weeds) for each kind of seed furnished, and in the case of a mixture, the proportions of each kind of seed.

D. Hydro-mulch shall be applied over all seeded areas and shall consist of cereal straw. Cereal straw shall be from grain crops that are free from noxious weeds, mold, or other objectionable matter. A trackifier shall be used with this mulch.

2.02 EQUIPMENT

A. Rangeland drill techniques will be used for seed application

PART 3 - EXECUTION

3.01 General:

A. All organic soils and mulch material shall conform to the requirements in Part 2 of this specification.

B. All organic mulch soils and gravel armoring will be constructed to the thickness and grade shown on the construction drawings and documents.

3.02 Placement:

A. All soils will be placed and spread to the design grade in an uncompacted state to promote moisture retention and root growth.

B. Seeding shall be performed after placement of the topsoil using rangeland drill techniques per Standard SNL/NM Specification 01562 Dust Control.

C. Following placement of the organic mulch soils to specified grade, a one-inch nominal thickness of gravel will be placed uniformly on the cover surface to protect the cover from erosion.

D. Placement of the gravel armoring shall not be performed prior to inspection and approval of the organic mulch soils by the SCR.

END OF SECTION

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SEEDING FOR FINAL COVER SYSTEM
Special Specification

Section 13700

Geomembrane Liner for Final Cover and Vadose Zone Monitoring Systems
PART 1 - GENERAL

1.01 DESCRIPTION

This section describes the flexible membrane liner (FML), or geomembrane, material products and protocols necessary for the construction of the containment cell final cover and Vadose Zone Monitoring System (VZMS) Primary Sub-Liner (PSL) sub-system and including:

A. High density polyethylene (HDPE) geomembrane material selection and specification.

B. Preparation of HDPE geomembrane material sub-grade.

C. Excavation of HDPE geomembrane material anchor trench.

D. Care and placement of HDPE geomembrane material and immediate cover material.

1.02 REFERENCES

A. Standard SNL/NM Specifications.

1. Specification 02200 Earthwork
2. Specification 01562 Dust Control

B. Special Specifications.

1. Special Specification 13600 Earthwork for Final Cover System.

2. Special Specification 13500 Earthwork for VZMS.

D. “Gundle Standards Manual, Materials and Installation”, Gundle Products Corporation, Rev. 4-95, April, 1995.

1.03 SUBMITTALS AND SPECIAL REQUIREMENTS

A. Guarantee of HDPE Geomembrane Material and Workmanship: The HDPE geomembrane materials shall be guaranteed, in writing, by the manufacturer or supplier for a period of 5 years. The guarantee shall be against manufacturing defects in material and workmanship and against deterioration due to ozone, ultraviolet, or other normal weather aging.

B. Experience of Contractor: The contractor shall have demonstrated his ability to perform this work by having successfully installed, in impoundment or waste management unit structures, a minimum of 1,000,000 square feet of similar-type flexible membranes. A list of installations shall be submitted for approval. The list shall include the client name, contact person, telephone, date of installation, size, and type of material installed. In addition, the on-site liner supervisor assigned full time to this work shall have directed the installation of a minimum of 500,000 square feet of similar-type liner in landfill or impoundment structures.

C. Samples and Specifications of Materials: Prior to ordering any materials, four samples (each measuring approximately 8 inches by 10 inches) of the HDPE geomembrane proposed for the work, along with certified physical property values, shall be submitted for approval. In addition, the contractor shall submit the manufacturer’s certification stating that the material proposed for use for this project has minimum physical properties equal to the certified values.

Four samples each of the geomembrane field joints and factory joints (if any) shall be submitted with a complete description of the seaming methods. Pipe boot details and test results, if not field fabricated, shall also be submitted.

The source of all geomembrane materials shall be selected in advance of use. Test results from samples shall be submitted to the Sandia Construction Representative (SCR) for approval not less than 30 days before the material is required for use.
D. **Quality Control (QC) Documents:** Prior to commencement of work, the manufacturer or supplier will submit the manufacturer's QC reports and QC certificates for all geomembrane rolls.

E. **Shop Drawings:** Shop drawings showing the proposed layout of the deployed HDPE rolls shall be submitted for approval prior to starting work. The proposed layout shall show the size, number, and position of all rolls. Locations of field joints and factory joints (if any) shall also be indicated. The scale of the drawing shall not be smaller than 1 inch = 50 feet.

F. **Work Plan:** Prior to commencement of work, the installer shall submit a work plan detailing anticipated method, equipment, manpower, and schedule for placement of the liners. The installer shall furnish the services of a competent, factory-trained, field technical representative to supervise the entire installation of the geomembranes.

**PART 2 - PRODUCTS**

2.01 **GEOMEMBRANE LINER**

A. The flexible membrane liner for the final cover and VZMS PSL sub-system shall consist of new, first-quality product designed and manufactured specifically for the purpose of this work. The product shall have been satisfactorily demonstrated by prior use to be suitable and durable for such purpose. Texturing will be required on both sides of the product used for the final cover. Smooth, un-textured project will be used for the VZMS PSL sub-system.

**PROPERTIES OF THE BLACK-SURFACED, SMOOTH 60-MIL HDPE LINER**

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<thead>
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<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>UNITS</th>
<th>NOMINAL VALUES</th>
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</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D 751/1593/5199</td>
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<tr>
<td>Density</td>
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<td>Tensile Properties (each direction):</td>
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<td>Strength at Break</td>
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<td>Strength at Yield</td>
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<td>Elongation at Break</td>
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**13700-3**

**GEOMEMBRANE LINER FOR FINAL COVER AND VADOSE ZONE MONITORING SYSTEMS**
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The untextured 60-mil HDPE for the VZMS PSL sub-system will have strength, durability, and permeability properties equivalent to, or better than, those of the textured product for the final cover.

2.02 EQUIPMENT

A. Product placement and seam welding equipment will be consistent with manufacturer's specifications.

B. Earthmoving equipment to be operated on top of the geomembrane for placement of final cover materials including the bedding sand, capillary break layers, native soil blend, and top soil layer will have ground contact pressures, when fully loaded, less than or equal to 15 psi.

ART 3 - EXECUTION

3.01 GENERAL

A. All installation details for the HDPE geomembrane liner are to be constructed in accordance with the manufacturer's specifications and as shown on the construction drawings.

B. Bedding surfaces for the geomembrane must be constructed to within +/- 0.1 ft of finish grade as indicated on the design drawings, and shall be smooth and free of projections that could puncture the geomembrane during installation.

C. The subgrade will be walked and inspected by SCR and the liner installer's representative prior to acceptance and placement of the geomembrane. The surfaces to be lined shall provide a firm, smooth, unyielding foundation for the
geomembrane. For the final cover geomembrane, the waste soils shall be prepared in accordance with Special Specification 13600 Earthwork For Final Cover System.

D. Anchor trench installation and inspection will take place as directed in Special Specification 13600 Earthwork for Final Cover System. The VZMS PSL sub-system will not require an anchor trench.

3.02 GEOMEMBRANE PLACEMENT

A. Installation Schedule: Field panels are placed only after the subgrade has been inspected by the SCR and membrane installer's representative. Field panels are placed one at a time and each field panel will be seamed immediately after its placement.

B. Location: Field panels shall be located by the installer's representative and will be installed in accordance with the specifications and in a manner best suited to the site conditions. A seam layout plan prepared by the installer will be provided to the SCR prior to mobilization.

C. Field Panel Identification: At the time of installation, each field panel will be assigned an "identification code" by the installer (alpha or alphanumeric).

The installer's representative will record the identification code, roll number, and date of installation of each geomembrane field panel.

D. Weather Conditions: Welding or placement of the geomembrane will not take place under any adverse weather conditions, including precipitation, excess moisture conditions, blowing dust or high winds (unless wind barriers are erected). Welding or placement shall not take place in areas of standing water.

E. Placement Method: The installer's representative shall ensure that:

1. Any equipment used shall be sized and configured to prevent and damage by handling, trafficking, excessive heat, leakage of hydrocarbons, or any other means.

2. The prepared underlying surface has not deteriorated since previous acceptance and is still acceptable immediately before geomembrane placement.
3. Construction equipment used shall not create excessive rutting of the subgrade.

4. The method used to place the panels minimizes wrinkles, especially differential wrinkles between panels.

5. No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.

6. The method used to unroll the geomembrane does not create scratches or crimps and does not damage the supporting soil.

7. Adequate temporary loading/anchoring shall be provided with materials not likely to damage the geomembrane such as sand bags or automobile tires to prevent uplift by wind. In high wind locations, continuous loading shall be applied along the edges of the panels to minimize risk of wind flow under the panels.

   Direct contact with the geomembrane shall be minimized.

F. Configuration

1. Panels shall be placed such that the long axis of the panel is positioned directly downslope, regardless of location on fill materials. For the PSL sub-system, directly downslope is a reference to the 1-percent slope to the north.

2. For the final cover, panels crossing the longitudinal crown of the disposal cell shall be of sufficient length to form a continuous single length, with the approximate center of the roll located on the crown and the ends of the roll extending to the required perimeter swale location.

3. For the final cover, shorter sideslope panels shall overlap the side (corner) crowns in a triangular fashion, such that no portion of the side crown contains a seam. Overlapping panels at the crown shall be shingled in the downslope direction.

4. For the PSL sub-system, the entire cell bottom excavation will be covered with 60-mil HDPE extending two feet up the side slopes and extending two feet into and against each PSL sub-system access tube trench sidewall. No connection is made across the trench.
5. All seams shall be constructed as per the manufacturer's recommendations and in accordance with Paragraph 3.03 of this specification.

G. Damage

The installer's representative and the CQA Engineer shall inspect each geomembrane panel for damage prior to welding. The SCR will identify the panel(s) or portions of panels that require repair. Damaged panels or portions of panels that have been rejected will be marked and their removal from the work area recorded by the SCR. Repairs to geomembranes shall be in accordance with Paragraph 3.04 of this specification.

3.03 GEOMEMBRANE SEAMING

A. Seam Layout: Seams will be made by overlapping adjacent sheets approximately four inches (4") for hot wedge welding and three inches (3") for extrusion welding.

In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented down and not across slope. For corners and odd-shaped geometric locations, the number of seams should be minimized. Horizontal seams should be a minimum of five feet from the toe of the slope, crest of berms, or areas of potential stress concentrations. A cross seam may be welded provided the panel end is cut at an angle greater than 45 degrees.

The seam numbering system will be compatible with the panel numbering system.

B. Seaming Equipment and Products: The approved process for field seaming is hot wedge welding. If desired, alternate field seaming processes may be submitted to the SCR for his approval.

The fusion welding apparatus must be an automated devise that produces a double seam with an enclosed space as specified.

The fusion welding apparatus shall be equipped with gauges showing the applicable temperatures and speed settings.

The fusion welding apparatus shall also be equipped with gauges giving the nip force on the knurled rollers and the supplied line voltage.
The installer must verify and report to the SCR that:

1. Equipment used for seaming is not likely to damage the geomembrane.

2. If an electric generator is used as a power source, it must be placed on a smooth base such that no damage is caused to the geomembrane.

3. An insulating plate shall be placed beneath the welding device when not in operation to prevent damage to the geomembrane.

C. Seam Preparation: The installer must verify and document that the area is clean and free of moisture, dust, dirt, or any other deleterious substances prior to seaming.

The seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

D. Seaming in Various Weather Conditions: The installer shall perform sealing operations within manufacturer recommended weather conditions. Adjustments for various weather conditions may be required. If excessive heat is generated by sunlight during the day, the installer may be required to split the work day such that seaming is performed during the cooler morning and late evening hours, or at night under artificial lighting.

In all cases, the geomembrane shall be dry and protected from the wind during seaming operations.

E. Trial seams: Trial seams will be made on fragments of geomembrane liner to verify that seaming equipment and conditions are adequate.

F. Seaming Procedure: Unless otherwise specified, the general procedure to be used by the installer consists of:

1. The rolls of geomembrane shall be overlapped by a minimum of four inches.

2. Wrinkles at the edges of the seams, or "fishmouths", shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed and any portion where the overlap is inadequate will be repaired in accordance with procedures described in Paragraph 3.04 of this specification.
3. Seaming will extend along panel edge into the anchor trench.

4. For hot wedge welding on damp subgrade, a movable protective layer of plastic may be required to be placed directly beneath the overlapped membranes to be welded. This is to prevent any moisture buildup between sheets prior to welding or provide a more stable base for the welding apparatus to travel on.

G. **Seam Testing**: Both destructive and non-destructive seam testing shall be performed.

3.04 **TESTING**

A. **Test Strips and Trial Seams**: Test strips shall be conducted to estimate the quality of the production field seams including equipment and operator proficiency. The SCR shall have the option of requesting test strips of any field seaming crew or device at anytime. The SCR shall observe all trial seam procedures and tests.

The following testing procedures shall be followed:

1. Test strips shall be made in sufficient lengths, as a single continuous seam, for required testing purposes.

2. Test strips shall be made every four hours. Additionally, they shall be made whenever personnel or equipment are changed, when climatic conditions reflect wide changes in geomembrane temperature, or when other conditions occur that could affect seam quality.

3. Test strips shall be approximately 3-feet long by 1-foot wide for extrusion welds and 6-feet long by 1-foot wide for hot wedge welds with the seam centered lengthwise. Overlaps will be representative of production seams.

4. Destructive testing on the trial seams shall begin as soon as the seam cools.

5. The cut specimens shall be randomly selected by the SCR and tested in both peel and shear using a field tensiometer supplied by the CQA contractor.
6. A new test strip shall be fabricated if any of the test specimens fail. If additional specimens fail, the seaming apparatus and seamer shall not be accepted and will not be used for seaming until the deficiencies are corrected and successful trial welds are achieved.

7. If the specimens pass, seaming operations can move directly to production seams.

B. Destructive Test Methods for Seams: Destructive testing shall be accomplished by cutting out and removing a portion of the completed production seam and then further cutting the sample into appropriately sized test specimens. The SCR shall select the sampling location where test specimens shall be cut from the seam. The SCR shall witness all seam sample cutting and all field tests and verify that proper identification and details accompany the test results. The SCR shall witness all seam sample cutting and all field tests and verify that proper identification and details accompany the test results.

Details required in CQA documents include:

- Date and time
- Ambient temperature
- Identification of seaming unit, group or machine
- Name of master seamer
- Welding apparatus temperature and pressure, or chemical type and mixture
- Pass or fail description
- A copy of the report shall be attached to the remaining portion of the sample.

The SCR shall observe and verify that the following procedures are adhered to during destructive testing:

1. When cutting samples from the geomembrane, only an upward hook blade shall be used.
2. Holes in the geomembrane resulting from seam sampling shall be repaired immediately in accordance with the repair procedures.

3. Samples shall be adequately numbered and marked with permanent identification.

4. A 28-inch long sample shall be taken from the seam and cut into two individual 14-inch samples. Individual samples go to the CQA Contractor and the Owner. The CQA Contractor shall cut the sample into five shear and five peel test specimens and shall conduct the appropriate tests immediately. The remaining sample shall be archived by the Owner.

5. The sample width perpendicular to the seam shall be 12 inches with the seam centrally located within this dimension.

6. Seam samples shall be taken at fixed increments along the total length of the seams. Increments shall be 250 feet. This value may be applied either directly to the record drawing during layout of the seams, or to each seaming crew as they progress during the work period.

7. This increment shall be held regardless of the location upon which it falls. Exceptions to avoid sumps, connections, protrusions, etc. may be made with the approval of the SCR.

8. Field testing of individual specimens shall be completed using an electric or hand tensiometer.

9. Shear tests shall be conducted in accordance with ASTM D 4437. Seam shear efficiencies shall be at least 95 percent of the specified minimum yield strength of the geomembrane.

10. Peel tests shall be conducted in accordance with ASTM D 4437. Seam peel efficiencies shall be at least 32 percent of the specified minimum yield strength of the geomembrane. Frontward and backward peel tests shall be performed.

11. Only one failure out of the five tested specimens per test type (i.e., shear or peel) is allowable. If the failure number is larger, two additional samples shall be taken, one on each side of the original sample each spaced 10 feet from it. If either one of these samples fail,
the iterative process of sampling every 10 feet is repeated until passing test results are observed. The entire seam between the two successful test samples shall be questioned, and the SCR may elect to have the contractor cap strip the entire seam or if the seam is made with a thermal fusion method, to extrude a fillet weld over the outer seam edge.

12. Verbal laboratory test results to verify field results shall be required within 24 hours after the laboratory receives the samples. The test results shall be directed to the SCR.

13. Each repair of a patched seam where a test sample had been removed shall be verified by nondestructive testing.

C. Nondestructive Test Methods for Seams: All field seams will be nondestructively tested over their full length using a vacuum test unit, air pressure testing, or other CQA approved method where applicable. Nondestructive testing is meant to verify the continuity of field seams and not to quantify seam strength. The SCR shall observe all nondestructive testing procedures.

The SCR shall observe and verify that the following procedures are adhered to during nondestructive testing:

1. Nondestructive testing shall be conducted as the seaming work progresses or as soon as a suitable length of seam is available.

2. Nondestructive testing shall be required for 100 percent of the field seams. The SCR may approve an alternative test method for seams occurring in sumps and at pipe penetrations.

3. Dual seam air pressure tests shall be in accordance with GRI GM-6.

4. The location, data, test number, name of test person, and outcome of tests shall be recorded.

5. In the event of failed nondestructive tests, the failed area shall be repaired by extrusion welding.

6. The SCR shall be informed of any deficiencies.
3.05 GEOMEMBRANE REPAIR PROCEDURES

A. Identification: All seams and non-seam areas of the geomembrane shall be inspected by the installer and SCR to identify any defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

Defective/damaged materials will be identified in a deficiency report, separately or on the Daily Progress Report, and the actions taken to resolve or correct the problem noted.

Work will not proceed with any materials or in any areas until they are repaired in accordance with Paragraph 3.04C of this specification.

B. Any portion of the geomembrane failing a destructive or non-destructive test shall be repaired. The repair method shall be proposed by the installer and approved by the SCR prior to implementing the repairs. Potential repair procedures include:

1. Patching may be used to repair large holes, tears, and contamination by foreign matter.
2. Spot welding may be used to repair pinholes or other minor localized flaws.
3. Capping may be used to repair large lengths of failed seams.
4. Topping may be used to repair areas of inadequate seams which have an exposed edge.

C. The following provisions must be satisfied:

1. Surfaces of the geomembrane which are to be repaired will be abraded no more than one hour prior to the repair.
2. All surfaces must be clean and dry at the time of the repair.
3. All repair procedures, materials, techniques, and seaming equipment used in repair procedures must be pre-approved by the SCR.
4. Patches or caps shall extend at least six inches beyond the edges of the defect, and all corners of patches will be rounded with a radius of at least three inches.

D. Repair - Non-Destructive Testing

Each repair will be non-destructively tested. Repairs which pass the non-destructive test will be taken as an indication of adequate repair. Failed tests indicate that the repair will be redone and re-tested until a passing test result is obtained.

3.06 BACKFILLING OF ANCHOR TRENCH

A. The anchor trench at the toe of the slope shall be adequately drained to prevent ponding or overland flow of precipitation into the trench that could soften the trench walls. The anchor trench will be backfilled in accordance with Special Specification 13600 Earthwork for Final Cover.

B. Since ambient temperatures can affect the condition of the geomembrane in terms of expansion or contraction, it may be desirable to backfill the trench during cooler periods of the day, when the geomembrane is in its most contracted state.

C. Care will be required when backfilling to prevent any damage to the geomembrane. Anchor trench backfilling operations will not be performed without the approval of the SCR.

3.07 PLACEMENT OF MATERIALS ON GEOMEMBRANE

A. Placement of soils or materials on top of the geomembrane will not take place until all required non-destructive testing or destructive testing has taken place and approval to proceed has been obtained by the SCR.

B. Equipment used for placing overlying materials shall not be driven on exposed geomembrane.

C. Placement of overlying materials should be performed to minimize wrinkles. Equipment operators shall be briefed on method and timing of material placement to deal with thermal expansion and contraction of the geomembrane.
APPENDIX G

OPERATING PROCEDURES

FINAL

SEPTEMBER 1997
SAMPLE MANAGEMENT OFFICE USER'S GUIDE

Author

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Date

5-16-96

Recommended for Approval

Nick Durand, 7513, Sample Management Office Project Leader

Date

5-13-96

Approved by:

William Jenkins, 7513, Environmental Project Support Manager

Date

5/16/96

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FOREWORD

This guide has been prepared by the Sandia National Laboratories/New Mexico (SNL/NM), Sample Management Office (SMO) for SNL/NM and contractor personnel performing environmental or waste sampling and testing. It is intended to acquaint the project or task leader and technical support personnel with the functions of and services provided by the SMO. The objective of the SMO is to assist task leaders with making optimal use of the available sampling and analytical resources and with ensuring consistent quality in sampling and analysis activities in order to meet project objectives.

1.0 OVERVIEW OF SAMPLE MANAGEMENT OFFICE SERVICES

The Sample Management Office (SMO) provides management, technical, and administrative support services to sampling and analysis activities within the Environmental Operations Center. Environmental monitoring, site investigations and restoration, and waste management at Sandia National Laboratories/New Mexico (SNL/NM) are performed by the Environmental Operations Center, 7500, through the associated Departments 7511 through 7585. Similar activities are initiated through Sandia Facilities Divisions and Energy and Environment Division. These activities commonly generate samples of water, soil, air, biota, and various wastes that require analysis for a wide variety of constituent parameters. Support services provided by the SMO in relation to these sampling and analysis activities include:

- Sample task planning and coordination
- Preparation or review of sampling and analysis plans
- Analytical cost estimation and budget preparation
- Invoice processing and tracking
- Scheduling of analytical services
- Procurement of sampling kits and containers

Continued on next page
Overview Diagram: Sample Management Services

Figure 1

Overview Diagram

1. Study Review
2. Preparing for Sample Event
3. Sample Collection for Definition of Sample
4. Sample Collection for Definition of Sample
5. Sample Collection for Definition of Sample
6. Issue Sample Collection for Definition of Sample
7. Issue Sample Collection for Definition of Sample
8. Issue Sample Collection for Definition of Sample

1.0 Overview of Sample Management Office Services

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May 9, 1996
Revision 01
AOP 94-22
Sample Management Office User's Guide
### 2.0 ANALYTICAL SUPPORT SERVICES, Continued

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**Routine Analytical Services**

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#### Waste Characterization

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<td>N/A</td>
</tr>
<tr>
<td>Reactivity, hydrogen sulfide</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Toxicity (TLC)</td>
<td>N/A</td>
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</tr>
<tr>
<td>TCLP Herbicides</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>TCLP Metals</td>
<td>N/A</td>
<td>6010</td>
</tr>
<tr>
<td>TCLP Pesticides</td>
<td>N/A</td>
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</tr>
<tr>
<td>TCLP Semivolatile</td>
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<td>8270</td>
</tr>
<tr>
<td>TCLP Vowellites</td>
<td>N/A</td>
<td>8280</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Organic Compounds</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Halogenated volatile organic</td>
<td>601</td>
<td>8010</td>
</tr>
<tr>
<td>Nonhalogenated volatile organic</td>
<td>N/A</td>
<td>8015</td>
</tr>
<tr>
<td>Aromatic volatile organic</td>
<td>402</td>
<td>8020</td>
</tr>
<tr>
<td>Acrolein, acrylonitrile, acetonitrile</td>
<td>503</td>
<td>8030</td>
</tr>
<tr>
<td>Phenols</td>
<td>604</td>
<td>8040</td>
</tr>
<tr>
<td>Phthalate Esters</td>
<td>806</td>
<td>8060</td>
</tr>
<tr>
<td>Organochlorine pesticides and PCBs</td>
<td>806</td>
<td>8080</td>
</tr>
<tr>
<td>Nitro aromatics and cyclic ketones</td>
<td>609</td>
<td>8090</td>
</tr>
<tr>
<td>Polynuclear aromatics</td>
<td>610</td>
<td>8100</td>
</tr>
<tr>
<td>Chlorinated hydrocarbons</td>
<td>612</td>
<td>8120</td>
</tr>
<tr>
<td>Organophosphorus Pesticides</td>
<td>N/A</td>
<td>8140</td>
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<tr>
<td>Chlorinated herbicides</td>
<td>N/A</td>
<td>8150</td>
</tr>
<tr>
<td>GC/MS for volatile organic</td>
<td>624</td>
<td>8245/8260</td>
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<tr>
<td>GC/MS for semivolatile organic</td>
<td>625</td>
<td>8250/8270</td>
</tr>
<tr>
<td>Polychlorinated dibenzodioxins and furans</td>
<td>613</td>
<td>8280</td>
</tr>
</tbody>
</table>

#### References:
- Resource Conservation and Recovery Act (RCRA)
- Clean Water Act (CWA)

Continued on next page
2.0 ANALYTICAL SUPPORT SERVICES, Continued

### Nuclear Analytical Services (Continued)

In addition to NAS provided by commercial laboratories, limited radioanalytical support for monitoring and screening is available on site at SNL/NM Department 7713, Radiation Protection Sample Diagnostics (RPSD). Samples originating in a Radioactive Materials Management Area or suspected of containing added radioactive components (exclusive of naturally occurring radioactivity) must be screened to determine the activity of radioactive constituents prior to being transported off site or shipped to a contracted laboratory. Sample screening is necessary to ensure proper packaging and handling of low-level radioactive samples in accordance with U.S. Department of Transportation (DOT) and International Air Transport Association (IATA) regulations, to ensure that contaminated samples are not inadvertently shipped to a RAS laboratory not possessing a license for radioactive materials, and to ensure that the radioactive materials license limits of a NAS laboratory will not be exceeded. Radioactivity counting methods available at the RPSD include gamma spectroscopy for water, soils, and waste samples, gross alpha, gross beta, and tritium determinations for water samples using liquid scintillation. Coordination between field samplers and the RPSD for radioactivity screening is a service provided by the SMO.

### Special Analytical Services

SAS include analytical requests for samples of unusual composition, analyses at ultra-low limits of detection, nonstandard or experimental techniques, and rush or emergency turnaround at RAS and NAS laboratories. SAS may also include analysis of classified materials, chlorinated furans and dioxins, analysis of extremely hazardous materials, and other parameters or tests outside the realm of environmental analysis or not listed in Tables 1 and 2. SAS requests must be arranged through the SMO prior to sample collection.
3.0 SAMPLE TASK PLANNING AND COORDINATION, Continued
3.0 SAMPLE TASK PLANNING AND COORDINATION, Continued

### Analytical Cost and Budget Estimation

Sampling and analysis projects generally require budgetary commitments and forecasting prior to initiating the activity. The SMO is responsible for management of service contracts between SNL/NM and the contractor analytical laboratories. The SMO will provide up-to-date cost information for analytical services. Using the sampling and analysis plan or detailed statement of work, the SMO can provide an itemized cost estimate showing charges per analysis and sample matrix for any of the selected contractor laboratories. Additionally, the SMO will coordinate with sampling contractors or SNL/NM budget coordinators to determine cost estimates for the labor and materials necessary for sampling activities in the field. Cost incurred for Sampling and Analysis will be distributed through the Service Center Information System (SCIS).

### Scheduling of Analytical Services

Requests for analytical services should be provided to the SMO with as much lead time as possible prior to the beginning of field activities. Project/Task Leaders should provide the SMO with estimates for the number of samples to be collected, the analyses to be requested, duration of the sampling activity, and the dates when sample shipments are anticipated. SMO forwards the information to the contract laboratory, where a schedule is established for the analytical work. **Typically, the SMO requires two weeks of lead time to schedule the analytical work and to ensure the availability of sample containers and equipment.**

It is imperative that requests for rush or emergency analytical services be preauthorized and scheduled at the laboratory in advance. Without advance scheduling, the SMO may not be able to procure priority analytical services when requested.

### Sampling Kits

Sampling kits are supplied by the SMO. Two weeks of lead time are required for the SMO to procure the sample containers and assemble the sampling kit. Sample kit request with short lead times may result in delayed sampling schedule. Sampling kits consist of shipping coolers, appropriate sample containers with appropriate preservative (if required and requested), sample labels, sample numbers, and field documentation and custody forms. The SMO will assemble the sampling kit from material stock or from supplies provided by the contracted laboratory. Field personnel can then pick up the prepared sampling kits from the SMO prior to sampling. The SMO facility for shipping and receiving, preparing sampling kits, and other operational support is located in Technical Area II, Building 919.

Continued on next page
3.0 SAMPLE TASK PLANNING AND COORDINATION, Continued

---

**Figure 3**

*Analysis Request and Chain of Custody Record*

*Continued on next page*
3.0 SAMPLE TASK PLANNING AND COORDINATION, Continued

Figure 3 (Continued)
Analysis Request and Chain of Custody Record

Continued on next page
4.0 SAMPLE TRACKING

Once samples have been shipped to the analytical laboratory, the SMO enters sample data in a computer database and tracks the status of the analytical and reporting processes. The SMO coordinates review of the laboratory analytical report or verification of the analytical data using SNL/NM approved procedures. Questions concerning laboratory data must be forwarded through the SMO to the analytical laboratory for resolution and/or reanalysis. The SMO is the sole technical interface between the field staff and the contract analytical laboratories. The status of any sample, analytical request, or data package can be quickly determined for field or project staff by query on the SMO Sample Tracking and Analytical Results Database. Sample collection information and periodic updates are entered into the STAR database by SMO data management personnel. Requests for information can quickly be determined by querying the database on a number of fields. The types of information entered into the SMO database includes:

- Sample identification number
- Collection date
- Analysis Request and Chain of Custody Record
- Sampling location
- Analyses requested
- Project contact
- Laboratory-assigned sample or project numbers
- SNL/NM budget case numbers
- Analytical costs.
6.0 RECORDS CENTER INTERFACE

Following completion of the data review or validation, the SMO transmits the original field collection and custody documentation along with the laboratory data report and review documentation to the ENVC Record Center and a copy to the task leader. The task leader receiving the transmittal package is responsible for reviewing the data and notifying the SMO of any errors. The SMO can notify the records center when data packages are transmitted to task leaders so that the Records Center may expect and track submittal of the records. Additionally, as the SMO analytical data archival is added to the SMO STAR database system, electronic storage of sampling and analysis records will be coordinated by the SMO.

7.0 QUALITY ASSURANCE

Many of the services provided by the SMO support quality assurance program objectives and serve quality control functions. As previously detailed, some of these quality control functions include writing or reviewing specifications of analytical requirements and acceptance criteria, checking field collection and sample custody documentation for accuracy and completeness, reviewing analytical reports for completeness and accuracy, and verifying data.

Additionally, the laboratories under contract to SNL/NM to perform chemical or radiochemical analyses are subject to quality controls through contract requirements and performance monitoring by the SMO. Performance-evaluation blind-spike samples are purchased or prepared by the SMO and submitted as blind-spike samples to the analytical laboratories routinely throughout the contract term. The performance-evaluation sample program monitors the laboratories' accuracy and precision in performance of a variety of analytical methods in water, soil, or waste matrices. Laboratory performance results are reviewed by the SMO and provided to the laboratories with requests for corrective actions. Environmental Operations department managers and Task Leaders, upon request, are provided with results from the performance evaluations, and performance evaluation reports are filed in the Environmental Operations Records Center.

Continued on next page
8.0 LIST OF CONTACTS

Requests for the SMO services and information can be obtained by contacting the following SNL/NM and/or contractor personnel.

<table>
<thead>
<tr>
<th>Name</th>
<th>Responsible</th>
<th>Telephone</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nick Durand</td>
<td>SMO Project Leader</td>
<td>848-0974</td>
<td>7513</td>
</tr>
<tr>
<td>Katherine Becker</td>
<td>Data Management Coordinator</td>
<td>848-0405</td>
<td>7513</td>
</tr>
<tr>
<td>Mack McLaughlin</td>
<td>Sample Management Coordinator</td>
<td>848-0445</td>
<td>7513</td>
</tr>
<tr>
<td>Pam Puissant</td>
<td>SMO Project Coordinator</td>
<td>848-0402</td>
<td>7513</td>
</tr>
<tr>
<td>Doug Salmi</td>
<td>SMO Project Coordinator</td>
<td>848-0963</td>
<td>7513</td>
</tr>
<tr>
<td>Lorraine Elliot</td>
<td>Budget Coordinator</td>
<td>848-0906</td>
<td>7513</td>
</tr>
<tr>
<td>Mark Lyon</td>
<td>Technical Consultant</td>
<td>262-8800</td>
<td>IT Corp.</td>
</tr>
<tr>
<td>Wyatt Booher</td>
<td>Technical Consultant</td>
<td>848-0952</td>
<td>IT Corp.</td>
</tr>
</tbody>
</table>
SYSTEM AND PERFORMANCE AUDITS

Recommended by:

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Author

Margie Marley
M. Marley, 7582 (IT Corporation)
Technical Reviewer

F. Nimick, 7582
QA Manager

S. Ward, 7511
Department Manager

B. Schwartz, 7500
ES&H Coordinator

Date

Approved By:

D. Fate, 7585
Department Manager
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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure describes the process for conducting system and performance audits of activities performed as part of the Sandia National Laboratories, New Mexico (SNL/NM) Environmental Restoration (ER) Project. It implements, in part, Section 12 of the SNL/NM ER Project Generic Quality Assurance Project Plan (QAPjP; SNL/NM, 1994). Both system and performance audits are referred to in this procedure as "audits."

Scope
This procedure applies to audits of activities performed as part of the SNL/NM ER Project. However, surveillances are not addressed in an ER Project operating procedure; they are implemented in accordance with Sandia GN470034.

Ownership
ER for Technical Areas and Miscellaneous Sites Department 7582, is the process owner of this procedure and is responsible for its development, interpretation, and revision.

2.0 RESPONSIBILITIES

ER Project Quality Assurance Manager
The ER Project Quality Assurance (QA) Manager
- is responsible for the overall effectiveness and implementation of the ER Project audit program,
- ensures that this procedure is prepared and maintained, and
- provides follow up to ensure completion of corrective actions for findings not resolved during the course of an audit.

Quality Assurance Officer
The QA Officer
- is responsible for all audits,
- develops an annual audit schedule and modifies it as necessary,
- maintains the audit status log,
2.0 RESPONSIBILITIES, continued

- ensures that all auditors are qualified and familiar with this procedure,
- appoints the audit team leader and audit team members,
- reviews and approves audit plans and checklists,
- reviews and approves audit reports,
- reviews and approves corrective actions proposed to remedy audit findings, and
- shares lessons learned with ER Project personnel.

Audit Team Leader

The audit team leader
- determines the audit purpose, scope, and basis,
- prepares a written audit plan,
- supervises the performance of the audit,
- assigns each audit team member to a specific area or areas to be audited,
- evaluates if the expertise of a technical specialist is required for matters relating to the audit,
- assigns technical specialists to assist the audit team as necessary,
- conducts entrance and exit meetings with the representatives of the audited organizations, and
- prepares and distributes audit reports.

Audit Team Members

Audit team members prepare audit checklists and perform audits as assigned by the audit team leader.
2.0 RESPONSIBILITIES, continued

Technical Specialist A technical specialist advises the audit team on technical matters relating to the audit under the direction of an audit team member or the audit team leader.

3.0 DEFINITIONS

External System Audit An audit of an organization external to the ER Project that conducts work under the direction of its own QA program for the ER Project.

Finding A direct violation of a specified requirement.

Internal System Audit An audit of an organization conducting work under the direction of the ER Project’s QAPjP for the ER Project.

Lead Auditor An individual who has demonstrated audit experience and satisfies the auditor requirements established by the QA Officer.

Objective Evidence Any recorded statement of fact, other information, or record pertaining to the quality of an item or activity based on observations, measurements, or tests.

Observation A condition noted during an audit that does not directly violate a specified requirement, but in the auditor’s opinion if left unchanged could potentially lead to a condition adverse to quality. Observations noted during the audit are reported to the audited organization, but do not require a written response.

Performance Audit A performance audit is the act of monitoring or observing whether an item or activity conforms to all pertinent requirements in SNL/NM ER Project Generic QAPjP and related sub-tier documents.
3.0 DEFINITIONS, continued

System Audit

An audit of the ER Project system activities performed to evaluate its compliance with a preselected subset of requirements identified in the SNL/NM ER Project Generic QAPjP and related sub-tier documents.

4.0 EQUIPMENT AND MATERIALS

None.

5.0 PROCEDURES

5.1 Audit Scheduling

During the first month of each fiscal year, the QA Officer shall prepare an annual audit schedule that includes internal and external audits of activities under the SNL/NM ER Project's direct control. The annual audit schedule shall identify the month and year of each audit, the organization and activities to be audited, and the requirements to be audited. The audit schedule will be revised or updated as necessary. In addition to regularly scheduled audits, supplemental audits may be initiated if deemed necessary by the QA Officer, ER Project Manager, or ER Project QA Manager.

Audits will be initiated as early as practical in the life of major ER Project activities to ensure that effective quality requirements have been specified and implemented. Major activities shall be designated by the QA Officer when the annual audit schedule is prepared. Each major

continued
5.1 Audit Scheduling, continued

activity shall be audited at least once annually. More frequent audits may be conducted at the request of technical or quality project management.

5.2 Audit Team Selection

The QA Officer shall assign a lead auditor as the audit team leader, and one or more team members by ensuring that:

• at least one technical specialist in the activity to be audited is assigned to the team if the activity is a technical investigation; and

• individuals are independent of any direct responsibility for performance of activities they are to audit.

Auditors shall be qualified based on criteria established by the QA Officer. When a technical specialist with prior audit experience is not available, it is permissible to use someone without prior audit experience under the direction of the audit team leader.

5.3 Audit Planning

The QA Officer shall provide the audit team leader with

• the name of the organization to be audited, and the names of the appropriate individuals within that organization,

• an audit number, from the audit status log (Attachment A), with the following format:

continued
5.3 Audit Planning, continued

ER-XX-YY, where XX is the fiscal year during which the audit is conducted, and YY is a sequential number beginning with 01 for the first audit conducted during that year.

The audit team leader shall be responsible for determining the purpose and scope of the audit, and the procedures or other requirements documents to be reviewed for program compliance. The audit team leader shall prepare an audit plan which identifies, at a minimum,

- the audit number,
- the organization to be audited,
- the name of the organization’s representative,
- the activities to be audited,
- the scope and requirements of the audit,
- the applicable requirements documents (including procedures),
- the audit schedule and agenda,
- the audit team members.

An example of an audit plan is provided in Attachment B. The audit plan shall be reviewed and approved by the QA Officer. The audit team leader should notify the organization to be audited at least one week in advance, and should follow up with a copy of the audit plan prior to conducting the audit.

The audit team leader shall brief the audit team members regarding the details of the audit and shall provide each member with a list of requirements and reference documents to be used to perform the audit.

The audit team members shall prepare an audit checklist from applicable reference or requirements documents to ensure depth, continuity, and complete coverage of items to be verified during the audit. The checklist will result in objective evidence that

- the audited elements provide adequate control and are being implemented effectively, or
5.3 Audit Planning, continued

- corrective actions for deficiencies cited during previous audits have been implemented effectively.

Attachment C (or functional equivalent) should be used for preparation of the audit checklist. The audit checklist shall serve as a guide and shall not restrict the freedom of the audit team to identify and pursue potential quality problems.

5.4 Audit Performance

The audit team leader shall conduct an opening meeting with representatives of the audited organization at the commencement of the audit. The scope of the audit shall be reviewed and an agenda shall be set for the audit. Attendees of the meeting shall be documented.

The audit team members shall conduct audits of activities as previously assigned by the audit team leader and shall document the results on the audit checklists. The documentation should include reference to the objective evidence of the results, verification of the status of any measuring and test equipment used, names of personnel contacted during the audit, and any observations or findings. Audit team members should keep the affected personnel apprised of any concerns, findings, or observations they have during the conduct of the audit.

When the audit has been completed, the audit team leader shall conduct an exit meeting with the representatives of the audited organization to discuss the results of the audit, including any observations and findings noted. Attendees of the meeting shall be documented.
5.5 Audit Reporting

The audit team leader shall prepare and submit to the QA Officer the audit report, within 10 calendar days of completion of the audit. The report shall contain at least the following:

• the audit title and number,
• the audit date(s) and location(s),
• the auditors' names,
• the personnel and organizations contacted,
• the audited organization,
• the audit purpose and scope,
• the list of documents/requirements audited against,
• the attendance lists for entrance/exit meetings,
• observations noted during the audit, including positive "findings,"
• findings and/or observations resolved during the audit,
• findings not resolved during the course of the audit, and
• a summary of the audit, including an overall assessment of the adequacy and effectiveness of the implementation of the QA program.

Audit reports shall be signed by the audit team leader and shall be approved by the QA Officer. The audit team leader shall distribute the

continued
5.5 Audit Reporting, continued

Audit reports to the direct supervisor (e.g., task leader, field team leader) of an activity/organization audited, with a copy to the audited organization's management, the QA Officer, the ER Project QA Manager, the ER Project Manager, the Department Manager of 7511, and the Environmental Operations Record Center. When the adequacy of Health and Safety Plans or other health and safety systems are audited, the audit report also shall be distributed to the ES&H Coordinator.

In accordance with AOP 94-25, the ER Project QA Manager provides follow up to ensure completion of corrective actions for findings not resolved during the course of an audit.

6.0 RECORDS

Records resulting from use of this procedure are

- the approved audit plan,
- completed audit checklists
- audit reports,
- correspondence related to the reports, if any,
- audit status log, and
- a record of completion of corrective action(s).

Each report and any related correspondence shall be submitted to the Environmental Operations Record Center at the time the report is transmitted to the affected organization(s). A copy of the relevant pages of the audit status log shall be submitted to the Records Center at the end of each fiscal year.
7.0 REFERENCES


8.0 ATTACHMENTS

Attachment A. Audit Status Log (Example)
Attachment B. Audit Plan (Example)
Attachment C. Audit Checklist
**ATTACHMENT A**

**SNL/NM ENVIRONMENTAL RESTORATION PROJECT**

**AUDIT STATUS LOG (EXAMPLE)**

<table>
<thead>
<tr>
<th>Audit No.</th>
<th>Organization(s) Surveyed</th>
<th>Audit Title</th>
<th>Date(s) of Audit</th>
<th>Audit Team Leader</th>
<th>Date Closed</th>
</tr>
</thead>
</table>

---

**Audit Report Issued**

---
ATTACHMENT B
AUDIT PLAN (EXAMPLE)

Audit No.: ________________ Audit Type: (Circle One) System or Performance

Organizational Name and Representative: ____________________________
______________________________________________________________

Audit Purpose and Scope: _________________________________________

______________________________________________________________

Requirements/Applicable Documents: ________________________________

______________________________________________________________

Specific Tasks/Activities to be Audited: ______________________________

______________________________________________________________

Persons/Affiliations to be Notified: _________________________________

______________________________________________________________

Auditor Team Members: __________________________________________

______________________________________________________________

Audit Schedule/Agenda: __________________________________________

______________________________________________________________

Prepared by: ___________________________________________________

Reviewed by: ___________________ (QA Officer)

cc: ___________________________
## ATTACHMENT C
**SNL/NM ENVIRONMENTAL RESTORATION PROJECT**
**AUDIT CHECKLIST**

**AUDIT NO.:**

**DATE:**

**ORGANIZATION(S) SURVEYED:**

**ACTIVITY(IES) AUDITED:**

**AUDITOR(S):**

---

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Reference # of Document/Revision in Which Requirement or Instruction is Referenced</th>
<th>Requirement or Instruction</th>
<th>Results (S, U, N/A)*</th>
<th>Personnel Contacted and Method of Verification (i.e., Objective Evidence)</th>
</tr>
</thead>
</table>

* S = Satisfactory; U = Unsatisfactory; N/A = Not Applicable
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

DEFICIENCY REPORTING

Recommended by:

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Author

M. Marley, 7582 (IT Corporation)
Technical Reviewer

F. Nimick, 7582
QA Manager

S. Ward, 7511
Department Manager

B. Schwartz, 7500
ES&H Coordinator

Approved By:

D. Fate, 7585
Department Manager

Date

DATE

UNCONTROLLED COPY

AOP94-25.RV0
DEFEICIENCY REPORTING

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure describes the methods by which conditions adverse to quality, referred to as deficiencies, are identified, documented, and corrected. This procedure implements the requirements of Section 15 of the Sandia National Laboratories, New Mexico (SNL/NM) Environmental Restoration (ER) Project Generic Quality Assurance Project Plan (QAPjP; SNL/NM, 1994).

Scope
This procedure applies to processes and items that are deficient and are identified as such during work conducted under the ER Project Generic QAPjP by SNL/NM ER Project personnel or contractor personnel. Deficiencies are documented on a Deficiency Report (DR) form (Attachment A). Each audit finding not resolved during the course of an audit must be documented on a DR. However, audit findings resolved during an audit do not require a DR.

This procedure does not apply to deficiencies in the areas of environment, safety, or health. Identification of these deficiencies is important; the Facility Manager Designee (for occurrences) should be contacted concerning such deficiencies.

Ownership
Environmental Restoration I, Department 7582, is the process owner of this procedure and is responsible for its development, interpretation, and revision.

2.0 RESPONSIBILITIES

ER Project Quality Assurance Manager
The ER Project Quality Assurance (QA) Manager
- originates DRs related to unresolved findings listed in audit reports,
- resolves the disposition of the DR if the originator and the responsible individual cannot agree on the disposition,
- reviews and approves all DRs,
- maintains the DR Log (Attachment B),
- retains the signed original DR,
- distributes signed information copies,
- ensures verification, completion, and proper documentation of corrective action(s), and
- compiles and distributes the completed records package.

Originator of a DR
The DR originator
- initiates a DR, and
- discusses the DR with the management of the organization proposed to assign a responsible individual.

Responsible Individual
The responsible individual
- proposes the disposition,
- forwards the DR to the ER Project QA Manager for approval, and
- implements the disposition of a deficiency.
3.0 DEFINITIONS

Deficiency  A condition that, if not corrected, could have a serious effect on operation or data defensibility. Such a condition might or might not be a nonconformance.

Corrective Action  A measure taken to rectify and preclude repetition of conditions adverse to quality.

Nonconformance  An explicit failure to comply with a requirement stated in either the SNL/NM ER Project Generic QAPjP or in an applicable requirements document.

4.0 EQUIPMENT AND MATERIALS

None.

5.0 PROCEDURE

5.1 Initiation of a Deficiency Report

Anyone working on the ER Project may initiate a DR by completing Part I of the form (additional pages may be added as necessary). The ER Project QA Manager shall initiate a DR for each finding listed in an audit report that is unresolved at the close of the audit (see AOP 94-24).

All ER Project personnel are responsible for identifying conditions or problems that may impair the quality of work being performed. In many cases, these conditions can be remedied in real time. In cases in which resolutions can be achieved immediately, a formal DR is not required. However, the DR process still can be used as a means of documenting a deficiency and its resolution.
5.2 Disposition of Deficiency

The originator shall provide the DR to and discuss the DR with the management of the organization proposed to be responsible for resolution of the deficiency. The management of the responsible organization then shall assign a responsible individual within the organization to propose and implement the disposition. The responsible individual shall

- complete Part II of the DR,
- have the authority required to implement the disposition,
- be competent in the specific area to be corrected,
- understand the requirements pertinent to the disposition, and
- have access to applicable background information.

The responsible individual shall ensure that further use, delivery, installation, or processing of a nonconforming process or item is prohibited until resolution of the DR is complete. A nonconforming item shall be identified by legibly marking the item with the DR number and the statement "Do Not Use." If possible, the item shall be segregated to prevent inadvertent use.

The originator and the responsible individual shall sign Part III of the DR when they are both satisfied with the proposed disposition. The responsible individual shall then forward the DR to the ER Project QA Manager for acceptance and approval. If for any reason, the originator and the responsible individual cannot agree on the disposition of the DR, they shall forward the DR on to the ER Project QA Manager for resolution.

5.3 Approval of Proposed Disposition

The ER Project QA Manager shall review the DR to be certain the deficiency and the disposition are clearly and properly stated. If additional information is needed or if modifications to the DR need to be made, the ER Project QA Manager will discuss changes with the originator and/or the responsible individual. When agreement is reached and the DR is acceptable, the ER Project QA Manager shall sign Part III of the DR signifying approval of the deficiency and corrective action as stated.

The ER Project QA Manager, or designee, shall maintain a DR Log (Attachment B). For each DR, the ER Project QA Manager shall record on the DR Log the next consecutive DR number, the date initiated, and the responsible individual. The ER Project QA Manager shall then record the DR
5.3 Approval of Proposed Disposition, continued

number on the DR. The ER Project QA Manager shall retain the signed original DR and shall send signed information copies to the management of the organization responsible and the responsible individual to notify them of the acceptability of the proposed disposition.

5.4 Implementation and Verification of Deficiency Disposition

Upon assurance that the proposed disposition is satisfactory to the ER Project QA Manager, the responsible individual shall implement the corrective action(s).

The responsible individual shall notify the ER Project QA Manager upon completion of the corrective action(s).

The ER Project QA Manager or designee then shall verify satisfactory completion of the corrective action(s). Any deficient process shall be evaluated and verified to have been adequately modified. Each nonconforming item shall be evaluated and verified to have been removed or corrected and that tags or labels have been removed. The ER Project QA Manager shall complete Part IV of the DR form.

5.5 Closing the Deficiency Report

After verification of completion of the corrective action(s) and completion of the DR, the DR is considered closed. The ER Project QA Manager shall

- prepare a records package that includes the DR, any attachments, and any related correspondence and forward one copy to the originator, and one copy to the responsible organization; the original shall be submitted to the Environmental Operations Records Center, and

- enter the close-out date on the DR Log.
6.0 RECORDS

Records generated as a result of use of this procedure are

- the DR,
- attachments to the DR as applicable,
- related correspondence, if any, and
- the DR Log.

The first three documents shall be compiled into a records package as specified in Section 5.5. The ER Project QA Manager shall forward a copy of the DR Log to the Environmental Operations Records Center (EORC) at least once during each fiscal year or as defined in an EORC retention schedule.

7.0 REFERENCES


8.0 ATTACHMENTS

Attachment A. Deficiency Report
Attachment B. Deficiency Report Log (Example)
ATTACHMENT A
SNL/NM ENVIRONMENTAL RESTORATION PROJECT
DEFICIENCY REPORT (DR)

DR No.: ________ (COMPLETED BY ER PROJECT QA MANAGER)  

<table>
<thead>
<tr>
<th>PART I - INITIATION (COMPLETED BY ORIGINATOR)</th>
<th>IF DR IS A RESULT OF AN AUDIT FINDING, ENTER AUDIT NUMBER __________</th>
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<tbody>
<tr>
<td>REQUIREMENT:</td>
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<tr>
<td>DESCRIPTION OF DEFICIENCY:</td>
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<tr>
<td>ORGANIZATION SUGGESTED FOR DISPOSITION:</td>
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<tr>
<th>PART II - DISPOSITION (COMPLETED BY RESPONSIBLE INDIVIDUAL)</th>
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<tr>
<td>CAUSE OF DEFICIENCY:</td>
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<tr>
<td>IMMEDIATE ACTION TAKEN:</td>
</tr>
<tr>
<td>CORRECTIVE ACTION TO PREVENT RECURRENCE:</td>
</tr>
<tr>
<td>DATE(S) FOR COMPLETION OF CORRECTIVE ACTION(S):</td>
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</table>

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<thead>
<tr>
<th>PART III - ACCEPTANCE AND APPROVAL OF PROPOSED DISPOSITION</th>
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<tr>
<td>ORIGINATOR (PRINT) SIGNATURE DATE ORG.</td>
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<tr>
<td>RESPONSIBLE INDIVIDUAL (PRINT) SIGNATURE DATE ORG.</td>
</tr>
<tr>
<td>ER PROJECT QA MANAGER (PRINT) SIGNATURE DATE ORG.</td>
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<tr>
<th>PART IV - VERIFICATION OF COMPLETION OR CLOSE OUT (COMPLETED BY ER PROJECT QA MANAGER)</th>
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<td>METHOD OF VERIFICATION, JUSTIFICATION, ETC:</td>
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<tr>
<th>ER PROJECT QA MANAGER (PRINT) SIGNATURE DATE ORG.</th>
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<tr>
<td>DR No.</td>
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AOP 94-25
Rev. 0
Page 9 of 9
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL, RESTORATION PROJECT

SHALLOW SOIL GAS SAMPLING

Recommended by:

________________________
D. Reaber, 7585 (Intera)
Author

________________________
C. Ardito, 7585 (Intera)
Technical Reviewer

Approved By:

________________________
D. Fate, 7585
Department Manager

OCT 31 1994
3/30/94
3/30/94
3/31/94

SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered In Red Ink)
Copy Number: ____________

DISK, SNL/SGOP1.WP5
SHALLOW SOIL GAS SAMPLING

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Attachment A. Soil-Gas Monitoring Log ............................................. 12
1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure is intended to ensure collection of acceptable and consistent soil-gas samples from less than 30 feet below ground surface.

Discussion
Soil-gas collection and analysis is a technique used to define the vertical and lateral extent of volatile-organic compound (VOC) plumes in unsaturated soil. SNL/NM uses two types of surveys to accomplish this objective. Shallow soil-gas surveys with the Geoprobe are performed to locate and map the lateral extent and vertical extent of VOC plumes in the upper 20 to 30 feet of unsaturated soil. Experience at SNL/NM indicates that the Geoprobe can consistently drive the probe to approximately 30 feet below ground surface. Sampling below 30 feet with the Geoprobe is often unreliable, difficult, time-consuming, and therefore, expensive.

Investigation of VOC plumes at depths greater than 30 feet below ground surface can be performed using procedures similar to the shallow surveys. However, a drill rig is required to advance the soil-gas probes.

Scope
This procedure applies to SNL/NM Environmental Restoration (ER) Project personnel and contractors who engage in shallow soil-gas sampling activities. A copy of this procedure should be available for reference during sampling activities.

Ownership
Environmental Restoration IV, Department 7585, is responsible for controlling and updating this procedure.
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

The Field Supervisor is responsible for scheduling or coordinating the necessary resources required for soil-gas sampling in accordance with the approved Sampling and Analysis Plan (SAP) provided by the ER Task Leader. Additionally, the Field Supervisor is responsible for the following:

- Maintaining communications with management and other groups for information that could affect the performance of this procedure.

- Ensuring that only trained field technicians are assigned to implement this procedure and that the training is documented.

- Ensuring that the necessary materials and equipment are available and that timely maintenance is provided.

- Ensuring quality is maintained during field analytical measurements through review of the documentation forms and logbooks.

- Providing field quality assurance (QA) through planning and use of established and approved procedures.

- Implementing corrective actions for field QA deficiencies.

- Providing notification of unusual field conditions, breach of well security, or required well maintenance to the ER Task Leader.

- Providing information and recommendations for the revision of this procedure.

- Ensuring that the health and safety plan specific to the work is available and followed by the field team.

continued
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS, continued

After receiving the appropriate training, the Field Technician is responsible for obtaining field analytical measurements of soil gas according to this procedure and the approved SAP. Additionally, the Field Technician is responsible for the following:

- Field calibrating equipment according to manufacturer's instructions manual and guidance provided in this procedure.

- Decontaminating and maintaining equipment as required by the appropriate procedure and equipment manual(s).

- Legibly documenting all field calibrations, measurements, and field conditions, as required by the appropriate procedures, and ensuring that all field documentation is complete.

- Taking measurements as required by the approved methodology and maintaining the quality of the analytical measurement at all times.

- Conducting activities in a safe, efficient manner so as not to injure anyone.

- Reading, signing, and following the health and safety plan specific to the work being performed.

- Coordinating storage and disposal of wastes generated during the implementation of this procedure.

- Informing the Field Supervisor of required well maintenance.

3.0 DEFINITIONS

None.
4.0 EQUIPMENT AND MATERIALS

Equipment requirements

- Soil-gas probe and drive rod with disposable or reusable drive head.
- Geoprobe rig.
- 3/8-inch polyethylene tubing of sufficient length to collect samples.
- 500-ml glass bulbs with Teflon™ stopcocks or Tedlar Bags.
- Organic vapor meter(s).
- SKC or equivalent constant discharge air-sampling pump.
- Soil-Gas Monitoring Logs (see attached sheet).
- SUMMA™ canisters (if they are to be used in addition to glass bulbs).

5.0 PROCEDURES

5.1 Preparation

Office

- Calibrate and service organic-vapor meters (FOPs 94-28 and 94-29). These organic vapor meters may consist of an H-Nu or Thermoenvironmental 580B equipped with a Photoionization Detector (PID) and/or Sensidyne Flame Ionization Detector (FID) or equivalent.
- Record the results of the equipment check in the field logbook (per FOP 94-25).
- Review the sampling plan for sampling locations and frequency of taking blank samples.

Preparatory field work

- Obtain clearance to drill from SNL/NM and DOE/KAO offices in charge of subsurface utilities.
- Stake the locations to be investigated.
- Clear the work area of obstructions.
- Decontaminate all sampling equipment before it is used to collect field samples (per FOP 94-26).
- Set the flow rate on the air pump to approximately 3 liters/minute.
5.2 Sample Collection Activities

This section describes the two options for sample-collection—the Geoprobe vacuum pump and the SKC (or equivalent) air pump. The SKC air-pump procedure is preferred because the soil gas can be screened with organic vapor meters as the soil gas is purged from the hole. In addition, the purge rate can be controlled with the air pump.

At any time before or during probe placement, the top of the Soil-Gas Monitoring Log should be completed (Site Name, Sampling Location, name(s) of Field Technician(s), and instrument information).

Collection of soil gas samples

Probes Placement

- Attach the soil-gas probe and rod to the Geoprobe. Refer to Geoprobe Model 8-MU Operation Manual for proper set-up procedure and operation.

- Advance the soil-gas probe to the desired depth with the Geoprobe Rig.

- Withdraw the probe approximately 6 inches to create an airspace beneath the probe and to allow the drive head to slide out of the probe.

Sample Collection with the Geoprobe-Vacuum Pump

Note that all references in *Italics* refer to the Geoprobe Model 8-MU Operation Manual

- Set up and test the Geoprobe vacuum sampling system (*Section IV, page 23*).

- Collect a sample train blank if required by the sampling plan. Collect gas sample as described below except do not install the soil-gas sample line in the probe pipe. Instead sample ambient air as far upwind from potential sources as is practical. If detection limits are less than 10 ppmv, sample zero-grade air instead of ambient air.

- Connect adaptor to the end of a soil-gas sample line, thread down the soil gas probe pipe and screw into the sampling point as described in *Section IV, page 121.*

continued
5.2 Sample Collection Activities, continued

Collection of soil gas samples, continued

- Connect vacuum gauge to a tee fitting on the surface end of the gas sample line.

- Label the gas sample bulb and connect between the sample line tee fitting and the Geoprobe sample vacuum tank.

- Soil gas is drawn from the formation, through the gas sample bulb and into the sample vacuum tank until the proper pressure is reached (Section IV, pages 21 to 23).

- The vacuum-side stopcock valve on the gas sample bulb is closed and the pressure in the bulb is allowed to equilibrate to atmospheric pressure.

- The other stopcock is closed; the sample is ready for analysis.

Sample Collection with the SKC-Air Pump

- Connect the polyethylene tubing to the glass bulb influent fitting.

- Connect the glass bulb effluent line to the air pump.

- Connect the organic vapor meter to the air pump discharge line at a tee fitting. Do not place the organic-vapor meter directly in line with the air pump as this may disturb the flow rate from the air pump.

- Turn the air pump on and purge the glass bulb and polyethylene tubing. Monitor the organic vapor meter and note the concentration versus time profile. Once the appropriate soil-gas volume is purged and the VOC concentration has stabilized, collect the soil-gas sample. If the concentration has not stabilized and is still increasing, continue to purge the system. If the concentration is decreasing, it is likely that there is a leak in the system and air is contaminating the bulb. Typical concentration versus time profiles are depicted on the Soil-Gas Monitoring Logs (Attachment A).
5.2 Sample Collection Activities, continued

<table>
<thead>
<tr>
<th>Collection of soil gas samples, continued</th>
<th>Collection of soil gas samples, continued</th>
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<tr>
<td>• Collect the soil-gas sample by closing the effluent side of the glass bulb first. Allow the bulb to equilibrate to atmospheric pressure and close the influent fitting. (In unsaturated soil at SNL/NM, empirical evidence shows that equilibration occurs almost instantaneously after closing the effluent port unless the polyethylene tubing is kinked or the drive tip has malfunctioned. In this case, the air pump will strain to pull the soil gas and the probe should be removed to inspect for damage).</td>
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<tr>
<td>• Disconnect the bulb from the sample line; the sample is ready for analysis.</td>
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<tr>
<td>• Complete the information on the Soil-Gas Monitoring Log.</td>
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<tr>
<td>• If necessary the polyethylene tubing can be connected to a second bulb or a SUMMA™ canister for collection of a quality assurance sample. These samples are submitted to an accredited analytical laboratory for analysis. The SUMMA™ procedure is similar to collecting a bulb sample; however, no air pump is required. The SUMMA™ canister is under a vacuum so when the valve on the canister is opened soil gas is drawn into the SUMMA™ canister. Empirical evidence shows that equilibrium is established within one to two minutes of opening the valve on the canister.</td>
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<td>• Vapor samples are not refrigerated during shipment to the laboratory.</td>
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<thead>
<tr>
<th>Documentation</th>
<th>Documentation</th>
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<tr>
<td>• Record field data as indicated on the Soil-Gas Monitoring Log (Attachment A).</td>
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<tr>
<th>Demobilization</th>
<th>Demobilization</th>
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<tr>
<td>• Remove the probe and tubing from the Geoprobe hole.</td>
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<td>• Decontaminate the probe (per FOP 94-26).</td>
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5.3 Postoperation

Field Tasks
- Ensure that all field equipment is accounted for, decontaminated, and ready for transport.
- Backfill each borehole with suitable grouting material and make sure that each location is properly staked to identify position and date of completion.

Documentation
- Record a brief description of cleanup and backfill activities in the field logbook.
- Complete logbook entries, verify the accuracy of the entries and sign and initial all pages of the field log.
- Review data collection sheets for accuracy and completeness.

Office
- Deliver original forms, logbooks, and laboratory calibration documentation to the Task Leader for technical review.
- Inventory equipment and supplies. Replace or repair all broken items. Purchase new equipment to replace existing equipment which was expended during the survey.

6.0 RECORDS

All original, completed Soil-Gas Monitoring Logs (see Attachment A) and copies of related pages from the field logbook shall be submitted to the Environmental Operations Records Center upon completion of sampling activities.
7.0 REFERENCES

FOP 94-25 Documentation of Field Activities
FOP 94-26 General Equipment Decontamination
FOP 94-28 Health and Safety Monitoring of Organic Vapors With a Flame Ionization Detector (FID)
FOP 94-29 Health and Safety Monitoring of Organic Vapors With a Photoionization Detector (PID)


8.0 ATTACHMENTS

Attachment A. Soil-Gas Monitoring Log
ATTACHMENT A

Soil Gas Monitoring Log

Date: ____________

Site Name: ________________ Sampling Location: ________________

Field Technician(s): __________________________

Printed Name __________________ Signature __________________

Instrument/Serial Number

PID: __________________ Bulb(eV) __________________

FID: __________________ Gas Concentration( ppm) Instrument Reading( ppm)

VOCs Present in Soil Gas

<table>
<thead>
<tr>
<th>Time</th>
<th>Sample Depth (ft)</th>
<th>PID Peak Concentration (ppm) Instrument</th>
<th>FID Peak Concentration (ppm) Instrument</th>
<th>Purge Volume (L)</th>
<th>Purge Rate (L/minute)</th>
<th>Curve Type (A,B,C)</th>
<th>Sample Number*</th>
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Surface Air Infiltration Dilutes VOCs

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<th>PID Peak Concentration (ppm) Instrument</th>
<th>FID Peak Concentration (ppm) Instrument</th>
<th>Purge Volume (L)</th>
<th>Purge Rate (L/minute)</th>
<th>Curve Type (A,B,C)</th>
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No VOCs Present

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<th>FID Peak Concentration (ppm) Instrument</th>
<th>Purge Volume (L)</th>
<th>Purge Rate (L/minute)</th>
<th>Curve Type (A,B,C)</th>
<th>Sample Number*</th>
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* Sample number should be the location number followed by a comma and the sample depth
DOCUMENTATION OF FIELD ACTIVITIES

Recommended by:

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SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered In Red Ink)

Copy Number:___________

DISK, SNL/DOCFIELD.WPS
DO DOCUMENTATION OF FIELD ACTIVITIES

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure provides guidelines and requirements for documentation of field activities, including the use and control of field logbooks and photodocumentation.

Scope
This procedure governs field logbook content and control as well as photodocumentation for site operations conducted for the SNL/NM Environmental Restoration (ER) Project. It applies to all ER staff and contractors who make entries in field logbooks and/or provide photographic documentation of activities.

Ownership
The Environmental Restoration Department I (7582) is the owner of this procedure and is responsible for its development, interpretation, and revision.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

Task Leader
The task leader is responsible for ensuring that all requirements in this procedure are followed by personnel involved with activities for which the procedure is relevant.

Field Personnel
Any individual involved with field activities to whom a logbook is assigned is responsible for complying with all requirements pertinent to logbook use and control.

Photographer
Any individual responsible for still or video photodocumentation is responsible for complying with all requirements pertinent to such photodocumentation.
3.0 PROCEDURES

3.1 Preparation

Prior to use in the field, each field logbook shall be marked with a unique control number issued by the ER Records Center. Each field logbook shall be assigned to one individual who is responsible for its care and maintenance.

Field logbooks shall be commercially available, bound notebooks (e.g. Lietz books or equivalent) or may be a book composed of forms designed for a specific task that is bound after the forms have been completed and prior to being issued a control number by the Records Center. All pages shall be numbered prior to initial use of the logbook. The following information shall be recorded inside the front cover of the logbook:

- Field Logbook Document Control Number (issued by the ER Records Center).
- Activity, if the logbook is to be activity-specific.
- Person and organization to whom the book is assigned, and phone number(s).
- Start date.

The use of specialized forms is an acceptable supplement to field logbooks; notation of the use of a form shall be made in the logbook. The specialized forms shall be kept as a separate attachment to the logbook. All forms shall be completed as accurately and completely as possible. Any nonapplicable portions of a form shall be marked "NA" or lined through to document that such items have been addressed.
3.2 Operation

3.2.1 Field Logbooks

The following is a list of requirements that shall be followed when using a logbook:

• Record work activity, general observations, quantities of materials, calculations, drawings, and related information directly in the logbook. Any additional forms used to record site information shall be referenced in the logbook.

• Do not start a new page until the previous one is full or has been completed with a single diagonal line through the remainder so that no additional entries can be made. Use both sides of each page in bound logbooks. If the logbook is composed of one-sided forms (per Section 3.1), only one side shall be paginated and used.

• **Do not erase or blot out any entry at any time.** Before an entry has been signed and dated, corrections may be made but care must be taken not to obliterate what was written originally. Deletions shall be made by a single line through the material to be deleted, accompanied by the initials of the individual making the deletion and the date.

• Do not remove any pages from the book.

• Logbook entries should be as detailed as possible, and should follow the guidelines set forth by specific procedures and/or the Task Leader for the activity being logged.

Specific requirements for field logbook entries follow.

• Each page shall be initialed and dated immediately below the last entry.

• The final entry page each day shall be signed and dated. If the signature is not legible, the name shall be printed next to the signature.

• All corrections shall be initialed and dated.
3.2.1 Field Logbooks, continued

- Multiple authors shall sign out of the logbook with the following statement:

  "Above notes authored by:
  
  
  Date  Signed  Printed Name"

- Successive authors shall sign and print their name before additional entries are made.

- If a page is not full when entries are finished, a diagonal line shall be drawn through the remainder of the page before signature and date are added.

- The following information shall be recorded with each daily entry:

  - Date and time of initiation of activity;
  - Name of individual keeping the log;
  - Description of activity being conducted, including the location (i.e., well, boring, or sampling location numbers) when appropriate;
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction and speed) and other pertinent data; and
  - Level of personal protection to be used.

  The time (military notation) should be recorded frequently, especially for events or measurements that are critical to the activity being logged. All measurements made and samples collected shall be recorded unless they are documented by automatic methods (e.g. data logger) or on a separate form required by a specific procedure. In these cases, the logbook shall reference the automatic data record or form.

  At each location where a sample is collected or an observation or measurement made, a detailed description of the location is required. Use a compass (include a reference to magnetic declination corrections), scale, rangefinder, or nearby surveyed markers, as appropriate. A sketch of the location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a compass direction indicator. Maps and sketches should be oriented with north (or vertically up) toward the top of the page.
3.2.1 Field Logbooks, continued

Other events and observations that should be recorded include:

- Changes in weather that impact activities being logged;
- Deviations from procedures outlined in any governing documents, including reasons for any noted deviation(s);
- Problems, down-time, or delays; and
- Upgrade or downgrade of personal protection equipment, including reasons for the changes.

3.2.2 Photodocumentation

3.2.2.1 General Requirements

The following is a list of requirements that shall be followed during photodocumentation of field activities:

- A standard reference marker shall be included as an integral component of all visual documentation for which scale is important. The reference marker is used to indicate the feature size in the visual media and should consist of a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or use thereof is not feasible, a common object of known size shall be included within the visual media.

- Blank white index cards should be available to make information/identification cards (slates) for inclusion in photos or videos. Black, indelible marking pens should be used to write on the slates in printing bold enough to be easily read when viewing the final media product.

- Arrows or pointers may be used to draw attention to specific features within the picture.
3.2.2.1 General Requirements, continued

- Contrasting backgrounds are suggested for the purpose of photographing objects. Additionally, a rack may be prepared on which to place an opened boring tube or core barrel when taking photographs.

When photographing continuous core, the scale of the shots shall be constant in the final product. Close-up shots may be taken in addition to, but not instead of, the constant-scale photographs.

- All still photographs should be made using a medium speed fine-grain color negative film in the 35-millimeter (35-mm) format.

Each new roll of film and video tape shall contain upon the first usable frame (for film) or at the beginning of the tape (for video), a slate with the following information:

- A control number (a unique number that is assigned consecutively by the photographer to each roll of film or video tape).

- Site location.

- Project.

- Photographer’s name.

- Date.

Video tapes shall have a black control track and, if necessary, an audio pulse laid within the tapes before recording.

A data-recording camera back that will record frame numbers directly onto the film and subsequent photographs, if available, shall be used for all still documentary photographs taken. The data-recording camera back should be capable of recording other information such as the date.
3.2.2.2 Close-up and Feature Photography

All close-up photographs shall include a standard reference marker of appropriate size as an indication of the feature size and should contain a slate marked with the site name, well number, core depth, or other indicator of the site to which the photograph is relevant.

Samples, core pieces and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their true color.

The photographer shall attach a permanent caption containing pertinent information to the photograph after it has been produced and prior to submitting it to the Environmental Operations Records Center. The caption shall contain the following information: brief site or scene description (what, where, who, why), date, film roll control number, and photograph document control number.

3.2.2.3 Site Photography

Site photography, in general, will consist predominantly of normal and wide-angle shots. A standard reference marker should be placed adjacent to the feature, or when this is not possible, within the same focal plane. If it is impractical to include the reference marker, the film/tape control number shall be entered in the photo logbook along with the frame number and all other information pertinent to the scene.

3.2.2.4 Photodocumentation Using Video Cameras

All documentary video tape recordings of ER Project field activities shall include an audio slate for all scenes. At the beginning of each video session an announcer shall recite the following minimum information: date, time (military units), photographer, and site location.

continued
3.2.2.4 Photodocumentation Using Video Cameras, continued

A standard reference marker should be used when taking close-up shots of site features with a video camera. The scene also should include a caption/slate. If used, it shall be placed adjacent and parallel to the feature being photographed.

Original video tape recordings shall not be edited. This will maintain the integrity of the information contained on the video tape. If editing is desired, a working copy of the original video tape recording can be made. The original, unedited tape shall be retained in the Environmental Operations Records Center.

3.2.3 Photodocumentation Information for the Field Logbook

Photographic activities shall be documented in a field logbook. The following information shall be recorded in the field logbook:

- An entry shall be made in the field logbook for each new roll/tape control number assigned. Include information that is recorded on the film/tape control slate.

- A description of the general set-up shall be recorded in the field logbook. Include pertinent information that will be necessary to provide a caption for each scene (refer to Section 3.2.2.1).

- The laboratory to be used for photo processing shall be recorded in the field logbook.

- Changes in photographic personnel shall be recorded.
3.3 Post-Operation

3.3.1 Field Logbooks

To guard against loss of data due to damage or disappearance of logbooks, copies of completed pages shall be forwarded periodically (weekly, at a minimum) to the Environmental Operations Records Center. At the conclusion of each activity or phase of site work, the completed logbook shall be submitted to the Record Center. Before submittal, the individual responsible for the logbook shall review all entries for appropriate signatures and dates, and for properly made corrections. A statement indicating that this review has been performed shall be added to the end of the logbook. (Example: "I have reviewed all entries for signatures, dates, and proper corrections.
Dated ______________ Signed/Printed.")

3.3.2 Photodocumentation

All film shall be sent to a photo laboratory (to be selected by the photographer) for developing and printing. The photographer is responsible for arranging transport of the film from the field to the photo laboratory, as well as delivery of photographs (and related negatives) or videos to the Environmental Operations Records Center.

Each roll of film, video tape recording and all photographs shall be original records. Therefore, all photographs and the associated set of negatives and original unedited documentary video tape recordings shall be submitted to the Environmental Operations Records Center within 30 days of completion and shall be handled according to standard records management procedures.

Film control numbers shall be permanently attached to the negative sleeve/holders by the photographer. Control numbers for photographs should contain the control number of the film and the frame number from which the photograph was made and be written on the back of the photograph. All control numbers shall be written with black indelible ink.

continued
3.3.2 Photodocumentation, continued

Original video footage shall be assigned a control number (per Section 3.2.2.1). The control number shall be written on the tape case as well as on the video tape itself. All control numbers shall be written with black indelible ink. Original video footage shall not be edited to preserve integrity of the record.

Completed pages of the logbook shall be copied weekly and submitted to the Environmental Operations Records Center as an interim backup or security copy of the record. The logbook shall be submitted within 30 days of completion and will replace the interim weekly submittals.

4.0 RECORDS

Records that can result from use of this procedure include: logbooks in which entries are complete, copies of logbook pages as appropriate, photographs and associated negatives, and videos. Requirements for submittal of these records to the Environmental Operations Records Center are stated in earlier sections of this procedure.

5.0 REFERENCES

None.

6.0 ATTACHMENTS

None.
GENERAL EQUIPMENT DECONTAMINATION

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4/4/94
Date
GENERAL EQUIPMENT DECONTAMINATION

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This Operating Procedure (OP) provides general instruction for decontaminating equipment.

Scope
This procedure applies to all field activities involving sampling at a suspected or actual hazardous waste site. Heavy equipment decontamination is covered by a separate procedure (FOP 94-57).

Ownership
Environmental Restoration Department I, Department 7582, is responsible for development, approval, and revision of this document.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

It is the responsibility of field personnel to ensure sampling equipment is adequately decontaminated before and after each use. Equipment decontamination immediately after sampling activities is necessary to minimize permanent contamination and prevent spread of hazardous or radioactive materials.

3.0 PROCEDURES

3.1 Preparation

- Review the applicable sampling and analysis plan to determine sampling equipment to be used and the analytes to be collected.
- Collect required equipment (see Table 1 for checklist).
- Coordinate schedules with management and sampling staff.

continued
3.1 Preparation, continued

- **Scope the decontamination evolution:**

  - Decontamination procedures depend on the levels of contamination present on the equipment and the type(s) of analyses required. The sampling plan must be consulted to determine the required sample analyses. Based on anticipated analyses, a combination of decontamination procedures described below should be used. The general decontamination procedure is usually adequate for collecting waste samples and environmental samples analyzed for general chemistry and radiological parameters. Additional decontamination (by steam cleaning) may be required for areas of heavy contamination.

  - Because rinsate may contain trace amounts of contaminants, decontamination should be performed in a manner such that rinsate is not discharged to the ground surface or to a sink. Rather, all waste resulting from decontamination should be handled according to procedures approved by the appropriate SNL/NM waste management department.

- **Plan for waste minimization**

  - SNL/NM is committed to waste reduction in every operation. Every effort should be considered to separate wastes by type and level of contamination. Local decontamination, vice general area, may be considered to remove small areas of more concentrated contamination.

  - Free liquid is an unacceptable waste form for radioactive or mixed waste streams. In this situation a "dry" decontamination modification may be considered. Saturated chemwipes are used for "dry" decontamination rather than using a free liquid stream to remove contamination.

(Note that an organic solvent rinse step has not been included in this procedure. The addition of solvents may make a nonregulated waste hazardous, or make a radioactive waste, mixed. If heavy organic contamination is encountered, pesticide-grade acetone, hexanes or methanol may be used to aid decontamination.)
3.2 General Equipment Decontamination

- Wear appropriate protective clothing. Because of the short duration of exposure and dilution of any contaminant(s), the required level of Personal Protective Equipment (PPE) for decontamination is typically one grade below the level required by the site Health and Safety Plan (HASP) for the associated field activity. At a minimum, gloves, apron or (Tyvek) coveralls, and eye protection are required.

- Wash sampling equipment in a warm laboratory-grade, non-phosphate detergent solution* and scrub items thoroughly with a brush.

- Rinse with warm tap water until residue is removed from equipment surfaces.

- Rinse with three successive rinses of deionized/distilled water.

- Invert and allow to air dry in a contaminant-free environment. If equipment is to be used immediately after decontamination, wipe dry with white paper towels.

- When dry, place equipment in a new, clean bag to prevent contamination.

- Enter date, name, time, method of decontamination, and volume of water collected, if any, in the field logbook (per FOP 94-25).

*Note that some items have inaccessible surfaces which may require alternate decontamination methods. For nonmetallic items (example: plastic tubing), a rinse with 20 percent nitric acid solution may replace the detergent rinse. If the only contaminants of concern are volatile organics, metallic items may be baked in a laboratory oven at 102 to 110 degrees centigrade for a minimum of 1 hour and then covered with aluminum foil.
3.3 Decontamination by Steam Cleaning

This procedure should be considered if general equipment decontamination is unlikely to result in sufficiently clean equipment (e.g., in areas of heavy contamination).

- Perform steam cleaning at a designated steam cleaning area. The steam cleaning area shall be clearly marked with yellow boundary lines or with distinct physical boundaries. Keep all equipment to be decontaminated within the boundary lines during steam cleaning. Prior to steam cleaning, check to ensure that adequate capacity is available to contain the rinse water.

- Collect all steam cleaning water for disposal as potential waste. Open all appropriate valves, and ascertain that any drains are not clogged with mud or debris.

- Steam clean all equipment, and ensure that the equipment remains clean while in transport to, or at, the field site. Plastic sheeting should be used beneath equipment stored on the ground.

- Enter date, name, time, and volume of water collected in the field logbook (per FOP 94-25).

4.0 RECORDS

Records generated are limited to entries in the field logbook. Copies of the relevant pages shall be submitted to the Environmental Operations Records Center with other documentation related to the sampling event(s) with which the decontamination is associated.

5.0 REFERENCES

FOP 94-25  Documentation of Field Activities
FOP 94-57  Decontaminating Heavy Equipment
### Table 1

**Equipment and Supplies Checklist**

#### Materials

- Squirt bottles
- Bug sprayer, detergent and tap water
- Bottle brushes
- White paper towels
- Plastic buckets with lids
- Plastic garbage bags and waste storage containers
- Field logbook

#### Reagents

- Distilled or deionized water
- Non-phosphate laboratory detergent (Liquinox\textsuperscript{R}, Sparkleen\textsuperscript{R}, etc.)
- Reagent grade hydrochloric and nitric acid
- 10 Molar sodium hydroxide
FIELD SAMPLE MANAGEMENT AND CUSTODY

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FIELD SAMPLE MANAGEMENT AND CUSTODY

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
The purpose of this Field Operating Procedure (FOP) is to provide guidance for field personnel in the management and custody of samples collected for the Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Project. Sample collection methods vary depending on equipment used to collect the sample. This FOP addresses actions that must be the same for all samples collected, regardless of collection or analysis method. Administrative guidance for the Sample Management Office (SMO) custody and management of samples is available in AOP 95-16.

Scope
This procedure applies to all samples collected in the field by ER Project staff and contractors that may be used to address regulatory concerns.

Ownership
The ER Logistics and Integration Department (7584) is responsible for maintaining and revising this FOP, as necessary.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

ER Field Office
The ER Field Office is responsible for providing support for the management and custody of all samples collected for ER Project activities. The ER Field Office is also responsible for maintaining the integrity of samples while they are in the possession of the ER Field Office, usually either as archived core or field screening samples.

Field Team Leader
The field team leader shall ensure that the sample team members are trained in proper sample management techniques.

Sample Storage Facility
The Sample Storage Facility (SSF) is a storage facility which is operated by the ER Field Office and is responsible for archived samples.
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS, continued

Sample Team Members
The sample team members are responsible for collecting samples and shall follow this procedure for sample management and custody operations.

Task Leader
The task leader shall:

- consult with the ER Field Office to complete appropriate request forms, bottle orders, and other necessary paperwork, and
- consult with the field team leader to ensure that items required for proper sample management are available and adequate.

3.0 DEFINITIONS

None.

4.0 EQUIPMENT AND MATERIALS

AOP 94-22 stipulates that materials used to perform sample management and custody for samples being shipped to a laboratory external to SNL/NM will be provided by the SMO as a "sampling kit." In addition, AOP 94-22 states that a request must be made two weeks prior to sample collection to allow the SMO the required time to procure sample containers and assemble the sampling kit.

Materials used to perform sample management and custody for samples being retained by the ER Project can be obtained by ER Field Office personnel.

continued
4.0 EQUIPMENT AND MATERIALS, continued

A list of typical field supplies is available from the ER Field Office. The equipment used to collect samples is specified in the sampling FOPs. Refer to the applicable procedure to determine the requirements.

5.0 PROCEDURE

5.1 Pre-field Activities

Prior to performing sample management and custody in the field, the following actions must be taken by the sample team members:

- If samples are to be shipped to a laboratory external to SNL/NM, pick up the "sampling kit" at the SMO. Ensure that the kit includes sample shipping coolers (including ice, if needed), appropriate sample containers with preservatives, sample numbers, sample labels, custody tape, and Analysis Request and Chain of Custody (ARCOC) forms.

- If samples will not be shipped off site of SNL/NM, such as drill core or field screening samples, contact the ER Field Office to determine appropriate materials for sample management and custody.

5.2 Field Activities

To perform sample management and custody the following actions must be taken by the sample team members:

1) **Complete the sample collection documentation.** When collecting samples, fill out the forms in accordance with current guidance and the field logbook in accordance with FOP 94-25. The ARCOC and instructions for completing it are provided as Attachment A.

continued
5.2 Field Activities, continued

2) **Photograph the sample.** If applicable, photograph the sample with the sample orientation observable in the photograph (if possible) and/or write a description of the orientation in the field logbook (e.g., notes as to the direction of uphole or the sky in a photograph, etc.). Write the location and sample number in the field logbook, and if applicable the depth interval. The documentation of photographs is described in FOP 94-25.

3) **Describe the sample lithology.** If applicable, describe the lithology of the sample. FOP 94-05 explains the procedure for describing lithology and contains a log form to be used for this purpose. When the description is complete, portions of the sample may be removed for analysis, following the procedure described below for split sample management.

4) **Survey the sample.** If applicable, perform gross beta and gamma radiation and volatile organic compounds surveys. At a minimum, a photoionization detector (PID) and pancake probe are acceptable to perform these surveys.

5) **If needed, split the sample.** A new "split" sample is assigned a sample number related to the sample that it was removed from (e.g., "fraction 2"). Fill out a separate ARCOC for the split fraction if it will be sent to a different destination than other fractions and handle/package the sample based on the sample type. Record this kind of sample splitting in the field logbook in a sample split table with the following headings or information: original sample number, original volume or recovery length, split fraction sample number including the fraction designation, approximate volume of split, and new ARCOC number. If on-site analysis destroys sample splits, note this fact in the field logbook.

6) **Handle and package the sample.** This step should be done by the person who filled out the ARCOC and this person should be confident that they know everything that has happened to the sample since it came out of the ground, well, etc. The initials on the custody seal should be the same as those on the first signature line on the ARCOC, which should be the same as those on the sample label. Initial and date the custody tape. It is suggested the tape be written on while it is still on the roll of backing paper because it is easier than after it is removed. Place the custody tape on the sample container so that the container cannot be opened without breaking the tape. Additional details are described below based on sample type:

   continued
5.2 Field Activities, continued

- **Liquid samples.** Put the sample in the appropriate container provided. Put custody tape and a sample label on the jar, mark the liquid level on the jar, except on Volatile Organic Analysis (VOA) vials, place the jar in a ziplock-type plastic bag, seal the bag, put a radiation and PID survey results sticker on the bag, if applicable, and place the sample either in an appropriately chilled cooler (if temperature is a requirement for sample preservation) or other sturdy box.

- **Composite solid samples.** Thoroughly mix the sample in a stainless steel bowl with a teflon or stainless steel stirring instrument, unless VOA will be performed on the sample. Typically samples collected for VOA will be collocated with samples for other analyses. However, site-specific sampling and analysis plans discuss site-specific details. Contain the sample by placing it in a ziplock-type bag, glass jar, or plastic jar. Put a sample label, custody tape, and radiation and PID survey results stickers on the sample container. Place each sample container in a cooler or other sturdy box lined with a closable clear plastic bag. If glass jars are used, they may each be placed in individual ziplock-type bags as a substitute for the closable clear plastic bag. When the box or cooler is full or exceeds about 30 pounds, seal the plastic lining bag.

- **Grab solid samples.** Transfer the sample from the core barrel or sampling device to a split PVC pipe of appropriate length and diameter, core box, ziplock-type bag, or jar. If applicable, tape the PVC pipe halves together and cap it, put a sample label and custody seal on it, put it in a plastic sleeve or bag, seal the bag, and place it in a core box. Put a radiation and PID survey results sticker on the end of the box with the sample identification number and location.

7) **Temporarily store the sample.** Put the packaged sample in a temporary storage location at the site where sample contamination will not occur and the sample will be out of the way of workers.
5.3 Post-Operation Field Activities

1) Verify completeness of the paperwork. After all the samples have been collected, photographed, described, split, and packaged, or at the end of each day, collect all the completed paperwork in one location. Verify the sample paperwork has been filled out correctly and completely. The original paperwork is sent with the sample and one copy is retained by the task leader or delegate.

2) Decontaminate equipment. Decontaminate all equipment used in accordance with FOP 94-26.

3) Contain the waste. The types of waste containers to be used are described in FOP 94-78.

4) Transport samples. Daily, or at specified intervals, load the samples into a vehicle for transportation. Secure the samples in the vehicle so they do not slide around during the trip. If someone other than a sample team member transports the samples to a storage, handling, or analytical facility, the ARCO form must be relinquished by a sample team member and received by the transporter.

Transport the samples to the appropriate location. The ARCO form must be signed by the transporter and by the receiver at the facility to relinquish custody. However, if the transporter is an authorized facility employee and will maintain custody of the sample, the sample will not be relinquished.

If the samples are taken to the SSF for archiving, unload samples into the appropriate receiving area (see SP 472074), checking for radiation stickers and other hazards labels. If a necessary survey has not been performed, it will not be accepted by the SSF.
6.0 RECORDS

After the analysis results and the original ARCOC have been received by the task leader, the task leader or delegate shall submit the original ARCOC to the Environmental Operations Records Center.

For samples archived at the SSF, a suspense copy of the ARCOC will be sent to the task leader. The original ARCOC will be retained by the SSF curator to allow future custody transfers of the sample to be documented.

7.0 REFERENCES


8.0 ATTACHMENTS

Attachment A. Analysis Request and Chain of Custody Form
## ANALYSIS REQUEST AND CHAIN OF CUSTODY

**Sample No. - Fraction** | **ER Sample ID or Sample Location Detail** | **Beginning Depth In Ft** | **ER Site No** | **Date/Time Collected** | **Sample Matrix** | **Type** | **Volume** | **Preservative** | **Sample Method** | **Sample Type** | **Lab Sample ID**
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---

**Location**

### Tech Area

**Building** | **Room**
--- | ---

**Reference LOV (available at SMO)**

**Parameter & Method Requested**

**Dept. No./Mail Stop:**

**Project/Task Manager:**

**Logbook Ref No.:**

**SMO Reference No.:**

**Record Center Code:**

**Lab Contact:**

**Lab Destination:**

**SMO Contact/Phone:**

**Send Report to SMO:**

**Case No.:**

**SMO Authorization:**

**Bill to:** Sandia National Laboratories

**Supply Services Department**

**P.O. Box 5800 MS 0004**

**Albuquerque, NM 87185 0004**

---

**RMMA**

**Yes** | **No** | **Ref. No.**
--- | --- | ---

**Sample Disposal**

**Return to Client** | **Disposal by lab**
--- | ---

**Turnaround Time**

**Normal** | **Rush** | ** Required Report Date**
--- | --- | ---

**Sample Tracking**

**Special Instructions/GC Requirements**

**Sample Tracking**

**Sample Tracking**

**Sample Tracking**

**Sample Tracking**

---

**Sample Name** | **Signature** | **Init** | **Company/Organization**
--- | --- | --- | ---

1. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

2. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

3. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

4. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

5. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

6. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

7. **Received by** | **Org.** | **Date** | **Time**
--- | --- | --- | ---

---

**WHITE - To Accompany Samples** | **BLUE - To Accompany Samples** | **YELLOW - SMO suspense Copy** | **PINK - Field Copy**
--- | --- | --- | ---

**Laboratory Copy** | **Return to SMO** | **To Accompany Samples**
--- | --- | ---
INSTRUCTIONS FOR COMPLETING THE ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

The Analysis Request and Chain of Custody Record must be accurately completed at the time of sample collection. The white original and blue copy accompany the samples to the laboratory. The yellow copy is filed at the SMO. The pink copy is the field record. Following sample receipt at the laboratory and completion of the laboratory fields on this form, the blue copy is returned to Sandia National Laboratories, Sandia Management Office (SMO) as verification of sample receipt. Following are instructions for completing the individual fields on this form:

- **Enter Page of Page:** Indicate the number of the current page and the total number of pages.
- **Department No.:** Record the number of the Sandia National Laboratories department responsible for collecting the samples and the corresponding mail stop.
- **Project/Tasks Manager:** Indicate the Sandia National Laboratories person responsible for managing the sample collection project or task.
- **Site Name:** Enter the sample collection site name or monitoring program name as appropriate.
- **Record Center Code:** Enter the sample collection site name or monitoring program name as appropriate.
- **Logbook Ref. No.:** Record logbook reference number if applicable.
- **SMO Reference No.:** Record Contractor Billing No. (if applicable).
- **Report to SMO:** Enter the Sandia person to whom the laboratory analysis report should be sent.
- **Contract No.:** Record the number of the contract between Sandia and the analytical laboratory responsible for the analysis.
- **Project Name:** Enter the sample collection site name or monitoring program name as appropriate.
- **Location:** Enter the technical area, building, and room from the list of available locations. List available from SMO.
- **Sample Number:** The laboratory must record and report to the SMO any abnormalities with the shipment that are found at sample receipt.
- **Serial Number:** The laboratory must record internally assigned sample identification numbers corresponding to the sample number(s).
- **Condition on Receipt:** The laboratory must record and report to the SMO any abnormalities with the shipment that are found at sample receipt.
- **RADI:** Indicate if samples were taken into custody.
- **Relinquished/Received by:** Record the names and affiliations of all members of the sample collection team.
- **Sample Disposal:** Check whether samples are to be returned to SMO or disposed of by the laboratory. Enter the date when samples should no longer be archived at the laboratory.
- **RJMA:** Indicate if samples were collected from a Radioactive Materials Management Area.
- **Possible Hazard Identification:** Indicate if the samples are suspected to contain sufficient concentrations of hazardous materials to pose health and safety hazards.
- **Special Instructions/QC Requirements:** Record special instructions/QC requirements.
- **Carrier/Waybill No.:** Record carrier number (if applicable).
- **Sample Type:** Enter the sample type (e.g., grab, Composite, Biased, etc.) from the LOV on special instructions.
- **Sample Collection Method:** Enter the sample collection method (e.g., grab, Composite, Biased, etc.) from the LOV.
- **Sample Location Detail:** See ER Sample Location in Special Instructions.
- **Beginning Depth:** Enter the Beginning Depth, in the units of feet.
- **Sample Container Type:** Indicate the type of sample container (a) used (e.g., polyethylene, glass, amber glass, etc.) from the LOV available in special instructions.
- **Sample Volume:** Indicate the volume of each sample fraction collected and units (i.e., oz., ml).
- **Preservative:** Record the chemical or physical methods used to preserve the sample prior to analysis (e.g., nitric acid, sodium hydroxide, ice, etc.) from the LOV in special instructions.
- **Sample Collection Method:** Enter the sample collection method (e.g., grab, Composite, Biased, etc.).
- **Sample Number:** Enter the unique SMO/Sample Management Office sample number and corresponding fraction number (if applicable) for samples in this set. Use a strictly numeric, one digit per block format.
- **ER Sample ID or Sample Location Detail:** See ER Sample Location in Special Instructions.
# ANALYSIS REQUEST AND CHAIN OF CUSTODY

<table>
<thead>
<tr>
<th>Location</th>
<th>Tech Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>Room</td>
</tr>
<tr>
<td>Sample No. - Fraction</td>
<td>ER Sample ID or Sample Location Detail</td>
</tr>
<tr>
<td>Date/Time Collected</td>
<td>Sample Matrix</td>
</tr>
</tbody>
</table>

**Reference LOV (available at SMO)**

**Parameter & Method Requested**

**Lab Sample ID**

**Abnormal Conditions on Receipt**

**Recipient Initials**

**Lab USE**

- **WHITE** - To Accompany Samples, Laboratory Copy
- **BLUE** - To Accompany Samples, Return to SMO
- **YELLOW** - SMO Suspense Copy
- **PINK** - Field Copy

**PAGE OF**
INSTRUCTIONS FOR COMPLETING THE ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD (continuation)

The Analysis Request and Chain of Custody Record (continuation) form is a continuation of Page 1 of the Analysis Request and Chain of Custody Record. The continuation form is completed in the field when there are more samples or sample fractions to record than can fit on the Analysis Request and Chain of Custody Record. Following are instructions for completing individual fields on the continuation sheet:

Page of: Enter the continuation sheet page number and the total pages comprising this Analysis Request and Chain of Custody Record.

AR/COC: In the upper right corner box, record the same number that is preprinted at a similar location on page 1 of the Analysis Request and Chain of Custody Form.

Project Name: Enter the sample collection site name or monitoring program name as appropriate.

Project/Task Manager: Indicate the Sandia National Laboratories person responsible for managing the sample collection project or task.

Case No.: Enter the Sandia budget case number to which the cost for these requested analyses will be attributed.

Location: Select the technical area, building, and room from the List Of Values (LOV) provided. List available from SMO.

Sample Number-Fraction: Enter the unique Sandia National Laboratories sample number and corresponding fraction number (if any) for samples in this set (e.g., 010234-1).

ER Sample ID or Sample Location Detail: See ER Sample Location ID special instruction.

Beginning Depth in Feet: Enter the Beginning Depth, in the units of feet.

ER Site Number: Enter the ER site number if applicable.

Date/Time Collected: Record the date and time each sample was collected.

Sample Matrix: Record a description of the sample matrix (e.g., soil, water, sludge, oil, waste, etc.).

Container Type: Indicate the type of sample container(s) used (e.g., polyethylene, glass, amber glass, etc.).

Sample Volume: Indicate the volume of each sample or sample fraction collected.

Preservative: Record the chemical or physical methods used to preserve the sample prior to analysis (e.g., nitric acid, sodium hydroxide, ice, etc.).

Sample Collection Method: Enter the sample collection method (e.g., grab, composite, biased, etc.).

Sample Type: Enter the sample type (e.g., TB, FS, DP, MS, etc.) from the LOV on special instructions.

Required Analytical Testing: List a complete description of the analysis to be performed on each sample. Include analytical method reference numbers when appropriate.

Lab Sample Number: The laboratory must record internally assigned sample identification number(s) corresponding to the Sandia sample number(s).

Condition on Receipt: The laboratory must record and report to the SMO any abnormalities with the shipment that are found at sample receipt.

Recipient Initials: The laboratory will ensure all pages of AR/COC are received by initialing on this line.
SPADE AND SCOOP METHOD FOR COLLECTION
OF SOIL SAMPLES

Recommended by:

L. Brouillard, 7585 (INTERA, Inc.)
Author

D. Sandhaus, 7585
(Excel Technical and Environmental Services, Inc.)
Technical Reviewer

Approved By:

D. Faye, 7585
Department Manager

UNCONTROLLED COPY

SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered In Red Ink)

Copy Number: ____________
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

SPADE AND SCOOP METHOD FOR COLLECTION
OF SOIL SAMPLES

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Attachment A. Equipment and Materials Checklist for the Spade and Scoop Method 7
1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
The purpose of this procedure is to present a protocol to be used by all Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Project investigators when collecting shallow soil samples with a spade and scoop.

Scope
This procedure applies to all ER Project activities that require collection of soil samples with a spade and scoop.

Ownership
ER for Landfills and Test Areas Department 7585 is the process owner of this document and is responsible for its development, interpretation, and revision.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

Individuals such as geologists and technicians who are involved in shallow soil sample collection are required to follow the procedures outlined in this procedure. This includes all individuals involved with and/or supporting the ER Project and the Site Wide Hydrogeologic Characterization Project.

3.0 DEFINITIONS

Grab Soil Sample
A single sample collected from one location. Representative of conditions at the sampling point.

Composite Soil Sample
A single sample comprised of a mixture of samples collected from several locations. Representative of average conditions over the area sampled.
4.0 EQUIPMENT AND MATERIALS

Equipment required to implement this procedure is listed in Attachment A.

The "spade and scoop method" is simply digging a hole and collecting a grab sample of soil from the bottom. A spade is recommended because it digs a flatter bottomed hole than a shovel.

The spade and scoop method will work in any soil type including cobbles (which will stop a hand auger). If a spade will not work in a given area, an alternate tool must be used. This could be a concrete saw for concrete, a pick-axe for asphalt, a mattock for roots and rocks, or a back hoe or post hole digger for deep holes or hard soil.

Holes deeper than two or three feet require much labor; a hand auger or back hoe may be more effective.

Proper back care must be exercised when digging. Work gloves may be needed to prevent blisters. Sturdy work boots are needed for pushing the spade into the ground. Goggles are needed when using a mattock, pick-axe or concrete saw. Personnel are not to enter excavations deeper than four feet unless the hole is shored or terraced (see FOP 94-39).

5.0 PROCEDURES

A. Contact SNL and/or KAFB facilities engineering to obtain information concerning the potential for underground utilities in the area prior to sampling. A digging permit will be required in some areas if sampling is conducted at depths greater than 18 inches.

B. Decontaminate sampling equipment before initiating sample collection per FOP 94-26.

C. Using the most effective tool available, dig to the required sampling depth. Remove loose, disturbed soil from the hole before collecting the sample. The sample should be collected with a clean stainless steel spade, scoop, trowel, or scoopula. If more than one sample container needs to be filled, homogenize the soil in a stainless steel pan and then separate the material into individual containers (applies to nonvolatile samples).
5.0 PROCEDURES, continued

D. Enter relevant information in the field logbook (e.g., personnel on site, type of equipment, sampling technique, sample depth, sample number, sample type, and decontamination procedures; see FOP 94-25).

E. When samples are collected for chemical analysis fill out Chain-of-Custody/Request forms and sample labels per FOP 94-34. Samples should be collected following the procedures described in the sampling plan and appropriate FOPs. Information provided in the sampling plan includes, sample locations, sample depth, sample number, sample type, shipping procedures, and responsibilities.

F. Complete a description of the sample using a lithologic description form. An example of this form and instructions for completing it are supplied in FOP 94-05.

G. After collecting the sample, decontaminate all sampling equipment using the procedures discussed in FOP 94-26. Return all supplies and equipment to their proper storage location. Refill the hole and restore the sampling area according to the instructions provided in the site-specific sampling plan.

H. Make sure all sampling locations are staked and the location ID is readily visible on the location stake. Sample locations should be plotted on a field map.

6.0 RECORDS

Records generated by using this procedure are the completed Lithologic Description Log (Soil) Forms, a field map showing sampling locations, and relevant pages from the field logbook. The forms and copies of any associated field logbook pages shall be submitted to the Environmental Operations Records Center at the conclusion of the sampling activity.
7.0 REFERENCES


8.0 ATTACHMENTS

Attachment A. Equipment and Materials Checklist for the Spade and Scoop Method
ATTACHMENT A

EQUIPMENT AND MATERIALS CHECKLIST FOR THE SPADE AND SCOOP METHOD

Sample Collection Equipment

___ Stainless steel spade
___ Stainless steel trowel
___ Stainless steel or Teflon™ scoop or lab spoon (scoopulas)
___ Stainless steel sampling trays or bowls
___ Tape measure (with increments of 0.1 ft)
___ Sturdy work boots
___ Work gloves
___ Stakes for identifying sample location
___ Sledge hammer for driving in stakes
___ Safety glasses
___ Plastic sheet
___ Disposable laboratory gloves
___ Sample bottles
___ Sample labels
___ Plastic bags
___ Parafilm and strapping tape
___ Permanent marking pens
___ Stapler or paper clips
___ Field map
___ Mobile Phone (for emergency communications)
SURFACE SEDIMENT/SOIL SAMPLING

Recommended by:

L. Brouillard, 7585 (INTERA, Inc.)
Author

W. McKenna, 7584 (Lamb Associates, Inc.)
Technical Reviewer

Approved By:

R. Fite, 7585
Department Manager
SURFACE SEDIMENT/SOIL SAMPLING

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6.0 RECORDS .................................................................................... 7
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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
The purpose of this procedure is to provide instructions to field personnel in four basic methods of surface sediment/soil sample collection.

Scope
This procedure is applicable to all personnel who are involved in surface sediment/soil sample collection for the Sandia National Laboratories, New Mexico (SNL/NM) Environmental Restoration (ER) Project site investigation and characterization activities.

Ownership
The ER for Landfills and Test Areas Department (7585) is responsible for the development, approval, distribution, revision, and implementation of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

Field Team Leader
The field team leader is responsible for monitoring the proper implementation of this procedure.

Field Team Members
The field team members should be familiar with the equipment and must document they have read and understand this procedure.

3.0 DEFINITIONS

Composite Samples
Nondiscrete samples composed of more than one specific aliquot collected at various locations or at different times. Analyzing this type of sample produces an average value for sampling locations or time period.

Grab Samples
A specific location at a given time is represented by a discrete aliquot. The sample is collected all at once and at only one particular point in the sample medium.

Sediments
Particles derived from rocks or biological materials that have been transported by a fluid. Sediments include solid matter suspended in or settled from water.
4.0 EQUIPMENT AND MATERIALS

Equipment and materials that may be needed to implement this procedure are listed below:

- Trowel, scoop, or hand corer
- Sampler operations manuals
- Shovel
- Bowl
- Tray
- Sample containers
- Protective gloves
- Tape measure

5.0 PROCEDURE

5.1 Sample Collection

Prior to collecting samples, review the sampling and analysis plan and FOP 94-34, regarding sample containers, preservation, packaging, and shipping. Refer to the sampling and analysis plan to locate sampling sites and decontamination area. Decontaminate all sampling equipment before taking the first sample and between samples in accordance with FOP 94-26.

Sediments may be watery with no cohesion and low viscosity or they may be compacted semi-solids where water is a small part of the mass. The sediment to be sampled may be at the bottom of a flowing arroyo or it may be exposed in a dry arroyo bed. Because of such differences, a variety of sampling methods and equipment may be required. Instructions for the collection of samples using four different collection methods are described below.

If samples are being collected for volatile, semivolatile or metals analysis, follow the applicable information provided in sections 5.2 and 5.3.
5.1.1 Sample Collection with a Scoop or Trowel

1. Clean off any surface debris (twigs, rocks, litter) in an area approximately 15 cm in radius around the sample collection point.

2. Using a precleaned shovel, remove the soil to the desired sample depth.

3. Using the stainless steel scoop or trowel, remove a thin layer of soil from the area the shovel contacted.

4. Collect the soil sample with a scoop or trowel and transfer it into the appropriate sample container.

5.1.2 Sample Collection with a Hand Corer

Hand corers are applicable to the same situations and materials as scoops and trowels. However, they have the further advantage of collecting an undisturbed sample that can profile any stratification in the sample caused by changes in the deposition. Some hand corers can be fitted with extension handles that will allow the collection of samples underlying a shallow layer of liquid. Most hand corers can also be adapted to hold liners made of brass or polycarbonate plastic. Care should be taken to choose a material that will not compromise the intended analytical procedures.

1. Clean off any surface debris (twigs, rocks, litter) in an area approximately 15 cm in radius around the sample collection point.

2. Push the corer into the material with a smooth continuous motion, twist, then withdraw in a single smooth motion. Record any pertinent information in the field logbook.

3. Remove sample and place in an appropriate container.

5.2 Collecting and Handling Samples for Volatiles Analysis

Place an undisturbed grab sample immediately into a 40-ml septum vial or in a 1 liter glass wide mouth bottle that has a Teflon™-lined cap. Do not mix the sample. Make sure the sample containers are filled to the top.
5.3 Collecting and Mixing Samples for Semivolatiles and Metals Analysis

1. If possible screen the sample through a precleaned 0-mesh (No. 10, 2mm) stainless steel screen for semivolatiles. Use a Teflon™ screen for samples requiring metals analyses.

2. Thoroughly mix the sample in a stainless steel or glass mixing container.

3. Place the sample in the middle of a 1 meter square piece of plastic and mix it by rolling it back and forth on the sheet of plastic.

4. Spread the sample out evenly on the sheet and divide the sample into quarters using a stainless steel spoon or trowel.

5. Take a sample from each quarter consecutively until the desired sample volume is reached.

5.4 Post Sample Collection Activities

1. If compositing a series of grab samples, use a decontaminated glass, stainless steel, or Teflon™ mixing bowl to combine and mix the sample.

2. Label samples, complete the sample documentation, prepare the samples for shipping, and temporarily store the samples in accordance with FOP 94-34.

3. After samples are secured, ensure that all equipment is accounted for and decontaminated in accordance with FOP 94-26.
6.0 RECORDS

All field logbook notes and forms associated with the collection of surface sediment/soil samples shall be submitted to the Environmental Operations Records Center by the task leader in accordance with FOP 94-25.

7.0 REFERENCES


8.0 ATTACHMENTS

None.
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

DECONTAMINATING DRILLING AND OTHER FIELD EQUIPMENT

Recommended by:

E. Morse, IT
Author

5-27-94
Date

J. Peace, 7585
Technical Reviewer

05/31/94
Date

Approved by:

J. Fernandez, 7583
Department Manager

5/31/94
Date

SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered In Red Ink)

Copy Number:__________
# DECONTAMINATING DRILLING AND OTHER FIELD EQUIPMENT

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<th>Title</th>
<th>Page</th>
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</tbody>
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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This Field Operating Procedure (FOP) specifies the methodology for the removal of contaminants from drilling and other field equipment during Environmental Restoration (ER) Project activities at Sandia National Laboratories/New Mexico (SNL/NM). Proper decontamination procedures of equipment must be followed for all environmental site investigation projects to assure proper quality control and prevent the introduction of contaminants as a result of site activities.

Scope
This FOP describes the equipment and procedures required to complete the decontamination of drilling and associated equipment specifically used to advance soil borings and install, rehabilitate, or decommission monitoring wells. Typical equipment that falls under this FOP includes drilling rigs, pulling (hoist) rigs, pipe trailers, service vehicles, drilling and tremie pipe, drill bits, well materials, tools, trenching and excavating equipment and Geoprobe\textsuperscript{TM}. This FOP applies to equipment used at environmental sites with suspected organic, inorganic and radiological contamination.

The requirements of this FOP apply to all SNL/NM ER Project personnel and contractors who use or oversee the use of drilling equipment and associated equipment in potentially contaminated areas.

Ownership
ER Department 7583 is responsible for the development, approval, distribution, revision, and control of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

Author
The author is responsible for writing and modifying this FOP. If the original author is unavailable to modify the FOP, than an alternate author will be assigned by the Department 7583 Manager or designee.

Technical Reviewers
Technical reviewers are responsible for evaluating this FOP for technical, administrative, and operational adequacy within their area of expertise.

ER Project Management
The ER Project Management is responsible for assigning authors and reviewers to prepare and revise this FOP and for approving the completed FOP.

continued
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS, continued

<table>
<thead>
<tr>
<th>ER Project Personnel</th>
<th>ER Project personnel responsible for conforming to this procedure include site geologists, engineers, and technicians performing decontamination work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER Project Task Leader</td>
<td>The ER Project Task Leader, or designee, is responsible for implementing decontamination procedures, based on the requirements of this FOP. Additionally, the Task Leader, or designee, is responsible for assuring that approved decontamination procedures are followed as needed and as appropriate and that all waste materials produced are properly managed. Other Task Leader responsibilities include assuring that appropriate personnel and equipment are provided to perform:</td>
</tr>
</tbody>
</table>

- Oversight of drilling equipment decontamination operations
- Observations and inspections of decontamination results as needed
- Radiological monitoring of equipment and decontamination wastes as needed
- Labeling, handling, storage, and disposal of decontamination wastes stored at the decontamination pad or accumulation area
- Location of portable decontamination pad.

| Drilling Contractor | The drilling contractor is responsible for assuring that appropriate personnel and equipment are assigned to implement the field decontamination, transport, and final decontamination activities. The drilling contractor is responsible for providing personnel, equipment, and materials to: |

- Perform equipment decontamination
- Set up and operate the decontamination equipment
- Handling decontamination wastes if requested by the Task Leader, or designee. |

3.0 DEFINITIONS

| Designated ER Decontamination Pad | A designated area in which a decontamination pad exists to support equipment during the decontamination process. The pad will be constructed to control and collect all fluids generated at the site for later sampling/disposal. |
3.0 DEFINITIONS, continued

Detergent
Phosphate-free laboratory-grade detergent (e.g., Alconox® brand Liquinox®).

Steam-Cleaner/High Pressure
A unit capable of generating a pressure of at least 200 pounds per square inch (psi) and producing hot water and/or steam (200°F plus).

Tap Water
Potable water from a source approved by the SNL/NM Task Leader. Use of water from a source not approved by SNL/NM or the U.S. Department of Energy (DOE) is prohibited.

4.0 EQUIPMENT

The following equipment and/or materials are required for decontaminating drill rigs and associated equipment. Drilling and other heavy equipment will be decontaminated at a Designated ER Decontamination site, as described below.

4.1 General Decontamination Equipment

The equipment needed to perform proper decontamination prior to work at SNL/NM work sites should include the following:

- 110-volt AC power supply and/or portable power generator
- Hot-water, high-pressure steam cleaner with 20 feet of pipe wand and 100 feet of hose
- Tap water (potable)
- Distilled/deionized water
- Stiff-bristle cleaning brushes, buckets, mops, rags, etc.
- Emery cloth or sand paper
- Chemical-free paper towels and/or absorbent wipes
- Long-handed shovel

continued
4.1 General Decontamination Equipment, continued

- Duct tape
- Opaque, waterproof plastic sheeting and splash curtains (if required in the project work plan)
- Wooden pallets and pipe racks (20-30 feet long)
- Liquinox® detergent, or equivalent (phosphate free)
- Dilute nitric acid (if required in the project work plan)
- Pressurized sprayers for tap water
- Methanol, isoctane, or other approved solvents (if required in the project work plan)
- Environmentally safe solvent or degreaser (Citrus Power #9652, or equivalent if required in the project work plan)
- Plastic spray bottles or sprayers for decontamination fluids
- Drains, pumps, drums, and tanks for the collection and holding of decontamination solutions
- A forklift outfitted with a "drum handler" (as needed)
- A two-wheeled "dolly" designed to carry 55-gallon drums, equipped with large wheels and tires (as needed)
- Trailer(s) or other tow vehicles, if necessary, to transport heavy equipment from the work sites to and from the designated ER decontamination pad (as needed)
- Secondary containment system for all liquid wastes (if required in the project work plan)
- 6 mil (0.001 inch) bag liners
- Plastic sheeting
- Other decontamination supplies including:
  - Bulk liquid tanks of appropriate size, with secondary containment

continued
4.1 General Decontamination Equipment, continued

- 55-gallon drums with bung lids for decontamination fluids
- 55 gallon drums with open top lids for personnel protective equipment (PPE), and 6-mil (0.001-inch) bag liners
- 100-foot garden-type hose
- Appropriate waste labels (as required by the project waste management plan)
- Any other equipment required in the project work plan, HASP, and/or project waste management plan.

If chemical and/or radiological monitoring is performed as part of the decontamination process, the monitoring will be conducted using the instruments specified in the project work plan and/or HASP. All radiation monitoring methods and instruments will be specified for the type of radiation expected to be encountered at the site. The site safety officer, or designee, shall keep all records of monitoring data and document the results in the field logbook according to FOP 94-25.

Typical instruments that may be used for monitoring purposes include:
- Organic vapor meter
- Geiger-Mueller Pancake Probe
- Alpha Scintillation Detector
- pH meter

5.0 PROCEDURE

5.1 Background

Decontamination of drilling and associated equipment is necessary to assure that the quality of borings, wells and samples are at sufficient levels to support decisions for future actions at the site. The ER Project Task Leader, or designee, shall follow the requirements set forth by this FOP and as required in the project work plan or waste management plan.

In order to verify that proper decontamination of equipment has taken place for each project, decontamination activities shall be documented in the project
5.1 Background, continued

field logbook according to FOP 94-25. The thorough documentation of the decontamination process will maintain needed information to support the overall ER Project objectives.

5.2 Regulatory Guidance

Regulations have not been promulgated that detail specific decontamination requirements. However, general guidance for decontamination of drilling and sampling equipment implemented in this FOP is provided in Section 6.1.9 of the RCRA Ground Water Monitoring Draft Technical Guidance Document (EPA, 1992) and in Appendix E, Section 9 of the Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (EPA, 1991). Additional guidance for the documentation of equipment decontamination is provided in Section 3.4 of "A Compendium of Superfund Field Operations Methods" (EPA, 1987).

5.3 Decontamination Pad

Decontamination of all drilling and associated equipment will be performed at the designated ER decontamination pad located in Technical Area III and/or at temporary decontamination pads mobilized to the work site. The designated ER decontamination pad consists of a rectangular, sheet metal pad with raised sidewalls. The pad rests on a secure concrete base and the unit is constructed in such a manner to easily control the entry and exit of equipment and materials to be cleaned, while maintaining containment of all fluids generated during the decontamination process. For remote sites, or sites that will require extensive decontamination, a portable sheet metal pad can be set up at the site. Temporary, portable pads should consider the following elements:

1) The location of the pad should be near the site without impeding drilling activities. The pad should also allow for decontamination without having to require equipment to leave the immediate area. Do not locate the pad in areas that have the potential for flooding.

2) An area adjacent to the pad will be reserved for pipe racks and wooden pallets so they can easily be moved onto the pad for cleaning of pipe, drill bits and small equipment.

continued
5.3 Decontamination Pad, continued

(3) A designated area will be selected to position the steam-cleaning unit with associated hose and wand of adequate length to clean equipment without having to repeatedly move the steam-cleaning unit.

(4) An area or table should be reserved to hold all small cleaning equipment and special decontamination fluids such as Liquinox®, methanol or nitric acid (if necessary).

(5) The pad shall be positioned so all water generated during the cleaning process will be collected and contained in the sump-like feature of the pad.

5.4 Frequency of Decontamination

Decontamination of drilling and associated equipment will be performed at a frequency necessary to maintain adequate quality control for ER Project site assessment and remediation purposes. The proper frequency of decontamination will assure that only clean equipment are mobilized to each site, used for all site activities, and maintain control of equipment leaving ER sites to prevent the spread of contamination. The frequency for equipment decontamination shall be followed:

- Prior to the initial start up of site activities.
- Prior to use at each boring or well drilled during a site investigation,
- After the completion of the site investigation or well installation project.

5.5 Initial Equipment Decontamination

All equipment that will be used for drilling, well installation, rehabilitation, and decommissioning of wells and borings shall be decontaminated by the drilling contractor at the ER Designated Decontamination site under the direction of the Task Leader, or designee.
5.5.1 Equipment Used Over the Borehole

(1) Prior to using any drilling or drilling support equipment that will be placed over the borehole (mast, drilling platform, hoists, chains, spindles, pulldowns, cathead, hand tools, etc.) thorough cleaning will be performed as follows:

- Use a properly functioning steam-cleaner and stiff-bristle cleaning brushes to completely remove all dirt, rust, oil, grease or other lubricants that may exist on the machinery or equipment that could potentially result in downhole contamination. Care should be taken to completely clean all surfaces that contact, or may contact down-hole tools or portions of equipment to be situated in the immediate area of the open borehole. The non-critical areas on the drilling or support equipment that do not pose an immediate threat to site contamination (rig front ends, cabs, forward framework, etc.) shall be cleaned of loose dirt, mud, and residues prior to mobilization to the site. Complete decontamination of the non-critical portions of the equipment is not necessary.

- For sites that require greater levels of quality control, as outlined in the project work plan, the drilling contractor may need to clean critical equipment that could impact sample quality with a non-phosphate detergent solution (e.g., Liquinox®) and rinsed through steam cleaning.

(2) The SNL/NM Task Leader, or designee, should inspect all decontaminated equipment to assure all dirt, oil, grease, or lubricants have been thoroughly removed. In addition, an inspection of the equipment for system leaks in hydraulic lines will be conducted prior to mobilization to the site. Any lines in which leaks could pose a contamination threat must be corrected prior to the start of site activities. The Task Leader may reject any or all drilling materials based upon the determination of the presence or suspicion of contamination or due to lack of performance to the specifications of this FOP. If the Task Leader deems the decontamination processes acceptable, the equipment will be wrapped in protective plastic (if possible) and released for mobilization to the site.

(3) If specified by the project work plan, designated personnel (i.e., Health Physicist) shall conduct radiological surveys to document the 'pre-site' status of the equipment. If these surveys indicate a pre-existing contamination problem, the Task Leader, SNL/NM Department Manager and Health Physics personnel will decide either to repeat the decontamination process, or reject use of the equipment. All equipment survey methods and results will be fully documented.
5.5.2 Downhole Equipment

Downhole equipment used to drill, sample, recondition, or construct wells must be properly cleaned prior to use in each individual borehole. Typical equipment used in downhole applications include drill bits, drill rod, wirelines, fishing tools, tremie pipe, auger flights, and core barrels. Sampling equipment decontamination will be performed following procedures set forth in FOP 94-26. Equipment that is exempt from decontamination prior to downhole use includes factory pre-cleaned and packaged sampling equipment and well materials. Factory cleaned equipment/materials with damaged packaging shall be decontaminated prior to use. The Task Leader will determine what equipment is exempt from the decontamination process. All exemptions shall be documented in the project field logbook. All other downhole equipment will be cleaned at a Designated ER Decontamination site by the drilling contractor prior to use at each site in accordance with the following procedure:

(1) Prior to cleaning, remove all labels, printing and/or writing on well casing, tremie pipes, bits, etc. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can provide materials without labels if specified when ordered.

(2) Thoroughly steam clean all downhole materials using a properly working steam cleaner and stiff bristle cleaning brushes to remove all dirt, lubricants or residues. All pipe should be cleaned on both the outer and inner surfaces. Inner surfaces can be cleaned with a long wand extension on the steam cleaner. Pay careful attention to joints and couplings where thread lubricants are used.

(3) If steam cleaning is deemed inadequate by the Task Leader as a result of inability to properly clean stubborn portions of the equipment, or more stringent project quality assurance/quality controls are required, the downhole equipment can be cleaned using one or more of the following solutions depending on the particular problem or contaminants of concern:

- For general oils, grease or pipe thread lubricants, scrub with a phosphate-free, laboratory-grade detergent (e.g., Liquinox® or equivalent) and follow this with a thorough steam clean rinse. An alternate cleaning solution is an environmentally-inert solvent (e.g., Citrus Power #9652® or equivalent) to remove stubborn grease or pipe thread compounds, followed by a steam clean rinse.

- If organic or metal contamination concerns are paramount, and a higher degree of decontamination is needed, selected joints of pipe or other
5.5.2 Downhole Equipment, continued

equipment can be steamed cleaned, rinsed with an organic solvent such as methanol or isooctane (for organics) or dilute nitric acid (for metals). The equipment will then be final rinsed with deionized water.

The Task Leader will determine what decontamination procedures will be required as directed in the project work plan and through oversight of the decontamination process.

(4) The Task Leader, or designee, shall approve equipment/materials prior to use. The equipment will be removed from service if it cannot be cleaned to the satisfaction of the SNL/NM Task Leader or designee.

(5) If specified in the project work plan or HASP, the site Health Physicist, or designee, shall conduct a radiation survey before release of the equipment and record the survey results in a health physics log book.

(6) When the equipment has been inspected and released for use, it will then be transported to the work site.

All pipe shall be washed on pipe racks to assure complete surface coverage can be achieved. Cleaned pipe will be moved to the pipe trailer which has been lined with clean plastic sheeting. All cleaned pipe will be covered with fresh plastic sheeting for transport to the drill site. Small equipment such as drill bits, core barrels, and hand tools will be cleaned on wooden pallets and protected with plastic for transport.

5.6 Inspection/Decontamination Activities at Work Site

The drill rig and associated equipment shall be properly maintained and kept clean by the drilling contractor throughout the entire drilling process and/or well completion, rehabilitation, or decommissioning process.

(1) The Task Leader will inspect the drill rig and all downhole equipment to be used for adequacy of decontamination. If the equipment has been soiled as a result of on-site activities, the Task Leader shall require additional equipment cleaning at the portable decontamination pad (if present), transport to the Designated ER Decontamination site for cleaning, or total removal from service.

continued
5.6 Inspection/Decontamination Activities at Work Site, continued

(2) The Task Leader will assure the drilling and associated equipment is not the source of potential contamination during its use at the site. All leaking hydraulic lines, seals, dirty filters, etc. that could impact clean equipment shall be repaired by the drilling contractor.

(3) Cleaned equipment should be stored at the site in such a manner as to prevent contamination prior to use.

(4) Small equipment decontamination can be performed at the site in the absence of the portable decontamination pad if proper containment of decontamination fluids can be arranged. Coordination with personnel performing on-site sampling equipment cleaning should be organized. Small equipment decontamination shall be performed in accordance with FOP 94-26.

(5) Fluid levels at the designated ER decontamination pad or temporary portable pads need to be inspected to assure excessive volumes of water are not allowed to accumulate. Decontamination fluids should be transferred into appropriate sized containers on a regular basis during ongoing site work and immediately after the completion of final equipment decontamination. Protocol for handling and disposing of decontamination fluids shall be managed in accordance with FOP 94-33.

5.7 Contamination Monitoring at Radiological Sites

SNL/NM ER sites that are classified as Radioactive Material Management Areas (RMMA) or sites that may pose a surface radiological hazard, will require special monitoring and, in some cases, special decontamination activities. Equipment used at these sites, especially contractor equipment obtained from outside SNL/NM must be properly monitored through a radiological contamination survey by a certified Health Physicist prior to entry to and exit from radiological hazard sites. Pre-entry monitoring should be performed to verify the condition of equipment entering the site. If radioactive contamination is pre-existing, the Task Leader and Department Manager shall determine if decontamination is an acceptable solution, or consider the rejection of the equipment for use at the site. Monitoring at the end of the project, will prevent the spread of radioactive contamination and verify that all equipment leaving the site is within the release criteria specified in DOE Order 5400.5 (DOE, 1990).
5.7 Contamination Monitoring at Radiological Sites, continued

Radiological monitoring shall be performed on all equipment used at the site. Special attention shall be given to tires, substructures, and equipment surfaces that have been in direct contact with the environmental media being investigated.

If equipment requires radiological decontamination prior to removal, the portable decontamination pad shall be mobilized to the site (if not already present). The equipment will be cleaned following standard protocol discussed in Sections 5.5.1 and 5.5.2 of this FOP. A follow-up contamination survey will be performed prior to authorization for release from the site.

6.0 RECORDS

- Project field logbook
- Any radiological survey results

The Task Leader is responsible for submitting records to the Environmental Operations Records Center.

7.0 REFERENCES


continued
7.0 REFERENCES, continued


FIELD CHANGE CONTROL

Recommended by:

M. Young, 7865 (IT)  3/14/96

Approved by:

F. B. Nimick, 7582  3/14/96
QA Manager
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

FIELD CHANGE CONTROL

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AL/3/5/96/MSdoc/SNL/FOP9468,RV1
1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
The purpose of this field operating procedure (FOP) is to describe the steps to be taken when a change is required during the execution of a field project. The procedure provides guidance for documentation of changes for activities or items that do not conform to the original site-specific work plan or supporting procedures.

Scope
This procedure applies to changes initiated by Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Project personnel during field activities. The procedure does not apply to corrections of typographical or grammatical errors, nor to changes to organization numbers resulting from reorganizations.

Ownership
Environmental Restoration Department 7582, is responsible for the development, approval, distribution, revision, control, and implementation of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

Originator
Request the technical change to be made, provide justification for the change, and define associated project impacts (i.e., cost, schedule, scope). After approval, distribute change directive (CD) form and copies thereof as described in Section 4.1.

SNL/NM Task Leader
Evaluate the change request (for technical changes) and either approve or disapprove the request. If initially approved, the Task Leader or designee shall seek appropriate approvals to implement the change, based on the class of the change.

QA Manager
Evaluate and approve or disapprove Class 2 and Class 3 changes on the CD form. Maintain the change log and assign CD numbers.

Department Manager
Evaluate and approve or disapprove all change directive for Class 2 and Class 3 changes on the CD form.
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

concluded

ER Project Manager Evaluate and approve or disapprove Class 3 changes on the CD form.

3.0 DEFINITIONS

Approving Authority The level of authority that approve CDs.

Change A change can result from the need to modify an original work plan or procedure for a specific task, generally in response to unanticipated conditions or changing project objectives. Changes can be made to cost, scope of work, procedures, or design requirements or may provide details that could not be specified in the site-specific work plans (e.g., for decisions that cannot be made until field conditions are known).

Change Directive A directive in writing from the approving authorities that implements a request for project change. Once approved, the directive shall be distributed to all personnel known to have a copy of the affected procedure(s).

4.0 PROCEDURE

4.1 Normal Process

A change may be requested during any phase of the project when modification to detailed work plans is needed to meet original or continued
4.1 Normal Process (continued)

changing project requirements. Changes may affect field procedures, work plans, designs, or project cost and schedule. The process of change control defined in this procedure assures that the actual course of work is known, and that the effect of the change on the project has been evaluated. Documented changes, together with the original work instructions will provide an “as-performed” record of the work.

All requests for changes shall be documented on a CD form (Attachment A). Technical justification and associated project impacts (e.g., cost, schedule, scope) shall be addressed in the request.

Project changes shall be classified as follows:

Class 1—Minor change that impacts the program to a limited extent (e.g., small cost/schedule impact or a change that may affect other projects) or has no expected impact. The CD can be approved by the Task Leader.

Class 2—Major changes to activities or cost or schedule requiring modification of operational or administrative procedures. Approval by the Task Leader, the QA Manager, and the responsible Department Manager is required.

Class 3—Major changes to cost, schedule, or technical approach that may impact data quality objectives and/or require notification of U.S. Department of Energy (DOE) and/or regulators. The Task Leader, the QA Manager, the responsible SNL/NM Department Manager, and the ER Project Manager must approve the change. DOE and regulator approval also may be necessary, as determined by the ER Project Manager.

In preparing the CD, the Task Leader shall assign a change classification and provide any additional information needed to support the CD. The action(s) necessary for implementing the change shall be noted on the CD.

If possible, all approvals required by the change classification shall be obtained prior to implementing the change. After obtaining approval of the CD, the CD shall be given to the Records Center and shall become part of the controlled distribution for any affected document(s). A copy of the CD shall be provided to the QA Manager, and to any personnel known to have uncontrolled copies of any affected document(s).
4.1 Normal Process (concluded)

All CDs shall be assigned a unique identifying number and shall be tracked in a change log (Attachment B) by the QA Manager or designee.

4.2 Exceptions to Normal Process

4.1.1 Changes Affecting Health and Safety

A Site Safety Officer (SSO) has the authority to change any procedure, without additional approval steps, if in his/her judgment following the procedure as written would result in unacceptable impacts to worker health or safety. If the SSO elects to make changes under such conditions, the changes shall be described in the SSO’s field logbook, together with a brief assessment of expected impacts of the change. As soon as practical after the field change, the SSO or designee shall complete a CD form to document the event and shall provide the original to the QA Manager and a copy of the relevant Task Leader.

4.1.2 Verbal Approval of Changes

If the process of getting written approvals on the CD form before implementing a change would result in unacceptable impacts on cost and schedule because of down time, the originator of a change may obtain verbal approvals. Such approvals shall be obtained from all individuals relevant to the class of change being considered, and shall be documented either on a CD form or in the originator’s field logbook. In all cases, written approvals shall be obtained as soon as practical after implementation of a field change.
5.0 RECORDS

Records that may be generated by use of this procedure include

- CD forms
- Associated correspondence or documentation, and
- Change log

The first two of these shall be submitted to the Environmental Operations Records Center upon completion. A copy of the relevant pages of the Change Log shall be submitted to the Records Center during the first quarter of each fiscal year.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Attachment A—SNL/NM ER Project Change Directive
Attachment B—SNL/NM ER Project Change Log
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<thead>
<tr>
<th>CHANGE REQUEST</th>
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<tr>
<td>The following (cost) (scope) (procedure) (design) (other) change is requested by:</td>
</tr>
<tr>
<td>Name</td>
</tr>
<tr>
<td>------</td>
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<table>
<thead>
<tr>
<th>SCOPE</th>
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<tbody>
<tr>
<td>Use other side or additional sheets if necessary. Attach related drawings, cost estimates, etc.</td>
</tr>
</tbody>
</table>

<table>
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<table>
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<th>DISPOSITION</th>
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<tr>
<td>7. Project time will be (increased) (decreased) (unchanged) by approximately ____ days.</td>
</tr>
<tr>
<td>Project cost will be (increased) (decreased) (unchanged) by approximately $______</td>
</tr>
</tbody>
</table>

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<th>CONCURRENCE</th>
</tr>
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<tbody>
<tr>
<td>8. Title of Change:</td>
</tr>
<tr>
<td>Change Classification: (place check) Class 1: ____ Class 2: ____ Class 3: ____</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>9. Conditions (if applicable)</td>
</tr>
<tr>
<td>10. Implementation Actions (if applicable):</td>
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</table>

<table>
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<tr>
<th>CONCURRENCE</th>
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</table>
| 11. Directive Recommended by Task Leader (Verbal Approval by: __________)
| on date: ______
| Print | Signature | Department | Date |

<table>
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<tr>
<th>CONCURRENCE</th>
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</table>
| 12. QA Manager Concurrence (Class 2 and 3 changes) (Verbal Approval by: __________)
| on date: ______
| Print | Signature | Department | Date |

<table>
<thead>
<tr>
<th>CONCURRENCE</th>
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</table>
| 13. Dept. Manager Concurrence (Class 2 and 3 changes) (Verbal Approval by: __________)
| on date: ______
| Print | Signature | Department | Date |

<table>
<thead>
<tr>
<th>CONCURRENCE</th>
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</thead>
</table>
| 14. ER Project Manager Concurrence (Class 3 changes) (Verbal Approval by: __________)
| on date: ______
| Print | Signature | Department | Date |

<table>
<thead>
<tr>
<th>CONCURRENCE</th>
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<tbody>
<tr>
<td>15. If disapproved, state reason(s)</td>
</tr>
</tbody>
</table>
| Name: __________
| Print | Signature | Department | Date |
ATTACHMENT B  
SNL/NM ER PROJECT CHANGE LOG

<table>
<thead>
<tr>
<th>Date</th>
<th>Change #</th>
<th>Type</th>
<th>ADS</th>
<th>Description/Scope of Change</th>
<th>Status</th>
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</thead>
</table>

1. C = cost, D = design, P = procedure, S = scope, O = other.
2. A = approved, D = disapproved.
PERSONNEL DECONTAMINATION
(LEVEL D, C & B PROTECTION)

Recommended by:

R. Conway, 7582
Author

4/1/94
Date

L. Fritts, 7582
Technical Reviewer

4/4/94
Date

K. Sturgis, 7711
Health and Safety Reviewer

4/20/94
Date

Approved By:

F. Nimick, 7582
Department Manager

4/21/94
Date
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

PERSONNEL DECONTAMINATION
(LEVEL D, C & B PROTECTION)

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<tr>
<td>8.0 Attachments</td>
<td>16</td>
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</table>
1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
The purpose of this procedure is to describe the equipment and procedures required for the decontamination of persons who will perform field activities in Level D, C & B protective clothing.

Scope
The procedures set forth herein shall apply to, and shall be used by, all personnel performing field activities for the Environmental Restoration (ER) Project. Site-specific personnel decontamination requirements shall be specified in the site-specific health and safety plans. Details should include such items as who performs decontamination and at what points respirators can be removed.

Ownership
Environmental Restoration I, Department 7582, controls, retains ownership, and is responsible for updating this document.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

The management structure of the ER Project includes the delegation of responsibility for implementation of the ER Project by the Manager to task leaders (TLs). The TL reports to upper level management, has authority to direct operations, and assumes control over all site activities. Correct disposal of any wastes generated during decontamination activities is the responsibility of the TL or designee.

Given the delegation of responsibility noted above, the TTLs have primary responsibility for protection of health and safety at operable units. To assist in discharging that responsibility, the TTL shall designate Site Safety Officers (SSOs) with authority to stop work if any operation threatens worker or public health and safety. The SSO has responsibility for overseeing correct decontamination procedure implementation. Radiation screening should be conducted whenever radioactive contamination is suspected.

continued
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS, continued

If radiation screening is necessary during decontamination, the screening shall be performed by an individual trained in the use of appropriate monitoring instrumentation. If elevated readings are obtained during screening, the SSO has the responsibility for immediate notification of Radiation Protection Operations.

3.0 DEFINITIONS

NA

4.0 EQUIPMENT AND MATERIALS

Required equipment and materials shall be identified in the site-specific Health and Safety Plan.

5.0 PROCEDURES

5.1 Preparation

5.1.1 Office

The following activities shall be performed in the office prior to the commencement of any field work.

A. Review the site-specific Health and Safety Plan (HSP), which contains descriptions of levels of personal protective equipment (PPE) to be used during field activities.
5.1.1 Office, continued

B. Obtain necessary clothing, protective gear, and equipment, as defined in the site-specific HSP. Ensure that adequate quantities of these items are at the site including gloves, protective clothing and respirator cartridges.

5.1.2 Documentation

There are no forms required to document decontamination procedures and the degree of decontamination attained. A summary of decontamination procedures (maximum, modified, or minimum) shall be recorded in the Health and Safety Logbook for the specific site.

5.2 Level D

5.2.1 Field

Before initiating field activities, designate an area for decontamination activities. Although Level D areas should be minimally contaminated, always use caution to prevent the potential spread of any unknown contaminants.

5.2.2 Operation

The following decontamination procedures are recommended for Level D protection. These measures represent suggested guidelines and may be modified to meet site-specific conditions.

A. Remove disposable coveralls, gloves, and boot covers and place in a plastic trash sack. If not significantly contaminated, the disposable coveralls and boot covers may be reused during the course of a single workday. However, these materials must be disposed of at the end of the workday.
5.2.2 Operation, continued

B. If dusty conditions have been encountered, use water-dampened paper towels to remove the dust from hard hats and safety glasses/goggles. Place used paper towels in a trash sack.

C. If necessary, decontaminate safety boots with water and a steel brush. Ensure that the water is collected in containers. Do not wear muddy or dusty boots out of the exclusion zone.

D. All workers should wash hands and face before leaving the site.

5.2.3 Postoperation

Collect all trash sacks containing disposable clothing and paper towels. Label and dispose of trash sacks and decontamination water according to the requirements of the installation, and of any applicable state and federal regulations. Return all unused items to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

5.3 Level C

5.3.1 Field

Before field activities begin, site work zones shall be established to prevent the accidental spread of hazardous substances. The establishment of work zones is site-specific and coordinated with the site safety officer each day before site work begins. Considerations for establishing work zones should include wind direction, weather conditions, emergency situations, changes in site activities, number of decontamination stations, and access.

continued
5.3.2 Maximum Decontamination Measures

The maximum decontamination measures for Level C are described in this section. These measures are guidelines and may be modified according to site-specific conditions. In no case, however, can measures be less inclusive than those described in Section 5.3.3 be used for Level C situations.

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a. Various size containers</td>
<td>Segregated equipment drop</td>
<td>Deposit equipment used at the site, (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) or plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Plastic drop cloths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>a. Containers (20-30 gallons)</td>
<td>Boot cover and glove wash</td>
<td>Scrub outer boot covers and gloves with decon solution or detergent and water.</td>
</tr>
<tr>
<td></td>
<td>b. Decon solution or detergent water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. 2-3 long-handled, soft-bristled scrub brushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>a. Containers (20-30 gallons) or high-pressure spray unit</td>
<td>Boot cover and glove rinse</td>
<td>Rinse off decon solution from Activity 2 using water.</td>
</tr>
<tr>
<td></td>
<td>b. Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. 2-3 long-handled, soft-bristled scrub brushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>a. Containers (20-30 gallons)</td>
<td>Tape removal</td>
<td>Remove tape around boots and gloves and deposit in waste container with plastic liner.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>a. Containers (20-30 gallons)</td>
<td>Boot cover removal</td>
<td>Remove boot covers and deposit in waste containers with plastic liners.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Bench or atools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>a. Containers (20-30 gallons)</td>
<td>Outer glove removal</td>
<td>Remove outer gloves and deposit in waste container with plastic liner.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 7      | a. Containers (20-30 gallons)  
         b. Decon solution or detergent water  
         c. 2-3 long-handled, soft-bristled scrub brushes | Suit and safety boot wash | Wash splash suit, gloves, and safety boots. |
| 8      | a. Containers (20-30 gallons) or high-pressure spray unit  
         b. Water  
         c. 2-3 long-handled, soft-bristled scrub brushes | Suit and boot rinse | Rinse off decon solution using water. Repeat as many times as necessary. |
| 9      | a. Air tanks or face masks and cartridge, depending on concentration and types of contaminants  
         b. Tape  
         c. Boot covers  
         d. Gloves | Canister or mask change | If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. The worker’s canister is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty. |
| 10     | a. Containers (20-30 gallons)  
         b. Plastic liners  
         c. Bench or stools  
         d. Boot jack | Safety boot removal | Remove safety boots and deposit in container with plastic liner. |
| 11     | a. Containers (20-30 gallons)  
         b. Drop cloths  
         c. Bench or stools  
         d. Plastic liners | Splash suit removal | With assistance of helper, remove splash suit. Deposit in container with plastic liner. |
| 12     | a. Table  
         b. Decon solution  
         c. Brush | Inner glove wash | Wash inner gloves with decon solution. |
| 13     | a. Basin or bucket  
         b. Water  
         c. Table | Inner glove rinse | Rinse inner gloves with water. |

continued
5.3.2 Maximum Decontamination Measures, continued

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>a. Containers (20-30 gallons)</td>
<td>Inner glove removal</td>
<td>Remove inner gloves and deposit in lined container.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>a. Containers (20-30 gallons)</td>
<td>Inner clothing removal</td>
<td>Remove inner clothing and place in lined container. Do not wear inner clothing away from the site, because there is a possibility that small amounts of contaminants might have been transferred in removing the outer clothing. When applicable, begin a gross alpha radiation survey.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>a. Water</td>
<td>Field wash</td>
<td>Shower if high-toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.</td>
</tr>
<tr>
<td></td>
<td>b. Soap</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Small table</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Basin or bucket</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Field showers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. Towels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>a. Trailer or other shelter</td>
<td>Re-dress</td>
<td>Put on clean clothes.</td>
</tr>
<tr>
<td></td>
<td>b. Tables</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Chairs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Lockers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Clothes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3.3 Minimum Decontamination Measures

The minimum decontamination measures for Level C are described in this section. These measures are guidelines and may be modified according to site-specific conditions.
### Minimum Measures for Level C Decontamination

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a. Plastic drop cloths</td>
<td>Segregated equipment drop</td>
<td>Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.</td>
</tr>
<tr>
<td>2</td>
<td>a. Containers (20-30 gallons)</td>
<td>Outer garment, boots, and gloves wash and rinse</td>
<td>Scrub outer boots, outer gloves, and splash suit with decon solution or detergent water. Rinse off with water.</td>
</tr>
<tr>
<td>3</td>
<td>a. Containers (20-30 gallons)</td>
<td>Outer boot and glove removal</td>
<td>Remove outer boots and gloves. Deposit in container lined with plastic.</td>
</tr>
<tr>
<td>4</td>
<td>a. Air tanks or masks and cartridge, depending on concentration and types of contaminants</td>
<td>Canister or mask change</td>
<td>If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. The worker's canister is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty.</td>
</tr>
<tr>
<td>5</td>
<td>a. Containers (20-30 gallons)</td>
<td>Boots, gloves, and outer garment removal</td>
<td>Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.</td>
</tr>
<tr>
<td>6</td>
<td>a. Containers (20-30 gallons)</td>
<td>Face piece removal</td>
<td>Face piece is removed. Avoid touching face with fingers. Face piece deposited in container lined with plastic.</td>
</tr>
<tr>
<td>7</td>
<td>a. Water</td>
<td>Field wash</td>
<td>Hands are thoroughly washed. Shower as soon as possible.</td>
</tr>
</tbody>
</table>
5.3.4 Postoperation

After the completion of field activities, all contaminated wash and rinse waters, decontamination solutions, and contaminated articles must be properly disposed following installation requirements and any applicable state and federal regulations.

After decontamination, return all unused or properly decontaminated equipment (per FOP 94-26) to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

5.4 Level B

5.4.1 Field

Before field activities begin, site work zones shall be established to prevent the accidental spread of hazardous substances. The establishment of work zones is site-specific and coordinated with the site health and safety coordinator at the time the site HSP is prepared. Considerations for establishing work zones should include wind direction, weather conditions, emergency situations, changes in site activities, number of decontamination stations, and access.

5.4.2 Maximum Decontamination Measures

The maximum decontamination measures for Level B are described in this section. These measures are guidelines and may be modified according to site-specific conditions.

continued
### Maximum Measures for Level B Decontamination

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Equipment Needed</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a. Various size containers</td>
<td>Segregated equipment drop</td>
<td>Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Plastic drop cloths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>a. Containers (20-30 gallons)</td>
<td>Boot cover and glove wash</td>
<td>Scrub outer boot covers and gloves with decon solution or detergent and water.</td>
</tr>
<tr>
<td></td>
<td>b. Decon solution or detergent water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. 2-3 long-handled, soft-bristled scrub brushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>a. Containers (20-30 gallons) or high-pressure spray unit</td>
<td>Boot cover and glove rinse</td>
<td>Rinse off decon solution from Activity 2 using copious amounts of water.</td>
</tr>
<tr>
<td></td>
<td>b. Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. 2-3 long-handled, soft-bristled scrub brushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>a. Containers (20-30 gallons)</td>
<td>Tape removal</td>
<td>Remove tape around boots and gloves and deposit in container with plastic liner.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>a. Containers (20-30 gallons)</td>
<td>Boot cover removal</td>
<td>Remove boot covers and deposit in containers with plastic liner.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Bench or stools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>a. Containers (20-30 gallons)</td>
<td>Outer glove removal</td>
<td>Remove outer gloves and deposit in container with plastic liner.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

continued
## 5.4.2 Maximum Decontamination Measures, continued

### MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

<table>
<thead>
<tr>
<th>STATION NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 7              | a. Containers (20-30 gallons)  
b. Decon solution or detergent water  
c. 2-3 long-handled, soft-bristled scrub brushes  
d. Plastic wrap  
e. Sponges or cloths | Suit and safety | Wash chemical-resistant splash suit, SCBA, gloves, and safety boots. Scrub with long-handled scrub brush and decon solution. Wrap SCBA regulator (if belt-mounted type) with plastic to keep dry. Wash backpack assembly with sponges or cloths. |
| 8              | a. Containers (20-30 gallons) or high-pressure spray unit  
b. Water  
c. 2-3 long-handled, soft-bristled scrub brushes | Suit, SCBA, boot and glove rinse | Rinse off decon solution using copious amounts of water. |
| 9              | a. Air tanks  
b. Tape  
c. Boot covers  
d. Gloves | Tank change | If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. The worker's air tank is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty. |
| 10             | a. Containers (20-30 gallons)  
b. Plastic liners  
c. Bench or stools  
d. Boot jack | Safety boot removal | Remove safety boots and deposit in container with plastic liner. |
| 11             | a. Rack or table  
b. Drop cloths  
c. Bench or stools | SCBA backpack removal | While still wearing face piece, remove backpack and place on the plastic liner. Disconnect hose from regulator valve. |
| 12             | a. Containers (20-30 gallons)  
b. Plastic liners | Splash suit removal | With the assistance of a helper, remove splash suit. Deposit in container with plastic liner. |

continued
### MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

<table>
<thead>
<tr>
<th>STATION NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>a. Basin or bucket</td>
<td>Inner glove wash</td>
<td>Wash inner gloves with decon solution.</td>
</tr>
<tr>
<td></td>
<td>b. Decon solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Small table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>a. Water</td>
<td>Inner glove rinse</td>
<td>Rinse inner gloves with water.</td>
</tr>
<tr>
<td></td>
<td>b. Basin or bucket</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Small table</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>a. Containers (20-30 gallons)</td>
<td>Inner glove removal</td>
<td>Remove inner gloves and deposit in lined container.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>a. Containers (20-30 gallons)</td>
<td>Inner Clothing</td>
<td>Remove inner clothing and place in lined container. Do not wear inner clothing away from site, because there is a possibility that small amounts of contaminants might have been transferred in removing the outer clothing. Begin a gross alpha radiation survey, when applicable.</td>
</tr>
<tr>
<td></td>
<td>b. Plastic liners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>a. Water</td>
<td>Field wash</td>
<td>Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.</td>
</tr>
<tr>
<td></td>
<td>b. Soap</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Small table</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Basin or bucket</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Field showers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. Towels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>a. Trailer or other shelter</td>
<td>Re-dress</td>
<td>Put on clean clothes.</td>
</tr>
<tr>
<td></td>
<td>b. Tables</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Chairs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Lockers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Clothes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 5.4.3 Minimum Decontamination Measures

The minimum decontamination measures for Level B are described in this section. These measures are only guidelines and may be modified according to site-specific conditions.

### MINIMUM MEASURES FOR LEVEL B DECONTAMINATION

<table>
<thead>
<tr>
<th>STATION NUMBER</th>
<th>EQUIPMENT NEEDED</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 1              | a. Various size containers  
                b. Plastic liners  
                c. Plastic drop cloths | Segregated equipment drop | Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area. |
| 2              | a. Containers (20-30 gallons)  
                b. Decon solution  
                c. Rinse water  
                d. 2-5 long-handed, soft-bristled scrub brushes | Wash and rinse outer garment, boots and gloves | Scrub outer boots, outer gloves, and chemical-resistant splash suit with decon solution or detergent water. Rinse off with water. |
| 3              | a. Containers (20-30 gallons)  
                b. Plastic liner  
                c. Bench or stools | Outer boot and glove removal | Remove outer boots and gloves. Deposit in container with plastic liner. |
| 4              | a. Air tanks or masks and cartridge, depending upon the concentration and types of contaminants  
                b. Tape  
                c. Boot covers  
                d. Gloves | Tank change | If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. The worker’s air tank is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty. |
| 5              | a. Containers  
                b. Plastic liners  
                c. Bench or stools  
                d. Boot jack | Safety boots, gloves, and outer garment removal | Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic. |
| 6              | a. Plastic sheets  
                b. Bench or stools | SCBA, face piece removal | SCBA backpack and face piece are removed. Avoid touching face with fingers. SCBA is deposited on plastic sheets. |
| 7              | a. Water  
                b. Soap  
                c. Tables  
                d. Wash basin or bucket | Field wash | Hands and face are thoroughly washed. Shower as soon as possible. |
5.4.4 Postoperation

At the completion of field activities, all contaminated wash and rinse water, decontamination solutions, and contaminated articles must be disposed following installation requirements and any applicable state and federal regulations.

All unused or properly decontaminated equipment (per FOP 94-26) will be returned to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

6.0 RECORDS

Copies of the relevant pages of the Site Safety Log Book shall be submitted to the Environmental Operations Records Center at the conclusion of sampling activities to which the pages pertained.

7.0 REFERENCES

FOP 94-26, "General Equipment Decontamination."

8.0 ATTACHMENTS

None.
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

SHALLOW SUBSURFACE DRILLING AND SOIL SAMPLING USING
MECHANIZED HYDRAULIC AUGERS OR THE
GEOPROBE® SOIL CORE SAMPLER

Recommended by:

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Author

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Technical Reviewer

Approved by:

F. Nimick, 7582
Department Manager, 7582

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SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

SHALLOW SUBSURFACE DRILLING AND SOIL SAMPLING USING MECHANIZED HYDRAULIC AUGERS OR THE GEOPROBE® SOIL CORE SAMPLER

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure provides requirements and guidance for the operation of mechanized hydraulic augers and probes to collect shallow (2- to 50-ft deep) subsurface soil samples.

Scope
This procedure applies to all SNL/NM and contractor personnel involved in the operation of and the collection of shallow subsurface soil samples using mechanized hydraulic augers or the Geoprobe® soil core sampler (hereinafter referred to as a Geoprobe® core sampler) under the Environmental Restoration (ER) Project. Additionally, this procedure is appropriate for use for building contamination assessment activities undertaken by other SNL/NM departments and projects.

Ownership
Department 7584 is responsible for the writing, revision, and maintenance of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

ER Project Task Leaders are responsible for developing sampling and analysis plans (SAP), and ensuring that drilling, sample collection, and management under these plans conform to the requirements in this procedure. In addition, the ER Project Task Leaders are responsible for obtaining the required permits and equipment for implementing this procedure.

The Field Team Leader, or designee, is responsible for monitoring proper implementation of this procedure.

The designated Site Safety Officer (SSO) is responsible for ensuring that all operations associated with use of mechanized hydraulic augers or similar devices, or with coring with a Geoprobe® core sampler, are performed in conformance with the site-specific health and safety plan (HSP).

The sampling technicians are responsible for being familiar with the objectives of the SAP and for proper drilling and coring, sample collection, and documentation. They also shall attest that they have read and understand this procedure.
3.0 DEFINITIONS

Auger Flights  Spiraling metal ribs welded to the auger sections which, while being rotated, carry soil to the surface. Solid-stem auger flights have a solid center, whereas hollow-stem auger flights contain a hollow center.

Disturbed Soil Sample  A soil sample whose in situ physical structure and fabric have been disturbed as a result of sample collection.

Drill Bit/Cutter Blade/Cutting Shoe  The cutting tool attached to the bottom of the auger drill stem. The cutting shoe is the cutting tool attached to the bottom of the Geoprobe® sampling tube.

Drillhead Assembly  Gear assembly attached to the drill mast that is used to rotate the auger sections.

Mast  Assembly of gears, pulleys, and equipment attached upright on a drill rig that is used to operate the drill/coring device.

Undisturbed Soil Sample  A soil sample whose in situ physical structure and fabric have not been disturbed, or have been only minimally disturbed, as a result of sample collection. An undisturbed soil sample can be collected by probing with a Geoprobe® core sampler. Additionally, an undisturbed soil sample can be collected by drilling to 6 in. above the required sample depth with a mechanized hydraulic auger, then collecting the sample with a thin-wall tube sampler. For both the Geoprobe® and the mechanized hydraulic auger methods for collecting undisturbed soil samples, the sampler is typically a hollow cylinder composed of brass or stainless steel and may contain a Teflon® or acetate liner.

4.0 DRILLING METHODS, EQUIPMENT, AND MATERIALS

4.1 Methods

The methods of boring discussed in this procedure are used for collection of shallow subsurface soil samples, both disturbed and undisturbed.
4.2 Equipment, Materials, and Documentation

Equipment and materials required to satisfy this procedure adequately may include, but is not limited to, the following:

- Little Beaver® and/or Big Beaver®
- Geoprobe® core sampler.
- Simco® auger-core sampler.
- Shovel.
- Hand auger.
- Stainless steel (or appropriate metal) core sampler and appropriate liners.
- Bucket auger.
- Hand tools (screwdrivers, pliers, open-ended wrenches up to 5/8-in. size, channel lock pliers, vise grips, adjustable wrenches, etc.).
- Measuring tape.
- Indelible markers.
- Distilled/deionized water.
- Hard hat, hearing protection, safety glasses, steel-toe safety boots, leather work gloves, and protective clothing (long sleeve cotton coveralls). The HSP guidelines may amend this list.
- Heavy plastic bags or sheeting, used to stage soil, drilling, and sampling equipment.
- Duct tape to secure plastic bags.
- Barricade tape and other site control materials.

Additional equipment or materials associated with this procedure is identified in the SAP, the HSP, and other procedures relevant to drilling operations.
4.2 Equipment, Materials, and Documentation, continued

Documentation:

- Appropriate field forms and/or logbook, in accordance with FOP 94-25 and AOP 95-16.
- Analysis Request/Chain of Custody Forms for sample documentation.

5.0 PROCEDURE

5.1 Preparation for Drilling Operations

5.1.1 Office

The Field Team Leader shall perform the following before initiating field activities:

1. Review the SAP, the HSP, this procedure, and any other applicable field operating procedures (FOP) relevant to using the mechanized augers or Geoprobe® core sampler for information regarding hazards that may be encountered during drilling and coring activities.

2. Ensure that each operator receives the appropriate classroom training and on-the-job training required to operate the drilling equipment. Attachment A contains the field training forms required to operate the drilling equipment.

3. Ensure that all appropriate Kirtland Air Force Base (KAFB) and SNL/NM permissions and permits required for drilling operations are secured. These permissions and permits include: a Digging Permit, obtained from KAFB Utility Office (if drill site will be on KAFB land) or from SNL/NM Department 7911, Site Utilities (if drill site is on land used by Department of Energy (DOE) or SNL/NM). If on KAFB land, secure a Site Permit, obtained from the KAFB Real Estate Office, and an AF-813 Permit, which grants permission to drill and is obtained from the KAFB Installation Restoration Project office.

continued
5.1.1 Office, continued

4. Coordinate the requirements for any additional state and federal permits (i.e., air permit) with SNL/NM Environmental Protection and Waste Management Departments, as appropriate.

5. Identify all equipment and field supply requirements, and prepare a list of sampling equipment and sampling supplies using the list in Section 4.0 as guidance. Complete a SNL/NM ER Field Office Work Request form which requests the necessary equipment and support, as described in the ER Project Field Operations Field Manual (MAN 95-01) (SNL/NM 1995a). Coordinate with the SNL/NM Field Coordinator to ensure that before entering the field all required equipment and supplies will be available in accordance with procedures for logistical meetings specified in MAN 95-01.

6. Coordinate sample arrangements with the SNL/NM Sample Management Office and on-site laboratory personnel.

7. Notify the SNL/NM ER Field Coordinator before beginning any field operations as specified in MAN 95-01. The Field Coordinator will then notify appropriate DOE and New Mexico State personnel, as necessary.

8. Identify all field team members and assign individual field responsibilities. The makeup of the field team may be identified in the SAP.

9. Meet with SNL/NM ER Field Coordinator or designee and coordinate all site preparation and logistical requirements and drilling operations protocols as specified in the MAN 95-01.

10. Assemble the field team and conduct a field readiness review meeting as specified in MAN 95-01.

11. Initiate a field logbook per FOP 94-25, if not already initiated.

12. Obtain a sufficient number of sample collection and ER Project forms and labels, sample containers, sample sleeves, drilling/probing tools, PPE, and all other supplies necessary to perform the work prior to drilling operations.

continued
5.1.1 Office, continued

13. Ensure that drilling and sampling equipment has been decontaminated per FOP 94-26 and FOP 94-57 before use.

14. Check equipment (i.e., auger cutting blade), as necessary, according to the manufacturer’s operating instructions. Inspect parts for wear or damage.

5.1.2 Field

1. Before marking coring and drilling locations, request a utilities map from SNL/NM facilities and delineate the location of underground utility lines.

2. Survey or map and clearly mark coring and drilling locations prior to beginning. The hole should be cored or drilled at the marked location. If the location must be moved, the new location shall be preapproved by the ER Project Task Leader, and shall be documented in the field logbook.

3. Clear the area to be drilled of surface debris and vegetation.

4. Determine the area of coring and drilling activities as well as the associated exclusion zone, and delineate the exclusion zone area with ropes or other barricades, and post signs at entry points, if required, in accordance with the HSP.

5. Check the fuel and hydraulic fluid levels in the equipment and fill, as necessary, in accordance with the manufacturer's operating instructions.

6. Conduct a tailgate health and safety briefing in accordance with FOP 94-01.

5.1.3 Precautions

* Gasoline must be handled very carefully when samples are to be collected for volatile organic compounds (VOC) or petroleum hydrocarbons. Fuel containers shall be kept closed except when being used and shall be stored at the downwind edge of the site control boundary.

continued
5.1.3 Precautions, continued

- Once VOC samples are collected, package and manage samples upwind from idling motors.
- Refrain from idling motors, if possible, while sampling for VOCs.
- When using mechanized augers or Geoprobe® core sampler, proper care must be exercised to prevent back injuries when pulling an auger or piece of drilling equipment out of a hole, especially if it is stuck or when moving a piece of equipment. Work gloves should be worn to prevent blisters or more severe injuries.

5.2 Drilling and Soil Sampling Using the Mechanized Hydraulic Augers

The following are general instructions for operating the Little Beaver®, Big Beaver® or SIMCO® auger-core sampler.

1. Assemble and/or operate the auger machine according to the manufacturer’s instructions (Little Beaver®, Inc. 1994a; 1994b; SIMCO®, Inc. 1995), following all applicable safety instructions. The auger machine shall be operated by a minimum of two persons.

2. Begin boring to the desired depth following manufacturer’s instructions for equipment operation. Allow the auger to rotate at the manufacturer’s suggested speed.

3. Place all excavated soil in an area/container adjacent to the hole in accordance with the SAP or Waste Management Plan.

4. After boring to the desired depth, and removing materials from the annulus, the hole is ready for sampling. The hole can be sampled by one of two methods:
   - Method 1 (Hollow Stem Augers): Stop the auger, detach the power source from the auger flights, and remove the center plug from the leading end of the auger flights (downhole) according
5.2 Drilling and Soil Sampling Using the Mechanized Hydraulic Augers, continued

to the manufacturer’s instructions. Assemble a sampling device (thin-wall tube sampler, core sampler, bucket auger, etc.) and advance this device into the hollow portion of the auger flights to the bottom of the hole in accordance with FOP 94-23 or FOP 94-27. Collect the soil sample.

• Method 2 (Solid Stem Augers): Stop the auger and pull the auger flights completely out of the hole according to the manufacturer’s instructions. If necessary, slightly rotate the auger to aid in pulling the auger flights from the hole. Assemble a sampling device (thin-wall tube sampler, core sampler, bucket auger, etc.) and advance this device into the open hole in accordance with FOP 94-23 or FOP 94-27. Collect the soil sample.

5. Remove the sample from the sampling device and determine if sample recovery was adequate. If not, as determined by the Field Team Leader, repeat the sampling procedure.

6. If required, perform borehole lithologic logging in accordance with FOP 94-05.

7. Once sampling is complete and all the equipment is removed from the drill site, fill in the sample hole as described in the SAP.

8. Document the drilling and sampling event according to the procedures outlined in FOP 94-25.

5.3 Drilling and Soil Sampling Using A Geoprobe® Core Sampler

The following are general instructions for operating the Geoprobe® core sampler.

1. Mobilize the Geoprobe® core sampler to the desired sampling location. A minimum of two persons shall be used to position the machine. If equipment was transported on a pickup truck, chock the two front wheels once the vehicle is in position. If using the SIMCO® Auger-Core Sampler, the Geoprobe® probing machine will already be in place.

continued
5.3 Drilling and Soil Sampling Using A Geoprobe® Core Sampler, continued

2. Pre-probe the sample location, if applicable, by driving a pilot hole to the desired sample depth according to the manufacturer's instructions (Geoprobe® Systems, 1993; SIMCO®, Inc., 1995). The pilot hole is required to penetrate gravel, asphalt, hard sands, or rubble. A probe attachment (i.e., drill steel bit or carbide bit) may be used to bore the pilot hole.

3. Assemble the desired sampler, which may include a sample liner, sample tube, cutting shoe, piston rod, piston tip, and stop-pin. A clean, new liner is recommended for each use.

4. Attach an appropriate probe rod to the assembled sampler and position the assembly for driving into the subsurface.

5. Drive the assembly into the subsurface until the drive cap is just above the ground surface.

6. Remove the drive cap and attach probe rods in succession until the leading end of the sampler reaches the desired sampling interval, re-attaching the drive cap as each rod is driven.

7. Once the sampling interval has been reached, position the Geoprobe® machine to allow for extension rod insertion and removal of the drive cap. NOTE: NEVER RAISE THE FOOT MORE THAN 6 INCHES FROM THE GROUND SURFACE WHILE DRIVING THE PROBE STRING.

8. Insert extension rods down the inside of the probe rods until the leading extension rod reaches the stop-pin at the top of the sampler assembly, if appropriate.

9. Attach the leading extension rod to the stop-pin, if appropriate, detach the stop-pin from the sampler, and remove the extension rods and stop-pin from the hole.

10. Re-attach the drive cap, reposition the Geoprobe® machine over the probe rods, and drive the tool string the length of the sampler.

11. Remove the tool string from the hole.
5.3 Drilling and Soil Sampling Using A Geoprobe® Core Sampler, continued

12. Unscrew the cutting shoe and pull the cutting shoe (with the liner attached) out of the sample tube, if appropriate.

13. Collect the sample according to instructions in the SAP and FOP 94-34, as well as from the Field Team Leader.

14. If required, perform borehole lithologic logging in accordance with FOP 94-05.

15. Document the coring and sampling event according to the procedures outlined in FOP 94-25.

5.4 Postdrilling Operations

- Restore the sampling area according to the instructions provided in the SAP. Fill all holes, or cover and mark if they must remain open.
- Make sure all drilling and sampling locations are properly staked and the location ID is readily visible on the location stake.
- Ensure that all equipment is accounted for and has been decontaminated in accordance with FOP 94-26 and FOP 94-57.
- Discard any damaged or used equipment which cannot be reused or repaired.
- Manage all waste in accordance with FOP 94-33.

6.0 RECORDS

Records generated as a result of implementing this procedure shall be submitted to the SNL/NM Environmental Operations Records Center at the conclusion of the drilling and sampling activities. These records must include equipment training records for equipment operation. Training records for equipment operators are maintained by the ER Project Field Operations Office.
7.0 REFERENCES


Sandia National Laboratories/New Mexico (SNL/NM), 1994e, "Safety Meetings, Inspections, and Pre-Entry Briefings," FOP 94-01, Sandia National Laboratories, Albuquerque, New Mexico.


continued
7.0 REFERENCES, continued


Sandia National Laboratories/New Mexico (SNL/NM), 1995a, "Environmental Restoration Field Office Field Manual 95-01, Revision 0, draft," MAN 95-01, Sandia National Laboratories, Albuquerque, New Mexico.


Sandia National Laboratories/New Mexico (SNL/NM), 1995c, "Field Waste Management," FOP 94-33, Sandia National Laboratories, Albuquerque, New Mexico.


8.0 ATTACHMENTS

Attachment A—Drilling Equipment Training Forms
ATTACHMENT A-1

Little Beaver/Big Beaver® Mechanized Hydraulic Auger
Field Training
ENVIRONMENTAL RESTORATION PROJECT FIELD OFFICE
DEPARTMENT 7584

"BEAVER" HYDRAULIC POWER AUGER FIELD TRAINING

NAME ______________________ DEPARTMENT __________
SSN____________________ COMPANY __________________

BEAVER POWER AUGER OPERATIONS MANUAL READ AND UNDERSTOOD:

_________________________ ____________________________
DATE TRAINEE SIGNATURE

OPERATOR (MINIMUM OF 6 HOURS ON THE JOB TRAINING)

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CERTIFIED AS A BEAVER HYDRAULIC POWER AUGER OPERATOR

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TRAINEER SIGNATURE DEPT. DATE

RP.7584:04/24/95
ATTACHMENT A-2
Geoprobe® Soil Core Sampler Field Training
ENVIRONMENTAL RESTORATION PROJECT FIELD OFFICE  
DEPARTMENT 7584  

GEOPROBE FIELD TRAINING  

NAME ______________________ DEPARTMENT ____________  
SSN ___________________ COMPANY ____________________  

GEOPROBE OPERATIONS MANUAL READ AND UNDERSTOOD  

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CERTIFIED AS GEOPROBE OPERATOR  

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As acknowledged by my signature, I, a qualified GeoProbe operator, have read, understand and will adhere to the conditions outlined by the amendment to the GeoProbe operating procedure below. I understand that this is an official document and will become a permanent part of the ER field office GeoProbe training records and will be kept on file in the GeoProbe operations manual.

**GeoProbe Operating Procedure Amendment:**

During the probing operation when the GeoProbe foot may be elevated from the ground no more than six (6) inches as prescribed in the GeoProbe operations manual, the assistant (individual who adds extension rods) must remain a minimum distance of two (2) feet from the GeoProbe foot. Maintaining this 2 foot minimum distance is the responsibility of the GeoProbe assistant. However, the GeoProbe operator shall not operate the GeoProbe during probing operations unless the assistant maintains the minimum distance. In addition, if chairs are used during GeoProbe operations, there shall not be a chair within a minimum distance of four (4) feet of the GeoProbe foot at any time.

Name Printed: __________________________ Signature: __________________________ Date: __________
ATTACHMENT A-3
SIMCO® 2400 Drillteam-Probe Field Training
# SIMCO 2400 DRILLTEAM-PROBE FIELD TRAINING

**NAME ______________________ DEPARTMENT ______________**

**SSN____________________ COMPANY __________________________**

## 2400 DRILLTEAM-PROBE OPERATIONS MANUAL READ AND UNDERSTOOD

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**CERTIFIED AS A SIMCO 2400 DRILLTEAM-PROBE OPERATOR**

---

**TRAINER SIGNATURE ______________________ DEPT ____ DATE ____**

RP:7584:11/04/54
SANDIA NATIONAL LABORATORIES
ENVIRONMENTAL RESTORATION PROJECT

CHIP, WIPE, AND SWEEP SAMPLING
FOR WASTE CHARACTERIZATION

Recommended by:

Edward Mignardot, 7582 (IT)
Author

Craig Brown, 7714 (EDI)
Technical Reviewer

Dwight Stockham, 7572
Technical Reviewer

Arthur Lynch, 7572
Technical Reviewer

Approved by:

Francis C. Nimick, 7582
Department Manager

Page 1 of 14

UNCONTROLLED COPY
1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure provides requirements and guidance for the collection of representative chip, wipe, and sweep samples to monitor potential contamination on hard surfaces.

Scope
This procedure applies to all SNL/NM and contractor personnel that collect chip, wipe, or sweep samples under the Environmental Restoration (ER) Project and is appropriate for use for building contamination assessment activities undertaken by other SNL/NM departments and projects. This method of sampling is appropriate for surfaces contaminated with non-volatile species of analytes that include semi-volatile organic compounds, polychlorinated biphenyls, and metals. The chip and sweep procedures may also be used for collection of samples for a radiological survey, but additional precautions not addressed herein (e.g., shipping requirements and requirements discussed in the site-specific health and safety plan [HSP] or radiological work permit [RWP]) would be required.

For instances that require very limited sampling (i.e., scoping-type characterization that would require rapid sampling of potential "hot spots" without implementation of a Sampling and Analysis Plan [SAP]), chip, wipe, and sweep samples can be collected without some of the controls outlined in this procedure. However, each scoping-type sampling activity must be dealt with on a case-by-case basis and certain controls outlined in this procedure will have to be followed in order to ensure that defensible samples are collected and to ensure worker safety.

The sampling methods discussed in this procedure are based on the EPA guidance provided in "Compendium of ERT Waste Sampling Procedures, EPA 540P-91008" (EPA 1991), and will be provided in the Sampling and Analysis Plan (SAP).

Ownership
Department 7582 is responsible for the writing, revision, and maintenance of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

The ER Project Task Leader is responsible for developing the SAP and ensuring that sample collection and management under the SAP conforms to the general guidance specified in this procedure. In addition, the ER Project

continued
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS, continued

Task Leader shall submit all records generated as a result of implementing this procedure to the Environmental Records Operations Center.

The Field Team Leader, or designee, is responsible for monitoring proper implementation of this procedure and completing all required documentation.

The sampling technicians should be familiar with the objectives of chip, wipe, or sweep sampling and shall attest that they have read and understand this procedure and associated procedures.

3.0 DEFINITIONS

Chip Sample
A sample collected by chipping a porous surface using a chisel in such a manner that any substance that has penetrated the surface at a shallow depth will be collected in the sample.

Wipe Sample
A sample collected by wiping a hard surface with a sterile pad in such a manner that removable contamination on the wiped surface will be adsorbed onto the pad.

Sweep Sample
A sample collected by sweeping a pre-measured surface area of loose debris using a hand-held brush.

4.0 EQUIPMENT AND MATERIALS

Equipment and materials required to satisfy this procedure adequately may include, but are not limited to, those listed in the following subsections:

4.1 General Equipment

- Precleaned wide-mouth sample containers of proper size and composition, with Teflon®-lined lids

continued
4.1 General Equipment, continued

- Disposable surgical gloves (for use when sampling) NOTE: When collecting wipe samples using water-saturated wipes, the gloves selected must protect sampling personnel.
- Leather gloves (for use when operating power equipment)
- Hand tools (screwdrivers, pliers, etc.)
- Single extension cord and GFCI protector
- Center punch
- Pry bar (2 ft to 3 ft in length)
- Metric measuring tape and yardstick
- Indelible markers and industrial crayons
- HEPA vacuum
- Medium-size disposable broom (camel’s hair brush or table dusting brush, depending on sampling area)
- Decontamination brushes, tubs, and containers.

4.2 Chip Sampling Equipment

- Medium-size, precleaned cold chisel made of tool-grade steel
- Stainless steel scraper
- Medium-size, precleaned hammer
- Electric hammer with chisel attachment (1 in. to 1.5 in. size bit).
4.3 Wipe Sampling Equipment and Materials

- Stainless steel forceps
- Reagent grade water
- Sterile, 100% cotton, individually wrapped gauze pads (3 in. x 3 in.)
- Whatman™ 50, 47-millimeter (mm)-diameter (or equivalent) filter papers.

4.4 Sweep Sampling Equipment

- Hand-held, fine-bristled disposable sweeper brush
- Precleaned stainless steel dust pan.

4.5 General Materials

- Heavy plastic bags and sheeting, 4.0 to 6.0 mils thick, for collecting sampling debris
- Duct tape or cloth tape to cover holes temporarily or to secure plastic bags
- Site control supplies
- Distilled/deionized water
- Ice, coolers
- Aluminum foil
- Labels for stored sampling debris.

5.0 PROCEDURE

The sampling methods discussed in this procedure are based on EPA guidance provided in "Compendium of ERT Waste Sampling Procedures, EPA 540P 91008" (EPA 1991), and will be provided in the SAP.
5.1 Method Summary

Since surface situations vary, no universal sampling method can be recommended. Rather, the method used must be tailored to suit a specific sampling site. The sampling locations should be selected based on the potential for contamination as a result of operation and/or experiment processes or personnel practices.

In general, chip sampling is appropriate for porous surfaces and is usually performed with either a hammer and chisel or an electric hammer/chisel. Wipe samples are collected from smooth surfaces to determine surficial contamination. Sweep sampling is an effective method for the collection of dust and residue from porous and nonporous surfaces. The sampling techniques used as well as specific quality assurance activities will be dictated in the SAP. The SAP will provide instructions on:

• Preparation of a sampling grid, and locating sampling points on the building layout plan
• Determination on the number of samples required, and the sample volumes required for each analyte by the analytical laboratory
• Determination of the size of area to be chipped, wiped, or swept
• Determination of sampling equipment and materials
• Preparation of quality assurance blanks
• Sample handling and analytical methods.

5.2 Preparation

5.2.1 Office

1. Contact the SMO laboratory liaison to inform him/her of the proposed sampling activities and to request him/her to order precleaned containers from the selected analytical laboratory. Requests for containers should be made at least two weeks in advance.
5.2.1 Office, continued

2. Prepare a list of sampling equipment and sampling supplies, using the list in Section 4.0. For ER Project concerns, contact the ER Project Field Office (ERFO) to reserve (or order) the necessary sampling equipment and supplies.

3. Ensure that all persons performing sampling activities at the site have read the SAP, the HSP, and this procedure.

5.2.2 Documentation

Obtain the appropriate sample collection and control documentation from the SMO. At a minimum, sample documentation will include:

- Sample identification numbers
- Sample labels
- Sample custody tape
- Analytical Request/Chain of Custody (AR/COC) forms
- Sample collection log forms

Obtain a logbook from the Environmental Operations Records Center.

5.2.3 Field

1. Obtain necessary sampling and monitoring equipment. For ER Project concerns, contact the ERFO.

2. Decontaminate sampling equipment as described in FOP 94-26. All items in contact with the medium being sampled must be clean. The use of disposable sampling equipment (e.g., brushes) is recommended to avoid cross-contamination of samples.

3. Locate and clearly mark all sample collection locations identified in the SAP. If required, and if the SAP allows, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions; changes must be documented as described in the SAP.

continued
5.2.3 Field, continued

4. Establish site control zones and delineate the areas with ropes and/or other barricades. Post "No Unauthorized Entry" signs at entry points, if applicable.

5.3 Chip Sample Collection

Sampling of porous surfaces is accomplished by using a chisel and hammer or electric hammer/chisel. The decontaminated sampling device remains wrapped in its protective sheathing until it is needed. Each decontaminated sampling device shall be used for the collection of only one sample. After collection, the sampling device must be decontaminated or disposed of.

1. Don a pair of work gloves.

2. Obtain a chisel or equivalent sampling device.

3. Chip the entire chipped sample area perpendicular to the surface, then parallel, to an even depth of approximately 1/8 inch. When collecting a wall sample, place clean plastic sheeting beneath the sample location to collect the chip sample.

4. Don a clean pair of sampling gloves.

5. Collect sample using a stainless steel scraper and brush. Composite and/or quarter the sample, if required in the SAP, to obtain a representative subsample. Place the sample in the appropriate sample container.

6. Cap the sample container, affix and initial/date the label and custody seal, and place in a Ziploc™ (or equivalent) doubled plastic bag. Record all pertinent information in the site logbook and on the appropriate form(s) per FOP 94-25.

7. Place sample in sample shipping cooler with cooling material, if required.

8. Decontaminate sampling equipment in accordance with FOP 94-26, or dispose of in accordance with SNL/NM waste disposal requirements.

9. After all samples have been collected, or at the end of the work day, deliver the samples to the SMO.
5.4 Wipe Sample Collection

Wipe sampling is accomplished using a sterile gauze wipe or filter paper and wiping a predetermined, premeasured surface area. The sample is packaged in an appropriately precleaned jar and packed in coolers for shipment to the laboratory. Each wipe collection pad shall be used for wiping only one sampling surface.

Most surfaces (rough surfaces and wet surfaces) encountered require use of dry wipes because they are more effective at absorbing potential surface contaminants than saturated wipes. The physical collection of the sample, however, is the same for both wet and dry wipes. Sampling personnel must thoroughly document the reason for changing from one method to another when the need for change from the SAP is required.

5.4.1 Sample Collection

1. Don a clean pair of sampling gloves appropriate for suspected contaminants, and locate the sampling point.

2. Collect a field blank by wiping a pair of sampling gloves with a pad before sample collection. (The field blank will determine if specific analytical interferences are present in the gloves.)

3. Select the appropriate size sampling template, or mark the surface to be sampled by punching the four corners of the area to be sampled with a clean center punch, and record this information in a logbook.

4. Obtain a wipe collection pad and wipe the marked area using straight, even strokes to draw the pad across the area. Wipe vertically, then horizontally, to ensure complete surface coverage. If more than one vertical or horizontal stroke is needed to cover the area, fold the used portion of the pad to the interior and perform the next stroke in the same direction as the first. Wipe the marked area until no visible material is picked up on the pad. If visible staining is still present, obtain a second pad and repeat the process.

5. Place the gauze pad(s) in the appropriate precleaned sample container.
5.4.1 Sample Collection, continued

6. Cap the sample container, affix and initial/date the label and custody seal, and place in a Ziploc™ (or equivalent) doubled plastic bag. Record all pertinent information in the site logbook or on the appropriate form(s) per FOP 94-25.

7. Place sample in sample shipping cooler with cooling material, if required.

8. Decontaminate sampling equipment in accordance with FOP 94-26.

9. After all samples have been collected, or at the end of the work day, deliver the samples to the SMO.

5.4.2 Wipe Sample Collection for Polychlorinated Biphenyls and Other Analytes

When collecting wipe samples for polychlorinated biphenyls (PCB) analyses, the sampler should use laboratory-prepared PCB test kits. Each test kit consists of a sterile wipe collection pad impregnated with hexane in an air-tight metal container. Follow guidance provided in the SNL/NM Operating Procedure 93-01.

In addition to the steps listed in Section 5.4.1, use precleaned stainless steel forceps and remove the pad from the reservoir jar, allowing excess sorbent to drip back into the jar; then wipe the sample area.

5.5 Sweep Sample Collection

Sweep sampling is appropriate for sampling of contaminated debris. This procedure utilizes a disposable hand-held brush to acquire a sample from a premeasured area.

1. Mark the designated area to be sampled, and record this information.

2. Don a clean pair of sampling gloves.

3. Sweep the measured area using a brush; collect the sample in a precleaned dust pan.

continued
5.5 Sweep Sample Collection, continued

4. Transfer the sample from the dust pan to the appropriate precleaned sample container.

5. Cap the sample container, affix and initial/date the label and custody seal, and place in a Ziploc™ (or equivalent) doubled plastic bag. Record all pertinent information in the site logbook or on the appropriate form(s) per FOP 94-25.

6. Place the sample in the sample shipping cooler with the cooling material, if required.

7. Decontaminate the sampling equipment in accordance with FOP 94-26 and dispose of the brush, if required, in accordance with SNL/NM waste disposal requirements.

8. After all samples have been collected, or at the end of the work day, deliver the samples to the on-site laboratory or the SMO, as appropriate.

5.6 Quality Assurance/Quality Control

The following general quality assurance procedures apply:

In general, all data must be documented on standard SNL/NM forms, field data sheets, and/or in a logbook, per FOP 94-25.

5.7 Postoperation

5.7.1 Field

1. Store samples until packaging and shipping in accordance with the SAP and FOP 94-34.

2. Inventory and decontaminate equipment on-site and return it to the ER Project Field Office.

3. Restore the site, as appropriate.

continued
5.7.1 Field, continued

4. Package any sampling or decontamination waste for disposal in accordance with SAP and the Site-Specific Waste Management Plan.

5.7.2 Documentation

Review sample collection and control documentation for completeness, according to FOP 94-25.

6.0 RECORDS

Records generated as a result of implementing this procedure shall be submitted by the ER Project Task Leader to the Environmental Operations Records Center at the conclusion of sampling activities. The records submitted to the records center must include field logbooks and associated field activity and daily health and safety monitoring forms.

7.0 REFERENCES


dcontinued
7.0 REFERENCES, continued

Sandia National Laboratories/New Mexico (SNL/NM), 1994c. "Laboratory Operating Procedure for Handling, Packaging and Shipping of Environmental Samples," LOP 94-03, Sandia National Laboratories, Albuquerque, New Mexico.


8.0 ATTACHMENTS

None
INTRUSIVE SAMPLING OF BUILDING MATERIALS
FOR WASTE CHARACTERIZATION

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FOP 96-02
Rev. 0
Page 1 of 29

SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered in Red Ink)
Copy Number:_________
# Intrusive Sampling of Building Materials for Waste Characterization

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

Purpose
This procedure provides general requirements and guidance for the intrusive sampling (e.g., core sampling) of building materials to characterize potential contamination.

Scope
This procedure applies to all SNL/NM and contractor personnel who collect, handle, or ship building material or ventilation system samples or composite samples for organic and inorganic constituents under the Environmental Restoration (ER) Project. This procedure is appropriate for establishing contamination assessment activities undertaken by other SNL/NM departments and projects. This method of sampling is appropriate for building materials contaminated with nonvolatile and volatile species of analytes that include polychlorinated biphenyls, metals, solvents, etc. The procedure also may be used for the collection of samples for a radiological survey, but additional precautions not addressed herein, [e.g., shipping requirements and requirements discussed in the site-specific health and safety plan (HSP) and radiological work permit (RWP)] would be required.

Ownership
Department 7582 is responsible for the writing, revision, and maintenance of this procedure.

2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS

ER Project Task Leaders are responsible for developing sampling and analysis plans (SAP), and ensuring that sample collection and management under the SAP conforms to the general guidance specified in this procedure. In addition, the ER Project Task Leader shall submit all records generated as a result of implementing this procedure to the Environmental Operations Records Center.

The Field Team Leader (FTL), or designee, is responsible for monitoring the proper implementation of this procedure, and completing all required documentation.

Sampling Technicians are responsible for being be familiar with the objectives of the building materials sampling program and shall attest that they have read and understand this procedure and associated operating procedures.
3.0 DEFINITIONS

Asbestos Containing Material (ACM)  Any material or product containing more than 1 percent asbestos.

Encapsulant  Liquid used to seal the edges of a hole made during coring or chiseling through a building material. The encapsulant is poured or brushed directly onto the edges of the hole and hardens overnight.

4.0 EQUIPMENT AND MATERIALS

Equipment and materials required to follow this procedure adequately may include, but are not limited to, the following:

Equipment

• Leather work gloves to operate electrical vibrating equipment.

• Medium-size paint brush.

• Medium-size chisel.

• Medium-size hammer.

• Stainless steel scraper or putty knife.

• Stainless steel scoop or trowel.

• Hand tools (screwdrivers, pliers, etc.).

• Impact drill (minimum of 1/2-in. drive).

• Power drill (3/8 to 1/2 in. size).

• Portable generator.

• Concrete coring bits for dry-coring concrete (1/2 in. to 1 in. in size).

• Hole saw bit (1 to 2 in. in diameter).

continued
4.0 EQUIPMENT AND MATERIALS, continued

- Tin snips or similar metal shearing tool.
- Single extension cord and GFCI protector.
- Pry bar (2 to 3 ft in length).
- Metric measuring tape and yardstick.
- Medium-size broom.
- Coolers with ice.

A vacuum cleaner of sufficient power and capacity, equipped with a high-efficiency particulate air (HEPA) filter, will be used to remove dust and small particles created during sampling. (A vacuum cleaner with a HEPA filter is required for use when sampling building material that may be contaminated with radioactive material, asbestos, and hazardous chemicals so that potentially contaminated particulates will not be released into the area.)

- Sampling enclosure such as the one shown in Attachment 1 will be used during core sampling to prevent the release of sampling dust and debris.
- A power trace may be used to determine the location of electrical wires in walls, ceilings, and floors.
- Heavy plastic bags and sheeting, 4.0 to 6.0 mils thick, which will be used to collect sampling dust and debris. Bags that may contain ACM sampling waste must be a minimum of 6.0 mils thick.
- Duct tape or cloth tape to cover holes temporarily or to secure plastic bags.
- Labels for sample containers and stored sampling debris.
- Sampling documentation.
- Precleaned sample containers of proper size and composition.
- Disposable surgical gloves.
- Indelible markers, industrial crayons, and/or carpenter chalk.
- Distilled/deionized water.

continued
4.0 EQUIPMENT AND MATERIALS, concluded

- Aluminum foil.
- Masking tape.
- Decontamination materials (brushes, LIQUI-NOX soap, wash tubs, etc.).
- Appropriate solvents.

5.0 PROCEDURE

5.1 Preparation

5.1.1 Office

- Prepare a list of sampling equipment and sampling supplies, using the list in Section 4.0. Make sure the equipment and supplies are available.

- As defined in the SAP, determine the location of sampling points before initiating the sampling, and review the proposed sampling points with the SNL/NM maintenance personnel to determine the probability that plumbing or electrical wires have been routed across that point.

- Coordinate shut down of facilities and provide temporary on-site electrical supply, if necessary.

- All persons performing sampling activities at the site shall have read the SAP, this procedure, the HSP, and the Asbestos Guidance (Attachment 2).

5.1.2 Documentation

Obtain the appropriate sample collection and control documentation from the Sample Management Office (SMO). Sample documentation required may include:

continued
5.1.2  Documentation, continued

- Sample identification numbers
- Sample labels
- Sample custody tape
- Sample collection log (SCL) and Analytical Request/Chain of Custody (AR/COC) forms

Obtain a logbook from the Environmental Operations Records Center.

5.1.3  Field

1. Obtain necessary sampling and monitoring equipment.

2. Decontaminate or preclean equipment per FOP 94-26, and ensure that it is in working order. Calibrate the equipment, if required, in accordance with the manufacturer's operating instructions.

3. Locate and mark sample collection locations for building material samples, and ventilation system samples in accordance with the SAP. Sampling locations are tagged or outlined with masking tape or carpenter chalk. If such is required and the SAP allows, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Document in the logbook any changes from the work described in the SAP.

4. Determine the area of sampling activities, delineate the area with ropes or other barricades, and post "No Unauthorized Entry" signs at entry points, if applicable.
5.1.4 Hazards Identification

Because the material being sampled is potentially hazardous, all dust and debris released by the sampling activities must be considered a health hazard; the HSP will dictate appropriate personal protective equipment (PPE) and air sampling.

The manner in which the following hazards will be mitigated will be discussed in a daily safety meeting:

- For holes in floors, if the flooring material is ACM or if the edges of the hole are disturbed after sampling, the fibers may be dispersed into air during sampling. The holes may present a trip and fall hazard.

- For holes in ceilings, dust from the attic area, which may contain asbestos, fiberglass, or other respiratory and dermal hazards, may be released into the work area during sampling.

- For holes in walls, dust from wall material, which may be a respiratory or dermal hazard and may contain asbestos, may be released into the work area during sampling.

- Some of the construction material used at SNL/NM facilities is ACM. It may be necessary to sample this material intrusively, resulting in the potential release of asbestos fibers.

Sampling and repair equipment and materials may present project-specific hazards to the sampling team. The HSP and safety meeting shall address hazards.

5.2 Sampling Building Materials

Building materials to be sampled may include, but are not limited to, concrete, wood, wallboard, sheet metal, roofing and concrete masonry units (CMU) (e.g., continued
5.2 Sampling Building Materials, continued

cinderblock). Building material subsamples are collected as cores of the entire thickness of the building at the sampling point, with the exception of concrete or CMU materials, which are sampled to a limited depth. Instructions for collecting building material composite samples are provided below.

1. Based on the material to be sampled, select the appropriate decontaminated impact chisel or coring bit, or hole saw as identified in Table 1. Insert device into drill and secure.

2. Don appropriate PPE as prescribed in the HSP.

3. At each sampling location, collect the building material sample by coring or chiseling through the entire thickness of the matrix of interest at the designated sampling point, if possible, using the sampling enclosure (Attachment 1). If it is not possible to penetrate the entire thickness of the material (e.g., concrete and CMUs), core to a minimum depth of 2 inches.

*Note: The coring bit should remain cool to the touch when sampling for volatile organic constituents to reduce the potential for volatilization. Whenever samples are collected for volatile organic compound analyses, it is recommended that the coring device be cooled (e.g., refrigerated) prior to coring operations. During extended coring operations, the bit may be cooled with distilled water.*

4. Don a new pair of sampling gloves and remove the core sample from the coring device by tapping the side of the coring device or using a decontaminated prying device and placing it directly into the appropriate prelabeled sampling container. If a chisel bit is used, collect the sample using a decontaminated stainless steel scraper or putty knife.

5. For ease of sample preparation, collect subsamples from each type of building material and place in separate sample jars. After size reduction has been performed according to Section 5.4 of this FOP, combine the samples in the appropriate sample jars.

6. Repeat this operation until all samples specified in the SAP are collected.
## Table 1
Tools Required for Sample Collection and Sample Preparation

<table>
<thead>
<tr>
<th>Building Material&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Sample Collection Tool</th>
<th>Sample Preparation Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>Impact drill with chisel bit</td>
<td>Using hammer and chisel bit, crush sample materials to TCLP-required size</td>
</tr>
<tr>
<td>Wood</td>
<td>Drill with spade bit</td>
<td>Using a stainless steel scoop or trowel, remove cuttings from spade bit enclosure; using shears, cut to TCLP-size requirements</td>
</tr>
<tr>
<td>Gypsum wall board/sheet rock</td>
<td>Drill with hole saw bit</td>
<td>Using a hammer, crush materials to TCLP-required size</td>
</tr>
<tr>
<td>Vinyl floor tile</td>
<td>Utility knife to cut tile; putty knife to lift pieces of tile, and collect tile</td>
<td>Using shears, cut to TCLP-required size</td>
</tr>
<tr>
<td>Glued-on ceiling tile</td>
<td>Utility knife to cut tile; putty knife or chisel to remove from surface</td>
<td>Using hammer, crush to TCLP-required size</td>
</tr>
<tr>
<td>Sheet metal</td>
<td>Hole saw or impact drill with chisel bit</td>
<td>Using shears, cut to TCLP-required size</td>
</tr>
<tr>
<td>Hung acoustic ceiling tile</td>
<td>Utility knife to cut tile</td>
<td>Using hammer, crush to TCLP-required size</td>
</tr>
<tr>
<td>Exterior siding&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Hole saw</td>
<td>Using hammer, crush to TCLP-required size</td>
</tr>
<tr>
<td>Roof shingles&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Hole saw and/or shears</td>
<td>Using shears, cut to TCLP-required size</td>
</tr>
<tr>
<td>Gravel/asphalt roof materials</td>
<td>Hole saw</td>
<td>Using shears, cut to TCLP-required size</td>
</tr>
</tbody>
</table>

<sup>a</sup>Some of the building materials may contain asbestos-containing materials (ACM).

<sup>b</sup>Seldom sampled because building exteriors are not expected to be contaminated.
### 5.2 Sampling Building Materials, continued

7. Attach a label and custody seal to the sample container and place it in a double plastic bag (bag just large enough to hold the container). Place the subsamples on gel-ice in a cooler and out of direct sunlight and refrigerate. Record all pertinent data in the site logbook or appropriate form(s) per FOP 94-25. Record on the SNL AR/COC forms before taking the next sample.

8. Decontaminate the coring device per FOP 94-26, if it becomes visibly contaminated, or whenever a new sample is to be collected.

### 5.3 Sampling Ventilation Systems

1. Use a \( \frac{1}{2} \)- to 1-in.-diameter decontaminated metal hole saw or tin snips.

2. Don appropriate PPE as prescribed in the HSP.

3. At each sampling location, collect a sample of the duct by using a hole saw, or cut a 100-cm\(^2\) piece of duct with tin snips (refer to Section 5.4 to prepare a composited sample for TCLP). For portions of the horizontal ventilation system being sampled, the samples should be collected from the bottom portion of the duct wherever possible.

4. Don a clean pair of sampling gloves and remove the sample from the hole saw (by tapping the side of the device or using a decontaminated prying device) or remove the sample with the tin snips. Place the sample directly into the appropriate prelabeled sampling container.

5. Repeat this operation until the entire ventilation system has been sampled.

6. Attach a label and custody seal to the sample container and place it in a double plastic bag (bag just large enough to hold the container). Place the sample on gel-ice in a cooler and out of direct sunlight and refrigerate.

7. Record all pertinent data in the site logbook or appropriate form(s) per FOP 94-25. Record on the SNL AR/COC forms before taking the next sample.

continued
5.3 Sampling Ventilation Systems, continued

8. Decontaminate the sample collection tool per FOP 94-26 if it becomes visibly contaminated, or prior to sampling another ventilation system.

5.4 Preparing Samples for TCLP

To prepare a representative sample, first collect samples as described above. Then use the following steps to prepare a sample for TCLP, which requires that particulates be equal to or less than 9.5 millimeters (mm) in diameter.

1. Cool samples to approximately 4°C prior to crushing. This generally requires refrigeration at least overnight.

2. For porous materials, crush an equivalent of each sample to be prepared using a tool listed in Table 1 so that the sample will pass through a 9.5-mm sieve. For vent materials and vinyl flooring, cut these materials using tin snips or suitable shears to no larger than a 9.5-mm (maximum dimension) size.

3. To prepare the sample, place the crushed and cut sample material into a clean jar and tumble it until well mixed. When analyzing for organic constituents, the sample should be kept cool while it is crushed or cut and tumbled.

4. Note on the AR/COC that additional laboratory particle size reduction is not required for the TCLP. In instances when it is not possible to analyze the entire sample fraction, duplicates of the sample may be taken to measure variability within the composited sample, and this shall be noted on the AR/COC prior to sample shipment.

Effort shall be made to retain volatile organic compounds in the samples collected and analyzed by performing the following:

• Collecting large pieces of building materials (e.g., concrete) which are chilled before crushing

continued
5.4 Preparing Samples for TCLP, continued

- Collecting samples using cold tools, when possible
- Instructing the laboratory to use all size pieces of a sample, including large pieces.
- Maintaining samples at approximately 4°C from collection to analysis.

Note: Nonporous material such as vent systems are not analyzed for volatile organic compounds.

5.5 Repairing Buildings for Reoccupancy After Sampling

If all or a portion of the building is currently or is to be reoccupied, building repairs may need to be done prior to public entry into the building. The SNL/NM department responsible for generating any hazards shall be responsible for building repairs, as necessary. Building repairs will be limited to patching holes, cleaning, and reinstalling floor grates and room fixtures.

5.5.1 Repairing Holes in Floors

Holes in concrete floors and slabs and wood floors must be replaced with the appropriate material (e.g., concrete, wood, etc.) before the building is reoccupied. The edges of holes in vinyl floor covering, including asbestos-containing vinyl flooring, must be sealed with an encapsulant or replaced with new floor covering. Carpet repairs should be made before the building is reoccupied. For short-term repairs, cover the hole with duct tape; for long-term repairs, cover the hole with a new piece of carpet.
5.5.2 Repairing Holes in Ceilings

Seal the edges of each hole in penetrated ACM ceiling tile with an encapsulant. Make sure that all ceiling material exposed by the sampling activity is covered with at least two layers of duct or cloth tape.

With regard to holes in drop ceilings with acoustical tiles, replace any panels removed during sampling, securing them in the metal support. Cover any holes with duct or cloth tape on both sides of the panel, if possible.

With regard to holes in ceilings of tiles attached to a wooden base, the following will be performed:

- If the tiles have been removed from the ceiling before sampling, vacuum the area on the ceiling from which the tiles were removed using a HEPA vacuum. Remove any loose material remaining around the area sampled. If the sampling procedure exposed friable material on the ceiling, seal the edges with an encapsulant. If the tiles are ACM, place them and any residual material in an approved ACM waste bag labeled "ACM," securely seal the bag, label it, and store it in accordance with FOP 94-78.

- If the tiles have been sampled on the ceiling, seal the edges of the hole with an encapsulant.

5.5.3 Repairing Holes in Walls

With regard to holes in interior gypsum wallboard, seal the edges of each hole with an encapsulant. Cover the hole with at least two layers of tape. In the case of paneling, cover the hole with duct tape. With regard to holes in concrete block where sampling did not penetrate through the entire thickness of the block, no action is necessary. Holes in stucco walls will be repaired with stucco patch using a stainless steel trowel before the building is reoccupied.

For holes in metal siding, cover the holes with duct or cloth tape. For a more permanent repair (depending on future use of the building), cover any exterior holes with a patch made of material similar to the existing material. With regard to holes in an exterior wall of other materials, seal the edges of the hole with an encapsulant. Cover the holes with at least two layers of duct or cloth tape.
5.5.4 Repairing Holes in Roof

Repairs to the building roof will be made upon completion of sampling activities. Replace shingles with new ones and mend flat roofs with tar.

5.5.5 Repairing Holes in Ductwork

The integrity of the ductwork must be restored using the appropriate repair technique defined by the FTL. Cover the hole with at least two layers of duct tape.

5.5.6 Repairing Electrical and Communications Systems

In the event that an electrical or communications wire is severed during sampling, a qualified SNL/NM electrician or communications repairman will make the repair after the sampling team has cleared the area of sampling equipment and debris, and the FTL and/or Site Safety Officer (SSO) have determined that it is safe to conduct the repairs. No sampling team member is to attempt to repair electrical or communications systems. If wires in the ceiling, floor, or wall are exposed during sampling, repair the wall, floor, or ceiling as described in the appropriate section of this procedure.

5.5.7 Repairing the Plumbing System

In the event that the plumbing system is damaged during sampling, a qualified SNL/NM plumber will make the necessary repairs after the sampling team has cleaned the area of sampling equipment and debris, and the FTL and/or SSO have determined that it is safe to conduct repairs. No sampling team member will attempt to repair plumbing systems.
5.6 Postoperation

5.6.1 Field

1. Store samples until packaging and shipment occur in accordance with the SAP, FOP 94-34, LOP 94-03, and AOP 94-22.

2. Inventory and decontaminate equipment on site per FOP 94-78.

3. Restore the site, as appropriate.

4. Package any sampling or decontamination waste for disposal in accordance with the SAP, site-specific Waste Management Plan, and FOP 94-78.

5.6.2 Documentation

Review sample collection and review documentation for completeness according to FOP 94-25.

6.0 RECORDS

Records generated as a result of implementing this procedure shall be submitted by the SNL/NM Task Leader to the Environmental Operations Records Center at the conclusion of sampling activities. These records include field logbooks and field activity and daily HSP monitoring forms.
7.0 REFERENCES


8.0 ATTACHMENTS

Attachment 1—Instructions for Using Sampling Enclosure
Attachment 2—Asbestos Guidance
ATTACHMENT 1

INSTRUCTIONS FOR USING SAMPLING ENCLOSURE

Equipment List

Sampling enclosure
Adapters
Vacuum cleaner with HEPA filter
Sampling equipment described in FOP or SAP

Procedure

1. Place enclosure over sampling point.
2. Choose an adapter that will fit the nozzle of the vacuum cleaner hose from those provided with enclosure and attach it to the nozzle.
3. Attach the adapter to the tube on the enclosure (see Figure 1).
4. Turn on the vacuum cleaner.
5. Chip or core sample through the hole in the top of the enclosure.
6. Remove the enclosure and transfer sample into the sample container.
7. Carefully vacuum any debris or dust not removed by the vacuum during Step 5.
8. Turn off vacuum cleaner.
9. Detach vacuum cleaner hose from enclosure.
10. Decontaminate the enclosure.
Attachment 1

Figure 1
Sampling Enclosure

3" Diameter Drill Bit Hole

1/2" Foam Rubber Tape

2" Diameter Tube For Attaching Vacuum Cleaner

Open at Bottom

1/9/95
ATTACHMENT 2

ASBESTOS GUIDANCE

The sampling procedures for Sandia National Laboratories, New Mexico (SNL/NM), Environmental Restoration Project and Building Decontamination and Demolition (BD&D) Program include intrusive techniques, such as core sampling using hole saws and chip sampling. It should be noted that asbestos abatement conducted at SNL/NM is performed under SNL/NM’s asbestos abatement program. The materials sampled may contain asbestos fibers, and the sampling technique may release the fibers into the air. Asbestos has been determined to cause disease in humans, and precautions should be taken by workers if they might be exposed to asbestos fibers due to sampling activities.

The Occupational Safety and Health Administration has set a limit of the amount of asbestos fibers a worker may breathe. If this limit is expected to be exceeded, the employer must follow OSHA requirements, and the worker must receive special training. The sampling techniques used for sampling of asbestos materials have been developed to keep the level of asbestos fibers released at levels significantly below the levels set by OSHA. Previous breathing zone monitoring of sampling team members have detected asbestos at levels less than 10 percent of the regulated level. Therefore, sampling team members and maintenance workers repairing the sampling holes should not be exposed to hazardous levels of asbestos, provided the team members and workers follow the procedures listed in this FOP. Air monitoring of the breathing zone is used to document compliance with OSHA standards.

OSHA has prepared two documents (29 CFR 1910.1001, Appendix G and Appendix H) describing asbestos, the health effects, personal protective equipment, and other information about asbestos. Employers must provide the information to workers who will be exposed to airborne asbestos levels above 0.1 fibers per cubic centimeter of air (0.1 f/cc) averaged over the 8-hour workday. SNL/NM workers should not be exposed to hazardous levels greater than 0.1 f/cc of airborne asbestos fibers. However, it is SNL/NM’s policy to provide its employees with information pertaining to the employee health and safety. Therefore, all SNL/NM sampling team members and maintenance workers who repair the sampling holes must read the following two OSHA documents and acknowledge that they have read the documents by signing the attached form.
ATTACHMENT 2 (CONTINUED)

Appendix G to §1910.1001
Substance Technical Information for Asbestos
Nonmandatory

I. Substance Identification

A. Substance: "Asbestos" is the name of a class of magnesium-silicate minerals that occur in fibrous form. Minerals that are included in this group are chrysolite, crocidolite, amosite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos.

B. Asbestos, tremolite, anthophyllite, and actinolite are used in the manufacture of heat-resistant clothing, automotive brake and clutch linings, and a variety of building materials including floor tiles, roofing felts, ceiling tiles, asbestos-cement pipe and sheet, and fire-resistant drywall. Asbestos is also present in pipe and boiler insulation materials, and in sprayed-on materials located on beams, in crawl spaces, and between walls.

C. The potential for a product containing asbestos, tremolite, anthophyllite, and actinolite to release breathable fibers depends on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to emit fibers. The fibrous or fluffy sprayed-on materials used for fireproofing, insulation, or sound-proofing are considered to be friable, and they readily release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tile or roofing felts are considered nonfriable and generally do not emit airborne fibers unless subjected to sanding or sawing operations. Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed or if they are broken during demolition operations.

D. Permissible exposure: Exposure to airborne asbestos, tremolite, anthophyllite, and actinolite fibers may not exceed 0.2 fibers per cubic centimeter of air (0.2 f/cc) averaged over the 8-hour workday.

II. Health Hazard Data

A. Asbestos, tremolite, anthophyllite, and actinolite can cause disabling respiratory disease and various types of cancers if the fibers are inhaled. Inhaling or ingesting
fibers from contaminated clothing or skin can also result in these diseases. The symptoms of these diseases generally do not appear for 20 or more years after initial exposure.

B. Exposure to asbestos, tremolite, anthophyllite, and actinolite has been shown to cause lung cancer, mesothelioma, and cancer of the stomach and colon. Mesothelioma is a rare cancer of the thin membrane lining of the chest and abdomen. Symptoms of mesothelioma include shortness of breath, pain in the walls of the chest, and/or abdominal pain.

III. Respirators and Protective Clothing

A. Respirators: You are required to wear a respirator when performing tasks that result in asbestos, tremolite, anthophyllite, and actinolite exposure that exceeds the permissible exposure limit (PEL) of 0.2 fl/cc. These conditions can occur while your employer is in the process of installing engineering controls to reduce asbestos, tremolite, anthophyllite, and actinolite exposure or where engineering controls are not feasible to reduce asbestos, tremolite, anthophyllite, and actinolite exposure. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos, tremolite, anthophyllite, and actinolite fiber concentrations do not exceed 2 fl/cc; otherwise, air-supplied, positive-pressure, full-facepiece respirators must be used. Disposable respirators or dust masks are not permitted to be used for asbestos, tremolite, anthophyllite, and actinolite work. For effective protection, respirators must fit your face and head snugly. Your employer is required to conduct fit tests when you are first assigned a respirator and every 6 months thereafter. Respirators should not be loosened or removed in work situations where their use is required.

B. Protective Clothing: You are required to wear protective clothing in work areas where asbestos, tremolite, anthophyllite, and actinolite fiber concentrations exceed the permissible exposure limit (PEL) of 0.2 fl/cc to prevent contamination of the skin. Where protective clothing is required, your employer must provide you with clean garments. Unless you are working on a large asbestos, tremolite, anthophyllite, and actinolite removal or demolition project, your employer must also provide a change room and separate lockers for your street clothes and contaminated work clothes. If you are working on a large asbestos, tremolite, anthophyllite, and actinolite removal or demolition project, and where it is feasible to do so, your employer must provide a clean room, shower, and decontamination room contiguous to the work area. When leaving the work area, you must remove
contaminated clothing before proceeding to the shower. If the shower is not adjacent to the work area, you must vacuum your clothing before proceeding to the change room and shower. To prevent inhaling fibers in contaminated change rooms and showers, leave your respirator on until you leave the shower and enter the clean change room.

IV. Disposal Procedures and Cleanup

A. Wastes that are generated by processes where asbestos, tremolite, anthophyllite, and actinolite are present include:

1. Empty asbestos, tremolite, anthophyllite, and actinolite shipping containers.
2. Process wastes such as cuttings, trimmings, or reject material.
3. Housekeeping waste from sweeping or vacuuming.
4. Asbestos, tremolite, anthophyllite, and actinolite fireproofing or insulating material that is removed from buildings.
5. Building products that contain asbestos, tremolite, anthophyllite, and actinolite removed during building renovation or demolition.
6. Contaminated disposable protective clothing.

B. Empty shipping bags can be flattened under exhaust hoods and packed into airtight containers for disposal. Empty shipping drums are difficult to clean and should be sealed.

C. Vacuum bags or disposable paper filters should not be cleaned but should be sprayed with a fine water mist and placed into a labeled waste container.

D. Process waste and housekeeping waste should be wetted with water or a mixture of water and surfactant prior to packaging in disposable containers.

E. Material containing asbestos, tremolite, anthophyllite, and actinolite that is removed from buildings must be disposed of in leak-tight 6-mil thick plastic bags, plastic-lined cardboard containers, or plastic-lined metal containers. These wastes, which are removed while wet, should be sealed in containers before they dry out to minimize the release of asbestos, tremolite, anthophyllite, and actinolite fibers during handling.

V. Access to Information
ATTACHMENT 2 (CONTINUED)

A. Each year, your employer is required to inform you of the information contained in this standard and appendices for asbestos, tremolite, anthophyllite, and actinolite. In addition, your employer must instruct you in the proper work practices for handling materials containing asbestos, tremolite, anthophyllite, and actinolite, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to asbestos, tremolite, anthophyllite, and actinolite. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure, and, if you are exposed above the permissible limit, he or she is required to inform you of the actions that are being taken to reduce your exposure to within the permissible limit.

C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept for at least thirty (30) years. Medical records must be kept for the period of your employment plus thirty (30) years.

D. Your employer is required to release your exposure and medical records to your physician or designated representative upon your written request.
II. Toxicology

Clinical evidence of the adverse effects associated with exposure to asbestos, tremolite, anthophyllite, and actinolite, is present in the form of several well-conducted epidemiological studies of occupationally exposed workers, family contacts of workers, and persons living near asbestos, tremolite, anthophyllite, and actinolite mines. These studies have shown a definite association between exposure to asbestos, tremolite, anthophyllite, and actinolite and an increased incidence of lung cancer, pleural and peritoneal mesothelioma, gastrointestinal cancer, and asbestosis. The latter is a disabling fibrotic lung disease that is caused only by exposure to asbestos. Exposure to asbestos, tremolite, anthophyllite, and actinolite has also been associated with an increased incidence of esophageal, kidney, laryngeal, pharyngeal, and buccal cavity cancers. As with other known chronic occupational diseases, disease associated with asbestos, tremolite, anthophyllite, and actinolite generally appears about 20 years following the first occurrence of exposure: There are no known acute effects associated with exposure to asbestos, tremolite, anthophyllite, and actinolite.

Epidemiological studies indicate that the risk of lung cancer among exposed workers who smoke cigarettes is greatly increased over the risk of lung cancer among non-exposed smokers or exposed nonsmokers. These studies suggest that cessation of smoking will reduce the risk of lung cancer for a person exposed to asbestos, tremolite, anthophyllite, and actinolite but will not reduce it to the same level of risk as that existing for an exposed worker who has never smoked.

III. Signs and Symptoms of Exposure-Related Disease

The signs and symptoms of lung cancer or gastrointestinal cancer induced by exposure to asbestos, tremolite, anthophyllite, and actinolite are not unique, except that a chest X-ray of an exposed patient with lung cancer may show pleural plaques, pleural calcification, or pleural fibrosis. Symptoms characteristic of mesothelioma include shortness of breath, pain in the walls of the chest, or abdominal pain. Mesothelioma has a much longer latency period...
compared with lung cancer (40 years versus 15-20 years), and mesothelioma is therefore more likely to be found among workers who were first exposed to asbestos at an early age. Mesothelioma is always fatal.

Asbestosis is pulmonary fibrosis caused by the accumulation of asbestos fibers in the lungs. Symptoms include shortness of breath, coughing, fatigue, and vague feelings of sickness. When the fibrosis worsens, shortness of breath occurs even at rest. The diagnosis of asbestosis is based on a history of exposure to asbestos, the presence of characteristic radiologic changes, end-inspiratory crackles (rales), and other clinical features of fibrosing lung disease. Pleural plaques and thickening are observed on X-rays taken during the early stages of the disease. Asbestosis is often a progressive disease even in the absence of continued exposure, although this appears to be a highly individualized characteristic. In severe cases, death may be caused by respiratory or cardiac failure.

IV. Surveillance and Preventive Considerations

As noted above, exposure to asbestos, tremolite, anthophyllite, and actinolite has been linked to an increased risk of lung cancer, mesothelioma, gastrointestinal cancer, and asbestosis among occupationally exposed workers. Adequate screening tests to determine an employee’s potential for developing serious chronic diseases, such as cancer, from exposure to asbestos, tremolite, anthophyllite, and actinolite do not presently exist. However, some tests, particularly chest X-rays and pulmonary function tests, may indicate that an employee has been overexposed to asbestos, tremolite, anthophyllite, and actinolite, increasing his or her risk of developing exposure-related chronic diseases. It is important for the physician to become familiar with the operating conditions in which occupational exposure to asbestos, tremolite, anthophyllite, and actinolite is likely to occur. This is particularly important in evaluating medical and work histories and in conducting physical examinations. When an active employee has been identified as having been overexposed to asbestos, tremolite, anthophyllite, and actinolite, measures taken by the employer to eliminate or mitigate further exposure should also lower the risk of serious long-term consequences.

The employer is required to institute a medical surveillance program for all employees who are or will be exposed to asbestos, tremolite, anthophyllite, actinolite or a combination of these minerals at or above the action level (0.1 fiber per cubic centimeter of air). All examinations and procedures must be performed by or under the supervision of a licensed physician, at a reasonable time and place, and at no cost to the employee.
Although broad latitude is given to the physician in prescribing specific tests to be included in the medical surveillance program, OSHA requires inclusion of the following elements in the routine examination:

(i) Medical and work histories with special emphasis directed to symptoms of the respiratory system, cardiovascular system, and digestive tract.

(ii) Completion of the respiratory disease questionnaire contained in Appendix D.

(iii) A physical examination including a chest roentgenogram and pulmonary function test that includes measurement of the employee’s forced vital capacity (FVC) and forced expiratory volume at one second.

(iv) Any laboratory or other test that the examining physician deems by sound medical practice to be necessary.

The employer is required to make the prescribed tests available at least annually to those employees covered; more often than specified if recommended by the examining physician; and upon termination of employment. The employer is required to provide the physician with the following information: A copy of this standard and appendices; a description of the employee’s duties as they relate to asbestos exposure; the employee’s representative level of exposure to asbestos, tremolite, anthophyllite, and actinolite; a description of any personal protective and respiratory equipment used; and information from previous medical examinations of the affected employee that is not otherwise available to the physician. Making this information available to the physician will aid in the evaluation of the employee’s health in relation to assigned duties and fitness to wear personal protective equipment, if required.

The employer is required to obtain a written opinion from the examining physician containing the results of the medical examination; the physician’s opinion as to whether the employee has any detected medical conditions that would place the employee at an increased risk of exposure-related disease; any recommended limitations on the employee or on the use of personal protective equipment; and a statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions related to asbestos, tremolite, anthophyllite, and actinolite exposure that require further explanation or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to exposure to asbestos, tremolite, anthophyllite, and actinolite, and a copy of the opinion must be provided to the affected employee.
**ATTACHMENT 2 (CONTINUED)**

**ACKNOWLEDGEMENT SIGNATURE PAGE**

**SIGNATURES**

By signing this sheet, I acknowledge that I have read and understand this asbestos guidance.

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VERIFICATION AND VALIDATION OF CHEMICAL AND RADIOCHEMICAL DATA

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VERIFICATION AND VALIDATION OF CHEMICAL AND RADIOCHEMICAL OPERATING PROCEDURE

1.0 PURPOSE, SCOPE, AND OWNERSHIP

Data verification and validation is a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. These criteria, or quality assurance objectives, are qualitative and quantitative statements that specify the level of data quality required to support project decisions. These criteria are established prior to data acquisition (i.e., sampling and analysis) and are documented in sampling plans. For Environmental Operations Center (EOC) projects and programs, specific criteria used to assess the quality of the measurement data generated are defined in project-specific sampling plans. For the Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Project, criteria used to assess the quality of measurement data for ER investigations are defined in the Generic Quality Assurance Project Plan (QAPP) for Resource Conservation and Recovery Act (RCRA) Facility Investigations (SNL/NM, 1994).

Once the measurement data are obtained, the data and the supporting documentation are examined and evaluated to determine if the data are of the quality specified in the sampling plan. Data validation is a multistep process carried out by the field personnel, the analytical laboratory, the sample management personnel, and SNL/NM project or program personnel. Field personnel are responsible for performing checks of sample collection documentation to ensure that it is correct and complete. The analytical laboratory reviews the analytical data to ensure that it meets the requirements of the laboratory’s quality assurance plan, contractual requirements, and analytical method requirements. The sample management office (SMO), or designee, performs the reviews which are the subject of this operating procedure (OP). Finally, the data requestor reviews all documentation and evaluates the data relative to the DQOs for the task.

1.1 Purpose and Scope

The purpose of this OP is to define the levels of, and procedures for, verification and validation of chemical and radiochemical measurement data that will be used by the EOC. For each level defined, it describes the specific components to be evaluated and provides the forms used to document the evaluation. The sampling plan should stipulate the level of verification and validation that is required for each investigation. This procedure is applicable to all projects under the SNL/NM EOC for which chemical and/or radiochemical measurement data are obtained.
1.2 Ownership

The SNL/NM EOC SMO is responsible for maintaining and revising this OP as necessary. Any comment or suggestions for improvement should be forwarded to the SMO.
2.0 RESPONSIBLE INDIVIDUALS AND ORGANIZATIONS
Sampling plans prepared by SNL/NM EOC describe responsibilities specific to the projects. This section describes the responsibilities of SNL/NM EOC project personnel and subcontractors as they relate to this OP.

2.1 SNL/NM Project/Task Leader
The SNL/NM Project/Task Leader is responsible for:

- Overseeing day-to-day implementation of assigned sampling project operations, including the requirements of this OP.

- Based on the data quality objectives (DQOs) of the project, identifying the level of quality control (QC) and the associated level of data verification and validation required.

- Communicating to the SMO the QC data requirements for a task.

- Ensuring that project personnel assigned to perform data verification and validation are qualified and are adequately familiarized with the procedures contained in this OP.

- Ensuring that this OP is implemented for review of analytical data and sampling records related to his/her project.

- Ensuring that documentation necessary to perform data verification and validation is made available to the data reviewer.

- Performing a final review of the sampling documentation package, evaluating the sampling data relative to the task, and giving final approval of the package.

- Ensuring that all nonconformances are adequately documented and approving all corrective action.

- Submitting the sampling documentation package to the EOC Records Center.
2.2 Sample Management Office (SMO)

The SMO is responsible for:

- Ensuring that no activities associated with sample handling and shipping will result in invalidation of the data generated by a sampling event.

- Processing and shipment of environmental samples following regulatory requirements for sample custody, sample packaging, and shipment to contract analysis laboratories.

- Interfacing with the analytical laboratory on SNL/NM ER Project matters pertaining to generation of analytical data.

- Assigning suitably qualified personnel to perform data validation for SNL/NM EOC projects and for providing training in validation as required.

- Requesting that the analytical laboratory perform corrective action when the data validation procedure reveals analytical nonconformance.

- Compiling the sampling documentation package and transmitting it to the SNL/NM Project/Task Leader.

- Monitoring contractor laboratory activities to ensure SNL/NM EOC quality assurance and contract-specific requirements are met.

2.3 Sampling Team

The sampling team, consisting of field and supervisory personnel, is responsible for:

- Executing the sampling plan in a manner that ensures that no field activities will result in invalidation of the data generated by a sampling event.

- Documenting the acquisition of field data and chain of custody completely and accurately (using the Sample Collection Log, field logbooks, Analysis Request and Chain of Custody Record [AR/COC] and appropriate SOPs) so that the sampling event can be reconstructed.

- Reviewing the field documentation to ensure that it is complete and accurate.

- Submitting the reviewed field documentation to the SMO once the samples have been delivered to the analytical laboratory.
2.4 Data Reviewer

The data may be reviewed by one or more persons, depending upon the level of verification/validation required and the qualifications of the persons assigned. Data verification may be performed by persons knowledgeable in aspects of analytical laboratory contract requirements. Data validation must be performed by persons knowledgeable in the analytical techniques used and familiar with project data quality requirements. The data reviewer(s) is responsible for

- Reviewing sample collection documentation and laboratory analytical data as described in this procedure.
- Completing the checklist(s) required by the level of data review being performed, attaching it to the sampling documentation and analytical data package, and returning the package to the SMO.
- Notifying the SMO of any corrections or information the analytical laboratory must provide.
- Notifying the SMO and the SNL/NM Project/Task Leader of any nonconformances noted during the data review process.
- Ensuring that any nonconformances (e.g., incorrect or missing analytical information) are adequately addressed.

2.5 Compliance and Quality Assurance Department

The SNL/NM EOC Compliance and Quality Assurance Department is responsible for

- Reviewing nonconformance documentation and approving corrective action.
- Periodically conducting an independent review of the implementation of this procedure and associated procedures.

2.6 Analytical Laboratory

The analytical laboratory is responsible for

- Performing validation of data in accordance with the internal laboratory quality assurance program.
- Correcting data, as necessary, if errors are found.
- Initiating corrective action in accordance with the internal laboratory quality assurance program when nonconformances are identified.
3.0 DEFINITIONS

3.1 Accuracy
Accuracy is the closeness of agreement between a measurement and the true value. When applied to a set of observed values, accuracy can be a combination of a random component and a common systematic error component. For the purposes of this procedure accuracy of measurement data is determined from analysis of laboratory control samples (LCS) and is expressed as percent recovery (%R) which is defined as follows:

\[
%R = \frac{\text{Measured value}}{\text{True value}} \times 100
\]

3.2 Analytical Data Package
The analytical data package is required for Data Verification and Validation Level 3 (DV3) (Section 5.4) and consists of the raw sample analytical data and associated calibration and QC data.

3.3 Analytical Summary Report
The analytical summary report, compiled by the analytical laboratory from the raw analytical data, consists of a brief narrative of the analytical task, including any problems associated with the analyses; sample data summary sheets; and QC data summary sheets.

3.4 Bias
A systematic error inherent in a method or caused by some artifact or idiosyncrasy of the measurement system. Extraction and sample preparation inefficiencies, blank contamination, mechanical losses and calibration errors are examples of bias. Several types of bias can exist concurrently so that the net bias overall can be evaluated.

Estimates of bias may be determined from analysis of surrogate spike and matrix spike samples. Bias is expressed as percent recovery, which is defined for surrogate spike samples as follows:

\[
%R = \frac{\text{Measured value}}{\text{True value}} \times 100
\]
and matrix spike samples as:

\[ \%R = \frac{\text{Measured value for spiked sample} - \text{Measured value for unspiked sample}}{\text{Known value of spike in the sample}} \times 100 \]

3.5 Comparability
Comparability is the extent to which one data set can be compared to another. A high degree of comparability is achieved through collecting and analyzing samples using consistent methodology and through reporting of data in consistent units.

3.6 Completeness
Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

3.7 Contamination
Contamination is the presence of analytes or interferents that are inadvertently added to the sample during the sample collection or analysis process. Consequently, measurement data would not give an accurate representation of the measured characteristic for the medium from which the sample was taken. Common sources of sample contamination are collection equipment, exposure to ambient contaminants, and contamination during the preparation and analysis process.

3.8 Corrective Action
Corrective action is the series of steps taken to ensure that the primary causes of conditions adverse to quality are identified promptly and corrected as soon as practical.

3.9 Critical Level (Radiochemical Measurements)
The critical level \( L_c \) is the net count rate (signal level) which must be exceeded before the sample is said to contain any measurable activity above background (i.e., above which an observed signal may be reliably recognized within 95 percent confidence as "detected"). There is a five percent chance that a true mean count will be falsely recorded as a positive value. The critical level is calculated from the following equation (except for gamma spectroscopy):

\[ L_c = 1.645S_o . \]
where,

\[ L_c = \text{the Critical Level, net counts} \]
\[ S_0 = \text{the standard deviation of the net count of a zero activity sample, net counts}. \]

The value \( S_0 \) is equivalent to the errors of two independent variables:

\[ S_0 = (S_{t0}^2 + S_b^2)^{0.5} \]

where,

\[ S_{t0} = \text{the standard deviation in the total count over counting time (T) of a zero activity sample (e.g., a sample of uncontaminated material), net counts} \]
\[ S_b = \text{the standard deviation in the total count of an analytical blank over the same time (T)}. \]

For gamma spectroscopy, it is assumed that an analytical blank value can be obtained directly from the counting data. This value is determined by a peak search and quantitation algorithm. The Critical Level equation for this situation reduces to the following expression.

\[ L_c = 1.645S_0 = 1.645 (2S_b^2)^{0.5} \]
\[ = 2.33S_b \]

3.10 Data Quality Objectives (DQO)

DQOs are qualitative and quantitative statements that specify the quality of data required to support project decisions. DQOs are established to ensure that the data collected are sufficient and of adequate quality for their intended uses. DQOs are documented in the project-specific sampling plans.

3.11 Decision Amount (DA)

DA is the amount of activity that would be indicated on a smear sample result when the decision would be made that it is positive:

\[ DA = 2.33 s_b/KT \]
where,

\[ s_B = \text{The standard deviation of the blank count, for time } T \text{ (which for pure Poison fluctuations would be the square root of the number of counts in time } T) \]

\[ K = \text{A calibration constant, in units of counts/minute per microcurie, or counts per minutes per dpm, obtained.} \]

3.12 Detection Limit (Chemical Measurements)

The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

For operational purposes, when it is necessary to determine the detection limit in the sample matrix, it shall be determined by multiplying the standard deviation obtained from the triplicate analyses of a matrix spike containing the analyte of interest at a concentration three to five times the estimated detection limit by 7.

Estimate the detection limit as follows:

Obtain the concentration value that corresponds to:

- An instrument signal/noise ratio within the range of 2.5 to 5.0
- The region of the standard curve where there is a significant change in sensitivity; i.e., a break in the slope of the standard curve.

Determine the variance \( (S') \) for each analyte as follows:

\[
S' = \frac{1}{(n-1)} \sum_{i=1}^{n} x_i^2 - \frac{1}{n} \left( \sum_{i=1}^{n} x_i \right)^2
\]

where \( x_i \) = the \( i \)th measurement of the variable \( x \)
Determine the standard deviation ($s$) for each analyte as follows:

$$s = (S')^{1/2}$$

Determine the detection limit for each analyte as follows:

Detection Limit = $t_{(n-1, \epsilon = 99)}$ ($s$)

where $t_{(n-1, \epsilon = 99)} = 6.965$ for three replicates as determined from the table of Student's $t$-values at the 99 percent level.

3.13 Detection Limit (Radiochemical Measurements)
The Detection Limit ($L_d$), is the value that should be specified and is defined as the smallest quantity of radioactive material that can be detected with some specified degree of confidence.

3.14 Lower Limit of Detection
The lower limit of detection is defined as the smallest activity that has a 95 percent probability of being detected with only 5 percent probability of falsely concluding its presence.

$$LLD = E \frac{4.65s_b}{V 2.22 \times 10^6 Y \exp (-\lambda \Delta t)}$$

$s_b$ = standard deviation of blank, counts/minute,
$E$ = counting efficiency, counts/disintegration,
$V$ = sample size in units of mass or volume,
$2.22 \times 10^6$ = number of disintegrations/min per $\mu$Ci,
$Y$ = fractional radiochemical yield, when applicable
$\lambda$ = radiological decay constant,
$\Delta t$ = elapsed time between sample collection and counting.
3.15 Determination Limit (Radiochemical Measurements)
The determination limit (also called minimum detectable activity) is the level at which the measurement precision is satisfactory for quantitative determination.

3.16 Minimum Detectable Activity (Radiochemical Measurements)
See "Determination Limit."

3.17 Nonconformance
A nonconformance is an unauthorized deviation from documented procedures, practices, or standards that could lead to the degradation of quality.

3.18 Practical Quantitation Limit (see Quantitation Limit)

3.19 Precision
Precision is the agreement among a set of replicate measurements. Precision data may be derived from duplicate or multiple analyses of environmental, matrix spike, and laboratory control samples. Precision between two measurements is defined in terms of relative percent difference (RPD), which is calculated as follows:

\[ RPD = \frac{|Measured \ Value \ 1 - Measured \ Value \ 2|}{Average \ Value \ of \ 1 \ and \ 2} \times 100 \]

Precision between multiple samples is defined evaluated in terms of relative standard deviation (RSD), which is calculated as follows:

\[ \%RSD = \frac{Standard \ Deviation}{Mean} \times 100 \]

\[ Standard \ Deviation = \left( \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1} \right)^{1/2} \]
and

\[ x_i = \text{Individual value used to calculate the mean} \]
\[ \bar{x} = \text{The mean of n values} \]
\[ n = \text{The total number of values}. \]

### 3.20 Data Qualifiers

Data qualifiers provided with the data indicate the associated deficiencies. Qualified data are data that do not fully meet the evaluation criteria of a project but provide useful information. Data qualifiers used in data validation are defined as follows:

- **A** = Laboratory accuracy and/or bias measurements do not meet acceptance criteria.
- **B** = Analyte present in blank.
- **J** = The associated value is an estimated quantity.
- **N** = There is presumptive evidence of the presence of the material.
- **NJ** = There is presumptive evidence of the presence of the material at an estimated quantity.
- **P** = Laboratory precision measurements do not meet acceptance criteria.
- **Q** = Quantitation limit reported does not meet DQO requirements.
- **R** = The data are unusable for their intended purpose. (Note: Analyte may or may not be present.)
- **UC (Chemical)** = The material was analyzed for but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
- **UR (Radiochemical)** = (Radiochemical) A result is so uncertain that, considered as a single data point, it is not appropriate to make numerical decisions based on its value.
- **UJ** = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
3.21 Quantitation Limit (Chemical Measurements)
The lowest analyte concentration of a given matrix which the laboratory can consistently measure for the level of rigor imposed on the analytical process. Quantitation limits are generally between 2 and 5 times the detection limit. Quantitation limits may also be called the "reporting limit" or "detection limit" by analytical laboratories.

3.22 EOC Sampling Plan
A written document that describes the objectives of an investigation and details an individual task associated with an investigation and how they will be performed. Sampling plans include sampling requirements, analytical methods and project-specific quality assurance/quality control requirements necessary to ensure that the DQOs of the project are achieved.

3.23 Sample Delivery Group
The results of a group of samples that are reported in an analytical report. Also called a project number by laboratories.

3.24 Sampling Documentation Package
The sampling documentation package is the group of documents submitted to the Environmental Operations Record Center for a sampling task. It consists of the Sample Collection Log(s), field logbook, AR/COC(s), shipping documents, analytical summary report(s) and/or analytical data package(s), data validation checklists (appropriate for the level of validation performed), any nonconformance and corrective action documentation necessary, and a final evaluation/approval record by the SNL/NM Project/Task Leader.
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4.0 MATERIALS AND EQUIPMENT
To perform data verification/validation, the following documentation shall be available:

- SNL/NM EOC sampling plan

- Sample control documentation: Copies of field logbooks, sample collection logs, chain-of-custody documents, and analysis request documents (such as the AR/COC)

- Analytical report(s), either the analytical summary report or, for the most stringent level of data verification/validation, the analytical data package from the analytical laboratory

- This OP and the applicable attachments.
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5.0 PROCEDURE

Three levels of verification/validation may be performed on chemical and radiochemical data generated by the sampling program: Data Verification/Validation Level 1 (DV1) (the least stringent) through Data verification/Validation Level 3 (DV3) (the most stringent). Data Verification/Validation Level DV1 and DV2 are routinely performed by the SNL/NM SMO for laboratory data generated by a contractor laboratory. It is recommended that Data Verification/Validation Level 3 be performed at a 5 percent frequency. A higher or lower frequency may be determined based on the data quality requirements of the particular project. The requirements of each are described in the following sections. Detailed procedures for data verification of chemical analyses are found in Attachments A and B. Attachment C describes the procedure for chemical data validation, and Attachment D is the procedure for verification and validation of radiological data.

5.1 Preliminary Actions

Several actions shall be performed prior to the initiation of or during sampling activities to ensure that data validation can be performed as specified in this procedure.

5.1.1 SNL/NM Project or Task Leader

During the planning stages of the investigation, decide on the level of data review necessary for that task. If the sample data will be reviewed at more than one level of stringency, determine the frequency of each level. Document the level(s) and frequency of each in the project-specific sampling and analysis plan. Relay that information to the SMO when scheduling analysis.

5.1.2 Sampling Team

Prior to initiating sampling, review the project-specific sampling and analysis plan for analyses required, QC samples to be collected, and special QC analyses that must be specified on the AR/COC (e.g., matrix spikes). If DV3 review is specified in the sampling and analysis plan, check with the SMO to ensure that the SNL/NM Project/Task Leader has relayed that information to the SMO.

5.1.3 Sample Management Office (SMO)

At the time sampling is scheduled, determine from the SNL/NM Project/Task Leader if special laboratory QC will be required and the level of verification/validation specified for the task. If DV3 review is specified, interface with the analytical laboratory(s) to ensure that the complete analytical data package (Section 3.2) is compiled and transmitted to the SMO upon completion of the analyses.
5.2 Data Verification/Validation Level 1
DV1 is primarily a documentation completeness check (verification). It ensures that field and sample control documents are complete and that the analytical laboratory has provided the data required in the sampling plan. If more stringent levels of data validation will be performed, it ensures that the analytical laboratory has provided all information and documents required. All analytical data generated by a sampling program must undergo at least a DV1 evaluation before being accepted.

To perform a DV1 evaluation, obtain the following documentation:

- Sampling plan which contains the project-specific quality assurance/quality control requirements
- Sample Collection Log(s) and copies of field logbook(s)
- AR/COC(s)
- Analytical summary report(s) or analytical data package.

Using the detailed procedure and the form provided in Attachment A, check the documentation. Some portions of the completeness check may be performed prior to receiving the analytical report (e.g., completeness check of sample control documentation). Document the completeness check, any findings, and their resolution on the Documentation Completeness Checklist (Attachment A). Sign and date the checklist. Attach the checklist to the sampling documentation package, and return the package to the SMO (see Section 5.5).

5.3 Data Verification/Validation Level 2
Data Verification/Validation Level 2 (DV2) is both a documentation completeness check and a data quality indicator evaluation (verification). Most SNL/NM EOC sample data will be assessed at this level of rigor. To perform a DV2 evaluation, collect the same documentation as described for DV1 (the analytical summary report is required, not the analytical data package). Perform a DV1 documentation completeness check as described in Section 5.2. Continue with a data quality indicator evaluation using the detailed procedure and the form provided in Attachment B. Document the data quality indicator evaluation, any findings, and their resolution on the Data Quality Indicator Checklist (Attachment B). Sign and date the checklist. Attach the checklist to the sampling documentation package, and return the package to the SMO (see Section 5.5).
5.4 Data Verification/Validation Level 3
DV3 is a thorough review of environmental sample, calibration, blank, spike, and laboratory control sample data (verification and internal validation). To perform a DV3 evaluation, collect the documents required for the DV1 and DV2 evaluations (Sections 5.2 and 5.3). In addition, collect the documentation, as appropriate, described in the following subsections, which the SMO must request from the analytical laboratory at the time the samples are submitted. Perform a documentation completeness check as described in Section 5.2 for DV1. Following the completeness check, thoroughly review the documentation using the detailed procedure and forms provided in Attachment C and/or Attachment D. Document the review, any findings, and their resolution on the appropriate form(s). Sign and date the forms when the review is complete. Attach the form(s) to the sampling documentation package, and return the package to the SMO (see Section 5.5). The following sections present the documentation required to perform a DV3 evaluation of inorganic, organic, and radiochemical analyses.

5.4.1 Inorganic Analyses
Inorganic analyses include trace metal analysis by inductively coupled plasma (ICP) or atomic absorption (AA) and wet chemistry analyses (e.g., nitrate/nitrite, phenolics, cyanide, and chloride). Gather the following documentation for review of all inorganic analyses:

- The sample delivery group (SDG) narrative
- Digestion/sample preparation logs
- Raw data printouts and summary forms for all sample analyses pertaining to the deliverable
- Instrument calibration logs, both initial and continuing
- Interference check sample data (for ICP analyses)
- Duplicate injection data (for AA analyses)
- Associated QC data (printouts, stripcharts, printer tapes, etc.) and summary forms, including
  - Method blanks
  - Laboratory control samples
  - Matrix spike/matrix spike duplicate samples.
5.4.2 Organic Analyses

Organic analyses verification/validation procedures apply to analyses by gas chromatography (GC), including those incorporating mass spectroscopy (MS) (i.e., volatile organic compound [VOC] and semivolatile organic compound [SVOC] analyses), total organic halogen analyses and total organic compound analyses. Gather the following:

- The SDG narrative
- Chromatogram (as appropriate), quantitation reports, and summary forms for each of the following:
  - Environmental samples
  - Initial calibration
  - Continuing calibration
  - Method blanks
  - Surrogate spike (system monitoring) compounds
  - Matrix spike and matrix spike duplicate samples
  - Laboratory control samples
- The environmental sample preparation and/or extraction sheets (as appropriate for the organic analysis performed)

For GC/MS analyses, also gather the following:

- Performance check (tuning) reports, including mass spectra and mass listing summary forms for each tune check performed
- The environmental sample mass spectra
- If tentatively identified compounds (TIC) are requested, the TIC summary form and the library search printout with the spectra for the three most likely TIC candidates.

5.4.3 Radiochemical Analyses

Gather the following documentation for radiochemical analyses:

- Case narrative
- Initial and continuing calibration data
- Method and/or instrument blank data
- Laboratory replicate analyses data
- Laboratory QC samples data
- Background counts data
- Minimum detectable activity (MDA), critical level, and determination limit
- Internal standards and carrier recovery factors data
- Environmental sample data.
5.5 Approval Procedure
When the DV1, DV2, or DV3 process is complete, the steps described below shall be followed.

5.5.1 Data Reviewer
1. Sign the form(s) appropriate to the level of data verification/validation performed.
2. Attach the form(s) to the sampling documentation package.
3. Return the package to the SMO.

5.5.2 SMO
1. Check the package for completeness.
2. Transmit the package to the SNL/NM Project/Task Leader.

5.5.3 Project/Task Leader
The Project/Task Leader should verify that the appropriate level of verification and validation were performed. The Project/Task Leader is responsible for final validation of the data, that is, determining if the resulting data is usable for its intended purpose. The Project/Task Leader must review all qualified data and accept or reject the data for final use in data analysis.
1. Review and evaluate the sampling documentation package.
2. Sign the package indicating approval.
3. Submit the package to the Environmental Operations Record Center.

5.6 Nonconformance and Corrective Action
Any nonconformances identified by or related to the use of this procedure shall be documented. Nonconformances that impact data usability shall be communicated to the SNL/NM Task Leader and the SMO for documentation and corrective action as soon as they are identified. Detailed discussions of corrective actions for data quality findings are provided in the attachments. In general, depending upon the nature of the finding, perform one of the following corrective actions:

- If sufficient information is available to determine the appropriate correction, make the correction, initial and date the correction, and note the resolution on the appropriate checklist or form.

- Notify the SMO of the finding, and have the SMO contact the analytical laboratory for a correction of the deficiency if possible. Once the deficiency is corrected, note the resolution on the appropriate checklist or form.
• Prepare a nonconformance report, and note on the appropriate checklist or form that the data are qualified, the reason, and possible effects on the data.
6.0 RECORDS

Work conforming to this OP produces the following records:

- DV1 generates the Documentation Completeness Checklist.
- DV2 generates the Documentation Completeness Checklist and the Data Quality Indicator Checklist.
- DV3 generates the following:
  - Documentation Completeness Checklist
  - Inorganic, Organic, and/or Radiochemical Data Assessment Summary Form
  - Inorganic, Organic, and/or Radiochemical Data Review Package.

Nonconformances and corrective actions also can result in records pertinent to data verification/validation. These also are included in the sampling documentation package. Note that Section 5.6 has most nonconformances and corrective actions documented on checklists and forms that already exist.
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7.0 REFERENCES


7.4 EG&G Rocky Flats (EG&G-RF), 1989, "Radiochemical Data Validation Guideline—Isotopic Analyses by Alpha Spectrometry (Draft)," EG&G Rocky Flats, Golden, Colorado.

7.5 Karnofsky, J., 1993, "Radiochemistry Data Validation, Draft #4."


8.0 ATTACHMENTS

8.1 Attachment A—Instructions for Performing a Documentation Completeness Check

8.2 Attachment B—Instructions for Performing a Data Quality Indicator Evaluation

8.3 Attachment C—Instructions for Performing a Complete Evaluation of Data Quality for Inorganic and Organic Analyses

8.4 Attachment D—Instructions for Performing a Complete Evaluation of Data Quality for Radiochemical Analyses

Attachments to this document are available through the SNL/NM EOC Records Center
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ATTACHMENT A

INSTRUCTIONS FOR PERFORMING A
DOCUMENTATION COMPLETENESS CHECK
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)
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2  SNL/NM Analytical Request and Chain-of-Custody
INSTRUCTION FOR PERFORMING A DOCUMENTATION COMPLETENESS CHECK  
(DATA VERIFICATION/VALIDATION LEVEL 1–DV1)

1.0 INTRODUCTION

This document provides instructions for performing a completeness check of the documentation generated during a Sandia National Laboratories/New Mexico (SNL/NM) Environmental Operation Center (EOC) and Environmental Restoration ER Project sampling and analysis event. Instructions for checking the following documents are included:

- Sample Collection Log (if used)
- Analysis Request and Chain of Custody Record (AR/COC)
- Analytical Report(s).

The Sample Collection Log and AR/COC may be multiple page documents. Each page shall be checked for the appropriate elements, as discussed in the following sections. Because each sampling event may generate samples that are shipped to multiple analytical laboratories (e.g., one for chemical analysis and one for radiochemical analysis), a single sample collection log may be associated with several AR/COC and analytical reports. An AR/COC is composed of associated samples, are designated as a sample delivery group (SDG) and are evaluated together. The completeness checks of each of the above documents may be performed at different times and by different persons. A single checklist should be generated for the sample data group and should remain with the documentation. Each reviewer must sign and date the section reviewed.

Action must be taken to correct any deficiency noted during the completeness check. This procedure provides instructions for performing corrective actions if deficiencies are noted during the review.

NOTE: Instructions are provided for reviewing the SNL/NM Sample Collection Log, SNL/NM AR/COC, and standard forms. This review procedure is applicable to review of all sample collection, analysis request, and sample custody documentation for SNL/NM Environmental Operations Center (EOC) investigations, projects, and programs generating data related to environmental assessment, waste characterization, or other regulatory compliance.
2.0 PROCEDURE

Gather the following documents:

- SNL/NM ER project-specific plans which contain sample collection, analysis, and quality control (QC) specifications. Usually an SNL/NM ER project work plan will contain the project-specific sampling plan and the project-specific quality assurance project plan (QAP/JP).

- Sample Collection Log and all associated sample collection documentation as required by Project Plan.

- AR/COC.

- Analytical report(s).

- Documentation Completeness Checklist found at the end of this procedure.

Review and document the findings as described below.

2.1 Sample Collection Log

The Sample Collection Log is an optional form to facilitate field data collection and review. Project/Task Leaders may choose to record collection data in Field Log Books. When the Sample Collection Log is not used, it is the Task Leader's responsibility to assure that all required information is recorded in Field Log Books. If the Sample Collection Log is used, however, all data should be recorded.

All blanks on the Sample Collection Log shall be filled in. Equivalent documentation shall provide the same information. **Sufficient information shall be contained on the sample collection documentation such that the sampling activities can be reconstructed from the information.** Check to see that each of the following blanks or boxes are complete on the Sample Collection Log (Figure 1) or that the information is provided in the documentation:

- Date.

- Sheet number and total number of sheets.

- General information, including weather, sampling procedure reference, contact information, and general sampling location (such as building number). The sampling procedure reference should be to the SNL/NM ER work plan or sampling and analysis plan and can be by title or by document number, or the plan can be attached. The space for general remarks does not have to be filled out.
### ENVIRONMENTAL PROGRAMS

**SAMPLE COLLECTION LOG**

<table>
<thead>
<tr>
<th>GENERAL INFORMATION</th>
<th>PURPOSE OF SAMPLING:</th>
<th>SAMPLE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE:</td>
<td>WEATHER:</td>
<td>MATRIX:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collected from:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drum</td>
</tr>
</tbody>
</table>

#### Sample Collection Log

**SCL-00708**

**ARGOC No:**

**PAGE:**

<table>
<thead>
<tr>
<th>DATE:</th>
<th>WEATHER:</th>
</tr>
</thead>
</table>

**SAMPLE NUMBER - FRACTION**

<table>
<thead>
<tr>
<th>Time</th>
<th>LOCATION</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>

**PROJECT NAME**

**CASHER NUMBER**

**PROJECT CONTACT**

<table>
<thead>
<tr>
<th>NAME</th>
<th>SIGNATURE</th>
<th>INT</th>
<th>COMPANY/ORGANIZATION</th>
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**SAMPLE TEAM MEMBERS**

<table>
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<th>1.</th>
<th>2.</th>
<th>3.</th>
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</table>

**SAMPLE TRACKING**

<table>
<thead>
<tr>
<th>SAMPLE DISTRIBUTION</th>
<th>TRANSPORTED BY</th>
<th>SPECIAL HANDLING</th>
</tr>
</thead>
</table>

**DATE SHIPPED (MM/DD/YY)**

**DATA ENTERED (MM/DD/YY)**

**NOTE:** Any additional sampling information must be recorded in an SNL-issued Log Book or SCL Continuation Form with a Reference No. entered in this space.

**WHITE - To Sample Management Office**

**PINK - Originator**

**TO BE COMPLETED BY SME**
Sample description: Both "matrix" and "collected from" sections must be filled out (i.e., a box marked). If multiple samples are collected from several matrices, the matrix should be indicated in the comments area of each sample.

Sample identification (ID) number(s) and fraction number(s).

Time of sample collection.

Location: Every line must be filled out with a specific description or a reference to an attachment.

Sample Type: Either "g" for "grab" or "c" for "composite" must be marked.

QC sample (i.e., QC sample): "Y" or "N" must be entered in the boxes.

Comments: This box may be left blank, unless the "QC Sample" box is marked "Y"; if so, a note as to the type shall be listed in the comments box. Additionally, any information associated with sampling event reconstruction, including sample depth, where appropriate.

Analyses requested.

Project information, including project name, case number, contact information, turnaround time, and regulatory program.

Additional information: Any log book references or SCL continuation form reference.

Sample team member(s), their signature(s), and initials.

The sample tracking information should be completed. However, if the Sample Collection Log completeness check is performed before being submitted to the Sample Management Office (SMO), the "Data Entered" and "By" spaces may be empty; this is not a deficiency.

Document that the information is provided by placing check marks in the "Yes" box of "Complete?" column of the table in the "Sample Collection Log" section of the Document Completeness Checklist. If any of the fields are incomplete, attempt to determine the missing information. Field logs may provide the necessary information. The sampling team also might be able to provide the information. When missing information is found, fill in the blank, initial, and date the entry. If missing information cannot be determined, check the appropriate "No" box, and note the finding in the "Completeness Assessment" section of the Documentation Completeness Checklist.
2.2 Analysis Request and Chain of Custody Record

All blanks on the AR/COC shall be filled out. Equivalent documentation shall provide the same information. On the AR/COC that has been returned by the analytical laboratory, check to see that each of the following blanks or boxes are complete (dittos or arrows are allowed if the meaning is clear) or that the information is provided:

- Page number and total number of pages.
- Project information.
- Sample shipping information.
- Contract and case number.
- SMO authorization signature.
- Location information.
- Sample number(s)/fraction number(s).
- Sample ID information.
- Date/time sample(s) collected.
- Sample matrix.
- Container type(s).
- Sample volume.
- Preservative (chemical and/or thermal).
- Sample collection method.
- Sample type.
- Required Analytical Testing. All lines shall specify analysis or shall make reference to an attachment. The attachment also shall be included and shall be cross-referenced to sample numbers. Analytical reference numbers should be used.
- Sample information, including hazards, turnaround time, disposal, and radioactive material management area designation (if applicable).
- Special instruction/QC requirements.
# Analysis Request and Chain of Custody Record

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Fraction</th>
<th>Sample Matrix</th>
<th>Data/Time Collected</th>
<th>Container Type</th>
<th>Sample Volume</th>
<th>Preservative</th>
<th>Required Analytical Testing</th>
<th>Lab Sample Number</th>
<th>Condition on Receipt</th>
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</table>

**Possible Hazard Identification**

- [ ] Non-Hazard
- [ ] Flammable
- [ ] Biohazard
- [ ] Poison
- [ ] Radioactive

**Turnaround Time**

- [ ] Normal
- [ ] Push

**Sample Disposal**

- [ ] Replenished by
- [ ] Disposal by Lab

![FACSIMILE Image]

Reference attached radiological screening for specific contact readings.

*White* - To Accompany Samples, Laboratory Copy

*Blue* - To Accompany Samples, Return to SMO

*Yellow* - SMO Suspense Copy

*Pink* - Field Copy
• Custody records: All times shall be accounted for. The initiator shall be a sample team member. The final custodian should be analytical laboratory personnel (see below). Organization, date, and time shall be filled out each time a sample changes custody. If the samples were hand-carried to the analytical laboratory, ensure that custody is documented for the entire time from collection through receipt at the analytical laboratory. If the samples were shipped to the analytical laboratory, ensure that a shipping receipt is included in the documentation package.

• Analytical laboratory sample number (in the "Lab Sample Number" space).

• Condition upon receipt.

Document that the information is provided by placing check marks in the first column of the table in the "Analysis Request and Chain of Custody Record" section of the Document Completeness Checklist. If any of the blanks are incomplete, attempt to determine the missing information. Field logs and the Sample Collection Log may provide the necessary information. The sampling team also might be able to provide the information. When missing information is determined (except for an unsigned chain of custody), fill in the blank, initial, and date the entry. If missing information cannot be determined, note the finding in the "Completeness Assessment" section of the Documentation Completeness Checklist. If the chain of custody is incomplete, a nonconformance report must be prepared as described in Section 5.6 of the "Data Verification/Validation Operating Procedure."

2.3 Document Comparison

The Sample Collection Log and the AR/COC (or equivalent documentation) must agree. Any discrepancies must be identified and corrected if possible. Compare the following items:

• Date on Sample Collection Log shall agree with "date collected" on AR/COC.

• Sample team members on the Sample Collection Log shall be those listed on the AR/COC.

• Sample ID numbers and fraction numbers on the Sample Collection Log shall be listed on an AR/COC or a note made on the log stating that the sample has been archived at SNL/NM. If the samples have been shipped to more than one analytical laboratory, several AR/COC will be associated with the log.

• For each sample fraction collected, the following shall agree on the Sample Collection Log and the AR/COC: the date and time.

• The project blocks on the Sample Collection Log shall agree with the project information on the AR/COC.
The sampling documentation should be compared to the project-specific QAP or sampling plan, if available, to determine if all the requirements have been met. Verify the following:

- The correct location was sampled.
- The correct number of investigative and QC samples were collected.
- The analyses required by the sampling plan were requested.

Document that the sampling documentation and plans agree by placing check marks in the "Yes" box in the "Complete?" column of the "Document Comparison" section of the Document Completeness Checklist. If any of the information does not agree, attempt to determine the correct information. Field logs and/or the sampling team members may provide the correct information. When the correct information is determined, change the incorrect form, sign, and date the entry. If the correct information cannot be determined, note the finding in the "Completeness Assessment" section of the Documentation Completeness Checklist. If the correct information cannot be determined, place a check in the "No" box in the "Complete?" column, and complete a nonconformance report as described in Section 5.6 of the "Data Verification/Validation Operating Procedure."

2.4 Analytical Laboratory Report

The analytical laboratory report shall be checked to ensure that it is complete. Verify that the following items have been included in the report:

- Data Review: The analytical laboratory shall designate a person responsible for reviewing the laboratory report before it is released to SNL/NM. The report shall be reviewed and signed by the laboratory designee.

- Sample Receipt: The date the samples were received by the analytical laboratory shall be documented on a summary page or included with the analytical results.

- Method Reference: The analytical methods used shall be stated in the analytical report. The methods used also shall be those required by the project-specific sampling plan and listed on the AR/COC.

- Quality Control Information: The laboratory shall provide a data summary of the laboratory control sample analyses; surrogate spike analyses, if organic analyses by gas chromatography were performed; and method/preparation blank analyses. The information shall include measures of bias, precision, and contamination for each analyte or a representative group of analytes (which shall cover the entire chromatographic range).
- Matrix Spike/Matrix Spike Duplicate Data: If matrix spike/matrix spike duplicate analyses were requested or are required by the method, the data shall be provided in the analytical report.

- SDG narrative discussing any problems, inconsistencies, or nonconformances.

Document that the analytical laboratory report is complete by placing check marks in the first column of the table in the "Analytical Laboratory Report" section of the Document Completeness Checklist. If any of the information is missing in the analytical report, inform the SMO of the finding(s). The SMO shall contact the analytical laboratory for a corrected report. Note all follow-up actions and the resolution in the "Completeness Assessment" section of the Documentation Completeness Checklist. If the correct information cannot be determined, a nonconformance report shall be prepared as described in Section 5.6 of the "Data Verification/Validation Operating Procedure."
# DOCUMENTATION COMPLETENESS CHECKLIST

## (DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

**Project Name ________________________________**

**Case Number ________________________________**

**Sample Numbers ________________________________**

<table>
<thead>
<tr>
<th>AR/COC No.</th>
<th>Analytical laboratory</th>
<th>SDG No.</th>
</tr>
</thead>
<tbody>
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<td>AR/COC No.</td>
<td>Analytical laboratory</td>
<td>SDG No.</td>
</tr>
<tr>
<td>AR/COC No.</td>
<td>Analytical laboratory</td>
<td>SDG No.</td>
</tr>
<tr>
<td>AR/COC No.</td>
<td>Analytical laboratory</td>
<td>SDG No.</td>
</tr>
</tbody>
</table>

*In the tables below, mark any information that is missing or incorrect.*

### 1.0 Sample Collection Log

<table>
<thead>
<tr>
<th>Date</th>
<th>Sheet number and total number of sheets below</th>
<th>General information</th>
<th>Sample description</th>
<th>Sample ID number(s) and fraction number(s)</th>
<th>Location</th>
<th>Time of sample collection</th>
<th>Sample type</th>
<th>Depth below surface</th>
<th>QC sample?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Complete?</th>
<th>Corrected?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

### Review

Reviewed by: ____________________________

Date: ____________________________

---

*a Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.

*b Comments are only required for QC samples; for other samples, this item can be blank.*
## 2.0 Analysis Request and Chain of Custody Record

<table>
<thead>
<tr>
<th>Item</th>
<th>Complete?</th>
<th>Corrected?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page number and total number of pages</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Project information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample shipping information</td>
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<td></td>
</tr>
<tr>
<td>Contract and case number</td>
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<td></td>
</tr>
<tr>
<td>SMO authorization signature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample number(s)/fraction number(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample ID information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Datetime sample(s) collected</td>
<td></td>
<td></td>
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<tr>
<td>Sample matrix</td>
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<td></td>
</tr>
<tr>
<td>Container type(s)</td>
<td></td>
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<tr>
<td>Sample volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preservative (chemical and/or thermal)</td>
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<td></td>
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<tr>
<td>Sample collection method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required analytical testing</td>
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<td></td>
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<tr>
<td>Sample information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special instruction/QC requirements</td>
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<tr>
<td>Custody records</td>
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<td>Lab sample number</td>
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<td></td>
</tr>
<tr>
<td>Condition upon receipt</td>
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</tr>
</tbody>
</table>

* Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

## 3.0 Document Comparison

<table>
<thead>
<tr>
<th>Item</th>
<th>Complete?</th>
<th>Corrected?</th>
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<tbody>
<tr>
<td>Dates on Sample Collection Log and AR/COC agree.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample team members on the Sample Collection Log and the AR/COC agree.</td>
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</tr>
<tr>
<td>Sample ID numbers on Sample Collection Log and AR/COC agree.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date and time on Sample Collection Log and AR/COC agree.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyses requested on AR/COC agree with those shown on Sample Collection Log.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project information on Sample Collection Log and AR/COC agree.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The sample location on the Sample Collection Log agrees with the AR/COC and project-specific plan requirements or authorized changes to the plan(s).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of investigatory and QC samples collected was that specified in the project-specific plan(s) or authorized changes to the plan(s).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The analyses requested on the AR/COC were those specified in the project-specific plan(s) or authorized changes to the plan(s).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.

Reviewed by: _____________________________ Date: ____________________
## DOCUMENTATION COMPLETENESS CHECKLIST
### (DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

### 4.0 Analytical Laboratory Report

<table>
<thead>
<tr>
<th>Item</th>
<th>Complete?</th>
<th>Corrected?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data reviewed, signature</td>
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<td></td>
</tr>
<tr>
<td>Date samples received</td>
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</tr>
<tr>
<td>Method reference number(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality control data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matrix spike/matrix spike duplicate data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrative complete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

### 5.0 Completeness Assessment
For each section below, mark the appropriate box and describe any problems that remain unresolved.

#### 5.1 Sample Collection Log

All boxes on the Sample Collection Log are complete:

- [ ] Yes
- [ ] No

If any boxes have been checked no, describe problem and resolution:

- [ ]

#### 5.2 Analysis Request And Chain Of Custody Record AR/COC

All boxes on the AR/COC review are complete:

- [ ] Yes
- [ ] No

If any boxes have been checked no, describe problem and resolution:

- [ ]

Reviewed by: __________________________
Date: __________________________
5.3 Document Comparison
All boxes on the Document Comparison are complete:
Some boxes have been checked no; all problems are resolved.

If any boxes have been checked no, describe problem and resolution:

5.4 Analytical Laboratory Report
All boxes on the Lab Report review are complete:
Some boxes have been checked no; all problems are resolved.

If any boxes have been checked no, describe problem and resolution:

BASED ON THE REVIEW, DOCUMENTATION IS COMPLETE:

Reviewed by:  
Date:  
Approved by:*  
Date:  

* Task/Project Leader must approve data package.

COMMENTS:
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ATTACHMENT B

INSTRUCTIONS FOR PERFORMING A
DATA QUALITY INDICATOR EVALUATION
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)
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INSTRUCTIONS FOR PERFORMING A DATA QUALITY INDICATOR EVALUATION  
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

1.0 INTRODUCTION
This document provides instructions for performing a data quality indicator (DQI) evaluation of data gathered for the Sandia National Laboratories/New Mexico (SNL/NM) Environmental Operations Center (EOC). It provides instructions for performing corrective action (when possible) for noted deficiencies and for qualifying the data, as necessary. The following DQIs are evaluated:

- Sample collection requirements (sample volume, container, and preservative).
- Holding times.
- Reporting units.
- Quantitation limits (also termed reporting limits or detection limits). For radiochemical analyses, two limits are evaluated: the critical level ($L_c$) and the determination limit ($L_d$) (or minimum detectible activity [MDA]).
- Analytical accuracy, based on laboratory control, matrix spike, and surrogate spike samples.
- Analytical precision, based on duplicate or replicate laboratory control and/or duplicate matrix spike samples.
- Sampling precision, based on field duplicates.
- Contamination, based on blank analysis. Blanks that may be evaluated include method blanks, reagent blanks, field blanks, trip blanks, and equipment blanks.
- For radiochemical analyses, the count time.

Prior to initiating the evaluation, the project-specific sampling plan should be reviewed to determine if different criteria for the data have been specified.

An AR/COC is composed of associated samples, are designated as a sample delivery group (SDG) and are evaluated together. The evaluation is documented using the Data Quality Indicator Checklist provided at the end of this document. A single checklist should be generated for each SDG and should remain with the SDG documentation. The reviewer performing the evaluation shall sign and date the checklist when the review is complete.
For any finding noted during the DQI evaluation, action shall be taken to correct the problem. The reviewer, the Sample Management Office (SMO), the analytical laboratory, and the sampling personnel each may be responsible for corrective action. For each section below, the appropriate corrective actions are described. Resolution of any findings shall be noted on the checklist, signed, and dated (if different than the original date).
2.0 PROCEDURE

Obtain the following documents:

- Sample Collection Log(s), or equivalent documentation
- Analysis Request and Chain of Custody Report(s) (AR/COC), or equivalent documentation
- The completed Data Verification/Validation Level 1 (DV1) Documentation Completeness Checklist
- Analytical report(s)
- The project-specific plans which should include the project-specific QAPjP and a sampling plan
- For radiochemical analyses, the current version of the "Program Plan for Managing Radioactive Materials Management Areas" (unless Lc and Ld or MDA are specified in the project-specific QAPjP).

Review the project-specific QAPjP and determine if the criteria differ from those specified in the SNL/NM EOC QAPP. Review the Documentation Completeness Checklist generated during the DV1 process for any problems noted, especially any which remain unresolved and may affect this procedure (e.g., missing analytical or quality control [QC] data). After review of the project-specific QAPjP and Documentation Completeness Checklist, perform the DQI evaluation as described below.

2.1 Data Qualifiers

A = Laboratory accuracy and/or bias measurements do not meet acceptance criteria.

B = Analyte present in blank.

J = The associated value is an estimated quantity.

N = There is presumptive evidence of the presence of the material.

NJ = There is presumptive evidence of the presence of the material at an estimated quantity.

P = Laboratory precision measurements do not meet acceptance criteria.
Q = Quantitation limit reported does not meet DQO requirements.

R = The data are unusable for the intended purpose. (Note: Analyte may or may not be present.)

UC (chemical) = The constituent was analyzed for, but was not detected above the sample quantitation limit or the sample detection limit.

UR (radiochemical) = A result is so uncertain that, considered as a single data point, it is not appropriate to make numerical decisions based on its value.

UJ = The constituent was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

2.2 Sample Collection: Volume, Container, and Preservation

Sample collection methodology affects the sample data quality. The DQIs evaluated are:

- Sufficient sample volume
- Proper container
- Correct method of preservation.

The sampling plan should specify the correct sample volume, container, and preservative.

2.2.1 Evaluation

On the AR/COC, verify the following:

- The correct volume of sample was collected.
- The correct type of container was used (i.e., glass or plastic).
- The correct preservative was used.

2.2.2 Action

1) If any of the above is incorrect, mark "No" on the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

2) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is estimated (J), and the reason for the qualification in the comments column (e.g., "wrong preservative used").
2.3 Holding Times

The U.S. Environmental Protection Agency (EPA) has only specified holding times for a water matrix, for organic analysis in soil and waste matrices, and for samples prepared by the toxicity characteristic leaching procedure (TCLP) prior to analysis.

2.3.1 Evaluation
Verify the following:

- The dates of sample analysis and any required preparation are reported
- Holding times have been met.

2.3.2 Action

1) If any of the dates are missing or the holding time was exceeded, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

2) If data for samples other than water, waste extracts are qualified based on EPA-established holding times for water; note this in the "Comments" section.

3) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is estimated (J), and the reason for the qualification in the comments column (e.g., "holding time exceeded by 7 days").

2.4 Reporting Units

The matrix and the proposed use of the data determine the appropriate units for reporting the data.

2.4.1 Evaluation
Verify that the reporting units

- Are the units appropriate for the matrix
- Meet the requirements specified in the methods requested in the project-specific QAPjP.

2.4.2 Action

1) If the units are inappropriate,

- Contact the analytical laboratory to determine if the laboratory can report the results in the appropriate units, or
- Determine if calculations can be performed using the information available to convert the reporting units to the required units. If so, perform the
calculations, record the results, and make reference in the comments section.

2) If the results cannot be converted to the appropriate units, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

3) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is qualified (R), and the reason for the qualification in the comments column.

4) Note all follow-up actions and the resolution in the "Comments" section.

2.5 Quantitation Limit
The quantitation limit shall meet the requirements of the project-specific QAPjP. The quantitation limit is also called the detection or reporting limit by some analytical laboratories; for radiochemical analyses, the \( L_c \) and the \( L_d \) or MDA are the limits reported. Quantitation limits will be elevated when high concentration of an analyte is present. This may only be a cause for concern when the other analytes are not detected in the same analysis. Quantitation limits are most important for nondetected parameters. For radiochemical analyses, the decision amount (for which criteria are contractual) shall be reported.

2.5.1 Evaluation
Verify that the quantitation limits specified in the project-specific QAPjP have been met.

2.5.2 Action

1) If the quantitation limit is exceeded, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

2) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is qualified (Q), and the reason for the qualification in the comments column.

3) If provided by the analytical laboratory, note the explanation for a raised limit in the "Comments" section.

4) If no explanation is provided, contact the analytical laboratory for an explanation.

5) Note all follow-up actions and the resolution in the "Comments" section.
2.6 Bias

Analytical bias is reported as percent recovery (%R). Analytical bias is reported for laboratory control sample (LCS) analysis, matrix spike analysis, and surrogate spike analysis.

2.6.1 Evaluation

Verify that %R is within laboratory control limits (documented in the analytical report) and the control limits specified in the project-specific QAPJJ or SAP for all LCSs, matrix spike samples, and surrogate spike samples (as appropriate).

2.6.2 Action

1) If any of the control limits for analytical accuracy for the LCS, surrogate spike, or matrix spike analyses were exceeded, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section. Note whether or not the laboratory was required (contractually) to perform corrective action.

2) LCS and Surrogate Spike

If LCS or surrogate spike limits are exceeded, an explanation should be provided by the analytical laboratory.

   a) Note the explanation for the exceeded limit and any corrective action taken by the analytical laboratory in the "Comments" section.

   b) If no explanation is provided, contact the analytical laboratory for an explanation.

   c) Note all follow-up actions and the resolution in the "Comments" section.

3) If the matrix spike control limit is exceeded, matrix effects are suspected; note the finding in the "Comments" section.

4) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is estimated (J,A), and the reason for the qualification in the comments column.

2.7 Precision

Analytical precision is reported as relative percent difference (RPD). Analytical precision is reported for duplicate LCS analysis (per laboratory contract) and, when requested or required by the method, for matrix spike duplicate analysis.

2.7.1 Evaluation
Verify that the RPD is within the control limits specified in the project specific QAPJIP or the QAPJIP for all LCSs and required matrix spike samples.

2.7.2 Action

1) If any of the control limits for analytical precision for the LCSs or matrix spike duplicate analyses were exceeded, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

2) Laboratory Control Samples

   a) Not all analytical laboratories use analytical precision for internal control, but this may be required contractually by SNL/NM. If LCS limits, either internal to the analytical laboratory or as stipulated in the project-specific QAPJIP, are exceeded, an explanation, though not required, should be provided by the analytical laboratory. Note the explanation for the exceeded limit and any corrective action taken by the analytical laboratory in the "Comments" section.

   b) If no explanation is provided, contact the analytical laboratory for an explanation. Unless contractually required, the analytical laboratory may not take corrective action based on precision findings.

   c) Note all follow-up actions and the resolution in the "Comments" section.

3) Matrix Spike/Matrix Spike Duplicates

   If the matrix spike duplicate RPD exceeds the control limit, poor analytical precision may be indicated. This may be caused by laboratory error, heterogeneity of the sample, or other causes. Note the finding in the "Comments" section.

4) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is estimated (J,P), and the reason for the qualification in the comments column.

2.8 Blanks

Blank analysis is used to assess whether contamination of the sample has occurred during sampling and sample shipment, preparation, and analysis. Contamination resulting from sampling and shipping are evaluated based upon field, equipment, and trip blanks. Contamination originating during sample preparation and analysis at the analytical laboratory are evaluated based upon method or reagent blanks.

2.8.1 Evaluation
Verify that blank results are less than the quantitation limit for all parameters analyzed. If contamination is detected in both the method or reagent blanks and an associated sample, the analytical laboratory may raise the quantitation limit for all associated samples to the level detected in the sample. Review the quantitation limit to determine if it has been elevated.

2.8.2 Action

1) If blank contamination was detected in any blank, mark the DQI checklist, note the sample and fraction number, the analysis affected, and describe the finding in the "Comments" section.

2) If method or reagent blank contamination is detected (except for the following common laboratory contaminants: acetone, 2-butanone, methylene chloride, toluene, and phthalate esters), an explanation should be provided by the analytical laboratory. Note the explanation for the contamination and any corrective action taken by the analytical laboratory in the "Comments" section. If no explanation is provided, contact the analytical laboratory for an explanation.

3) Sample results should be qualified as undetected (U) if the sample concentration is less than ten times the concentration in any blank of the common laboratory contaminants listed above or five times the concentration in any blank of any other contaminant.

4) Note all follow-up actions and the resolution in the "Comments" section.

5) In the "Summary" section of the checklist, indicate the affected sample/fraction number, that the result is qualified (B), and the reason for the qualification in the comments column.

2.9 Narrative
A narrative that summarizes the analytical process and any problems encountered during the analyses should accompany the analytical report.

2.9.1 Evaluation
Verify that the narrative provides a thorough explanation of any findings noted, except for sample collection errors (a brief note of such errors is sufficient) and matrix effects (i.e., low matrix spike recovery or precision that was outside the limits).

2.9.2 Action

1) If the narrative is incorrect or deficient
   - Note it in the "Comments" section
   - Contact the analytical laboratory for a corrected narrative.
2) Note all follow-up actions and the resolution in the "Comments" section.
DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Project Name: ________________________________
Case Number: ________________________________
Sample Numbers: __________________________________

<table>
<thead>
<tr>
<th>AR/COC No.</th>
<th>Analytical laboratory</th>
<th>SDG No.</th>
</tr>
</thead>
<tbody>
<tr>
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1.0 EVALUATION

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<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
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</thead>
<tbody>
<tr>
<td>1) Sample volume, container, and preservation correct?</td>
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<td></td>
</tr>
<tr>
<td>2) Holding times met for all samples?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Reporting units appropriate for the matrix and meet project-specific requirements?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Quantitation limit met for all samples?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Laboratory control sample accuracy reported and met for all samples?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reviewed by: ________________________________
Date: ________________________________
DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
<th>If no, Sample ID No./Fraction(s) and Analysis</th>
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<tr>
<td>c) Matrix spike recovery data reported and met for all samples for which it was requested?</td>
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<td>6) Precision</td>
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<tr>
<td>a) Laboratory control sample precision reported and met for all samples?</td>
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<tr>
<td>b) Matrix spike duplicate RPD data reported and met for all samples for which it was requested?</td>
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<td>7) Blank data</td>
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<tr>
<td>a) Method or reagent blank data reported and met for all samples?</td>
<td></td>
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<tr>
<td>b) Sampling blank (e.g., field, trip, and equipment) data reported and met?</td>
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<td>8) Narrative included, correct, and complete?</td>
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</table>

2.0 COMMENTS: All items marked "No" above must be explained in this section. For each item, give SNL/NM ID No. and the analysis, if appropriate, of all samples affected by the finding.

Reviewed by: __________________________

Date: __________________________
3.0 SUMMARY: Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted. Use the qualifiers given at the end of the table if possible. Explain any other qualifiers in the comments column.

<table>
<thead>
<tr>
<th>Sample/Fraction No.</th>
<th>Analysis</th>
<th>Qualifiers</th>
<th>Comments</th>
</tr>
</thead>
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<tr>
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</table>

QUALIFIERS:

- **J** = Estimated quantity (provide reason)
- **B** = Contamination in blank (indicate which blank)
- **P** = Laboratory precision does not meet criteria
- **R** = Reporting units inappropriate
- **N** = There is presumptive evidence of the presence of the material
- **UJ** = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
- **Q** = Quantitation limit does not meet criteria
- **A** = Laboratory accuracy does not meet criteria
- **U** = Analyte is undetected (indicate which analyte and reason for qualification)
- **NJ** = There is presumptive evidence of the presence of the material at an estimated quantity.

Reviewed by: __________________________

Date: __________________________
### SAMPLE FINDINGS SUMMARY CONTINUATION SHEET

<table>
<thead>
<tr>
<th>Sample/Fraction No.</th>
<th>Analysis</th>
<th>Qualifiers</th>
<th>Comments</th>
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</table>

Reviewed by: ______________________  Approved by:* ______________________

Date: ______________________  Date: ______________________

*Task/Project Leader must approve data package.
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ATTACHMENT C

INSTRUCTIONS FOR PERFORMING A COMPLETE EVALUATION OF DATA QUALITY FOR INORGANIC AND ORGANIC ANALYSES (DATA VERIFICATION/VALIDATION LEVEL 3—DV3)
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INSTRUCTIONS FOR PERFORMING A COMPLETE EVALUATION
OF DATA QUALITY FOR INORGANIC AND ORGANIC ANALYSES
(DATA VERIFICATION/VALIDATION LEVEL 3-DV3)

1.0 INTRODUCTION
This procedure provides instructions for performing a Sandia National Laboratories/New
Mexico (SNL/NM) Environmental Operations Center (EOC) Data Verification/Validation Level 3
(DV3) evaluation. A DV3 evaluation is a review of raw and summary analytical data and,
using professional judgment, a determination of the validity of the data. The criteria cited in
this procedure are taken from "Test Methods for Evaluating Solid Waste, Physical/Chemical
be documented in project-specific sampling plans. This procedure is derived from procedures
for data review developed by the U.S. Environmental Protection Agency's (EPA) contract
laboratory program (CLP) (EPA, 1988; EPA, 1991) and for activities conducted under the EPA
Removal Program (EPA, 1990b). EPA CLP and Removal Program guidance has been used
where SW-846 does not provide evaluation criteria or corrective action recommendations.

1.1 Qualifiers
During validation, the reviewer may note that analytes were not detected, that certain values
were estimated, that laboratory contamination may have been present, or that other aspects of
the analysis qualify the data. For the purpose of this procedure, the following code letters and
associated definitions will be used to denote data qualifications.

A = Laboratory accuracy and/or bias measurements do not meet
   acceptance criteria

B = Analyte present in blank

J = The associated value is an estimated quantity.

N = There is presumptive evidence of the presence of the
   material.

NJ = There is presumptive evidence of the presence of the
    material at an estimated quantity.

P = Laboratory precision measurements do not meet acceptance
   criteria.

Q = Quantitation limit report does not meet DQO requirements.
R = The data are unusable for their intended purpose. (Note: Analyte may or may not be present.)

UC (chemical) = The constituent was analyzed for, but was not detected above the sample quantitation or the sample detection limit.

UR (radiochemical) = A result is so uncertain that, considered as a single data point, it is not appropriate to make numerical decisions based on its value.

UJ = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

The reviewer may determine that qualifiers other than those used in this document are necessary to describe or qualify data. In these instances, it is the responsibility of the reviewer to thoroughly document and explain the qualifiers used.

Prior to initiating the DV3 evaluation, a documentation completeness check must be performed using the procedure described in the "Data Validation Operating Procedure" for a Data Validation Level 1 evaluation.

1.2 Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AA</td>
<td>atomic absorption</td>
</tr>
<tr>
<td>BFB</td>
<td>bromofluorobenzene</td>
</tr>
<tr>
<td>CCB</td>
<td>continuing calibration blank</td>
</tr>
<tr>
<td>CCV</td>
<td>continuing calibration verification</td>
</tr>
<tr>
<td>CF</td>
<td>calibration factor</td>
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<tr>
<td>CV</td>
<td>coefficient of variation</td>
</tr>
<tr>
<td>%D</td>
<td>percent difference</td>
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<tr>
<td>DFTPP</td>
<td>decafluorotriphenylphosphine</td>
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<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<tr>
<td>GC</td>
<td>gas chromatography</td>
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<td>GC/MS</td>
<td>gas chromatography/mass spectrometry</td>
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<td>ICP</td>
<td>inductively coupled plasma-atomic emission spectroscopy</td>
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<tr>
<td>ICS</td>
<td>interference check sample</td>
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<tr>
<td>ICV</td>
<td>Initial Calibration Verification</td>
</tr>
<tr>
<td>IDL</td>
<td>instrument detection limit</td>
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<tr>
<td>LCS</td>
<td>laboratory control sample</td>
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<tr>
<td>MS</td>
<td>matrix spike</td>
</tr>
<tr>
<td>MSA</td>
<td>method of standard addition</td>
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<tr>
<td>MSD</td>
<td>matrix spike duplicate</td>
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</table>
1.3 Definitions

1.3.1 Bromofluorobenzene
Volatile instrument performance check compound

1.3.2 Calibration Curve
A plot of absorbance versus concentration of standards

1.3.3 Continuing Calibration Blank
A deionized water sample run every ten samples designed to detect any carryover contamination.

1.3.4 Continuing Calibration Verification
A standard run every ten samples designed to test instrument performance.

1.3.5 Decafluorotriphenylphosphine
A semivolatile instrument performance check compound,
1.3.6 Holding Time
The time period from sample collection to laboratory analysis or time period to sample preparation and subsequent analysis.

1.3.7 Initial Calibration Blank
The first blank standard run to confirm the calibration curve.

1.3.8 Initial Calibration Verification
The first standard run to confirm the calibration curve.

1.3.9 Initial Calibration
The establishment of a calibration curve with the appropriate number of standards and concentration range. The calibration curve plots absorbance or emission versus concentration of standards.

1.3.10 Internal Standards
The compounds added to every VOC and SVOC standard, blank, matrix spike, duplicate, and sample extract at a known concentration, prior to instrumental analysis. Internal standards are used as the basis for quantitation of the target compounds.

1.3.11 Matrix Spike
The introduction of a known concentration of analyte into a sample to provide information about the effect of the sample matrix on the digestion and measurement methodology.

1.3.12 M/Z
The ratio of mass (m) to charge (z) of ions measured by GC/MS.

1.3.13 Post Digestion Spike
The addition of a known amount of standard after digestion. (Also identified as analytical spike, or spike, for furnace analyses).

1.3.14 Quality Assurance
The total program for assuring the reliability of data.

1.3.15 Quality Control
The routine application of procedures for controlling a process (such as analysis of samples).
1.3.16 Sample Delivery Group
Defined by one of the following, whichever occurs first:

- Field samples from one sampling event
- Each of 20 field samples from a sampling event
- Each 14-day calendar period during which field samples from one sampling event are received at an analytical laboratory.

1.3.17 Serial Dilution
A sample run at a specific dilution to determine whether any significant chemical or physical interferences exist due to sample matrix effects (ICP only).

1.3.18 Tentatively Identified Compounds
A compound that is not on the target compound list and is tentatively identified from search of the National Institute of Standards and Technology (NIST) (or equivalent) mass spectral library.
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2.0 REVIEW OF DATA FOR INORGANIC ANALYSES

This chapter of the procedure provides the method for reviewing data generated by the following inorganic methods:

- **Metals** analyzed by the inductively coupled plasma (ICP) method, EPA Method 6010A [EPA, 1986], Standard Methods 3120 [APHA, 1992], or EPA Test Method 200.7 [EPA, 1983]

- **Metals** analyzed by flame and graphite furnace atomic absorption (AA) spectroscopy, EPA Methods in the 7000 series [EPA, 1986], EPA 200 Series [EPA, 1983], or Standards Methods 3000 Series [APHA, 1992]

- **Mercury** analyzed by cold vapor AA spectroscopy, EPA Test Methods 7470 and 7471 [EPA, 1986], EPA Test Methods 245.1/245.5 [EPA, 1983], or Standard Method 3112B [APHA, 1992]

- **Cyanide** by titration or colorimetric methods, EPA Test Methods 9010A and 9012A [EPA, 1986], EPA Test Methods 335.1, 335.2 [EPA, 1983], or Standard Method 4500-CN Series C, D, E, and G [APHA, 1992]

- **Oil and grease** by gravimetric or extractive methods, EPA Test Methods 9070 and 9071A [EPA, 1986], or Standard Method 5520 [APHA, 1992]

- **Phenolics** by spectrophotometric and colorimetric methods, EPA Test Methods 9065A, 9066A, and 9067A [EPA, 1986], or Standard Methods 5530 and 6420 [APHA, 1992]

- **Chloride** by titration or colorimetric methods for soils and sediments, EPA Test Methods 9250A, 9251A, and 9252 [EPA, 1986] or by ion chromatography for aqueous samples by EPA Method 300.0 [EPA, 1983] or Standard Methods 4500-C-1, E, and F [APHA, 1992]

- **Nitrate and nitrite** by the colorimetric method EPA Test Method 9200 [EPA, 1986] for soils and sediments or EPA Methods 353.2 or 353.3 [EPA, 1983] for aqueous samples or Standard Method 4500 [APHA, 1992] Series


- **Sulfate** by colorimetric or turbidimetric methods, EPA Methods 9035A, 9036A, and 9038A [EPA, 1986] for soils and sediments or by ion chromatography EPA Method 300.0 [EPA, 1983] for aqueous samples or Standard Method 4500 Series [APHA, 1992]

- Other nationally recognized analytical procedures.
The DV3 evaluation for inorganic analyses requires a review of the following:

- Holding times
- Calibration
  - Initial
  - Initial and continuing calibration verification
- Blank data
- ICP interference check sample data
- Laboratory control sample data
- Duplicate sample data
- Matrix spike sample data
- Furnace AA quality control (QC)
- ICP serial dilution data
- Sample result verification
- Field duplicates data
- Overall quality of data

The DV3 evaluation form is included at the end of this chapter.

2.1 Holding Times and Preservation

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis.

2.1.1 Criteria

Technical requirements for sample holding times and preservation for inorganic analyses have only been established for water matrices and waste matrices undergoing hazardous waste analysis by the toxicity characteristic leaching procedure (TCLP). The following water-matrix holding time and preservation requirements were established under 40 CFR 136 (the Clean Water Act) and adopted for waste analysis in SW-846:

- Metals—6 months; preserved to pH less than 2 with nitric acid
- Mercury—28 days in glass container, 14 days in plastic container; preserved to pH less than 2 with nitric acid
- Cyanide—14 days; preserved to pH greater than 12 with sodium hydroxide
- Oil and Grease—28 days; preserved to pH less than 2 with sulfuric acid (extractive and gravimetric) or hydrochloric acid (gravimetric only)
- Phenolics—7 days to extraction and 40 days from extraction to analysis; preserved to pH less than 2 with sulfuric acid
• Chloride—28 days; no chemical preservation required

• Nitrates/Nitrites—28 days; preserved to pH less than 2 with sulfuric acid

• Sulfide—7 days, stored headspace free; zinc acetate added (the surface of solid samples must be moistened with zinc acetate in solution) and aqueous samples preserved to a pH greater than 9 with sodium hydroxide

• Sulfate—28 days; no chemical preservation required.

Samples must be maintained at 4 ± 3 degrees centigrade (°C) from collection to preparation for analysis.

The following hazardous waste holding time requirements were established under 40 CFR 261, Appendix II (TCLP):

• Metals
  - From collection to TCLP extraction, 180 days
  - From TCLP extraction to analysis, 180 days
  - Total holding time, 360 days

• Mercury
  - From collection to TCLP extraction, 28 days
  - From TCLP extraction to analysis, 28 days
  - Total holding time, 56 days

In accordance with 40 CFR 261, Appendix II, samples for hazardous waste evaluation using the TCLP method must not be chemically preserved but should be maintained at 4°C from collection through analysis.

2.1.2 Evaluation
Verify holding times by comparing the sampling date on the Sample Collection Log, or equivalent documentation, with the dates of analysis found in the laboratory raw data (digestion logs and instrument run logs).

\[
\text{Analyte Holding Time (Days)} = \text{Analysis Date} - \text{Sampling Date}
\]

Examine the digestion and/or distillation logs to determine if samples were preserved at the proper pH.
2.1.3 Action

If 40 CFR 136 criteria for holding times and preservation are not met for aqueous samples, qualify all results greater than instrument detection limit (IDL) as estimated (J) and results less than IDL as undetected, estimated (UJ).

If holding times are exceeded, the SNL/NM ER Task Leader must use professional judgment to determine the reliability of the data and the effects of additional storage on the sample results. The expected bias would be low and the Task Leader may determine the results less than IDL are unusable (R).

Due to limited information concerning holding times for soil samples, it must be stated in the project-specific QAP or sampling plan whether or not water holding-time criteria are to be applied to soil samples. If the data are qualified when water holding-time criteria are applied to soil samples, clearly document that in the review summary.

2.2 Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run and continuing calibration verification ensures that the initial calibration is still valid.

2.2.1 Criteria

2.2.1.1 Initial Calibration

Instruments and apparatus must be calibrated each time the instrument or apparatus is set up, daily, and at the intervals (specific to the method) listed below:

- ICP analysis
  - A blank and at least one standard (preferably three) must be used in establishing the calibration curve.
  - A midrange standard must be analyzed as an unknown.

- Atomic absorption analysis
  - A blank and at least three standards must be used in establishing the calibration curve.
- A midrange standard must be analyzed as an unknown.

- **Mercury analysis**
  - A blank and at least five standards must be used in establishing the calibration curve.
  - A midrange standard must be analyzed as an unknown.

- **Cyanide analysis**
  - A blank and at least six standards must be used in establishing the calibration curve for the colorimetric method.
  - A midrange standard must be analyzed as an unknown.
  - A high and low standard must be distilled and analyzed as unknowns. Results should be ±10 percent of the undistilled concentration.

- **Phenolics by spectrophotometric and colorimetric methods**
  - A blank and at least three standards must be used in establishing the calibration curve.
  - New standards and a new curve must be prepared every hour of continuous sample analysis for spectrophotometric methods and every 12 hours for the colorimetric method.
  - A midrange standard must be prepared and analyzed as an unknown.

- **Chloride by colorimetric methods only**—A blank and at least three standards must be used in establishing the calibration curve.

- **Nitrates and nitrites by colorimetric methods**
  - A blank and at least five standards must be used in establishing the calibration curve.
  - A new curve must be prepared for every sample batch.

- **Sulfate by colorimetric or turbidimetric methods**
  - A blank and three standards for colorimetric methods and five standards for the turbidimetric method must be used in establishing the calibration curve.
New standards and a new curve must be prepared every hour of continuous sample analysis for colorimetric methods and every 12 hours for the turbidimetric method.

2.2.1.2 Initial and Continuing Calibration Verification (ICV and CCV)
Calibration verification must be performed at the frequency given in the following table for the methods included. The verification must meet the criteria where listed.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Method Number</th>
<th>Frequency</th>
<th>SW-846 Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals (inductively coupled plasma)</td>
<td>6010A</td>
<td>Calibration check must be performed initially and after every 10 samples.</td>
<td>Percent Recovery (%R) must be 90-110 percent.</td>
</tr>
<tr>
<td>Metals including mercury (atomic absorption spectroscopy)</td>
<td>7000 series</td>
<td>Calibration check must be performed initially and after every 10 samples.</td>
<td>Percent Recovery (%R) must be 80-120 percent.</td>
</tr>
<tr>
<td>Sulfate (colorimetric)/Phenolics</td>
<td>9035A/9036A/9038A/9065A/9066A/9057A/9250A/9251A</td>
<td>Calibration check must be performed initially and after every 10 samples.</td>
<td>None specified.</td>
</tr>
<tr>
<td>Chloride (colorimetric, 2 methods)</td>
<td>9010A/9012A</td>
<td>Check standard must be run every sample batch.</td>
<td>Result must be within 15 percent of the expected value for the check standard.</td>
</tr>
<tr>
<td>Cyanide</td>
<td>9030/9070/9200/9252</td>
<td>Check standard must be run every 15 samples.</td>
<td>None specified.</td>
</tr>
</tbody>
</table>

2.2.2 Evaluation
Verify that the instrument was calibrated daily, each time the instrument was set up, and at the frequency required in the method. Verify that the correct number of standards and blanks were used. Verify that the check standard was analyzed as required by the method.

Check the distillation log, and verify that the midrange cyanide standard was distilled (or that all standards were distilled if sulfides are present).

Recalculate one or more ICV and CCV percent recovery (%R) per type of analysis (ICP, graphite furnace AA, etc.) using the following equation, and verify that the recalculated value agrees with the laboratory-reported values. Due to possible rounding discrepancies, allow results to fall within 1 percent of the windows (e.g., 89 to 111 percent).
\[
\%R = \frac{\text{Found}}{\text{True}} \times 100
\]

where,

\text{Found} = \text{Concentration of each analyte measured in the analysis of the ICV or CCV solution}

\text{True} = \text{Concentration of each analyte in the ICV or CCV source.}

2.2.3 Action

If the minimum number of standards as defined in Section 2.2.1 was not used for initial calibration, or if the instrument was not calibrated as required by the method (see requirements above), qualify the data as unusable (R).

Qualify results that are greater than IDL as estimated (J) and results that are less than IDL as estimated (UJ).

\textbf{Note:} For critical samples, further evaluation of the calibration curve may be warranted to determine if qualification is necessary.

If the midrange cyanide standard was not distilled, qualify all associated results as estimated (J).

If the ICV or CCV \%R falls outside the acceptance windows, use professional judgment to qualify all associated data. If possible, indicate the bias in the review. The following guidelines are recommended:

- Qualify results greater than IDL as estimated (J) if the ICV or CCV \%R falls within the ranges of:
  - 75 to 89 percent or 111 to 125 percent for ICP
  - 70 to 84 percent or 116 to 130 percent for cyanide
  - 65 to 79 percent or 121 to 135 percent for AA and mercury.

- Results less than IDL are acceptable if the ICV or CCV \%R is within the range of:
  - 111 to 125 percent for ICP
- 116 to 130 percent for cyanide
- 121 to 135 percent for AA and mercury.

- Qualify results less than IDL as estimated (UJ) if the ICV or CCV %R is:
  - 75 to 89 percent for ICP
  - 70 to 84 percent for cyanide
  - 65 to 79 percent for AA and mercury.

- Qualify all positive results as unusable (R) if the ICV or CCV %R is:
  - Less than 75 percent for ICP
  - Less than 70 percent for cyanide
  - Less than 65 percent for AA and mercury.

- Qualify results greater than IDL as unusable (R) if the ICV or CCV %R is:
  - Greater than 125 percent for ICP
  - Greater than 130 percent for cyanide
  - Greater than 135 percent for AA and mercury.

2.3 Blanks
The assessment of blank analysis results is to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks applies to any blank associated with the samples. If problems with any blank exist, all data associated with the project must be carefully evaluated to determine whether or not there is an inherent variability in the data for the project or if the problem is an isolated occurrence not affecting other data.

2.3.1 Criteria
One method blank must be analyzed per analytical batch or per every 20 samples, whichever is more frequent. No contaminants should be in the blank(s).

2.3.2 Evaluations
Review the results reported on the Blank Summary as well as the raw data (ICP printouts, strip charts, printer tapes, bench sheets, etc.) for all blanks and verify that the frequency of analysis was correct and results were accurately reported.
2.3.3 Action

Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. Sample results greater than IDL but less than 5 times the amount in any blank should be qualified as (U) (5X criterion).

Any blank with a negative result whose absolute value is greater than IDL must be carefully evaluated to determine relevance to the sample data.

**Note:** The blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. In particular, soil-sample results reported on forms will not be on the same basis (units, dilution) as the calibration blank data report on forms. The reviewer may find it easier to work from the raw data when applying 5X criterion to soil-sample data/calibration blank data.

In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

### 2.4 ICP Interference Check Sample

The ICP interference check sample (ICS) verifies the analytical laboratory's interelement and background correction factors.

#### 2.4.1 Criteria

An ICS must be run at the beginning and end of each sample analysis run (or a minimum of twice per 8-hour working shift, whichever is more frequent).

Results for the ICS analysis must fall within the control limits of ±20 percent of the true value.
2.4.2 Evaluation
Recalculate from the raw data (ICP printout) one or more of the percent recoveries (%R) using the following equation, and verify that the recalculated value agrees with the laboratory reported values.

\[
ICS \%R = \frac{\text{Found Solution AB}}{\text{True Solution AB}} \times 100
\]

where,

\[
\text{Found Solution AB} = \text{Concentration (in } \mu\text{g/L)} \text{ of each analyte measured in the analysis of Solution AB}
\]

\[
\text{True Solution AB} = \text{Concentration (in } \mu\text{g/L)} \text{ of each analyte in Solution AB.}
\]

Check ICS raw data for results with an absolute value greater than IDL for those analytes that are not present in the ICS solution.

2.4.3 Action
For samples with concentrations of aluminum, calcium, iron, and magnesium that are comparable to or greater than their respective levels in the ICS:

- If the ICS recovery for an element is greater than 120 percent and the sample results are less than IDL, the data are acceptable for use.

- If the ICS recovery for an element is greater than 120 percent and the sample results are greater than IDL, qualify the affected data as estimated (J).

- If the ICS recovery for an element falls between 50 and 79 percent and the sample results are greater than IDL, qualify the affected data as estimated (J).

- If sample results are less than IDL and the ICS recovery for that analyte falls within the range of 50 to 79 percent, the possibility of false negatives may exist. Qualify the data for these samples as estimated (UJ).

- If the ICS recovery for an element falls less than 50 percent, qualify the affected data as unusable (R).

Note: If possible, indicate the bias for the estimated results in the review.
If results greater than IDL are observed for elements that are not present in the ICS solution, the possibility of false positives exists. An evaluation of the associated sample data for the affected elements should be made. For samples with comparable or higher levels of interferents and with analyte concentrations that approximate those levels found in the ICS (false positives), qualify sample results greater than IDL as estimated (J).

If negative results are observed for elements that are not present in the ICS solutions and their absolute value is greater than IDL, the possibility of false negatives in the samples may exist. If the absolute value of the negative results is greater than IDL, an evaluation of the associated sample data should be made. For samples with comparable or higher levels of interferents, qualify results for the affected analytes less than IDL as estimated (UJ).

In general, the sample data can be accepted if the concentrations of aluminum, calcium, iron, and magnesium in the sample are found to be less than or equal to their respective concentrations in the ICS. If these elements are present at concentrations greater than the level in the ICS or other elements are present in the sample at greater than 10 mg/L, the reviewer should investigate the possibility of other interference effects by using Table 2 of EPA Method 6010. These analyte concentration equivalents presented in the table should be considered only as estimated values, since the exact value of any analytical system is instrument-specific. Therefore, estimate the concentration produced by an interfering element. If the estimate is greater than 10 percent of the reported concentration of the affected element, qualify the affected results as estimated (J).

2.5 Laboratory Control Sample (LCS)
The LCS serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation.

2.5.1 Criteria
Laboratory control samples shall be analyzed with every sample batch, such as 2 LCS every 20 or fewer samples.

All metal analyses LCS results must fall within the control limits of 80 to 120 %R.

All other inorganic analyte LCS results must fall within the control limits of 75 to 125 %R.
2.5.2 Evaluation

Review laboratory forms, and verify that results fall within the control limits.

Check the raw data (ICP printout, strip charts, bench sheets) to verify the reported recoveries. Recalculate one or more of the recoveries (%R) using the following equation:

\[ LCS \%R = \frac{LCS \text{ Found}}{LCS \text{ True}} \times 100 \]

where,

LCS Found = Concentration (in µg/L for aqueous, mg/kg for solid) of each analyte measured in the analysis of LCS solution

LCS True = Concentration (in µg/L for aqueous, mg/kg for solid) of each analyte in the LCS source.

2.5.3 Action

2.5.3.1 Metal Analytes LCS

- If the LCS recovery for any analyte falls within the range of 50 to 79 percent or greater than 120 percent, qualify results greater than IDL as estimated (J).
- If results are less than IDL and the LCS recovery is greater than 120 percent, the data are acceptable.
- If results are less than IDL and the LCS recovery falls within the range of 50 to 79 percent, qualify the data for the affected analytes as estimated (UJ).
- If LCS recovery results are less than 50 percent, qualify the data for these samples as unusable (R).

2.5.3.2 Other Inorganic Analytes LCS

- If the LCS recovery for any analyte falls within the range of 45 to 74 percent or greater than 125 percent, qualify all sample results greater than IDL as estimated (J).
• If the LCS results are greater than 125 percent and the sample results are less than IDL, the data are acceptable.

• If the LCS results fall within the range of 45 to 74 percent, qualify all sample results less than IDL as estimated (UJ).

• If LCS recovery results are less than 45 percent, qualify the data for those samples as unusable (R).

2.6 Duplicate Sample Analysis
Duplicate analyses are indicators of laboratory precision for each sample matrix. Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision; therefore, the results may have more variability than laboratory duplicates, which measure only laboratory performance. It is also expected that soil duplicate results will have a greater variance than water matrices, due to difficulties associated with collecting identical field samples.

2.6.1 Criteria
Samples identified as field blanks cannot be used for duplicate sample analysis.

For duplicate samples prepared at the analytical laboratory, a control limit of ± 20 percent for the relative percent difference (RPD) shall be used for samples analyzed for metals. A control limit of ± 25 percent for the RPD shall be used for samples analyzed for all other inorganic parameters.

For chloride analysis by titrimetric methods, every tenth sample must be run in duplicate.

For field duplicates, control limits should be specified in the project-specific QAP/P.

2.6.2 Evaluation
Review laboratory report and verify that results fall within the control limits.

Check the raw data, and recalculate one or more RPD using the following equation to verify that results have been correctly reported.
\[ RPD = \frac{|S-D|}{(S+D)/2} \times 100 \]

where,

\( S = \) First sample value (original)
\( D = \) Second sample value (duplicate).

Verify that a field blank was not used for duplicate analysis.

Samples that are field duplicates should be identified using Sample Collection Logs, or equivalent documentation, or sample field sheets. The reviewer should compare the results reported for each sample, calculate the RPD, and compare with the control limits specified in the project-specific sampling plan.

2.6.3 Action

If the RPD for a particular analyte falls outside the appropriate control windows, qualify the results for that analyte in all associated samples of the same matrix as estimated (J).

If the field blank was used for duplicate analysis, all other QC data must be carefully checked, and professional judgment must be exercised when evaluating the data.

Any evaluation of the field duplicates should be provided with the reviewer’s comments.

2.7 Matrix Spike Sample Analysis

The matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology.

2.7.1 Criteria

Samples identified as field blanks cannot be used for spiked sample analysis.

Spike recovery (\( \%R \)) must fall within the control limits of 75 to 125 percent. However, spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or more.
A control limit of ±20 percent for the RPD shall be applied to the spike and spike duplicate data results.

Matrix spikes must be analyzed at the frequencies given in the following table. If a method is not listed, the frequency is not specified in the procedure.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Method Number</th>
<th>Matrix Spike Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate and nitrite/Oil and grease (gravimetric method)</td>
<td>9200 9070</td>
<td>Run matrix spike every 10 samples.</td>
</tr>
<tr>
<td>Chloride (2 colorimetric and 2 titrimetric methods)</td>
<td>9250A/9251A/ 9252</td>
<td>Run matrix spike duplicates every analytical batch or every 20 samples, whichever is more frequent.</td>
</tr>
<tr>
<td>Cyanide (colorimetric and titrimetric methods)</td>
<td>9010A/9012A</td>
<td></td>
</tr>
<tr>
<td>Oil and grease (extractive method)</td>
<td>9071A</td>
<td></td>
</tr>
<tr>
<td>Phenolics (2 spectrophotometric and 1 colorimetric method)</td>
<td>9065A/9066A 9067A</td>
<td></td>
</tr>
<tr>
<td>Metals by ICP and AA (including mercury)</td>
<td>6010A/7000 series</td>
<td></td>
</tr>
<tr>
<td>Sulfate (2 colorimetric and 1 turbidimetric method)</td>
<td>9035A/9036A/ 9038A/</td>
<td></td>
</tr>
<tr>
<td>Sulfide (2 titrimetric methods)</td>
<td>9030A/9031</td>
<td></td>
</tr>
</tbody>
</table>

2.7.2 Evaluation
Review the laboratory report and verify that results fall within the specified limits.

Verify that a field blank was not used for spike analysis.

Check raw data and recalculate one or more %R using the following equation to verify that results were correctly reported.

$$\% R = \frac{(SSR - SR)}{SA} \times 100$$
where,

\[ \text{SSR} = \text{Spiked sample result} \]
\[ \text{SR} = \text{Sample result} \]
\[ \text{SA} = \text{Spike added}. \]

Check the raw data, and recalculate one or more RPD using the following equation to verify that results have been correctly reported.

\[ RPD = \frac{|S-D|}{(S+D)/2} \times 100 \]

where,

\[ S = \text{First sample value (matrix spike)} \]
\[ D = \text{Second sample value (matrix spike duplicate)}. \]

2.7.3 Action

2.7.3.1 Recovery

- If the spike recovery is greater than 125 percent, or less than 30 percent, and the reported sample results are less than IDL, the data are unacceptable for use (R).

- If the spike recovery is outside the 75 to 125 percent bracket and the sample results are greater than IDL, qualify the data for these samples as estimated (J).

- If the spike recovery falls within the range of 30 to 74 percent and the sample results are less than IDL, qualify the data for these samples as estimated (UJ).

- If the field blank was used for matrix spike analysis, all other QC data must be carefully checked, and professional judgment must be exercised when evaluating the data. Include this information on the evaluation form.

Note: If the matrix spike recovery does not meet criteria (except for silver), a postdigestion spike is required for all methods except furnace to determine if the analyte was lost during the sample digestion step. These data are not used to qualify sample results; however, this information must be included in the summary report.
2.7.3.2 Relative Percent Difference

- If matrix spike duplicate analysis results for a particular analyte fall outside the appropriate control windows, qualify the results for that analyte in all associated samples of the same matrix as estimated (J).

- If the field blank was used for matrix spike duplicate analysis, all other QC data must be carefully checked, and professional judgment must be exercised when evaluating the data.

2.8 Furnace Atomic Absorption Quality Control

Serial dilutions and furnace postdigestion spikes establish the precision and accuracy of the individual analytical determinations.

2.8.1 Criteria

If a matrix interference is suspected, a postdigestion spiked sample should be analyzed. Results of serial dilutions of both samples and spiked samples must agree within ±10 percent RPD, otherwise the method of standard addition (MSA) should be used to quantify analytes.

2.8.2 Evaluation

Check raw data to verify that serial dilutions agree within ±10 percent RPD.

Review data to verify that any samples for which serial dilution results were greater than 10 percent RPD were analyzed by MSA.

2.8.3 Action

If serial dilutions are outside the ±10 percent RPD limits and the sample has not been analyzed by MSA as required, qualify the data as estimated (J).

If any of the samples analyzed by MSA have not been spiked at the appropriate levels, qualify the data as estimated (J).

2.9 ICP Serial Dilution

Serial dilution determines whether significant physical or chemical interferences exist due to sample matrix.
2.9.1 Criteria
If the analyte concentration is sufficiently high (concentration in the original sample is minimally a factor of 10 above the IDL), an analysis of a 5-fold dilution must agree within 10 percent of the original results.

2.9.2 Evaluation
Check the raw data and recalculate the %D using the following equation to verify that the dilution analysis results agree with results reported.

\[
%D = \frac{|I-S|}{I} \times 100
\]

where,

\[
I = \text{initial sample result} \\
S = \text{Serial dilution result (Instrument Reading x 5)}
\]

Check the raw data for evidence of negative interference, i.e., results of the diluted sample are significantly higher than the original sample.

2.9.3 Action
When criteria are not met, qualify the associated data as estimated (J).

If evidence of negative interference is found, use professional judgment to qualify the data.

2.10 Sample Result Verification
The objective is to ensure that the reported quantitation results are accurate.

2.10.1 Criteria

- Analyte quantitation must be calculated according to the appropriate method. For sample quantitation using calibration curves, samples must be diluted if sample value is outside the linear dynamic calibration range of the instrument.
- For chlorine by titrimetric analysis using silver nitrate, a second sample must be analyzed at one-half dilution.
- The following method-specific criteria must be met:
- For nitrate/nitrite analysis of colored samples, one sample should be run without the brucine-sulfanilic acid reagent as an interference control sample.

- For sulfate analysis of colored samples by the turbidimetric method, one sample should be run without the barium chloride reagent as an interference control sample.

2.10.2 Evaluation
The raw data should be examined to verify the correct calculation of sample results reported by the laboratory. Digestion and distillation logs, instrument printouts, strip charts, etc., should be compared to the reported sample results.

Examine the raw data for any anomalies (i.e., baseline shifts, negative absorbances, omissions, legibility, etc.).

Verify that there are no transcription or reduction errors (e.g., dilutions, percent solids, sample weights) on one or more samples.

Verify that results fall within the linear range of the ICP and within the calibrated range for the non-ICP parameters.

Verify that sample results are greater than 5 times the ICP IDL if ICP analysis results are used for arsenic, thallium, selenium, or lead.

Note: When the laboratory provides both ICP and furnace results for an analyte in a sample and the concentration is greater than the ICP IDL, the results can assist in identifying quantitation problems.

For methods requiring calculations to obtain results, perform at least one calculation to verify the laboratory’s results.

2.10.3 Action
If there are any discrepancies found, the laboratory may be contacted by the SMO to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer may determine that qualification of the data is warranted.
2.11 Overall Assessment of Data for a Case

It is appropriate for the data reviewer to make professional judgments and express concerns and comments on the validity of the overall data for a project. This is particularly appropriate when there are several QC criteria out of specification. The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform the SNL/NM ER Task Leader concerning data quality and data limitations in order to assist the Task Leader in avoiding inappropriate use of the data, while not precluding any consideration of the data at all. If qualifiers other than those used in this document are necessary to describe or qualify the data, it is necessary to thoroughly document/explain the additional qualifiers used. The cover form and supplementary documentation must be included with the review.

2.12 Forms

This section provides the forms for validation of inorganic data. The forms are as follows:

2.12.1 Inorganic Data Assessment Summary Form

2.12.2 Inorganic Data Review Package

- Cover Page
- Holding Times Form
- Calibration Verification Form
- Blank Analysis Results Form
- ICP Interference Check Sample Analysis
- Laboratory Control Sample Form
- Laboratory Precision Evaluation Form
- Matrix Spike Results Form
- Standard Addition/Furnace AA Analysis Form
- Serial Dilution Results/ICP Analysis Form
- Field Precision Evaluation Form
INORGANIC DATA ASSESSMENT SUMMARY FORM  
(Data Verification/Validation Level 3—DV3)

SITE OR PROJECT __________________________  CASE NO. __________________________

ANALYTICAL LABORATORY ________________  SAMPLE IDS __________________________

LABORATORY REPORT # ____________________  __________________________

TASK LEADER ____________________________  __________________________

NO. OF SAMPLES __________________________  __________________________

DATA ASSESSMENT SUMMARY

<table>
<thead>
<tr>
<th></th>
<th>ICP</th>
<th>AA</th>
<th>MERCURY</th>
<th>CYANIDE</th>
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<tbody>
<tr>
<td>1.</td>
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✓ (check mark) — Acceptable
Other — Qualified:

J - Estimate
UJ - Undetected, estimated
R - Unusable (analyte may or may not be present)

ACTION ITEMS: ____________________________

AREAS OF CONCERN: ____________________________

REVIEWED BY: ____________________________

DATE REVIEWED: ____________________________
1.0 HOLDING TIMES

List holding time criteria used to evaluate samples, indicating which samples exceed the holding time. Holding time begins with validated time of sample collection.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Holding Time Criteria</th>
<th>Sample ID</th>
<th>Days Holding Time was Exceeded</th>
<th>Action</th>
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</table>

Were the correct preservatives used? Yes ☐ No ☐

List below samples that were incorrectly preserved.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Type of Samples</th>
<th>Deficiency</th>
<th>Action</th>
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</table>

Reviewed By: _____________________________ Date: _____________________________
2.0 INSTRUMENT CALIBRATION

2.1 Percent Recovery Criteria

Indicate %Recovery (%R) criteria used to evaluate calibration standards:

Metals: 
Mercury: 
Cyanide: 
Other: 

List below the analytes which did not meet %R criteria for initial and continuing calibration standards:

<table>
<thead>
<tr>
<th>Analysis Date</th>
<th>ICV/CCV #</th>
<th>Analyte</th>
<th>%R</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

2.2 Analytical Sequence

Did the laboratory use the proper number of standards for calibration as described in the EPA method? Yes ☐ No ☐

Have initial calibrations been performed at the beginning of each analysis and at the frequency indicated by the EPA method? Yes ☐ No ☐

Have continuing calibration standards been analyzed at the beginning of sample analysis and at a minimum frequency indicated by the EPA method and at the end of the analysis sequence? Yes ☐ No ☐

If no for any of the above, outline deviations and actions taken below:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Reviewed By: _____________________________ Date: _____________________________
Were the correlation coefficients for the calibration curves for AA, Hg, CN, and other spectrophotometric methods ≥0.995? (Check calculations performed for calibration curves.) Yes ☐ No ☐

If no, list: ___________________________

Check for transcription and calculation errors involving calibration summary forms and raw data. Briefly summarize errors and associated actions when data quality might have been affected.

3.0 BLANK ANALYSIS

3.1 Initial and Continuing Calibration Blanks

Have Initial and Continuing Calibration Blanks (ICB/CCB) been analyzed at the frequency required in the EPA method? Yes ☐ No ☐

If no, summarize problems and resolutions in the narrative report.

List analytes detected in ICB and CCBs below:

NOTE: For soil samples, convert blank values to mg/kg using digestion weights and volumes.
3.2 Method Blank

Was one method blank analyzed for:

- Each of 20 samples? Yes □ No □
- Each digestion batch? Yes □ No □
- Each matrix type? Yes □ No □
- Both AA and ICP when both are used for the same analyte? Yes □ No □
- or
- At the frequency indicated in the EPA method or QAP? Yes □ No □

**NOTE:** Method blank is the same as the calibration blank for mercury and for wet chemistry analysis.

List analytes detected in method blank samples below. **NOTE:** For soil samples, be sure to calculate blank values using digestion weights and volumes.

<table>
<thead>
<tr>
<th>Preparation Date</th>
<th>Analyte</th>
<th>Conc.</th>
<th>Required Detection Limits</th>
<th>Action Level</th>
<th>Samples Affected</th>
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</table>

Is concentration in the method blank below the detection limit? Yes □ No □

Affected samples:

- 
- 
- 
- 

Reviewed By: ____________________________ Date: ____________________________
3.3 Field/Rinse/Equipment Blanks

Was a field/equipment blank analyzed as required by the EPA method or QAPJP? Yes □ No □

List below analytes detected in the field blanks. NOTE: For soil samples, calculate blank values using digestion weights and volumes.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Conc.</th>
<th>Required Detection Limits</th>
<th>Action Level</th>
<th>Samples Affected</th>
</tr>
</thead>
</table>

4.0 ICP INTERFERENCE CHECK SAMPLE ANALYSIS

Was an ICP interference check sample (ICS) analyzed at the beginning and end of a run or at least twice every 8 hours? (Not required for Ca, Mg, K, and Na) Yes □ No □

Samples affected: ________________________________

Are the values of the ICS for solution AB within 80-120%? Yes □ No □

If no, is the concentration of Al, Ca, Fe, or Mg lower than in ICS? Yes □ No □
INORGANIC DATA ASSESSMENT SUMMARY FORM  
(Data Verification/Validation Level 3—DV3)

If no, list below all analytes which did not meet %R criteria and in which the concentration of Al, Ca, Fe, or Mg is higher than in the ICS:

<table>
<thead>
<tr>
<th>Date</th>
<th>Analyte</th>
<th>%R</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

Are any results > IDL for those analytes which are not present in the ICS solution A? Yes □ No □

If yes, results >2 (absolute value of the IDL) indicate either a positive or negative interference and must be qualified.

Samples affected: ____________________________________________________________

Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

5.0 LABORATORY CONTROL SAMPLES (LCS)

Was an LCS analyzed at required frequency? Yes □ No □

Samples affected: ____________________________________________________________

Reviewed By: ___________________________ Date: ___________________________
INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

List below any LCS recoveries not within limits.

<table>
<thead>
<tr>
<th>Preparation Date</th>
<th>Analyte</th>
<th>%R</th>
<th>Action</th>
<th>Samples Affected</th>
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6.0 LABORATORY DUPLICATE ANALYSIS

Were laboratory duplicates analyzed at required frequency? Yes □ No □

Samples affected: ________________________________________________________________

Was laboratory duplicate analysis performed on field or equipment blanks? Yes □ No □

Samples affected: ________________________________________________________________

Is any value for sample duplicate pair <PQL and the other value >10xPQL? Yes □ No □

Samples affected: ________________________________________________________________

Reviewed By: ___________________________ Date: ___________________________
List below concentrations of any analyte that did not meet criteria for duplicate precision:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Matrix</th>
<th>Preparation Date</th>
<th>Analyte</th>
<th>PQL</th>
<th>RPD</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

7.0 FIELD DUPLICATE SAMPLE ANALYSIS

Were field duplicates collected at the frequency indicated in the EPA method or QAPjP?
Yes □ No □

If yes, qualify data associated only with the field duplicate pair. Calculate RPDs for each analyte in which both values are greater than the IDL.

Is any value for sample duplicate < practical quantitation limit (PQL) and other value >10xPQL? Yes □ No □

Reviewed By: ____________________ Date: ____________________
INORGANIC DATA ASSESSMENT SUMMARY FORM  
(Data Verification/Validation Level 3—DV3)

List below the analytes that do not meet RPD or PQL criteria. Use the same criteria as those used for laboratory duplicate analysis or criteria specified in EPA method or sampling plan.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Matrix</th>
<th>Collection Date</th>
<th>RPD</th>
<th>Control Limit</th>
<th>Action</th>
<th>Samples Affected</th>
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Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

8.0 MATRIX SPIKE ANALYSIS

NOTE: This matrix spike is a predigestion/predistillation spike.

Was a matrix spike prepared and analyzed at the required frequency? Yes ☐  No ☐
INORGANIC DATA ASSESSMENT SUMMARY FORM  
(Data Verification/Validation Level 3—DV3)

Were matrix spikes performed at the concentrations specified by the EPA method?  Yes ☐ No ☐

Samples affected: ________________________________________________________________  

______________________________________________________________________________

Was matrix spike analysis performed on field or equipment blanks? Yes ☐ No ☐

If equipment or field blanks are the only aqueous samples, matrix spike analysis may be performed; however, matrix spike samples must be present for the other matrices.

Samples affected: ________________________________________________________________  

______________________________________________________________________________

List below the % recoveries for analytes that did not meet the criteria:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Matrix</th>
<th>Preparation Date</th>
<th>Analyte</th>
<th>%R</th>
<th>Action</th>
<th>Samples Affected</th>
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Check for transcription/calculation errors. Also check to ensure matrix spike concentrations are not affected by sample dilutions performed. If matrix spike concentrations are diluted below or close to IDL based on sample dilutions performed, use professional judgment in qualifying data. Ensure that the laboratory performed sample dilutions only when necessary as indicated by QA/QC requirements. Briefly summarize errors and associated actions when data quality might have been affected.

Reviewed By: ___________________________ Date: ___________________________
NOTE: If preparation blank spikes are analyzed, evaluate recoveries. These recoveries can indicate whether excursions in matrix spike recovery are caused by sample matrix effects or poor digestion efficiencies and/or problems with matrix spike solution. For example, if matrix spike recovery for selenium is 0% and preparation blank spike recovery for selenium is 92%, this may indicate sample matrix effects.

9.0 FURNACE ATOMIC ABSORPTION ANALYSIS

Were duplicate injections present for each sample, including required QC analyses (not required if MSA is done)? Yes ☐ No ☐

Samples affected: ____________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Were postdigestion spikes analyzed for samples, including QC samples? Yes ☐ No ☐

Were postdigestion spikes analyzed at the required concentration? Yes ☐ No ☐

Samples affected: ____________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Was a dilution analyzed for samples with postdigestion spike recovery <40%? Yes ☐ No ☐

Samples affected: ____________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

MSA Analysis (Method of Standard Additions)—MSA is required when serial dilutions are not with ±10%. Was MSA required for any sample but not performed? Yes ☐ No ☐

Are MSA calculations outside the linear range of the calibration curve? Yes ☐ No ☐

Reviewed By: ____________________________ Date: ____________________________

AU/2-94/NP/SNL:SOP3044C.R1
NOTE: Ensure the spiking concentrations used for MSA analysis were at 50–100% and 150% of sample concentration or absorbance.

Samples affected:

10.0 SERIAL DILUTION ANALYSIS

NOTE: Serial dilution analysis (ICP) is required only for initial concentrations equal to or greater than 10xIDL.

If applicable, was a serial dilution performed for:

- Each 20 samples? Yes □ No □
- Each matrix type? Yes □ No □

Samples affected:

List below results which did not meet criteria of %D <10% for analyte concentrations greater than 50xIDL before dilution:

<table>
<thead>
<tr>
<th>Analysis Date</th>
<th>Sample ID</th>
<th>Analyte</th>
<th>IDL</th>
<th>%D</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

Check for calculation errors and negative interferences.

Reviewed By: __________________ Date: __________________
11.0 SAMPLE RESULT VERIFICATION

11.1 Verification of Instrumental Parameters

Are instrument detection limits present and verified on a quarterly basis? Yes □ No □

Are IDLs present for each analyte and each instrument used? Yes □ No □

Is the IDL greater than the required detection limits for any analyte? Yes □ No □
(If IDL > required detection limits, flag values less than 5xIDL.)

Samples affected: ___________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Are ICP Interelement Correction Factors established and verified annually? Yes □ No □

Are ICP Linear Ranges established and verified quarterly? Yes □ No □

If no for any of the above, review problems and resolutions in narrative report. ______________________________
__________________________________________________________________________

11.2 Reporting Requirements

Were sample results reported down to the PQL? Yes □ No □

If no, indicate necessary corrections. _____________________________________________
__________________________________________________________________________

Were sample results that were analyzed by ICP for Se, Ti, As, or Pb at least 5xIDL? Yes □ No □

Were sample weights, volumes, and dilutions taken into account when reporting sample results and detection limits? Yes □ No □

Reviewed By: ___________________________ Date: _____________________________
INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

If no for any of the above, sample results may be inaccurate. Note necessary changes and if errors are present, request resubmittal of laboratory package.

Were any sample results higher than the linear range of calibration curve and not subsequently reanalyzed at the appropriate dilution?  Yes ☐ No ☐

Samples affected: __________________________________________________________

11.3 Sample Quantitation

Check a minimum of 10% of positive sample results for transcription/calculation errors. Summarize necessary corrections. If errors are large, request resubmittal of laboratory package.

Comments:

Approved By:* __________________________

Date: __________________________

*Task/Project Leader is responsible for approval of data set.

Reviewed By: __________________________ Date: __________________________
3.0 REVIEW OF ORGANIC ANALYSES DATA

This chapter of the procedure provides the method for reviewing data generated by the following methods of organic analyses:

- Gas chromatography/mass spectroscopy (GC/MS) for volatile organic compounds (VOC) by EPA Method 8240A (packed column) or 8250 (capillary column) and for semivolatile organic compounds (SVOC) by EPA Method 8270A (capillary column)
- Gas chromatography (GC) for pesticides (organochlorine) and polychlorinated biphenyls (PCB) by EPA Method 8080A and for herbicides (chlorinated) by EPA Method 8150A
- Column chromatography for total organic halogens (TOX) by EPA Method 9020A
- Neutron activation analysis for TOX by EPA Method 9022A
- Analysis using a carbonaceous analyzer for total organic carbon by EPA Method 9060A for soil and sediment samples or EPA Method 415.2 for aqueous samples.

The DV3 evaluation for organic analyses requires a review of the following:

- Holding times
- GC/MS instrument performance check
- Initial calibration
- Continuing calibration
- Blanks
- System monitoring compounds (surrogate spikes)
- Matrix spikes, matrix spike duplicates
- Laboratory control samples
- Internal standards
- Target compound identification
- Compound quantitation limits
- Tentatively identified compounds
- System performance
- Overall quality of data.

3.1 Holding Times and Sample Preservation

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis and based on the correct preservation of samples.

To review the holding times, collect the investigative sample data summary, the Sample
Collection Log, the Analysis Request and Chain of Custody Report, the raw data, and the sample delivery group (SDG) narrative.

3.1.1 Criteria
For most organic analyses, requirements for sample holding times have been established by the EPA for water, soil, and waste matrices and for samples undergoing hazardous waste analysis by TCLP. The holding times for TOX and TOC are established for a water matrix only. The holding times for other nonaqueous matrices, such as sediments, oily wastes, and sludge, are currently under investigation by the EPA. When the results are available, they will be incorporated into the data evaluation process. The project-specific QAPIP should state whether or not aqueous or soil holding times should be applied to other matrices.

Chemical sample preservation is only applicable to water matrices. Solids and other nonaqueous matrices, such as sediments, oily wastes, and sludge, need not be chemically preserved. All samples should be maintained at 4°C from collection through analysis.

The holding time criteria for samples except those undergoing TCLP, as stated in SW-846, are as follows:

- Maximum holding time for VOCs in cooled (4±2°C), acid-preserved (pH 2 or below) water samples, concentrated waste samples, and soils/sediment/sludge samples is 14 days from sample collection.
- For SVOCs, pesticides, PCBs, and herbicides in cooled (at 4°C) water samples, the maximum holding time is 7 days from sample collection to extraction and 40 days from sample extraction to analysis.
- For SVOCs, pesticides, PCBs, and herbicides in concentrated waste, soil, sediment, and sludge samples, the maximum holding time is 14 days from sample collection to extraction and 40 days from sample extraction to analysis.

The holding time criteria for water samples as stated in 40 CFR 136 (the Clean Water Act) are as follows:

- For TOX, the maximum holding time is 7 days from sample collection to extraction and 40 days from sample extraction to analysis.
- For TOC, the maximum holding time from sample collection to analysis is 28 days.
The holding time for organic samples for hazardous waste analysis are established in 40 CFR 261, Appendix II. The holding times are:

- From sample collection to TCLP extraction, the holding time for all organic compounds is 14 days.
- From TCLP extraction to preparative extraction (not applicable to VOCs), the holding time is 7 days.
- For SVOCs, pesticides, PCBs, and herbicides, from preparative extraction to analysis, the holding time is 40 days. For VOCs, from TCLP extraction to sample analysis, the holding time is 14 days.
- For mercury the holding time from sample collection to TCLP extraction is 28 days and 28 days from preparation extraction to determinative analysis.

The preservation requirements for aqueous samples, as stated in SW-846, are as follows:

- Samples for VOC analysis should be preserved to a pH of less than 2 with hydrochloric acid (HCl) or sulfuric acid (H₂SO₄) and if residual chlorine is present, with sodium thiosulfate (Na₂S₂O₃).
- No chemical preservation should be used in samples for SVOC, pesticide, PCB, and herbicide analysis except sodium thiosulfate if residual chlorine is present.
- No chemical preservation should be used with waste samples.
- Samples for either TOX or TOC analyses should be preserved to a pH less than 2 with sulfuric acid (HCl also may be used for TOC samples).
- Verify addition of Na₂S₂O₃ in field notes and correct pH from sample extraction sheets.

3.1.2 Evaluation

Holding times are established by comparing the sampling date on the Sample Collection Log (or equivalent documentation) with the date of extraction on the sample extraction sheets (if applicable), the date of analysis on the investigative sample summary forms. Information contained in the complete SDG file should also be considered in the determination of holding times.

Verify that the analysis dates on the investigative sample summary forms and the raw data/SDG file are identical.
Examine the sample records to determine if samples were preserved thermally or chemically, as appropriate. If adequate documentation on sample preservation is not available, contact the sampler. If the sampler cannot be contacted, then it must be assumed that the samples were unpreserved.

If there is no indication in the SDG narrative or the sample records of a problem with the samples (e.g., samples not maintained at 4°C or containing headspace in the container), then the integrity of samples can be assumed to be good. If it is indicated that there were problems with the samples, then the integrity of the sample may have been compromised, and professional judgment should be used to evaluate the effect of the problem on the sample results.

3.1.3 Action
If holding times are exceeded, document in the data review narrative that holding times were exceeded, and qualify the sample results as follows:

- **VOC Samples**
  - If there is no evidence that VOC samples were properly preserved and the holding times exceeded 14 days, qualify positive results as estimated (J) and sample quantitation limits as undetected, estimated (UJ).

- **SVOCs, Pesticides, PCBs, Herbicides, TOX, and TOC Samples**
  - If holding times are exceeded, flag all positive results as estimated (J) and sample quantitation limits as undetected, estimated (UJ), and document that holding times were exceeded.

If holding times are grossly exceeded (e.g., by greater than 2 times the required time for volatiles) either on the first analysis or upon reanalysis, the reviewer must use professional judgment to determine the reliability of the data and the effects of additional storage on the sample results. Should the reviewer determine that qualification is necessary, nondetected volatile target compounds may be qualified unusable (R). Positive results are considered approximations and are qualified as estimated (J).

Whenever possible, the reviewer should comment on the effect of the holding time exceedance on the resulting data in the data review narrative.
3.2 GC/MS Instrument Performance Check

GC/MS instrument performance checks (formerly referred to as tuning) are performed to ensure mass resolution, identification, and to some degree, sensitivity. These criteria are not sample-specific. Conformance is determined using standard materials; therefore, these criteria should be met in all circumstances. To review the instrument performance check, collect the bromofluorobenzene (BFB) mass spectra for VOCs and decafluorotriphenylphosphine (DFTPP) mass spectra for SVOCs and the mass listing for each analysis.

3.2.1 Criteria

The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples or standards are analyzed. The instrument performance check (VOC: BFB; SVOC: DFTPP) for GC/MS analyses must meet the ion abundance criteria given below.

3.2.1.1 Bromofluorobenzene

<table>
<thead>
<tr>
<th>MASS</th>
<th>ION ABUNDANCE CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>15.0 to 40.0 percent of mass 95</td>
</tr>
<tr>
<td>75</td>
<td>30.0 to 60.0 percent of mass 95</td>
</tr>
<tr>
<td>95</td>
<td>Base peak, 100 percent relative abundance</td>
</tr>
<tr>
<td>96</td>
<td>5.0 to 9.0 percent of mass 95</td>
</tr>
<tr>
<td>173</td>
<td>Less than 2.0 percent of mass 174</td>
</tr>
<tr>
<td>174</td>
<td>Greater than 50.0 percent of mass 95</td>
</tr>
<tr>
<td>175</td>
<td>5.0 to 9.0 percent of mass 174</td>
</tr>
<tr>
<td>176</td>
<td>95.0 to 101.0 percent, exclusive, of mass 174</td>
</tr>
<tr>
<td>177</td>
<td>5.0 to 9.0 percent of mass 176</td>
</tr>
</tbody>
</table>

**Note:** All ion abundances must be normalized to mass 95, the nominal base peak.

3.2.1.2 Decafluorotriphenylphosphine (DFTPP)

<table>
<thead>
<tr>
<th>MASS</th>
<th>ION ABUNDANCE CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>30.0 to 60.0 percent of mass 198</td>
</tr>
<tr>
<td>68</td>
<td>Less than 2.0 percent of mass 69</td>
</tr>
<tr>
<td>70</td>
<td>Less than 2.0 percent of mass 69</td>
</tr>
<tr>
<td>127</td>
<td>40.0 to 60.0 percent of mass 198</td>
</tr>
<tr>
<td>197</td>
<td>Less than 1.0 percent of mass 198</td>
</tr>
<tr>
<td>198</td>
<td>Base peak, 100 percent relative abundance</td>
</tr>
<tr>
<td>199</td>
<td>5.0 to 9.0 percent of mass 198</td>
</tr>
</tbody>
</table>
275  10.0 to 30.0 percent of mass 198
365  Greater than 1.0 percent of mass 198
441  Present, but less than mass 443
442  Greater than 40.0 percent of mass 198
443  17.0 to 23.0 percent of mass 442

Note: All ion abundances must be normalized to mass 198, the nominal base peak.

3.2.2 Evaluation

Compare the data presented on each Instrument Performance Check Form with each mass listing submitted to ensure the following:

- The Instrument Performance Check Form is present and completed for each 12-hour period during which samples were analyzed.
- The laboratory has not made transcription errors between the data and the form. If there are major differences between the mass listing and the forms, a more in-depth review of the data is required. This may include obtaining and reviewing additional information from the laboratory.
- The appropriate number of significant figures has been reported (number of significant figures given for each ion in the ion abundance criteria column) and that rounding is correct.
- The laboratory has not made calculation errors.

Verify from the raw data (mass spectral listing) that the mass assignment is correct, that the VOC mass listing is normalized to mass 95, and that the SVOC mass is normalized to mass 198.

Verify that the ion abundance criteria were met.

- VOC: The criteria for mass 173, 176, and 177 are calculated by normalizing to the specified mass.
- SVOC: The criteria for mass 68, 70, 441, and 443 are calculated by normalizing to the specified mass.

If possible, verify that spectra were generated using appropriate background subtraction techniques. Since the BFB and DFTPP spectra are obtained from chromatographic peaks that should be free from coelution problems, background subtraction should be done in accordance with the following procedure. Three scans (the peak apex scan and the scans
immediately preceding and following the apex) are acquired and averaged, and background subtraction must be accomplished using a single scan prior to the elution of BFB or DFTPP.

**Note:** All instrument conditions must be identical to those used in the sample analysis. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting the contract specifications are contrary to the quality assurance objectives and are therefore unacceptable.

### 3.2.3 Action

If the laboratory has made minor transcription errors that do not significantly affect the data, the data reviewer should make the necessary corrections on a copy of the form.

If the laboratory has failed to provide the correct forms or has made significant transcription or calculation errors, the SMO should contact the laboratory and request corrected data. If the information is not available, then the reviewer must use professional judgment to assess the data. The analytical laboratory’s designated contact person should be notified.

If mass assignment is in error (such as mass 96 is indicated as the base peak rather than mass 95), classify all associated data as unusable (R).

If ion abundance criteria are not met, professional judgment may be applied to determine to what extent the data may be utilized. Guidelines to aid in the application of professional judgment to this topic are discussed as follows:

- For VOCs, the most important factors to consider are the empirical results that are relatively insensitive to location on the chromatographic profile and the type of instrumentation. Therefore, the critical ion abundance criteria for BFB are the mass 95/96, 174/175, 174/176, and 176/177 ratios. The relative abundances of mass 50 and 75 are of lower importance.

- For SVOCs, some of the most critical factors in the DFTPP criteria are the noninstrument-specific requirements that are also not unduly affected by the location of the spectrum on the chromatographic profile. The mass ratios for 198/199 and 442/443 are critical. These ratios are based on the natural abundances of carbon-12 and carbon-13 and should always be met. Similarly, the relative abundances for mass 68, 79, 197, and 441 indicate the condition of the instrument and line suitability of the resolution adjustment and are very important. Note that all of the foregoing abundances relate to adjacent ions; they are relatively insensitive to differences in instrument design and position of the spectrum on the chromatographic profile.
• For SVOCs, for the ions at mass 51, 127, and 275, the actual relative abundance is not as critical. For instance, if mass 275 has 40 percent relative abundance (criteria: 10.0 to 30.0 percent) and other criteria are met, then the deficiency is minor.

• For SVOCs, the relative abundance of mass 365 is an indicator of suitable instrument zero adjustment. If relative abundance for mass 365 is zero, minimum detection limits may be affected. On the other hand, if mass 365 is present but less than the 1.0 percent minimum abundance criteria, the deficiency is not as serious.

Decisions to use analytical data associated with BFB or DFTPP instrument performance checks not meeting SW-846 method requirements should be clearly noted on the data review narrative.

If the reviewer has reason to believe that instrument performance check criteria were achieved using techniques other than those described in Section 3.2.2.4, additional information on the instrument performance checks should be obtained. If the techniques employed are found to be at variance with the method or laboratory’s quality assurance plan requirements, the performance and procedures of the laboratory may merit evaluation. Concerns or questions regarding laboratory performance should be noted for action. For example, if the reviewer has reason to believe that an inappropriate technique was used to obtain background subtraction (such as background subtracting from the solvent front or from another region of the chromatogram rather than the BFB peak), this should be noted for action.

3.3 Initial Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for compounds on the method list. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. To review the initial calibration data, obtain the initial calibration forms, quantitation reports, and chromatogram.

3.3.1 Criteria

For both GC and GC/MS analyses, initial calibration standards containing both target organic compounds and system monitoring (surrogate) compounds are analyzed at five concentrations at the beginning of each analytical sequence or as necessary if the continuing calibration acceptance criteria (Section 3.4) are not met. The lowest concentration must be near but
above the method detection limit, and the other concentrations must span the range of the
instrument. The initial calibration (and any associated samples and blanks) must be analyzed
within 12 hours of the associated instrument performance check.

For GC/MS systems, initial calibration standard response factors (RRFs) for system monitoring
compounds (surrogates) must be greater than or equal to 0.05 for SVOCs and 0.30 for VOCs
(except bromoform, which must be greater than or equal to 0.25).

For GC/MS systems, the percent relative standard deviation (%RSD) from the initial calibration
must be less than or equal to 30 percent for all compounds.

For GC systems, if the %RSD is less than 20, linearity can be assumed, and the average
response factor can be used rather than a calibration curve.

TOX by EPA Method 9020A or 9022A:

- The purity of each carbon batch must be verified; the batch must contain less
  than 1,000 nanograms of chloride per 40 milligrams of carbon.
- Each time the carbon is replaced, the column must be calibrated in duplicate.
  The net recovery must be within 5 percent of the standard.
- The repeatability of the method background must be established daily using at
  least two blanks.
- Calibration blank and standard net response must be within 3 percent of the
  standards' values.
- For EPA Method 9022A (using neutron activation), the detector must be
  calibrated using a radioactive standard, which must fall within one channel of the
  true energy.

For TOC by EPA Method 9060A, the analyzer must be calibrated using a series of standards
that encompass the expected range of sample values.

3.3.2 Evaluation

Verify that the correct concentrations and concentration span of standards were used for the
initial calibration.
If any sample results were calculated using an initial calibration, verify that the correct standard (i.e., the 50 µg/L standard) was used for calculating sample results and that the samples were analyzed within 12 hours of the associated instrument performance check.

Evaluate the initial calibration RRFs and average RRF for all target compounds and system monitoring compounds (surrogates):

- Check and recalculate the RRFs and average RRF for at least one target compound associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).
- Verify that, for all target VOCs and SVOCs and associated system monitoring compounds (surrogates), the initial calibration RRFs are greater than or equal to the values given in Section 3.3.1.

For GC/MS systems, evaluate the %RSD for all target VOCs and SVOCs and associated system monitoring compounds (surrogates):

- Check and recalculate the %RSD for one or more target compound(s); verify that the recalculated value(s) agrees with the laboratory reported value(s).
- Verify that all target compounds have a %RSD of less than or equal to 30.0 percent.
- If the %RSD is greater than 30.0 percent, then the reviewer should use professional judgment to determine the need to check the points on the curve for the cause of the nonlinearity. This is checked by eliminating either the high point or the low point and recalculating the %RSD.

If errors are detected in the calculations of either the RRFs or the %RSD, perform a more comprehensive recalculation.

For GC analyses in which the average RF was used rather than the calibration curve, verify that it was the appropriate action:

- Recalculate the %RSD to verify that it was less than 20 percent.
- Recalculate the calibration factor for one analyte using the following:
3.3.2.1 TOX Analyses

- Verify that the carbon purity of the batch was determined.
- Verify that the repeatability of the method background was determined daily.
- For analysis using neutron activation (EPA Method 9022A), verify that the detector was calibrated using a NIST traceable radioactive standard.

3.3.3 Action

All GC/MS analyses will be qualified using the following criteria:

1. If the %RSD is greater than 30.0 percent and all initial calibration RRFs are greater than or equal to the values given in Section 3.3.1, qualify positive results as estimated (J) and nondetected target compounds using professional judgment.

2. If any initial calibration RRF is less than the values given in Section 3.3.1, qualify positive results that have acceptable mass spectral identification as estimated (J), using professional judgment, and nondetected analytes as unusable (R).

For all GC analyses, if the calibration factor was used when the calibration curve should have been used, qualify positive results as estimated (J) and nondetected target compounds as undetected, estimated (UJ).

At the reviewer's discretion, a more in-depth review to minimize the qualification of data can be accomplished by considering the following:

- For GC/MS analyses, if any of the required compounds have a %RSD greater than 30.0 percent and if eliminating either the high or the low point of the curve does not restore the %RSD to less than or equal to 30.0 percent:
  - Qualify positive results for that compound(s) as estimated (J)
  - Qualify nondetected volatile target compounds based on professional judgment.

- For all organic analyses, if the high point of the curve is outside of the linearity criteria (e.g., due to saturation):
  - No qualifiers are required for positive results in the linear portion of the curve.
- Qualify positive results outside of the linear portion of the curve as estimated (J).
- No qualifiers are needed for volatile target compounds that were not detected.
- For all organic analyses, if the low end of the curve is outside of the linearity criteria:
  - No qualifiers are required for positive results in the linear portion of the curve.
  - Qualify low-level positive results in the area of nonlinearity as estimated (J).
  - Qualify nondetected volatile target compounds based on professional judgment.

If the laboratory has failed to provide adequate calibration information, the SMO should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgment to assess the data.

Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

If calibration criteria are grossly exceeded, this should be noted for laboratory action.

3.4 Continuing Calibration and Retention Time Windows
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data. Continuing calibration establishes the 12-hour relative response factors on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis. For review of the continuing calibration data, collect calibration summary forms, quantitation reports, and chromatograms.

3.4.1 Criteria

3.4.1.1 Continuing Calibration
Continuing calibration standards containing both target compounds and system monitoring compounds (surrogates) are analyzed at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of the method blank and samples.
For GC, a mid-range GC continuing calibration standard is analyzed every 10 samples. For VOC and SVOC analyses by GC/MS, a mid-level standard is run every 12 hours. For TOX analyses, a mid-range check standard is run every 8 samples. For TOC analyses, a mid-range check standard is not specified.

The continuing calibration RRF for GC/MS system monitoring compounds (surrogates) must be greater than or equal to 0.05 for SVOCs and 0.30 for VOCs (except bromoform which must be greater than or equal to 0.25).

The percent difference (%D) between the initial calibration and the continuing calibration must be within the following:

- For GC/MS VOC analyses—±25.0 percent
- For GC/MS SVOC analyses—±30.0 percent
- For all other GC analyses—±15 percent.

3.4.1.2 Retention Time Windows
Daily retention time windows must be established for each analyte to be determined by gas chromatography. A window is the absolute retention time of the calibration standard as the midpoint, ± 3 times the standard deviation determined during the initial setup of the instrument.

Mid-point standards must be analyzed throughout the analysis sequence and must fall within the window.

3.4.1.3 Neutron Flux
For TOX by neutron activation (EPA Method 9022A), a mid-range standard must be run with every sample batch to monitor neutron flux.

3.4.2 Evaluation

3.4.2.1 Continuing Calibration
Verify that the continuing calibration was run at the required frequency and that the continuing calibration was compared to the correct initial calibration.

Evaluate the continuing calibration results for all target compounds and system monitoring compounds:
• Check and recalculate the continuing calibration value for at least one target compound associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

• Verify that all target compounds and system monitoring compounds meet the specifications.

Evaluate the %D between initial calibration average results and continuing calibration results for one or more compound(s).

• Check and recalculate the %D for one or more target compound(s) associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

• Verify that the %D is within the limits given in Section 3.4.1.1 for all target compounds and system monitoring compounds. Note those compounds that have a %D outside the criterion.

If errors are detected in the calculations of either the continuing calibration value or the %D, perform a more comprehensive recalculation.

3.4.2.2 Retention Time Windows
Verify that retention time windows have been established daily.

Verify that all succeeding standards in the analysis sequence fall within the daily window.

3.4.3 Action
The reviewer should use professional judgment to determine if it is necessary to qualify the data for any target compound. If qualification of data is required, it should be performed using the following guidelines:

• GC/MS Analyses
  - If the %D is outside the criterion and the continuing calibration RRF is greater than or equal to the criteria in Section 3.4.1.1, qualify positive results as estimated (J).
  - If the %D is outside the criterion and the continuing calibration RRF is greater than or equal to the criteria in Section 3.4.1.1, qualify nondetected volatile target compounds undetected, estimated (UJ).
- If the continuing calibration RRF is less than the criteria in Section 3.4.1.1, qualify positive results that have acceptable mass spectral identifications as estimated (J) or use professional judgment.

- If the continuing calibration RRF is less than the criteria in Section 3.4.1.1, qualify nondetected target compounds as unusable (R).

- For GC Analyses
  - If the %D for standard analysis is greater than 15 percent on the quantitation column or greater than 20 percent on the confirmation column, qualify all associated positive samples as estimated (J).
  - If standards do not fall within the retention time windows, professional judgment should be used in the evaluation of associated sample results.

If the laboratory has failed to provide adequate calibration information, the SMO should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgment to assess the data.

Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

If calibration criteria are grossly exceeded, this should be noted for laboratory action.

3.5 Blanks
The purpose of laboratory (or field) blank analysis is to determine the essence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples (e.g., method blanks, instrument blanks, trip blanks, and equipment blanks). If problems with any blank exist, all associated data must be carefully evaluated to determine whether or not there is an inherent variability in the data or if the problem is an isolated occurrence not affecting other data. To review blank data, collect the investigative sample summary form, the method blank summary form, chromatograms, and quantitation reports.

3.5.1 Criteria
No contaminants should be found in the blanks above the PQLs.
A method blank analysis must be performed after the calibration standards and at the following frequencies:

- For TOC, GC, and GC/MS analyses, once per 20 samples or once per sample (extraction) batch
- For TOX analysis, once every 8 samples
- For TOX analysis by neutron activation, a 100-second blank to verify that there are no stray radioactive sources near the instrument detector.

For GC and GC/MS systems, an instrument blank should be analyzed after any sample that has a high concentration of a given compound to check that the blank is free of interference and the system is not contaminated.

3.5.2 Evaluation
Review the results of all associated blanks on the forms and raw data (chromatogram and quantitation reports) to evaluate the presence of target and nontarget compounds in the blanks.

Verify that a method blank analysis has been reported per matrix, per concentration level, at the frequency given in Section 3.5.1. The reviewer can use the method blank summary form to identify the samples associated with each method blank.

Verify that the instrument blank analysis has been performed following any sample analysis where a target analyte(s) is reported at high concentration(s).

3.5.3 Action
If the appropriate blanks were not analyzed with the frequency described above, the data reviewer should use professional judgment to determine if the associated sample data should be qualified. The reviewer may need to obtain additional information from the laboratory. The situation should be noted for laboratory action.

Action regarding unsuitable blank results depends on the circumstances and origin of the blank. Positive sample results should be reported, unless the concentration of the compound in the sample is less than or equal to 10 times the amount in any blank for the common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and phthalates) (10X criterion) or 5 times the amount for other volatile target compounds (5X criterion). In
instances where more than one blank is associated with a given sample, qualification should be based upon a comparison, with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

Specific actions are described in the following subsections.

If a compound is found in a blank but not found in the sample, no action is taken. If the contaminants found are target compounds (or interfering nontarget compounds) at significant concentrations above the quantitation limit, this should be noted for laboratory action.

Any target compound detected in the sample (other than the common volatile laboratory contaminants) that was also detected in any associated blank is qualified if the sample concentration is less than 5 times the blank concentration. The quantitation limit may also be elevated. Typically, the sample quantitation limit is elevated to the concentration found in the sample. The reviewer should use professional judgment to determine if further elevation of the quantitation limit is required. For the common laboratory contaminants, the results are qualified undetected (U) by elevating the quantitation limit to the concentration found in the sample when the sample concentration is less than 10 times the blank concentration.

The reviewer should note that blanks may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5X and 10X criteria, such that a comparison of the total amount of contamination is actually made.

Additionally, there may be instances where little or no contamination was present in the associated blanks, but qualification of the sample is deemed necessary. If the reviewer determines that the contamination is from a source other than the sample, he/she should qualify the data. Contamination introduced through dilution water is one example. Although it is not always possible to determine, instances of this occurring can be detected when contaminants are found in the diluted sample result but are absent in the undiluted sample result. Since both results are not routinely reported, it may be impossible to verify this source of contamination. In this case, the 5X or 10X criteria may not apply; the target compound should be reported as not detected, and an explanation of the data qualification should be provided in the data review narrative.
If gross contamination exists (e.g., saturated peaks by GC/MS), all affected compounds in the associated samples should be qualified as unusable (R) due to interference. This should be noted for laboratory action if the contamination is suspected of having an effect on the sample results.

If inordinate numbers of other target compounds are found at low levels in the blank(s), it may be indicative of a problem and should be noted for laboratory action.

The same consideration given to the target compounds should also be given to tentatively identified compounds (TICs), which are found in both the sample and associated blank(s). (See Chapter 3.12 for TIC guidance.)

If an instrument blank was not analyzed following a sample analysis that contained an analyte(s) at high concentration(s), sample analysis results after the high-concentration sample must be evaluated for carry-over. Professional judgment should be used to determine if instrument cross-contamination has affected any positive compound identification(s). If instrument cross-contamination is suggested, it should be noted for laboratory action, if the cross-contamination is suspected of having an effect on the sample results.

3.6 System Monitoring Compounds (Surrogate Spikes)
Laboratory performance on individual samples is established by means of spiking activities. Samples analyzed by GC and GC/MS are spiked with system monitoring compounds (also referred to as surrogates) prior to sample analysis. The evaluation of the results of these system monitoring compounds is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the evaluation and review of data based on specific sample results is frequently subjective and demands analytical experience and professional judgment. Accordingly, this section consists primarily of guidelines, in some cases with several optional approaches suggested. To review system monitoring (surrogate) compound analyses, collect system monitoring summary forms, quantitation reports, and chromatogram.

3.6.1 Criteria
The following system monitoring compounds are required to be added to all samples and blanks to measure their recovery in investigative sample and blank matrices:
• Three volatile system monitoring compounds: 1,2-dichloroethane-$d_4$, 4-bromofluorobenzene, and toluene-$d_8$

• Six semivolatile system monitoring compounds (three acid compounds and three base/neutral compounds): nitrobenzene-$d_5$; 2-fluorobiphenyl; p-terphenyl-$d_{14}$; phenol-$d_6$; 2-fluorophenol; and 2,4,6-tribromophenol

• Two pesticide/PCB system monitoring compounds: decachlorobiphenyl and 2,4,5,6-tetrachloro-m-xylene

• One or two (unspecified in method) herbicide system monitoring compounds, which should not be deuterated analogs.

Recoveries for system monitoring compounds (surrogates) analyzed by GC must be within laboratory-established control limits. For GC/MS analyses, system monitoring compounds in investigative samples and blanks must be within the limits specified in Table 3-1 in Section 3.15.

3.6.2 Evaluation
Check raw data (e.g., chromatogram and quantitation reports) to verify the recoveries on the System Monitoring Compound Recovery Form. Check for any calculation or transcription errors.

Check that the system monitoring compound (surrogate) recoveries were calculated correctly. The equation can be found in the appropriate SW-846 Method.

The following should be determined from the System Monitoring Compound (Surrogate) Recovery Form(s):

• If any system monitoring (surrogate) compound(s) is out of specification, there should be a reanalysis to confirm that the noncompliance is due to sample matrix effects rather than laboratory deficiencies.

  **Note:** When there are unacceptable system monitoring compound (surrogate) recoveries followed by successful reanalyses, the laboratories are required to report only the successful run.

• Verify that medium soils were first reextracted prior to reanalysis when this occurs.
• Verify that no blanks have system monitoring compounds (or surrogate) outside the criteria.

Any time there are two or more analyses for a particular sample, the reviewer must determine which are the best data to report. Considerations should include, but are not limited to:

• System monitoring compound (surrogate) recovery (marginal versus gross deviation)
• Holding times
• Comparison of the values of the target compounds reported in each sample analysis
• Other QC information, such as performance of internal standards.

3.6.3 Action
Data are qualified based on system monitoring compounds (surrogate) results if the recovery of an system monitoring compound (surrogate) is out of specification. For system monitoring compound (surrogate) recoveries out of specification, the following approaches are suggested based on a review of all data from the package, especially considering the apparent complexity of the sample matrix. The table at the end of this section summarizes the guidelines.

If a system monitoring compound (surrogate) has a recovery greater than the upper acceptance limit (UL):

• For SVOCs only, specify the fraction that is being qualified, (i.e., acid, base/neutral, or both).
• Detected target compounds are qualified as estimated (J).
• Results for nondetected target compounds should not be qualified.

If a system monitoring compound (surrogate) has a recovery greater than or equal to 10 percent but less than the lower acceptance limit (LL):

• For SVOCs only, specify the fraction that is being qualified (i.e., acid, base/neutral, or both).
• Detected target compounds are qualified as estimated (J).
For nondetected target compounds, the sample quantitation limit is qualified as undetected, estimated (UJ).

If a system monitoring compound (surrogate) shows less than 10 percent recovery:

- For SVOCs only, specify the fraction that is being qualified (i.e., acid, base/neutral, or both).
- Detected target compounds are qualified as estimated (J).
- Nondetected target compounds may be qualified as unusable (R).

In the special case of a blank analysis with system monitoring compounds (surrogate) out of specification, the review must give special consideration to the validity of associated sample data. The basic concern is whether the blank problems represent an isolated problem with the blank alone or whether there is a fundamental problem with the analytical process. For example, if one or more samples in the batch show acceptable system monitoring compound (surrogate) recoveries, the reviewer may choose to consider the blank problem to be an isolated occurrence. However, even if this judgment allows some use of the affected data, analytical problems should be noted for laboratory action. Also note if there are potential contractual problems associated with the lack of reanalysis of samples that were out of specification.

Whenever possible, potential effects of the data resulting from system monitoring recoveries not meeting the advisory limits should be noted in the data review narrative.

**Qualification of Analytes Based on System Monitoring Compound (Surrogate) Recoveries**

<table>
<thead>
<tr>
<th>Surrogate Recovery</th>
<th>greater than UL</th>
<th>10% to LL</th>
<th>less than 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detected analytes</td>
<td>J</td>
<td>J</td>
<td>J</td>
</tr>
<tr>
<td>Nondetected analytes</td>
<td>No Qualification</td>
<td>UJ</td>
<td>R</td>
</tr>
</tbody>
</table>
3.7 Matrix Spikes/Matrix Spike Duplicates

Data for MS/MSD are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. These data alone cannot be used to evaluate the precision and accuracy of individual samples. However, when exercising professional judgment, this data should be used in conjunction with other available QC information. To evaluate MS/MSD data, collect the MS and MSD data summary forms, chromatograms, and quantitation reports.

3.7.1 Criteria

MS and MSD samples are analyzed a frequency of 1 MS and 1 MSD per 20 samples for GC and GC/MS analyses and 1 per sample batch for TOX and TOC analyses. For samples analyzed for hazardous waste characterization by TCLP, one MS must be analyzed for each waste type at a minimum of one per analytical batch.

Spike recoveries and RPD should be within the advisory limits provided in the QAPJP.

3.7.2 Evaluation

Verify that MS and MSD samples were analyzed at the required frequency and that results are provided for each sample matrix.

Inspect results for the MS/MSD recovery and RPD on the summary forms, and verify that the results are within the advisory limits.

Verify transcriptions from raw data, and verify calculations.

Check that the MS/MSD recoveries and RPD were calculated correctly.

3.7.3 Action

No action is taken on MS/MSD data alone. However, using informed professional judgment, the data reviewer may use the MS and MSD results in conjunction with other QC criteria and determine the need for some qualification of the data.

The data reviewer should first try to determine to what extent the results of the MS/MSD affect the associated data. This determination should be made with regard to the MS/MSD sample itself, as well as for specific analytes for all samples associated with the MS/MSD.
In those instances where it can be determined that the results of the MS/MSD affect only the sample spiked, qualification should be limited to this sample alone. However, it may be determined through the MS/MSD results that a laboratory is having a systematic problem in the analysis of one or more analytes, which affects all associated samples.

The reviewer must use professional judgment to determine the need for qualification of positive results of nonspiked compounds.

Note: If a field blank was used for the MS/MSD, a statement to that effect must be included for the laboratory.

3.8 Laboratory Control Samples

Data for LCS are generated to provide information on the accuracy and precision of the analytical method and on the laboratory performance. The requirements given in this chapter are in accordance with the SNL/NM ER Program QAPjP and deviate from the requirements of SW-846 in the number of analytes in the control sample for VOCs and SVOCs. In addition, SW-846 methods require that four QC samples be analyzed rather than the two specified below. To review the LCS data, collect the laboratory’s control limits for LCS precision and bias, LCS summary form, LCS chromatograms, and quantitation reports.

3.8.1 Criteria

An LCS must be analyzed once per SDG and concurrently with the samples in the SDG.

The LCS for VOC analysis should contain the following compounds, in addition to the required surrogate:

- Vinyl chloride
- 1,2-Dichloroethane
- Carbon tetrachloride
- 1,2-Dichloropropane
- Trichloroethene
- 1,1,2-Trichloroethane
- Benzene
- cis-1,3-Dichloropropene
- Bromoform
- Tetrachloroethene
- 1,2-Dibromoethane
- 1,4-Dichlorobenzene.
The LCS for SVOC analysis should contain the following (or equivalent) in addition to the required surrogates:

- Phenol
- 2-Chlorophenol
- 4-Chloroaniline
- 2,4,6-Trichlorophenol
- bis(2-Chloroethyl)ether
- Nitroso-di-n-propylamine
- Hexachloroethane
- Isophorone
- Trichlorobenzene
- Naphthlene
- 2,4-Dinitrotoluene
- Diethylphthalate
- N-Nitrodiphenylamine
- Hexachlorobenzene
- Benzo(a)pyrene.

The LCS for pesticide/PCB analysis should contain the following (or equivalent) in addition to the required surrogates:

- 4,4'-DDD
- Endosulfan II
- Endrin
- 4,4'-DDT
- Endosulfan sulfate
- Another single-component pesticide.

If the method is only to be used to analyze for PCBs, chlordane, or toxaphene, the LCS must contain the most representative multicomponent parameter.

The LCS for herbicide analysis should contain all analytes detected by the method in addition to the required surrogates. These analytes are the following:

- 2,4-D
- 2,4-DB
- Dichlorprop
- MCPA
- 2,4,5-T
- Dalapon
- Dicamba
- Dinoseb
• MCPP
• 2,4,5-TP.

Precision and bias acceptance limits for LCS will be established by the analytical laboratory based on historical data and will be documented in the laboratory's quality assurance plan. LCS acceptance is based on these limits. The criteria for surrogate recovery and internal standard performance also apply.

3.8.2 Evaluation
Verify that LCS samples were used at the required frequency and that results are provided for each SDG.

Inspect results on the LCS Recovery Form, and verify that the results for recovery and RPD are within the laboratory QC limits.

Verify transcriptions from raw data, and verify calculations.

Check that the LCS recovery was calculated accurately and that the correct equation was used.

3.8.3 Action
If the LCS criteria are not met, then the laboratory performance and method accuracy are in question. Professional judgment should be used to determine if the data should be qualified or rejected. The following guidance is suggested for qualifying sample data for which the associated LCS recovery does not meet the required criteria.

Action on the LCS recovery should be based on the number of compounds that are outside of the recovery criteria, the magnitude of the exceedance of the criteria, and the laboratory quality assurance program requirements.

If the LCS recovery criteria are not met, the LCS results should be used to qualify sample data for the specific compounds that are included in the LCS solution. Professional judgment should be used to qualify data for compounds other than those compounds that are included in the LCS. Professional judgment to qualify non-LCS compounds should take into account the compound class, compound recovery efficiency, analytical problems associated with each
compound, and comparability in performance of the LCS compound to the non-LCS compound.

If the LCS recovery is greater than 140 percent, positive sample results for the affected compound(s) should be qualified as estimated (J).

If the mass spectral criteria are met but the LCS recovery is less than 60 percent, the associated detected target compounds should be qualified as estimated (J), and the associated nondetected target compounds should be qualified unusable (R).

If more than half of the compounds in the LCS are not within the required recovery criteria, all of the associated detected target compounds should be qualified unusable (R).

Action on noncompliant surrogate recovery and internal standard performance should follow the procedures provided in Sections 3.6 and 3.10, respectively. Professional judgment should be used to evaluate the impact that noncompliance for surrogate recovery and internal standard performance in the LCS has on the associated sample data.

It should be noted for laboratory action if a laboratory fails to analyze an LCS with each SDG or if a laboratory consistently fails to generate acceptable LCS recoveries.

3.9 Internal Standards
Internal standards performance criteria ensures that GC and GC/MS sensitivity and response are stable during each analysis. The use of internal standards is optional for GC methods (EPA Methods 8080A and 8150A) but required for GC/MS systems. To review internal standard data, collect the Internal Standard Area Summary, quantitation reports, and chromatograms.

3.9.1 Criteria
The criteria in the discussion below are given for GC/MS systems only. GC criteria are not established and therefore cannot be included.

The internal standards for VOC analysis are:

- Bromochloromethane
- 1,4-difluorobenzene
- Chlorobenzene-$d_5$. 
The internal standards for SVOC analysis are:

- 1,4-Dichlorobenzene-$d_4$
- Naphthalene-$d_8$
- Acenaphthene-$d_{10}$
- Phenanthrene-$d_{10}$
- Chrysene-$d_{12}$
- Perylene-$d_{12}$

Equivalent surrogate standards exhibiting similar chromatographic nature may be substituted in both VOC and SVOC analyses. Internal standard area counts must not vary by more than a factor of two (-50 to +100 percent) from the associated calibration standard.

The retention time of the internal standard must not vary more than ±30 seconds from the retention time of the associated calibration standard.

3.9.2 Evaluation

Check raw data (e.g., chromatograms and quantitation lists) to verify the internal standard retention times and areas reported on the Internal Standard Area Summary.

Verify that all retention times and internal standard areas are within criteria.

If there are two analyses for a particular fraction, the reviewer must determine which are the best data to report. Considerations should include:

- Magnitude and direction of the internal standard area shift
- Magnitude and direction of the internal standard retention time shift
- Holding times
- Comparison of the values of the target compounds reported in each fraction
- Other QC.

3.9.3 Action

If an internal standard area count for a sample or blank is outside -50 or +100 percent of the area for the associated standard:

- Positive results for compounds quantitated using that internal standard should be qualified as estimated (J).
- Nondetected compounds quantitated using an internal standard area count greater than 100 percent should not be qualified.
Nondetected compounds quantitated using an internal standard area count less than 50 percent are reported as the associated sample quantitation limit and qualified undetected, estimated (UJ).

If extremely low area counts are reported or if performance exhibits a major abrupt drop-off, a severe loss of sensitivity is indicated. Undetected target compounds should then be qualified as unusable (R).

If an internal standard retention time varies by more than 30 seconds, the chromatographic profile for that sample must be examined to determine if any false positives or negatives exist. For shifts of a large magnitude, the reviewer may consider partial or total rejection of the data for that sample fraction. Positive results should not need to be qualified as unusable (R) if the mass spectral criteria are met.

If the internal standards performance criteria are grossly exceeded, this should be noted for laboratory action. Potential effects on the data resulting from unacceptable internal standard performance should be noted in the data review narrative.

3.10 Target Compound Identification
The objective of the criteria for qualitative analysis is to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not) or a false negative (not reporting a compound that is present). To review the target compound identification data, collect the sample summary forms, quantitation reports, mass spectra (if appropriate), and chromatograms.

The identification criteria can be applied more easily in detecting false positives than false negatives. More information is available for false positives due to the requirement for submittal of data supporting positive identifications. Negatives, or nondetected compounds, on the other hand represent an absence of data and are, therefore, more difficult to assess. One example of detecting false negatives is not reporting a target compound that is reported as a TIC.

3.10.1 Criteria

3.10.1.1 Gas Chromatography

- The peak from the sample extract must fall within the daily retention time window.
• Confirmation analysis by a second GC with alternate detector or by MS analysis if available.

• Standards must fall within the daily window (see Section 3.4).

3.10.1.2 Mass Spectroscopy

• The relative retention times (RRTs) must be within ± 0.06 RRT units of the standard RRT.

• Mass spectra of the sample compound and a current laboratory-generated standard (i.e., the mass spectrum from the associated calibration standard) must match according to the following criteria:

  - All ions present in the standard mass spectrum at a relative intensity greater than 10 percent must be present in the sample spectrum.

  - The relative intensities of these ions must agree within ± 20 percent between the standard and sample spectra. (Example: For an ion with an abundance of 50 percent in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70 percent.)

  - Ions present at greater than 10 percent in the sample spectrum but not present in the standard spectrum must be considered and accounted for.

3.10.1.3 EPA Method 8080 for Pesticides/Polychlorinated Biphenyls

Endrin and DDT are easily degraded in the gas chromatograph injection port if there is a buildup of residue. The percentage of endrin and DDT breakdown must be less than 20 percent.

Second column confirmation must be used if compound identification is ambiguous.

3.10.2 Evaluation

3.10.2.1 Gas Chromatography

• Check that all peaks that are identified fall within the daily retention time windows established for that analyte.

• Check that the continuing calibration standard analyzed with that sample for the analyte identified falls within the same window.
• Check that a confirmation GC or MS analysis has been performed and that it agrees with the identification.

• Check the chromatogram to verify that peaks are accounted for, i.e., major peaks are either identified as target compounds, system monitoring compounds surrogate, or internal standards.

3.10.2.2 Mass Spectroscopy

• Check that the RRT of reported compounds is within ± 0.06 RRT units of the standard RRT.

• Check the sample compound spectra against the laboratory standard spectra to see that it meets the specified criteria.

3.10.2.3 EPA Method 8080 for Pesticides/Polychlorinated Biphenyls

• Check that a mid-concentration standard containing only 4,4"-DDT and endrin has been analyzed prior to running the samples and that the percent breakdown of endrin and DDT have been calculated.

• Verify calculations of breakdown.

The reviewer should be aware of situations (e.g., high concentration samples preceding low concentration samples) when sample carry-over is a possibility and should use judgment to determine if instrument cross-contamination has affected any positive complete identification. The EPA methods specify that an instrument blank must be run after samples containing high levels of a target analyte.

3.10.3 Action

The application of qualitative criteria for GC and GC/MS analysis of target compounds requires professional judgment. It is up to the reviewer's discretion to obtain additional information from the laboratory. If it is determined that incorrect identifications were made, all such data should be qualified as not detected (U) or unusable (R).

Professional judgment must be used to qualify the data if it is determined that cross-contamination has occurred.
Any changes made to the reported compounds or concerns regarding target compound identifications should be clearly indicated in the data review narrative. The necessity for numerous or significant changes should be noted for laboratory action.

3.11 Compound Quantitation and Reported Quantitation Limits

The objective is to ensure that the reported quantitation results and quantitation limits are accurate. To review the quantitation results and reported limits, collect the sample summary form, sample preparation sheets, SDG narrative, quantitation reports, and chromatograms.

3.11.1 Criteria

Compound quantitation, as well as the adjustment of the quantitation limits, must be calculated according to the correct equation. For TOGs, carbonate and bicarbonate (inorganic carbons) must be removed physically during the sample preparation or must be accounted for in the final calculations.

Compound RRFs must be calculated based on the internal standard associated with that compound for packed column analyses. For analyses performed by capillary column method (EPA Method 8260), the target compounds will not necessarily be associated with the same internal standard as in the packed column method, depending on the compound elution order. For mass spectroscopy methods, quantitation must be based on the quantitation ion (mass) specified in the EPA Method employed for both the internal standard and target analytes. The compound quantitation must be based on the RRF from the appropriate daily standard.

TOX by column chromatography should be analyzed in duplicate and TOG shall be analyzed in quadruplicate.

For TOX by column chromatography, the second column measurements should not exceed 10 percent of the two-column total measurement.

3.11.2 Evaluation

For all fractions, raw data should be examined to verify the correct calculation of all sample results reported by the laboratory. Quantitation lists and chromatogram should be compared to the reported positive sample results and quantitation limits. Check the reported values.

Verify that the correct internal standard, quantitation ion, and RRF were used to quantitate the compound. Verify that the same internal standard, quantitation ion, and RRF are used.
consistently throughout, in both the calibration as well as the quantitation process. For analyses performed by capillary column, the reviewer should use professional judgment to determine that the laboratory has selected the appropriate internal standard.

Verify that the quantitation limits have been adjusted to reflect all sample dilutions and dry weight factors that are not accounted for by the method.

3.11.3 Action
If any discrepancies are found, the laboratory may be contacted by the SMO to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer must use professional judgment to decide which value is the best value. Under these circumstances, the reviewer may determine qualification of data is warranted. A description of the reasons for data qualification and the qualification that is applied to the data should be documented in the data review narrative.

Numerous or significant failures to accurately quantify the target compound or to properly evaluate and adjust quantitation limits should be noted for laboratory action.

3.12 Tentatively Identified Compounds
Chromatographic peaks in volatile and semivolatile fraction analyses by GC/MS that are not target analytes, system monitoring (surrogate) compounds, or internal standard are potential TICs. TICs must be qualitatively identified by a NIST mass spectral library search and the identifications assessed by the data reviewer. To evaluate the TIC report, collect the Organic Analyses Data Sheet, the chromatograms, library search printout, and spectra for three TIC candidates.

3.12.1 Criteria
If required by the SNL/NM ER Program project-specific QAPjP, the laboratory must conduct a mass spectral search of the NIST library and report the possible identity for the 10 largest volatile and semivolatile fraction peaks that are not system monitoring (surrogate) compounds, internal standards, or target compounds, but which have area or height greater than 10 percent of the area or height of the nearest internal standard. TIC results are reported for each sample on the Organic Analyses Data Sheet.
3.12.2 Evaluation

Guidelines for tentative identification are as follows:

- Major ions (greater than 10 percent relative intensity) in the reference spectrum should be present in the sample spectrum.

- The relative intensities of the major ions should agree within ±20 percent between the sample and the reference spectra.

- Molecular ions present in the reference spectrum should be present in the sample spectrum.

- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination, interference, or coelution of additional TIC or target compounds.

- When the above criteria are not met, but in the technical judgment of the data reviewer or mass spectral interpretation specialist the identification is correct, the data reviewer may report the identification.

- If in the data reviewer’s judgment the identification is uncertain or there are extenuating factors affecting compound identifications, the TIC result may be reported as unknown.

Check the raw data to verify that the laboratory has generated a library search for all required peaks in the chromatogram for samples and blanks.

Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level nontarget compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of the blank chromatogram may require looking for peaks that are less than 10 percent of the internal standard height but present in the blank chromatogram at a similar relative retention time.

All mass spectra for every sample and blank must be examined.

Since TIC library searches often yield several candidate compounds having a close matching score, all reasonable choices must be considered.
The reviewer should be aware of common laboratory artifacts/contaminants and their sources (e.g., aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs. Examples are:

- Common laboratory contaminants: Ar (mass 40), CO₂ (mass 44), siloxanes (mass 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluorotrichloromethane), and phthalates at levels less than 100 µg/L or 4000 µg/Kg.

- Solvent preservatives such as cyclohexene which is a methylene chloride preservative. Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

- Aldol condensation reaction products of acetone include: 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

Occasionally, a target compound may be identified in the proper analytical fraction by nontarget library search procedures, even though it was not found on the quantitation list. If the total area quantitation method was used, the reviewer should request that the laboratory recalculate the result using the proper quantitation ion. In addition, the reviewer should evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine whether the false negative result is an isolated occurrence or whether additional data may be affected.

Target compounds could be identified in more than one fraction. Verify that quantitation is made from the proper fraction.

Library searches should not be performed on internal standards or system monitoring (surrogate) compounds.

TIC concentration should be estimated assuming a RRF of 1.0.

3.12.3 Action

All TIC results should be qualified tentatively identified (NJ), with approximated concentrations.

General actions related to the review of TIC results are as follows:
• If it is determined that a tentative identification of a nontarget compound is not acceptable, the tentative identification should be changed to unknown or an appropriate identification.

• If all requested peaks were not library searched and quantitated, the SMO should request these data from the laboratory.

TIC results that are not sufficiently above 10 times the level in the blank should not be reported. (Dilutions and sample size must be taken into account when comparing the amounts present in blanks and samples.)

When a compound is not found in any blanks, but is a suspected artifact of a common laboratory contaminant, the result may be qualified as unusable (R).

In deciding whether a library search result for a TIC represents a reasonable identification, professional judgment must be exercised. If there is more than one possible match, the result may be reported as either compound X or compound Y. If there is a lack of isomer specificity, the TIC result may be changed to a nonspecific isomer result (e.g., 1,3,5-trimethyl benzene to trimethyl benzene isomer) or to a compound class (e.g., 2-methyl, 3-ethyl benzene to substituted aromatic compound).

The reviewer may elect to report all similar compounds as a total (e.g., all alkanes may be summarized and reported as total hydrocarbons).

Other case factors may influence TIC judgments. If a sample TIC match is poor, but other samples have a TIC with a good library match, similar relative retention time, and the same ions, identification information may be inferred from the other sample TIC results.

Physical constants such as boiling point may be factored into professional judgment of TIC results.

Any changes made to the reported data or any concerns regarding TIC identifications should be indicated in the data review narrative.

Failure to properly evaluate and report TICs should be noted for laboratory action.
3.13 System Performance
During the period following instrument performance QC checks (e.g. blanks, tuning, calibration), changes may occur in the system that degrade the quality of the data. While this degradation would not be directly shown by QC checks until the next required series of analytical QC runs, a thorough review of the ongoing data acquisition can yield indicators of instrument performance.

3.13.1 Criteria
There are no specific criteria for system performance. Professional judgment should be applied to assess the system performance.

3.13.2 Evaluation
Abrupt, discrete shifts in the reconstructed ion chromatogram (RIC) baseline may indicate a change in the instrument's sensitivity or the zero setting. A baseline shift could indicate a decrease in sensitivity in the instrument or an increase in the instrument zero, possibly causing target compounds, at or near the detection limit, to miss detection. A baseline shift could indicate problems such as a change in the instrument zero, a leak, or degradation of the column.

Poor chromatographic performance affects both qualitative and quantitative results. Indications of substandard performance include:

- High RIC background levels or shifts in absolute retention times of internal standards.
- Excessive baseline rise at elevated temperature.
- Extraneous peaks.
- Loss of resolution.
- Peak tailing or peak splitting that may result in inaccurate quantitation.

3.13.3 Action
Professional judgment must be used to qualify the data if it is determined that system performance has degraded during sample analyses. Any degradation of system performance which significantly affected the data should be documented for laboratory action.
3.14 Overall Assessment of Data

The overall assessment of a data package is a brief narrative in which the data reviewer expresses concerns and comments on the quality and, if possible, the useability of the data. To evaluate the data, collect the entire data package, data review results, and (if available) the project-specific QAPjP and sampling plan.

3.14.1 Criteria

Assess the overall quality of the data. Review all available materials to assess the overall quality of the data, keeping in mind the additive nature of analytical problems.

3.14.2 Evaluation

Evaluate any technical problems that have not been previously addressed. If appropriate information is available, the reviewer may assess the useability of the data to assist the data user in avoiding inappropriate use of the data. Review all available information, including the project-specific QAPjP (specifically the data quality objectives), sampling plan, and communication with data user that concerns the intended use and desired quality of these data.

3.14.3 Action

Use professional judgment to determine if there is any need to qualify data that were not qualified based on the QC criteria previously discussed. Write a brief narrative to give the user an indication of the analytical limitations of the data. Any inconsistency of the data with the SDG narrative should be noted for laboratory action. If sufficient information on the intended use and required quality of the data are available, the reviewer should include his/her assessment of the useability of the data within the given context.

3.15 Tables

This section provides tables for use in validating organic data. The tables are as follow:
3.15.1 Surrogate Spike Recovery Limits for Sample Data

3.15.2 Quality Control Acceptance Criteria for Sample Data from Volatile Organic Analysis by U.S. EPA Method 8240A

3.15.3 Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by U.S. EPA Method 8270

3.15.4 Quality Control Acceptance Criteria for Sample Data from Organochlorine Pesticide and PCB Analysis by U.S. EPA Method 8080

3.15.5 Quality Control Acceptance Criteria for Sample Data from Chlorinated Herbicide Analysis by U.S. EPA Method 8150A
### Table 3-1
Surrogate Spike Recovery Limits for Sample Data

<table>
<thead>
<tr>
<th>Surrogate Compound</th>
<th>Low/High Water Samples (% Recovery)</th>
<th>Low/High Soil/Sediment Samples (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volatile Organic Compound Analysis by EPA Method 8240A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Bromofluorobenzene</td>
<td>86-115</td>
<td>74-121</td>
</tr>
<tr>
<td>1,2-Dichloroethane-d&lt;sub&gt;4&lt;/sub&gt;</td>
<td>75-114</td>
<td>70-121</td>
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<tr>
<td>Toluene-d&lt;sub&gt;8&lt;/sub&gt;</td>
<td>88-110</td>
<td>81-117</td>
</tr>
<tr>
<td><strong>Semivolatile Organic Compound Analysis by EPA Method 8270A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrobenzene-d&lt;sub&gt;5&lt;/sub&gt;</td>
<td>35-114</td>
<td>23-120</td>
</tr>
<tr>
<td>2-Fluorobiphenyl</td>
<td>43-116</td>
<td>30-115</td>
</tr>
<tr>
<td>p-Terphenyl-d&lt;sub&gt;14&lt;/sub&gt;</td>
<td>33-141</td>
<td>18-137</td>
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<tr>
<td>Phenol-d&lt;sub&gt;6&lt;/sub&gt;</td>
<td>10-94</td>
<td>24-113</td>
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<tr>
<td>2-Fluorophenol</td>
<td>21-100</td>
<td>25-121</td>
</tr>
<tr>
<td>2,4,6-Tribromophenol</td>
<td>10-123</td>
<td>19-122</td>
</tr>
</tbody>
</table>

Table 3-2
Quality Control Acceptance Criteria for Sample Data from Volatile
Organic Analysis by U.S. EPA Method 8240A\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^c$ (µg/L)</th>
<th>Range for $x^d$ (µg/L)</th>
<th>Range for $p^e$ (%) Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>6.9</td>
<td>15.2-26.0</td>
<td>37-151</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>6.4</td>
<td>10.1-28.0</td>
<td>35-155</td>
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<td>Bromoforin</td>
<td>5.4</td>
<td>11.4-31.1</td>
<td>45-169</td>
</tr>
<tr>
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<td>\textsuperscript{d}61-41.2</td>
<td>D-242</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>5.2</td>
<td>17.2-23.5</td>
<td>70-140</td>
</tr>
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<td>Chlorobenzene</td>
<td>6.3</td>
<td>16.4-27.4</td>
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<td>D-50.4</td>
<td>D-305</td>
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<td>Chloroform</td>
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<td>13.7-24.2</td>
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<td>D-45.9</td>
<td>D-273</td>
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<td>13.8-26.6</td>
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<td>11.8-34.7</td>
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<td>17.0-28.8</td>
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<td>14.2-28.4</td>
<td>59-155</td>
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<td>14.3-27.4</td>
<td>49-155</td>
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<td>3.7-42.3</td>
<td>D-234</td>
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<td>13.6-28.4</td>
<td>54-156</td>
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<td>1,2-Dichloropropane</td>
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<td>3.8-36.2</td>
<td>D-210</td>
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<td>1.0-39.0</td>
<td>D-227</td>
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<tr>
<td>trans-1,3-Dichloropropene</td>
<td>10.4</td>
<td>7.6-32.4</td>
<td>17-183</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>7.5</td>
<td>17.4-25.7</td>
<td>37-162</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>7.4</td>
<td>D-41.0</td>
<td>D-221</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>7.4</td>
<td>13.5-27.2</td>
<td>46-157</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>5.0</td>
<td>17.0-25.6</td>
<td>54-148</td>
</tr>
<tr>
<td>Toluene</td>
<td>4.8</td>
<td>16.6-26.7</td>
<td>47-150</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>4.6</td>
<td>13.7-30.1</td>
<td>52-162</td>
</tr>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>5.5</td>
<td>14.3-27.1</td>
<td>52-150</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>6.6</td>
<td>18.5-27.6</td>
<td>71-157</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^c$ ($\mu$g/L)</th>
<th>Range for $x^d$ ($\mu$g/L)</th>
<th>Range for $p^e$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichlorofluoromethane</td>
<td>10.0</td>
<td>8.9-31.5</td>
<td>17-181</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>20.0</td>
<td>D-43.5</td>
<td>D-251</td>
</tr>
</tbody>
</table>

\(^a\)EPA, 1987.
\(^b\)Based on analysis of a quality control reference sample that contains 20 micrograms per liter (µg/L) of each analyte.
\(^c\)\(s\) = Standard deviation of four recovery measurements, in µg/L.
\(^d\)\(x\) = Average of four recovery measurements, in µg/L.
\(^e\)\(p\) = Percent recovery measured.
\(^f\)\(D\) = Detected; result must be greater than zero.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for s (^c) (µg/L)</th>
<th>Range for x (^d) (µg/L)</th>
<th>Range for p (^e) (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>27.6</td>
<td>60.1-132.3</td>
<td>47-145</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>40.2</td>
<td>53.5-126.0</td>
<td>33-145</td>
</tr>
<tr>
<td>Aldrin</td>
<td>39.0</td>
<td>7.2-152.2</td>
<td>D-166</td>
</tr>
<tr>
<td>Anthracene</td>
<td>32.0</td>
<td>43.4-118.0</td>
<td>27-133</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>27.6</td>
<td>41.8-133.0</td>
<td>33-143</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>38.8</td>
<td>42.0-140.4</td>
<td>24-159</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>32.3</td>
<td>25.2-145.7</td>
<td>11-162</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>39.0</td>
<td>31.7-148.0</td>
<td>17-163</td>
</tr>
<tr>
<td>Benzo(ghi)perylene</td>
<td>58.9</td>
<td>D-195.0</td>
<td>D-219</td>
</tr>
<tr>
<td>Benzy1 butyl phthalate</td>
<td>23.4</td>
<td>D-139.9</td>
<td>D-152</td>
</tr>
<tr>
<td>β-BHC</td>
<td>31.5</td>
<td>41.5-130.6</td>
<td>24-149</td>
</tr>
<tr>
<td>δ-BHC</td>
<td>21.6</td>
<td>D-100.0</td>
<td>D-110</td>
</tr>
<tr>
<td>Bis(2-chloroethyl)ether</td>
<td>55.0</td>
<td>42.9-126.0</td>
<td>12-158</td>
</tr>
<tr>
<td>Bis(2-chloroethoxy)methane</td>
<td>34.5</td>
<td>49.2-164.7</td>
<td>33-184</td>
</tr>
<tr>
<td>Bis(2-chloroisopropyl)ether</td>
<td>45.3</td>
<td>62.8-138.6</td>
<td>36-166</td>
</tr>
<tr>
<td>Bis(2-ethylhexyl)phthalate</td>
<td>41.1</td>
<td>28.9-136.8</td>
<td>8-158</td>
</tr>
<tr>
<td>4-Bromophenyl phenyl ether</td>
<td>23.0</td>
<td>64.9-114.4</td>
<td>53-127</td>
</tr>
<tr>
<td>2-Chloronaphthalene</td>
<td>13.0</td>
<td>64.5-113.5</td>
<td>60-118</td>
</tr>
<tr>
<td>4-Chlorophenyl phenyl ether</td>
<td>33.4</td>
<td>38.4-144.7</td>
<td>25-158</td>
</tr>
<tr>
<td>Chrysene</td>
<td>48.3</td>
<td>44.1-139.9</td>
<td>17-168</td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>31.0</td>
<td>D-134.5</td>
<td>D-145</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>32.0</td>
<td>19.2-119.7</td>
<td>4-136</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>61.6</td>
<td>D-170.6</td>
<td>D-203</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>70.0</td>
<td>D-199.7</td>
<td>D-227</td>
</tr>
<tr>
<td>Di-n-butyl phthalate</td>
<td>16.7</td>
<td>8.4-111.0</td>
<td>1-118</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>30.9</td>
<td>48.6-112.0</td>
<td>32-129</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>41.7</td>
<td>16.7-153.9</td>
<td>D-172</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>32.1</td>
<td>37.3-105.7</td>
<td>20-124</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^c$ (µg/L)</th>
<th>Range for $x^{3d}$ (µg/L)</th>
<th>Range for $p^e$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,3'-Dichlorobenzidine</td>
<td>71.4</td>
<td>8.2-212.5</td>
<td>D-262</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>30.7</td>
<td>44.3-119.3</td>
<td>29-136</td>
</tr>
<tr>
<td>Diethyl phthalate</td>
<td>26.5</td>
<td>D-100.0</td>
<td>D-114</td>
</tr>
<tr>
<td>Dimethyl phthalate</td>
<td>23.2</td>
<td>D-100.0</td>
<td>D-112</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>21.8</td>
<td>47.5-126.9</td>
<td>39-139</td>
</tr>
<tr>
<td>2,6-Dinitrotoluene</td>
<td>29.6</td>
<td>68.1-136.7</td>
<td>50-158</td>
</tr>
<tr>
<td>Di-n-octylphthalate</td>
<td>31.4</td>
<td>18.6-131.8</td>
<td>4-146</td>
</tr>
<tr>
<td>Endosulfan sulfate</td>
<td>16.7</td>
<td>D-103.5</td>
<td>D-107</td>
</tr>
<tr>
<td>Endrin aldehyde</td>
<td>32.5</td>
<td>D-188.8</td>
<td>D-209</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>32.8</td>
<td>42.9-121.3</td>
<td>26-137</td>
</tr>
<tr>
<td>Fluorene</td>
<td>20.7</td>
<td>71.6-108.4</td>
<td>59-121</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>37.2</td>
<td>D-172.2</td>
<td>D-192</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>54.7</td>
<td>70.9-109.4</td>
<td>26-155</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>24.9</td>
<td>7.8-141.5</td>
<td>D-152</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>26.3</td>
<td>37.8-102.2</td>
<td>24-116</td>
</tr>
<tr>
<td>Hexachloroethane</td>
<td>24.5</td>
<td>55.2-100.0</td>
<td>40-113</td>
</tr>
<tr>
<td>Indeno(1,2,3-cd)pyrene</td>
<td>44.6</td>
<td>D-150.9</td>
<td>D-171</td>
</tr>
<tr>
<td>Isophorone</td>
<td>63.3</td>
<td>46.6-180.2</td>
<td>21-196</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>30.1</td>
<td>35.6-119.6</td>
<td>21-133</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>39.3</td>
<td>54.3-157.6</td>
<td>35-180</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table 3-3 (Continued)
Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by U.S. EPA Method 8270a,b

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for s(^c) (µg/L)</th>
<th>Range for (x)^d (µg/L)</th>
<th>Range for (p^e) (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Nitrosodi-n-propylamine</td>
<td>55.4</td>
<td>13.6-197.9</td>
<td>D-230</td>
</tr>
<tr>
<td>PCB-1260</td>
<td>54.2</td>
<td>19.3-121.0</td>
<td>D-164</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>20.6</td>
<td>65.2-108.7</td>
<td>54-120</td>
</tr>
<tr>
<td>Pyrene</td>
<td>25.2</td>
<td>69.6-100.0</td>
<td>52-115</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>28.1</td>
<td>57.3-129.2</td>
<td>44-142</td>
</tr>
<tr>
<td>4-Chloro-3-methylphenol</td>
<td>37.2</td>
<td>40.8-127.9</td>
<td>22-147</td>
</tr>
<tr>
<td>2-Chlorophenol</td>
<td>28.7</td>
<td>36.2-120.4</td>
<td>23-134</td>
</tr>
<tr>
<td>2,4-Chlorophenol</td>
<td>26.4</td>
<td>52.5-121.7</td>
<td>39-135</td>
</tr>
<tr>
<td>2,4-Dimethylphenol</td>
<td>26.1</td>
<td>41.8-109.0</td>
<td>32-119</td>
</tr>
<tr>
<td>2,4-Dinitrophenol</td>
<td>49.8</td>
<td>D-172.9</td>
<td>D-191</td>
</tr>
<tr>
<td>2-Methyl-4,6-dinitrophenol</td>
<td>93.2</td>
<td>53.0-100.0</td>
<td>D-181</td>
</tr>
<tr>
<td>2-Nitrophenol</td>
<td>35.2</td>
<td>45.0-166.7</td>
<td>29-182</td>
</tr>
<tr>
<td>4-Nitrophenol</td>
<td>47.2</td>
<td>13.0-106.5</td>
<td>D-132</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>48.9</td>
<td>38.1-151.8</td>
<td>14-176</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table 3-3 *(Continued)*

Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by U.S. EPA Method 8270\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for ( s^c ) (µg/L)</th>
<th>Range for ( \bar{x}^d ) (µg/L)</th>
<th>Range for ( p^e ) (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>22.6</td>
<td>16.6-100.0</td>
<td>5-112</td>
</tr>
<tr>
<td>2,4,6-Trichlorophenol</td>
<td>31.7</td>
<td>52.4-129.2</td>
<td>37-144</td>
</tr>
</tbody>
</table>

\textsuperscript{a}EPA, 1987.

\textsuperscript{b}Based on analysis of a quality control reference sample that contains 100 micrograms per liter (µg/L) of each analyte.

\( s^c \) = Standard deviation of four recovery measurements, in µg/L.

\( \bar{x}^d \) = Average of four recovery measurements, in µg/L.

\( p^e \) = Percent recovery measured.

\( D \) = Detected; result must be greater than zero.
### Table 3-4

**Quality Control Acceptance Criteria for Sample Data from Organochlorine Pesticide and PCB Analysis by U.S. EPA Method 8080**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^c$ (μg/L)</th>
<th>Range for $x^d$ (μg/L)</th>
<th>Range for $p^e$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>0.42</td>
<td>1.08-2.24</td>
<td>42-122</td>
</tr>
<tr>
<td>α-BHC</td>
<td>0.48</td>
<td>0.98-2.44</td>
<td>37-134</td>
</tr>
<tr>
<td>β-BHC</td>
<td>0.64</td>
<td>0.78-2.60</td>
<td>17-147</td>
</tr>
<tr>
<td>δ-BHC</td>
<td>0.72</td>
<td>1.01-2.37</td>
<td>19-140</td>
</tr>
<tr>
<td>γ-BHC</td>
<td>0.46</td>
<td>0.86-2.32</td>
<td>32-127</td>
</tr>
<tr>
<td>Chlorodane</td>
<td>10.0</td>
<td>27.6-54.3</td>
<td>45-119</td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>2.8</td>
<td>4.8-12.6</td>
<td>31-141</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>0.55</td>
<td>1.08-2.60</td>
<td>30-145</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>3.6</td>
<td>4.6-13.7</td>
<td>25-160</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.76</td>
<td>1.15-2.49</td>
<td>36-146</td>
</tr>
<tr>
<td>Endosulfan I</td>
<td>0.49</td>
<td>1.14-2.82</td>
<td>45-153</td>
</tr>
<tr>
<td>Endosulfan II</td>
<td>6.1</td>
<td>2.2-17.1</td>
<td>D-202</td>
</tr>
<tr>
<td>Endosulfan sulfate</td>
<td>2.7</td>
<td>3.8-13.2</td>
<td>26-144</td>
</tr>
<tr>
<td>Endrin</td>
<td>3.7</td>
<td>5.1-12.6</td>
<td>30-147</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.40</td>
<td>0.86-2.00</td>
<td>34-111</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>0.41</td>
<td>1.13-2.63</td>
<td>37-142</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>12.7</td>
<td>27.8-55.6</td>
<td>41-126</td>
</tr>
<tr>
<td>PCB-1016</td>
<td>10.0</td>
<td>30.5-51.5</td>
<td>50-114</td>
</tr>
<tr>
<td>PCB-1221</td>
<td>24.4</td>
<td>22.1-75.2</td>
<td>15-178</td>
</tr>
<tr>
<td>PCB-1232</td>
<td>17.9</td>
<td>14.0-98.5</td>
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<td>PCB-1242</td>
<td>12.2</td>
<td>24.8-59.6</td>
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<tr>
<td>PCB-1248</td>
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<td>38-158</td>
</tr>
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<td>PCB-1254</td>
<td>13.8</td>
<td>22.2-57.9</td>
<td>29-131</td>
</tr>
<tr>
<td>PCB-1260</td>
<td>10.4</td>
<td>18.7-54.9</td>
<td>8-127</td>
</tr>
</tbody>
</table>


*Based on analysis of a quality control reference sample prepared as per Method 8080.

$s^c$ = Standard deviation of four recovery measurements, in micrograms per liter (μg/L).

$x^d$ = Average of four recovery measurements, in μg/L.

$p^e$ = Percent recovery measured.

$D$ = Detected; result must be greater than zero.
### Table 3-5

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Spike (µg/L)</th>
<th>Mean Recovery (%)</th>
<th>Standard Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>10.9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Dalapon</td>
<td>23.4</td>
<td>66</td>
<td>8</td>
</tr>
<tr>
<td>2,4-DB</td>
<td>10.3</td>
<td>93</td>
<td>3</td>
</tr>
<tr>
<td>Dicamba</td>
<td>1.2</td>
<td>79</td>
<td>7</td>
</tr>
<tr>
<td>Dichlorprop</td>
<td>10.7</td>
<td>97</td>
<td>2</td>
</tr>
<tr>
<td>MCPA</td>
<td>2020</td>
<td>98</td>
<td>4</td>
</tr>
<tr>
<td>MCPP</td>
<td>2080</td>
<td>94</td>
<td>4</td>
</tr>
<tr>
<td>2,4,5-T</td>
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<td>85</td>
<td>6</td>
</tr>
<tr>
<td>2,4,5-TP</td>
<td>1.0</td>
<td>88</td>
<td>5</td>
</tr>
</tbody>
</table>

*aAll results based upon seven replicate analyses. Esterification performed using the bubbler method. Data obtained from reference 9.*
3.16 Forms
This section provides forms for use in validating organic data. The forms are as follows:

3.16.1 Organic Data Assessment Summary Form

3.16.2 Organic Data Review Package

- Cover sheet
- Data Completeness Form
- Holding Time Form
- GC/MS Tuning Form
- Calibration Verification Form
- Blank Analysis Results Form
- Surrogate Spike Recoveries Form
- Matrix Spike/Matrix Spike Duplicate Form
- Field Duplicate Precision Form
- Internal Standard Performance Form
- Pesticide Instrument Performance (EPA Method 8080) Form
- Pesticide Calibration (EPA Method 8080) Form
- Sample Quantification Form.
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

SITE OR PROJECT __________________________ SAMPLE IDS __________________________
ANALYTICAL LABORATORY __________________________ NO. OF SAMPLES __________________________
LABORATORY REPORT # __________________________
CASE NO. __________________________

DATA ASSESSMENT SUMMARY

Describe problems/qualifications below (Action Items and Areas of Concern)

1. HOLDING TIMES/PRESERVATION
   VOC SVOC PEST/PCB OTHER
2. GC/MS INST. PERFORM.
3. CALIBRATIONS/WINDOWS
4. BLANKS
5. SURROGATES
6. MATRIX SPIKE/DUP
7. LABORATORY CONTROL SAMPLES
8. INTERNAL STANDARDS
9. COMPOUND IDENTIFICATION
10. SYSTEM PERFORMANCE
11. OVERALL ASSESSMENT

✓ (check mark) — Acceptable: Data had no problems or qualified due to minor problems
N - Data qualified due to major problems
X - Problems, but do not affect data
Qualifiers: J - Estimate
          UJ - Undetected, estimated

ACTION ITEMS: ____________________________________________________________

AREAS OF CONCERN: ______________________________________________________

Reviewed By: __________________________ Date: __________________________
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

PROJECT/TASK LEADER:

ACTION ITEMS:

AREAS OF CONCERN:

OVERALL DATA QUALITY ASSESSMENT

Reviewed By: _____________________________
Date: _____________________________

AL/2-94/WP/SNL:SOP3044C.R1
1.0 HOLDING TIMES AND PRESERVATION

Indicate the holding time criteria below that was used to evaluate the samples.

SW-846, 3rd. ed.
Other: ___________________________________________________

List below samples that were over holding time criteria.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>VTSR</th>
<th>Date Analyzed</th>
<th>Action</th>
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<tbody>
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</tbody>
</table>

NOTE: VTSR = Validated time of sample receipt.

Were the correct preservatives used? Yes ☐ No ☐

List below samples that were incorrectly preserved.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Type of Sample</th>
<th>Deficiency</th>
<th>Action</th>
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<tbody>
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</table>

Reviewed By: ____________________________
Date: ____________________________

AL/2-94/WP/2N/L:SOP3044C.R1
2.0 GC/MS TUNING CRITERIA

Has a GC/MS tuning performance been analyzed for every twelve hours of sample analysis for each GC/MS instrument used? Yes □ No □

Was the correct standard (listed in the EPA Method) used? Yes □ No □

Have the ion abundance criteria been met for each tune? Yes □ No □

NOTE: GC/MS abundance criteria is specified by EPA method for GC/MS analysis (EPA 8240A or 8270A).

If no for any of the above, list all the data associated with the tune that either failed criteria or in which there was no tune.

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Problem</th>
<th>Sample Affected (Action)</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

Check for transcription/calculation errors. If errors are present, briefly summarize necessary changes:

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________

Is the spectra of the mass calibration acceptable? Yes □ No □

Reviewed By: __________________________
Date: __________________________
3.0 GC INSTRUMENT PERFORMANCE.

3.1 DDT Retention Time

Is DDT retention time for packed columns >12 minutes (except for OV-1 and OV-101)?

Yes ☐ No ☐

If no, list below the DDT standards that failed criteria:

Affected samples and compounds:

3.2 Retention Time Windows

List below compounds that were not within the retention time windows.

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Compound</th>
<th>RT</th>
<th>RT Window</th>
<th>Action</th>
<th>Affected Samples</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

3.3 DDT and Endrin Degradation

List below the standards that have a DDT or Endrin breakdown of >20% (or a combined breakdown of >20%).

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Standard ID</th>
<th>DDT/Endrin</th>
<th>% Breakdown</th>
<th>Action</th>
<th>Affected Samples</th>
</tr>
</thead>
</table>

3.4 DBC Retention Time Check

Is the %D between EVAL A and each analysis (quantitation and confirmation) DBC retention time within QC limits (2% for packed column, 0.3% capillary ID <0.32 mm, and 1% for megabore)?

Yes ☐ No ☐

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample ID</th>
<th>DBC %D</th>
<th>Action</th>
</tr>
</thead>
</table>

For the above criteria outlined in Sections 8.1–8.4, check for transcription/calculation errors.

If errors are found, list below with necessary corrections:

---

Reviewed By: __________________________
Date: ________________________________

AL/2-94/WP/SLN:SOP3044C.R1
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

4.0 INITIAL CALIBRATION

Has initial calibration been performed as required in the EPA method? Yes ☐ No ☐

Were the correct number of standards used to calibrate the instrument? Yes ☐ No ☐

For GC analyses of PCBs and Pesticides, did the laboratory follow the correct 72-hour sequence of analysis? Yes ☐ No ☐

List below compounds which did not meet initial calibration criteria outlined by the EPA method.

<table>
<thead>
<tr>
<th>Instrument ID</th>
<th>Date</th>
<th>Compound</th>
<th>RF/%RSD</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

Check for transcription/calculation errors. If errors are present, summarize necessary corrections below:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Reviewed By: ____________________________
Date: ________________________________
5.0 CONTINUING CALIBRATION

Have continuing calibration standards been analyzed at the frequency specified in the EPA method?

Yes [ ] No [ ]

List below all compounds which did not meet continuing calibration requirements.

<table>
<thead>
<tr>
<th>Instrument ID</th>
<th>Date</th>
<th>Compound</th>
<th>RF/%D</th>
<th>Action</th>
<th>Samples Affected</th>
</tr>
</thead>
<tbody>
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</table>

Check for transcription and calculation errors. If errors are found, briefly summarize necessary corrections below:

____________________________________

____________________________________

____________________________________

____________________________________

Reviewed By: _______________________
Date: ____________________________

AL/2-94/WP/SNL:SOP3044C.R1
6.0 BLANK ANALYSES

6.1 Method/Reagent and Instrument Blanks

Has a method/reagent blank been analyzed for each set of samples or for every 20 samples of similar matrix, whichever is more frequent? Yes ☐ No ☐

Has an instrument blank been analyzed at least once every twelve hours for each GC/MS system used? Yes ☐ No ☐

6.2 Field/Rinse/Equipment Blanks

Are there field/rinse/equipment blanks associated with each sampling day or at frequency specified in the sampling plan? Yes ☐ No ☐

List below compounds for which analyses were requested that were detected in any of the blanks analyzed:

<table>
<thead>
<tr>
<th>Date</th>
<th>Blank ID</th>
<th>Compound</th>
<th>Conc. ( )</th>
<th>PQL ( )</th>
<th>Action Level</th>
<th>Samples Affected (Action)</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

PQL = Practical Quantitation Limit from EPA Method.

Reviewed By: __________________________
Date: __________________________

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ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

Are there any TICs present in the blanks that are also present in the samples? Yes □ No □
If yes, list below.

__________________________________________________________________________

__________________________________________________________________________

7.0 SURROGATE RECOVERY

Were surrogate recoveries evaluated for each of the samples analyzed by GC or GC/MS?
Yes □ No □

If surrogate standards other than those presented by SW-846 are used, list below with reference to applicable control limits used to evaluate the percent recoveries.

<table>
<thead>
<tr>
<th>Surrogate Compound</th>
<th>Control Limits</th>
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</thead>
<tbody>
<tr>
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</tbody>
</table>

List below the percent recoveries which did not meet either SW-846 criteria or criteria listed above.

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample ID/Matrix</th>
<th>Surrogate Compound</th>
<th>%Rec</th>
<th>Action</th>
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<tbody>
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Reviewed By: ____________________________
Date: ____________________________
**ORGANIC DATA ASSESSMENT SUMMARY FORM**
(Data Verification/Validation Level 3 DV-3)

If surrogate recovery was outside of control limits, were the samples or method blank reanalyzed?

<p>| | |</p>
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<thead>
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<tbody>
<tr>
<td>Yes</td>
<td>No</td>
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</tbody>
</table>

Are method blank surrogate recoveries outside of limits upon reanalysis? Yes | No

Are transcription/calculation errors present? Yes | No

If yes, note necessary corrections.

- 
- 
- 
- 
- 

Reviewed By: __________________________
Date: __________________________

AL2-94/WP/SLC/SOP/3044C.R1
8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) ANALYSIS

Were MS/MSDs analyzed at the frequency required by the EPA method or QAP/IP for each matrix type?
Yes ☐  No ☐

List below % recoveries and RPDs of compounds which did not meet criteria. Indicate on chart criteria used to evaluate recoveries and RPDs.

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample ID/Matrix</th>
<th>Compound</th>
<th>%Rec</th>
<th>RPD</th>
<th>Action</th>
</tr>
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Reviewed By: __________________________
Date: __________________________

AL/2-94/WP/SNL:SOP3044C.R1
9.0 LABORATORY CONTROL SAMPLE ANALYSIS

Have laboratory control samples containing a representative number of the compounds of interest been analyzed at the frequency specified in the EPA method or QAP/IP?
Yes ☐  No ☐

Evaluate percent recoveries based on control limits established in individual EPA methods, or use established laboratory control limits. List below recoveries of compounds which did not meet criteria with reference to control limits used.

<table>
<thead>
<tr>
<th>Date</th>
<th>Compound</th>
<th>%Rec</th>
<th>Control Limits</th>
<th>Action</th>
<th>Samples Affected</th>
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</table>

Control Limit Reference: ______________________________________________________

Evaluate RPD based on control limits established in individual EPA methods, or use established laboratory control limits. List below recoveries of compounds which did not meet criteria with reference to control limits used.

<table>
<thead>
<tr>
<th>Date</th>
<th>Compound</th>
<th>%Rec</th>
<th>Control Limits</th>
<th>Action</th>
<th>Samples Affected</th>
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Control Limit Reference: ______________________________________________________
**ORGANIC DATA ASSESSMENT SUMMARY FORM**  
(Data Verification/Validation Level 3 DV-3)

**10.0 INTERNAL STANDARDS EVALUATION**

List below the internal standard areas of samples or blanks which did not meet criteria.

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample ID</th>
<th>Internal</th>
<th>Acceptable Range</th>
<th>Action</th>
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</thead>
<tbody>
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</table>

Are retention times of the internal standards within 30 seconds of the associated calibration standard?  
Yes □  No □

**11.0 TARGET COMPOUND LIST ANALYTES**  
11.1 GC/MS Analyses

Are the reconstructed ion chromatograms, the mass spectra for the identified compounds, and the data system printouts included?  Yes □  No □

Is chromatographic performance acceptable with respect to:

- Baseline stability?  Yes □  No □
- Resolution?  Yes □  No □
- Peak shape?  Yes □  No □
- Full-scale graph (attenuation)?  Yes □  No □

Reviewed By: __________________________  
Date: ________________________________

AL2-94/WP/SNL/SOP3044C.R1
Other: 

Is the RRT of each reported compound within the limits given in the method of the standard RRT in the continuing calibration? Yes ☐ No ☐

Are all the ions present in the standard mass spectrum at a relative intensity greater than 10% also present in the mass spectrum? Yes ☐ No ☐

Do sample and standard relative intensities agree within 20%? Yes ☐ No ☐

If no for any of the above, indicate below problems and qualifications made to data:

11.2 GC Analyses

Are there any transcription/calculation errors between the raw data and the reporting forms? Yes ☐ No ☐

If yes, review errors and necessary corrections below; if errors are large, resubmittal of laboratory package may be necessary.

Are retention times of sample compounds within the calculated retention time windows for both quantitation and confirmation analysis? Yes ☐ No ☐

Was GC/MS confirmation performed when required by the EPA method? Yes ☐ No ☐

If no for any of the above, reject positive results except for retention time windows if associated standard compounds are similarly shifted.

Reviewed By: _____________________
Date: _____________________

AU2-94/WPSNL/SOP3044C.R1
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

Samples affected: ________________________________________________________

Check chromatograms for false negatives, especially for the multiple peak components (toxaphene and PCBs). If false negatives are apparent and the appropriate PCB standards were not analyzed, or if confirmed analysis was not present, flag the affected data.

Samples affected: ________________________________________________________

NOTE: Due to the complexities of PCB/pesticide analysis, each analytical run should be reviewed to verify identification and column performance.

12.0 FIELD DUPLICATE ANALYSIS

Were field duplicates submitted for analysis? Yes □ No □

If yes, calculate RPD and use professional judgment to determine if the data needs to be qualified. List results below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample ID</th>
<th>Compound</th>
<th>Sample Result</th>
<th>Duplicate Result</th>
<th>RPD</th>
<th>Affected Samples</th>
</tr>
</thead>
<tbody>
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</table>

13.0 COMPOUND QUANTITATION/REPORTED DETECTION LIMITS

Are there any transcription/calculation errors from raw data to reported results (check at least 10% of positive results)? Yes □ No □

In addition, verify that the correct internal standard, quantitation ion, and RRF were used to calculate the result for a minimum of 10% of sample data.

Reviewed By: ____________________________
Date: ____________________________

AL/2-94/WP/SNLSOP3044CR1
ORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3 DV-3)

Do TIC and "best match" standard relative ion intensities agree within 20%? Yes ☐ No ☐

Comments

Reviewed By: ____________________________
Date: ____________________________

Approved By:* ____________________________
Date: ____________________________

*Data package must be approved by Project/Task Leader.
Check chromatograms for false negatives, especially for the multiple peak components (toxaphene and PCBs). If false negatives are apparent and the appropriate PCB standards were not analyzed, or if confirmed analysis was not present, flag the affected data.

NOTE: Due to the complexities of PCB/pesticide analysis, each analytical run should be reviewed to verify identification and column performance.

12.0 FIELD DUPLICATE ANALYSIS

Were field duplicates submitted for analysis? Yes ☐ No ☐

If yes, calculate RPD and use professional judgment to determine if the data needs to be qualified. List results below.

<table>
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<tr>
<th>Date</th>
<th>Sample ID</th>
<th>Compound</th>
<th>Sample Result</th>
<th>Duplicate Result</th>
<th>RPD</th>
<th>Affected Samples</th>
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</table>

13.0 COMPOUND QUANTITATION/REPORTED DETECTION LIMITS

Are there any transcription/calculation errors from raw data to reported results (check at least 10% of positive results)? Yes ☐ No ☐

In addition, verify that the correct internal standard, quantitation ion, and RRF were used to calculate the result for a minimum of 10% of sample data.
QUALITY ASSURANCE PLAN
FOR THE SNL/NM SAMPLE MANAGEMENT OFFICE

Author:

Nick Durand, Project Leader, 7576

4-5-96

Date

Approval recommended by:

Dick Rohde, Manager, 7501

04/08/96

Date

Approved by:

Bill Jenkins, Manager, 7513

4/8/96

Date

UNCONTROLLED COPY

SNL
7500 Environmental Operations
Records Center
CONTROLLED DOCUMENT
(If Numbered In Red Ink)

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<th>Page</th>
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<td>1</td>
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<td>1</td>
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<td>ARCOCC</td>
<td>Analysis Request/Chain of Custody</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>CERCLA</td>
<td>Comprehensive Environmental Resource, Compensation and Liability Act</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CMS</td>
<td>Corrective Measure Studies</td>
</tr>
<tr>
<td>COC</td>
<td>constituents of concern</td>
</tr>
<tr>
<td>DOE</td>
<td>United States Department of Energy</td>
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<tr>
<td>DQO</td>
<td>data quality objective</td>
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<tr>
<td>Eh</td>
<td>Redox potential</td>
</tr>
<tr>
<td>ENVC</td>
<td>Environmental Operations Center</td>
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<tr>
<td>EPA</td>
<td>United States Environmental Protection Agency</td>
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<tr>
<td>ER</td>
<td>environmental restoration</td>
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<tr>
<td>FOP</td>
<td>Field Operating Procedure</td>
</tr>
<tr>
<td>GC</td>
<td>gas chromatography</td>
</tr>
<tr>
<td>GC/MS</td>
<td>gas chromatography/mass spectroscopy</td>
</tr>
<tr>
<td>HASL</td>
<td>Designation for the DOE Environmental Measurements Laboratory's Procedure Manual; i.e., HASL-300</td>
</tr>
<tr>
<td>HPLC</td>
<td>high performance liquid chromatography</td>
</tr>
<tr>
<td>HSWA</td>
<td>Hazardous and Solid Waste Amendments</td>
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<tr>
<td>LCS</td>
<td>laboratory control samples</td>
</tr>
<tr>
<td>LOP</td>
<td>Laboratory Operating Procedure</td>
</tr>
<tr>
<td>MDA</td>
<td>minimum detectable activity</td>
</tr>
<tr>
<td>MDL</td>
<td>method detection limit</td>
</tr>
<tr>
<td>MS/MSD</td>
<td>matrix spike/matrix spike duplicate</td>
</tr>
<tr>
<td>µg/g</td>
<td>micrograms/gram</td>
</tr>
<tr>
<td>µg/kg</td>
<td>micrograms per kilogram</td>
</tr>
<tr>
<td>mg/kg</td>
<td>milligrams per kilogram</td>
</tr>
<tr>
<td>µg/L</td>
<td>micrograms per liter</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
</tr>
<tr>
<td>NCR</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td>NCAR</td>
<td>Nonconformance Corrective Action Report</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>OP</td>
<td>operating procedure</td>
</tr>
<tr>
<td>pCi/L</td>
<td>picocuries per liter</td>
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<tr>
<td>pCi/g</td>
<td>picocuries per gram</td>
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<tr>
<td>PARCC</td>
<td>Precision, Accuracy, Representativeness, Completeness and Comparability</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl</td>
</tr>
<tr>
<td>PIP</td>
<td>Program Implementation Plan</td>
</tr>
<tr>
<td>PQL</td>
<td>practical quantitation limit</td>
</tr>
<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>QAP</td>
<td>Quality Assurance Plan</td>
</tr>
<tr>
<td>QAPjP</td>
<td>Quality Assurance Project Plan</td>
</tr>
<tr>
<td>QAQC</td>
<td>Quality Assurance/Quality Control</td>
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<td>QC</td>
<td>Quality control</td>
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ACRONYMS AND ABBREVIATIONS (Continued)

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<th>Acronym</th>
<th>Description</th>
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<td>RCRA</td>
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</tr>
<tr>
<td>RFI</td>
<td>RCRA Facility Investigation</td>
</tr>
<tr>
<td>RPD</td>
<td>relative percent difference</td>
</tr>
<tr>
<td>SAP</td>
<td>Sampling and Analysis Plan</td>
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<tr>
<td>SARA</td>
<td>Superfund Amendment and Reauthorization Act</td>
</tr>
<tr>
<td>SCL</td>
<td>Sample Collection Log</td>
</tr>
<tr>
<td>SNL/NM</td>
<td>Sandia National Laboratories/New Mexico</td>
</tr>
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<td>SMO</td>
<td>Sample Management Office</td>
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<tr>
<td>SOW</td>
<td>Statement of Work</td>
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<tr>
<td>SVOC</td>
<td>semivolatile organic compounds</td>
</tr>
<tr>
<td>SWMU</td>
<td>Solid Waste Management Unit</td>
</tr>
<tr>
<td>UST</td>
<td>underground storage tank</td>
</tr>
<tr>
<td>UV</td>
<td>ultra-violet</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic compounds</td>
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1.0 PROJECT DESCRIPTION

1.1 Introduction

This Quality Assurance Plan (QAP) provides the quality assurance/quality control (QA/QC) requirements for activities performed by Sandia National Laboratories, New Mexico (SNL/NM) Sample Management Office (SMO). Quality assurance/quality control requirements included in this QAP are written to provide confidence that the work produced by SMO will meet the quality requirements of the United States Department of Energy (DOE) orders and regulatory agencies. Standard QA requirements for environmental sampling and analytical activities are mandated herein.

This QAP addresses the 16 essential elements detailed in the EPA document "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80 (EPA, 1983) and meets the requirements of the DOE Orders 5700.6C "Quality Assurance" and 5480.19 "Conduct of Operations."

Quality assurance (QA) is a system of measures taken to ensure that a desired product or service meets a defined level of quality. Quality control (QC) consists of the activities defined in procedures which implement the QA system. These procedures usually define standards of performance that are necessary to meet program objectives. This QAP is a comprehensive document intended to state the QA objectives of the SMO and provide requirements for detailed implementation.

During the lifetime of this QAP, it is anticipated that some of the requirements and procedures of the SMO may change. Document revisions shall be reviewed, incorporated, reissued and implemented using the appropriate SNL/NM Operating Procedures (OP) for document control. Document revisions and ownership are the responsibility of the SMO.

1.2 Facility Description

SNL/NM is operated for the DOE by Sandia Corporation. The laboratory is a multi-disciplinary research and development organization which focuses on national security and energy projects. Research at SNL/NM generates radioactive, mixed, and hazardous wastes which are managed by line organizations in compliance with applicable regulations. In conjunction with these activities are ongoing environmental monitoring and restoration activities. The SMO coordinates environmental sampling and analytical support services for SNL/NM ENVC operations.

1.3 Program Description

The fundamental goal of the SMO is to provide sampling and analytical data management support, and manage analytical services to the various environmental monitoring and waste characterization programs, and the ER Project at SNL/NM. The primary QA objective of the SMO is to ensure that environmental data is of adequate technical quality and content to meet the data quality objectives (DQO) specified by SNL/NM environmental programs and projects. In conjunction with this objective, the SMO is responsible for coordinating efforts associated with sampling, sample management, sample analyses, data verification and validation, and analytical records management. Specific tasks performed by the SMO may include.
• Sample task planning and coordination
• Preparation and review of sampling and analysis plans
• Sample management services
• Analytical services and liaison between each project/monitoring program and the analytical laboratories
• Analytical data report verification and validation
• Sample information management and data base maintenance for analytical data
• Analytical services procurement and assessment

1.4 Scope

The SNL/NM SMO has been established to assist in the coordination of sampling events and to manage samples and resulting data from environmental samples collected for environmental regulatory compliance at SNL/NM. This includes hazardous, radioactive, and mixed waste samples; ground, storm, and waste water samples; waste site characterization samples; environmental monitoring samples; and building decontamination samples. The SMO provides support to ENVC projects and programs in sampling and analysis plan technical review, sample packaging and shipment, laboratory analysis, data management and review, and SNL contracts management. Although the SMO provides sample and data management, it is not the owner of the samples or data. The final disposition of samples and data is the responsibility of the project that generated the samples.
2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 Project Organization

The overall organizational structure of the SMO is presented in the SMO Program Plan. Figure 2-1 identifies the hierarchy of documents that dictate the programmatic, administrative, and procedural operations of the SMO. A personnel organization chart (Figure 2-2) provides organizational details, position titles, and lines of authority at and below the SMO Coordinator level. Project communication is the responsibility of all project staff. Necessary communication shall be made regarding project-related work between and among program participants.

2.2 Quality Assurance Responsibilities

The Quality Assurance Department is delegated by 7500 Management the responsibility for quality assurance controls. The Quality Assurance Department operates independently of the project management line of authority and cost and schedule constraints. No SMO program duties are assigned to the Quality Assurance Department that preclude full attention to QA responsibilities or that conflict with reporting and resolving QA issues. The Quality Assurance Department is responsible for

- Assist in interpretation and clarification of appropriate regulations, orders, policies, and standards
- Assisting Task and Project Leaders in the development of project-specific quality assurance project plans (QAPjPs) and sampling and analysis plans (SAPs)
- Reviewing and recommending approval for QAPjPs
- Ensuring that QA assessments of the programs, projects, and laboratories are conducted on a systematic basis
- Providing guidance on program-specific QA matters, i.e., acceptance criteria and verification of program efficiency and implementation to ensure quality requirements are met.
- Ensuring that QA deficiencies are properly recognized and resolved.

2.3 SMO Staff Responsibilities

All personnel working on SMO activities are responsible for adherence to QA requirements stipulated in this QAP which are applicable to their specific task(s). Each individual has an obligation to identify and act towards resolving conditions adverse to quality. Staff with additional programmatic responsibilities are identified below. SAPs and other QA related documentation should delineate any other personnel with project-specific QA responsibilities.
Figure 2-1
Quality Assurance Documents Governing SMO Activities

7500 QA Plan

SMO Project Plan
(PLN 96-31)

SMO QA Plan
(QUA 95-01)

- AOP for Data Management (AOP 96-01)
- AOP for Contract Lab Management
  (AOP 95-15)
- AOP for Sample Management & Custody
  (AOP 95-16)
- AOP for Sample & Analysis Plan Preparation
  (AOP 95-14)

Project-Specific Sampling & Analysis Plans

TOP for Chemical & Radiochemical Data Review
(TOP 94-03)

SMO AOP for Limited Sampling Operations
(AOP 96-03)
Figure 2-2
SMO Organization Chart

CQA 7501
Richard Rohde
Manager

SMO Project
Management
Nick Durand
Project Leader

Financial Budget Support
Lorraine Elliott

Data Base Upgrade Effort
Kevin Kinney
Sherry Bisco

Customer Interface, Project
and Contract Coordination

Sample Data Records
Management

Sample Processing and
Collection

Pam Puisant
Project Coordinator
Doug Salmi
Project Coordinator

Kathy Becker
Angela Chavez
Deborah Constant∗
Howard Seeley∗

Dan McLaughlin
Shipping/Receiving Coordinator
Ed Rankin∗
Devis Biawell
Doug Perry∗
Ken Sansone∗

* Indicates Contractor Personnel
2.3.1 SMO Project Leader Responsibilities

The SMO Project Leader is responsible for

- Reviewing and recommending approval of sampling and analysis plans, and operating procedures for sampling programs conducted by the SMO.
- Managing contractor laboratory services including procurement, routine performance assessments, and general laboratory oversight.
- Facilitating implementation of QA requirements for the SMO.
- Interfacing with the Records Management Coordinator for maintenance of project documentation, and to resolve record management concerns for storage and maintenance of sampling and analysis records.
- Ensuring that sufficient QA and QC checks are in place to maintain the integrity of the SMO sample information management and analytical results databases.

2.3.2 SMO Project Coordinator

The SMO Project Coordinator is responsible for coordinating efforts associated with SMO analytical services. Specific responsibilities include

- Acting as a point of contact between Task and Project Leaders and the analytical laboratories.
- Acting as Sandia Delegated Representative for analytical laboratory contracts.
- Obtaining appropriate sample containers from a vendor or analytical laboratory.
- Scheduling projects with contract laboratories.
- Ensuring data quality requirements are communicated to the laboratory and verifying that these requirements have been achieved.
- Reviewing project-specific Sample Analysis Plans to ensure quality of analytical data.
- Resolving problems, issues, non-compliances, and errors for projects with regard to analytical data.
- Ensuring appropriate QC analyses are performed and that project specific data quality requirements are met for laboratory operations.
- Performing analytical data report verification and validation to ensure contractual and data quality requirements are met, as requested by the customers.
- Conducting visits, and technical system audits of contractor laboratories to ensure compliance with this QAP.

2.3.3 SMO Shipping and Receiving Coordinator

The Sample Management Office Shipping and Receiving Coordinator is responsible for

- Ensuring samples are properly stored, packaged, and shipped to the analytical laboratories in accordance with this QAP.
- Notifying analytical laboratories of any QA/Health and Safety concerns regarding shipped samples.
- Ensuring that sample custody is properly maintained and documented in accordance with this QAP.
• Overseeing the day to day operations of the SMO Shipping and Receiving facility and support personnel.

2.3.4 SMO Data Management Coordinator
The SMO Data Management Coordinator is responsible for the traffic management of data flow and data storage. This includes both hardcopy paper records from field activities, and analytical laboratories, and electronic data relating to sample tracking or analytical results.

2.3.5 Quality Coordinator
A Quality Coordinator, assigned to support SMO, is responsible for providing guidance and expertise in the areas of QA/QC relating to operations of the SMO.

2.3.6 Contract Laboratories
Analytical laboratories are responsible for performing all analyses in accordance with the contract statement of work which will contain applicable requirements in this QAP.

2.3.7 Database Administrator
The Database Administrator is responsible for:

• Overall design, operation, and maintenance of the SMO database
• Reviewing and implementing improvements to system performance, establishing system design, and determining the need for changes to the design
• Identifying new users
• Responding to system upgrades and new products
• Training and supervising data management staff
• Performing system backup and restoration functions
• Developing new forms and reports with the Data Administrator
• Supporting and maintaining the database
• Resolving all error messages generated by Oracle™
• Establishing user accounts, passwords, and privileges within Oracle™
• Submitting requests to the Environmental Operations Records Center (EORC) for issuance of applicable user guides and procedures
• Submitting requests to Administrative and Support staff to establish new user accounts on the LAN
• Performing programming changes

2.4 Training
Basic training and qualification guidance is provided by the Sandia Education and Training Organization. Training requirements are presented in activity-specific operating procedures.

2.4.1 Assessment Team Leader Training Requirements
For any assessment conducted under Section 10 of this Quality Assurance Plan, the Assessment Team Leader shall have completed an Authorized Auditor Training Course and a Lead Auditor Certification Evaluation for NQA-1 Lead Auditors.
2.5 Procurement

The SMO follows the QA guidelines provided by the Sandia Purchasing Organization. For laboratory contracts, further guidelines and requirements are described in the Administrative Operating Procedure for Contract Laboratory Management (AOP 95-15).
3.0 DATA QUALITY REQUIREMENTS

The SMO has the primary responsibility of ensuring that the quality of the data generated for environmentally related programs and projects at SNL/NM meet the minimum corporate data quality requirements necessary to determine and demonstrate compliance with DOE requirements and local, state and federal environmental regulations. The DQO process provides a means of defining the appropriate quality of the data required to support these projects. The level of detail and data quality requirements vary, based on the intended use of the data. Data quality requirements, a result of the DQO scoping process, specify the analytical methodology, the field and laboratory QC requirements and associated acceptance criteria necessary to ensure that the DQOs of a specific project have been obtained.

This chapter outlines the DQO process that should be used to establish data quality requirements for SNL/NM programs utilizing SMO services and establishes the minimum data quality requirements for measurement data generated by and for the SMO. Procedures for performing the DQO scoping process are presented in detail in an associated administrative OP (SNL/NM, 1994a).

3.1 Data Quality Objectives

The DQO process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. It relates the data needs to the specific decision to be made (Fisk, 1994 and EPA, 1987a). The level of detail and data quality requirements vary, based on the intended use of the data. The DQO development process helps to specify the level of uncertainty that a decision maker is willing to accept in results derived from environmental data when the results are used in a regulatory or programmatic decision. From that, the data quality requirements for each data collection activity can be specified in program or project specific SAPs or work plans. The DQO process is briefly described below.

DQOs are qualitative and quantitative statements derived from the outputs of each step of the DQO process that

1. Clarify the study objectives
2. Define the most appropriate type of data to collect
3. Determine the most appropriate conditions from which to collect the data and
4. Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

The development of DQOs should begin during the planning stage of each environmental data collection effort consists of a seven-stage process:

1. Prepare a clear qualitative statement of the decision to be made for the problem under evaluation.
2. State why environmental data are needed (i.e., data gaps) and how the data will specifically be used.
3. Identify the inputs needed to perform the decision making process.
4. Specify the domain (i.e., the environmental or physical system from which samples will be collected).
5. Develop a decision rule to integrate the outputs.
6. Specify the limits on decision errors. Specify quantitative and qualitative goals for assessing data quality.
7. Determine the calculations (statistical and otherwise) that will be performed on the data to arrive at a result.
8. Define the most effective sampling design that provides data meeting the DQOs and develop a SAP.

Some of the criteria that can be used to assess the quality of measurement data generated are the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Precision and accuracy objectives are based on derived accuracy and precision for the analytical methods used. Further criteria for specific programs should be defined in Steps 5, 6, and 7 of the DQO process.

3.2 Analytical Data Levels

Once the DQOs for the project have been determined, the quality of the analytical data required to meet the DQOs is determined. Four levels of data quality are routinely generated. Ranging from Field Data (1) to Validated Analytical Data Packages (4). Each analytical data level and the minimum quality requirements for each level are described below.

3.2.1 Field Data

**Methodology**
Analysis is performed using portable instruments and wet chemistry techniques in a field environment.

**Calibration Requirements**
Instrument calibration is performed in accordance with requirements of an approved field operating procedure (FOP) authored by the organization responsible for the field activity.

**Minimum Quality Control Requirements**
At a minimum, calibration verification is performed at the beginning and end of each day of use. More frequent calibration verification may be required depending on the stability of the instrument or method. Results of calibration verification must fall within the acceptance range specified in the FOP; otherwise, the data are considered to be unusable and analysis must be repeated.

**Documentation Requirements**
An FOP specifying specific operation of the instrument or technique must be prepared.

The calibration standard or titrant concentration, date of preparation, date of expiration, and lot number must be recorded.

Results of field measurements and calibration verification results must be recorded on a standardized field form and signed by the person performing the measurements.
3.2.2 Field Laboratory Data

Methodology
Analysis is performed in a field laboratory setting using field or laboratory grade instruments or standardized wet chemistry procedures.

Calibration Requirements
Instruments must be calibrated in accordance with the manufacturer's specifications and an approved laboratory operating procedure (LOP) authored by the organization performing the analysis.

Minimum Quality Control Requirements
A calibration verification standard is analyzed at the beginning and end of each day of operation or the appropriate frequency to ensure the required level of data accuracy; whichever is most frequent. QC samples (e.g., laboratory control samples and method blanks) are analyzed concurrently with each analytical batch to demonstrate control of laboratory operations for accuracy, precision, and system contamination.

Documentation Requirements
An LOP must be prepared for each analytical technique used prior to generating data. Each LOP must contain the following elements.

a. Brief Description of Method—Include a description for scope, application, and interferences.
b. Apparatus and Materials—Include instrument specifications, operating and programming parameters, and support equipment and materials.
c. Reagents and Standards—Specify the purity of each reagent to be used. Provide procedures for preparing each reagent and standard. Describe the standardization procedure.
d. Sample Preparation Procedure—Describe the procedure for preparing samples including methods for introducing spikes, surrogate standards, etc.
e. Sample Analysis Procedure—Specify instrument operating parameters, calibration requirements, and calculating results.
f. Quality Control Requirements—Specify the types and frequencies of QC samples to be analyzed. Specify the method for determining acceptance for each QC parameter. Specify the corrective actions to follow when QC sample results exceed acceptance criteria.
g. References—List methods and sources used to develop the LOP.

A standardized laboratory form, or bench sheet, can be used to record the analytical measurements including QC samples. Include the name of the analyst, date of analysis, analytical results, and quantitation limits. The data are then reviewed and approved by the laboratory manager.

3.2.3 Verified Laboratory Data
Detailed requirements for operations and reporting for laboratory-generated data are specified in the "Administrative Procedure for Contract Laboratory Management" (SNL/NM, 1994b). Analytical data requirements are summarized below.
Methodology
Analyses are performed in accordance with a recognized analytical procedure in a controlled laboratory setting. The applicable EPA analytical test method is used for performing chemical analyses when appropriate; otherwise, a nationally recognized, validated test method shall be used.

Table 3-1
Environmental Regulatory Programs, Regulations and Analytical Methods References

<table>
<thead>
<tr>
<th>Regulatory Program</th>
<th>Regulation</th>
<th>Analytical Method</th>
</tr>
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<tbody>
<tr>
<td>(CERCLA) Superfund Reauthorization Act (SARA)</td>
<td>40 CFR 300</td>
<td>User's Guide to the Contract Laboratory Program, EPA/540/8-89/012</td>
</tr>
<tr>
<td>Clean Air Act</td>
<td>40 CFR 50 to 80</td>
<td>Appendices in 40 CFR 50 to 80</td>
</tr>
<tr>
<td>Clean Water Act</td>
<td>40 CFR 136</td>
<td>40 CFR 136 Appendix A</td>
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<tr>
<td>Safe Drinking Water Act</td>
<td>40 CFR 141</td>
<td>40 CFR 141 Appendix A</td>
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</table>

Radiochemical analyses shall be performed following procedures contained in the most recent edition "Environmental Measurements Laboratory Procedures Manual" (HASL-300) (DOE, 1990), DOE Methods for Evaluating Environmental and Waste Management Samples (DOE/EM-0089T, Rev. 2, Oct. 1994), or equivalent EPA test methods or SNL/NM approved laboratory specific methods may be substituted. A list of the applicable analytical method references for pertinent environmental regulatory programs are listed in Table 3-1.

Calibration Requirements
Instruments are calibrated in accordance with the applicable analytical test method.

Minimum Quality Control Requirements
QC sample requirements are specified in the contract statement of work between SNL/NM and the laboratory, the laboratory's QA plan, and in the published test method. QC samples must be prepared and analyzed with each analytical batch (20 or less samples) and must include measurements of laboratory accuracy, precision, and system contamination. The laboratory data report is validated by the analytical laboratory in accordance with its QAP and is verified by the SMO for compliance with laboratory contract requirements and data quality criteria specified in the associated SAP.

Documentation Requirements
Reporting requirements are specified in the laboratory's Statement of Work (SOW). A summary report including analytical and QC results is prepared, validated, and approved by the laboratory. A data verification checklist shall be completed by the SMO.
3.2.4 Validated Laboratory Data

Methodology
In addition to Validated Laboratory Data Quality requirements the analytical data package is validated by the SMO. Data verification and validation requirements are discussed in Chapter 8.

Minimum Quality Control Requirements
QC requirements are identical to the QC requirements specified in Section 3.2.3.

Documentation Requirements
Complete analytical data reports are prepared by the laboratory and includes instrument printouts for initial and continuing calibration, calibration verification, sample and QC sample analyses. Data verification and validation checklists are prepared by the SMO for each analytical report.

3.3 Data Quality Requirements for Field and Laboratory Activities

Analytical data meeting or exceeding the data quality requirements specified in Section 3.2.3 will generally be used for environmental programs and projects for the purposes of demonstrating compliance with permits and making regulatory decisions. Field and Laboratory Data may be used for regulatory and decision making purposes if so documented in a SAP or QAP for the particular project.

All laboratories which generate analytical measurement data for the purposes of regulatory compliance require a QAP. The QAP shall address in detail the QA/QC goals and protocols for all aspects pertinent to the operation of analytical laboratories. QAP format and requirements for laboratory operations are given in "Report on Minimum Criteria to Assure Data Quality Objectives (EPA, 1990) and "Emergency Standard Practice for Generation of Environmental Data Related to Waste Management Activities" (ASTM 16-90).

Appropriate QC checks shall be used throughout the course of each analysis event to estimate the precision, accuracy, contamination, and the matrix effect associated with each analytical technique. SAPs should specify the types and frequencies of QC samples for field and laboratory activities and should adhere to the laboratory QC requirements specified in this QAP and the associated administrative OPs (SNL/NM, 1994a; SNL/NM, 1994b; SNL/NM, 1994c; SNL/NM, 1994d).

3.3.1 Field Quality Control Requirements

Analytical data derived from SNL/NM environmental programs is generally obtained by the analysis of samples at off-site laboratories. However, to collect representative data for certain parameters, measurements may be performed in the field at the time of sample collection. Examples of field measurement data include but are not limited to specific conductance, temperature, redox potential (eH), pH, and alkalinity of surface-water and groundwater samples.

The primary QC requirement for all field measurements is to verify that the measurements were obtained to the degree of accuracy consistent with their intended use, and provide documentation of adherence to the measurement procedures. Adherence to the procedures
described in approved FOPs, developed by the organization responsible for the activity, shall provide confidence that the data quality requirements for field measurement data are met.

3.3.2 Sampling Precision

Field QC requirements, specified in FOPs, SAPs, and work plans should include, when appropriate, provisions to measure variability introduced by the sampling technique. Acceptance criteria for sampling precision are established as part of the DQO process.

3.3.3 Laboratory Data Quality Requirements

Each laboratory shall have procedures in place to ensure that laboratory controls are in place during each analysis activity. Laboratories shall demonstrate that the analytical process is in control by concurrently preparing and analyzing QC samples with each analytical batch and assessing the data for indications of analytical accuracy, precision, and contamination.

In addition to conforming with method specific QC requirements, laboratory control samples (LCS) shall be concurrently prepared and analyzed with each analytical batch. Procedures for establishing precision and accuracy control limits for organic and metals analyses based on LCS analysis are given in the "Handbook for Analytical Quality Control in Water Wastewater Laboratories" (EPA, 1979), in HASL-300 (DOE, 1990) and the "Handbook for Analytical Quality Control in Radioanalytical Laboratories" (EPA, 1977).

Laboratory control samples shall be used to establish initial control limits and to control subsequent analyses. Control limits shall be updated in accordance with the laboratory's QAP, or at a minimum, annually. LCS shall use an appropriate sample matrix fortified with the target analytes at appropriate concentrations. Standards used to prepare LCS should be traceable to a nationally recognized source. For methods with multiple target analytes (e.g., gas and liquid chromatography, inductively coupled plasma, and gamma spectroscopy), a representative suite of target analytes may be substituted. However, the target analytes or isotopes selected shall encompass the entire chromatographic or spectral range of the analytical method.

Sample data generated with associated QC samples that fall within prescribed control limits shall be considered to be generated while the laboratory was in control. Data generated with laboratory QC samples outside acceptance limits are considered to be generated while the laboratory is out of control and require corrective action. All laboratory data reported with LCS values outside control limits shall be rejected or conditionally qualified and stated as such in the laboratory report. Results of LCS analyses and associated laboratory control limits shall be included with each analytical report. Mandatory precision and accuracy data quality requirements for environmental measurements are identified below.

3.3.3.1 Laboratory Precision

Precision refers to the agreement among a set of replicate measurements without assumption or knowledge of the true value. At a minimum, the laboratory shall maintain precision indicator data within the following boundaries for each analytical batch containing SNL/NM samples:

- For metals analyses, values for aqueous LCS shall fall within 0 to 20 Relative Percent Difference (RPD) of a set of duplicate LCS measurements. The RPD value for non-aqueous liquids and solid LCS shall range from 0 RPD to the historical mean RPD plus three standard deviation units, for the matrix of interest.
• All other inorganic aqueous sample LCS shall fall within 0 to 25 RPD for each set of duplicate LCS measurements. The non-aqueous liquids and solid LCS RPD values shall range from 0 to the historical mean RPD plus three standard deviation units, for the matrix of interest.

• For organic compounds analyses, aqueous LCS values shall fall within the limits established in the analytical method. Non-aqueous LCS shall range from 0 to the historical mean RPD plus three standard deviation units.

• The precision of aqueous duplicate LCS analyses for radiological measurements shall range from 0 to the historical mean RPD plus three standard deviation units. In instances where sample preparation is not part of the analytical process (e.g., gamma spectroscopy), calibration verification standards (CVS) or duplicate sample measurements shall be performed. If CVS are used, the key isotopes shall fall within ± 3 standard deviation units of the mean value. For duplicate sample measurements, the reported activity of the greater value shall fall within the associated error range of the lesser value for the most abundant isotope present in the sample.

3.3.3.2 Measurement Data Accuracy

Measurement data accuracy refers to the agreement between an observed value and the accepted reference value. At a minimum, the laboratory shall maintain accuracy indicator data within the following boundaries for each analytical batch containing SNL/NM samples:

• The data quality requirement for aqueous metals analyses is to maintain the LCS measurements within 80 to 120 percent of the reference value. The data quality requirement for non-aqueous LCS values is to maintain LCS results within 3 standard deviation units from the historical mean recovery.

• The accuracy objective for all other inorganic analytes in an aqueous matrix is to maintain LCS measurements within 75 to 125 percent recovery of the reference value. Non-aqueous liquids and solid LCS recovery values shall be maintained within 3 standard deviation units from the historical mean recovery, for the matrix of interest.

• The accuracy objective for organic compound analyses for aqueous LCS are specified in the analytical method, non-aqueous and solid LCS recovery values shall fall within 3 standard deviation units from the historical mean recovery of the target analyte of interest, for the matrix of interest.

• The accuracy objective for radiological analyses is to maintain the recovery of LCS within 3 standard deviation units from the mean historical recovery for the isotope of interest.

3.3.4 Matrix Effect

In addition to assessing the precision and accuracy of each analytical process, where appropriate environmental samples shall be systematically evaluated for the matrix effect that the sample may have on the analytical system. This shall be accomplished by the preparation and analysis of matrix spike/matrix spike duplicate (MS/MSD) samples at the analytical laboratory. Matrix effect studies on routine water samples is usually inappropriate. MS/MSD analyses shall be performed in accordance with the specified analytical procedure.

The matrix effect on the accuracy of the analytical process should be determined for matrix types and batches of samples submitted to the laboratory. Samples designated by field personnel for MS/MSD analyses, in accordance with the project specific SAP or work plan, shall
be split into duplicate samples by the laboratory and fortified with the appropriate target analytes at appropriate concentrations, often specified in the analytical method. In addition to MS/MSD analyses, surrogate compounds shall be routinely added to samples intended for analysis by gas chromatography, when appropriate to the analytical method. Surrogate compounds shall be added at the sample preparation step at concentrations specified in the analytical method.

Matrix spike/matrix spike duplicate suggested acceptance limits for environmental data generation activities are as follows:

- The precision of metals and other inorganic analyses should be maintained within 0 to 50 RPD, and recovery should be within ± 25 percent of true value
- Precision and accuracy matrix effect measurements of organic compound MS/MSD analyses should meet the acceptance limits specified in the analytical method
- Surrogate compound recoveries should fall within limits specified in Appendix B, Tables B-4 and B-5
- Matrix effect on the precision and accuracy of the analytical system for radiological measurements should fall within 3 standard deviation units of the mean historical value for matrix spike analyses

3.3.5 Field and Laboratory Contamination

Quality control samples to evaluate contamination contributed from the sampling and analytical process should be evaluated with each sampling event and batch of samples analyzed at the laboratory. For the purposes of this program, contamination of samples during collection, transport, or analysis shall be maintained at a minimum. Therefore, target analytes should not be present in the appropriate laboratory blank samples at detectable concentrations or if present, below the laboratory quantitation limit. Procedures for evaluating sample analysis results when blank sample contaminants are present shall be followed. If laboratory contamination is observed at unacceptable levels, corrective action shall be initiated. Environmental sample results shall be qualified if laboratory contamination of associated blanks is observed. Field, equipment, and trip blanks with levels of contamination above corresponding laboratory quantitation limits shall be evaluated accordingly. Results of laboratory blank analyses shall be included with each analytical report.

3.3.6 Representativeness

Representativeness expresses the degree to which samples or analytical data represent a characteristic of a population, a process condition, or an environmental condition. Data representativeness should be attained through the proper design of the sampling program, including proper collection and processing of samples to ensure their representativeness, critical samples and background and/or upgradient samples, which give confidence that sample locations and the number of samples chosen describe the site sufficiently. The sampling program design should be developed considering applicable statistical methods (Gilbert, 1987) and EPA guidance (EPA, 1986c; EPA, 1986d; EPA, 1987a; EPA, 1988; EPA, 1989a; EPA, 1989b; EPA, 1989c; EPA, 1989d; EPA, 1989e) to provide confidence that an appropriate number of samples are collected and that sample locations provide suitable coverage.
3.3.7 Completeness

Completeness is a measure of the number of analytical data points meeting acceptance criteria for accuracy, precision, and any other required acceptance criteria compared to the expected number of data points. The SNL/NM SMO objective for analytical data completeness is 100 percent for critical samples and greater than 80 percent for all others. Critical samples should be identified in SAPs. Data completeness can be affected by several factors, such as laboratory accidents, insufficient sample volume, missed holding times, or sample breakage during shipment. Additionally, the ability to meet or exceed this objective depends on the nature of the samples submitted for analysis. Reported quantitation limits are heavily dependent upon the characteristics of the sample matrix, and thus, samples with unusual matrices should not be included in the completeness calculation.

3.3.8 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data comparability is be enhanced through the consistent use of standardized sampling techniques and the prescribed analytical methods (e.g., EPA SW-846). Data results shall be reported in units that are consistent with existing site data and applicable regulatory levels.

Data generated in more than one contractor laboratory for a single sampling project, or for the same media sampled over time, are comparable when standard sampling techniques and prescribed analytical methods are used. Duplicate or split samples sent to more than one contractor laboratory should be monitored for interlaboratory precision.

Data generated for duplicate or split samples in a field laboratory setting (Level 2 data) may, or may not, be comparable with contractor laboratory data (Level 3 data). Only when the field and contractor laboratories both adhere to requirements of the same prescribed analytical method can the data be considered comparable. Interlaboratory precision between the field laboratory and contractor laboratory should be calculated whenever split or duplicate samples are submitted. A minimum of 10 percent to 20 percent of a project samples should be split between both laboratories to calculate interlaboratory precision and to determine if bias might exist in the field laboratory results relative to the contract laboratory's methods.
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4.0 SAMPLING PROCEDURES

The selection of appropriate sampling locations and sampling strategies follows directly upon the development of project-specific DQOs. The chosen sampling strategy should provide attainment of data of the necessary quantity and quality to fill data gaps and consequently support specific decisions and/or regulatory actions.

In most cases, procedures for collecting soil and aqueous samples are selected, as appropriate, from FOPs developed by the organization responsible for sampling activity. The exact procedure(s) to be used for each sampling event should be defined in SAPs and work plans. If an SNL/NM approved FOP is used, it only needs to be referenced. If a unique procedure is needed (i.e., passive air, animal trapping, dioxin wipe sampling), then a detailed FOP should be written and be included as an appendix to the SAP or work plan. All sampling operations should be coordinated with the SNL/NM SMO.

4.1 Sample Containers

All samples should be collected and containerized in appropriate, properly pre-cleaned sample containers. Sample containers may vary according to the matrix and nature of the sample to be collected. Refer to applicable SMO guidance (SNL/NM, 1994d) for more specific information on the selection of the correct containers, container cleaning, required sample volumes, labeling preservation criteria, and holding times. This information is for routine analytical measurements such as physical properties, metals, organics, semivolatile organics, inorganics, polychlorinated biphenyls (PCB), pesticides, and radionuclides. Nonroutine measurements may have specialized requirements necessitating coordination with the SMO, preparation of a new OP or reference to other protocols.

4.2 Sample Preservation and Chain-of-Custody During Shipment

Sample preservation and chain-of-custody procedures for environmental and waste characterization activities are coordinated with the SMO. Appropriate procedures should be followed to facilitate sample preservation and ensure that all appropriate holding times can be met. Meeting analysis holding times is the joint responsibility of the sampling team leader, the SMO, and the analytical laboratory.

All samples shall be labeled when collected and stored as required by the appropriate OP. Chain-of-custody and associated documentation for all samples shall be maintained. Chain of custody requirements are presented in Chapter 3.0.

4.3 Quality Control Samples

Quality control samples should be collected as part of all SNL/NM sampling efforts unless it can be demonstrated that QC samples are not required to measure attainment of DQOs. Specific QC samples should be identified for all sampling activities in SAPs and work plans. Chapter 9.0 presents detailed information on the types and frequencies of field QC samples should be collected.
4.4 Equipment Decontamination

All samples should be collected with properly decontaminated equipment. Equipment decontamination is an integral part of the QA process for sample collection. The implementation of proper decontamination practices and procedures should be included in instructions on use of sample collection equipment in FOPs. The use of each type of sampling equipment is described in FOPs which should be reviewed for additional information regarding specific decontamination procedures. Wash water and other fluids created during decontamination shall be handled in accordance with the applicable SNL/NM policy specified in the SNL/NM ES&H Manual and any applicable project-specific waste management plans.

All expendable sampling equipment should be certified clean prior to use. The use of expendable sampling equipment should provide the highest level of quality data by minimizing the possibility of cross-contamination between samples. Also, the use of expendable sampling equipment does not generate decontamination solutions that require disposal at additional cost.
5.0 CHAIN OF CUSTODY

Chain-of-custody procedures are used to provide confidence for the proper handling of samples during collection and analysis. Sample custody procedures require that the possession and handling of the sample from the moment of its collection through analysis be documented by written record. The chain-of-custody records shall be initiated at the time of sample collection and remain in effect until the sample is disposed of. Chain of custody requirements for sample management are described below. Procedures for implementing these requirements are addressed in the SMO's "Administrative Operating Procedure for Sample Management and Custody" (SNL/NM, 1994d).

5.1 Sample Designation

Samples shall be assigned a unique numeric identifier as part of the chain-of-custody control during the transfer of samples from the time of collection through analysis and reporting. This identifier shall, at a minimum, be recorded on the sample label, field notes, analysis request and chain-of-custody record, and associated documentation to ensure traceability.

5.2 Field Custody Documentation

Record-keeping documentation for the samples shall include:

- Field logbook or standardized forms to document sampling activities in the field
- Waterproof labels to identify individual samples containers and preservation requirements
- Chain-of-custody record sheets for documenting transfer and possession of samples
- Laboratory analysis request sheet for documenting analyses to be performed. This may be combined with the chain-of-custody record sheet

The original chain-of-custody record sheets shall accompany the samples to the analytical laboratory. They should be sealed in plastic bags to provide protection from moisture during shipment to the analytical laboratory. The chain-of-custody record sheets shall list the sampler, sample number, sampling date and time, sample matrix, number of containers, preservatives used, analyses requested, turn-around time required and the shipping way-bill number. Individuals receiving and relinquishing custody of the samples shall sign and date the form using indelible ink. Standard documents that are used with each sample collection activity are identified below.

5.2.1 Field Logs

Data collection activities performed at a site should be documented using indelible ink. Entries onto forms and in notebooks should be as detailed and descriptive as possible, to provide objective documentation of the day's events. Collectively, all field documentation should be documented in enough detail that the sequence of daily activities may be reconstructed without reliance on the collector's memory. Field documentation quality assurance is the Project/Task Leader's responsibility.
5.2.2 Sample Collection Log Forms and Logbooks

As a means of facilitating the collection of accurate field and sampling information, standardized sample collection forms or logbooks may be used. SNL/NM SMO sample collection log (SCL) forms may be used to record data. Field data describing the sampling site, location, weather conditions, contact persons, sampling equipment, sample descriptions, etc., are recorded such that all relevant conditions are known and the event can be reconstructed later. Project-specific forms may be developed to meet unique data collection needs for individual tasks.

5.3 Laboratory Custody Documentation

The following subsections describe typical analytical laboratory custody procedures associated with sample receipt, storage, preparation, analysis and general security. Specific custody procedures for laboratory operations shall be described in the analytical laboratory QAPs and be adhered to for all analyses. It is the responsibility of the SMO to verify that the analytical laboratories are adequately performing the required procedures discussed in the following subsections.

5.3.1 Sample Receipt

Each analytical laboratory participating in analysis of SNL/NM SMO samples shall inspect the samples and documentation and inform the SMO of the sample arrival and condition of each shipment upon receipt. At a minimum, the following items shall be addressed:

- The analytical laboratory sample custodian shall inspect all sample containers for integrity. The condition of the samples upon receipt and presence of leaking or broken containers shall be noted on the chain-of-custody record, or Sample Check-in Form.
- The sample custodian shall also identify any discrepancies in the chain-of-custody documentation. The sample custodian shall sign the chain-of-custody record (with date and time of receipt), thus assuming custody of the samples.
- The information on the chain-of-custody record shall be compared with that on sample tags and labels to verify sample identity. The analytical laboratory sample custodian shall notify the SMO of all discrepancies in the chain-of-custody record. Any inconsistencies shall be resolved with the SMO before sample analysis proceeds. If needed, the SMO shall initiate and document all necessary corrective actions.
- Samples shall be placed in appropriate secure storage prior to analysis.
- The sample custodian shall alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

5.3.2 Sample Records

All analytical laboratory records shall be made in indelible ink in a bound notebook or appropriate standardized form according to the applicable analytical laboratory standard operating procedures. Analytical records may also be recorded in electronic format.

5.4 Corrections to Documentation

Incorrect entries shall be crossed out with a single line and the correct information shall be entered, initialed and dated by the person making the correction. There shall be no erasures, write-overs or deletions in any type of data document record. The original entry shall not be obliterated. Pages shall not be removed from field notebooks. Information that is voided or
superseded shall be clearly noted as such. Unused pages of field notebooks will be lined through, signed, and dated. Whenever possible, a brief explanation should be provided as to the reason why this information is no longer applicable.

5.5 Final Evidence File Documentation

The SMO shall maintain records to document QA/QC activities and to provide support for possible evidential proceedings. Records which provide documentary evidence of quality shall be specified, prepared and maintained in accordance with appropriate SNL/NM recordkeeping procedures. All SMO records shall be transferred to the Environmental Operations Records Center for cataloging and storage in accordance with DOE and EPA requirements.
6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 Overview

Equipment designated in sampling plans or work plans should provide data compatible with specified project requirements and desired results. The equipment type, range, accuracy and precision will be specified to meet project DQOs. Measuring and test equipment used in the field or an analytical laboratory must be controlled by formal calibration procedures, which are required to provide confidence in the proper operation of equipment and instruments. Calibration procedures shall be followed to produce and document the quality of data necessary to meet specified levels of analytical objectives, as required to meet project DQOs.

Calibration procedures ensure that measurement devices are calibrated and adjusted at specified, predetermined intervals using equipment and material having known valid relationships to National Institute of Standards and Technology (NIST), American Society for Testing and Materials (ASTM), or other widely recognized standards; or accepted values of natural physical constants. If national standards do not exist, the basis for the calibration should be documented. Calibration is based on the type of equipment, inherent stability of the equipment, manufacturer's recommendations, values given in national standards, intended level of analytical quality, or required published methodology.

6.2 Field Equipment

Calibration should be done according to manufacturer's specifications or as otherwise described in the SNL/NM FOPs and LOPs. Instrument maintenance and calibration shall be documented, and the records maintained for each field instrument used. These records should provide documentation concerning the instrument's ability to provide accurate measurements. Each instrument shall be assigned a unique serial number or designator so that tracking of instrument records can be accomplished. Unique identifiers or designators shall be used on all related documentation. All instruments found to be out of calibration will be tagged with recall tags and unavailable for use until repair and documented recalibration have been performed.

6.3 Laboratory Equipment

Before any instrument is used as a measuring device, the instrument response to known reference materials must be determined through the process of calibration. The manner in which various instruments are calibrated is dependent on the type of instrument, its intended use, and the analytical method. All analytical laboratories shall have specific detailed instrument calibration procedures for each analytical instrument, which will include the methods for verification and documentation of instrument conditions prior to and during testing.

Routine calibration standards are used in the analytical laboratory to demonstrate that the performance of an instrument will not cause unacceptable error in the analysis. This calibration will indicate instrument stability and sensitivity with respect to the required analytical method. Calibration criteria for each sampling event, beyond that given in the analytical methods, should be specified in project-specific sampling and analysis plans.
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7.0 ANALYTICAL PROCEDURES

Analytical procedures used should provide measures that ensure that the predetermined data QA objectives and goals of sampling and analysis plans are met. The SMO shall have procedures in place for initiating subcontractor laboratory support services. The laboratories shall have QA programs that ensure the required quality of data is consistently generated. Analytical laboratory measurement data shall be generated as per the laboratory's SOW, and measurement of field parameters should follow appropriate SNL/NM FOPs. This chapter presents analytical procedures and detection/quantification limits for data generation activities performed by the SMO.

7.1 Laboratory Methods

Groundwater, surface-water, soil, sediment, waste media, biota, and air samples collected are analyzed using the applicable EPA method (see Table 3-1) or other approved analytical methods. Radionuclides are analyzed using laboratory-specific methods, as per the laboratory's SOW, that follow DOE and EPA guidance for analyzing samples for radionuclides. Miscellaneous analytes and physicochemical tests on soil samples should be analyzed according to the applicable American Society of Testing and Materials (ASTM) methods.

All analytical methods shall be performed as written. Any changes and modifications shall be documented thoroughly in the narrative summary for the data package. All parameters specified by the method shall be determined. Compounds (i.e., tentatively identified compounds) may be added to subsequent analyses if they are identified and judged to be of concern.

Appendix B, Tables B-8 through B-13, from SW-846 (EPA, 1986b; EPA, 1987b; EPA, 1990) contain, for specific EPA SW-846 analytical methods, a list of parameters to be determined and, as appropriate, the Practical Quantitation Limits (PQL) or MDL for each parameter. Radionuclide Minimum Critical Levels are listed in Appendix B, Table B-14, and MDLs for miscellaneous analytes are listed in Table B-15. The contracts with analytical laboratories may vary over time. Thus, certain methods, PQLs, MDLs, or critical levels may change, particularly for the radiological analytes.

7.2 Field Testing

As part of some SAPs, several analytical parameters may be measured in the field during the environmental investigation. Approved SNL/NM FOPs shall be used for field determination of these parameters. Detection limits for field measurements, if applicable, should be included in the FOPs.
8.0 DATA REDUCTION, VERIFICATION AND VALIDATION, AND REPORTING

This chapter presents QA protocols for data reduction, verification, validation, and reporting activities performed as part of the SNL/NM SMO function.

8.1 Data Reduction

Data reduction is defined as those activities involved in the conversion of raw data to reportable units; transfer of data between recording media; and computation of summary statistics, standard errors, confidence intervals, and statistical tests (e.g., outlier evaluation). Statistically acceptable data analysis procedures shall be implemented for all data reduction steps.

8.1.1 Field Technical Data Reduction

Field technical data (i.e., level 1 data) collected during monitoring and investigations can generally be characterized as either objective or subjective. Objective data include all direct measurements (e.g., field analytical data, water-level measurements). Subjective data include descriptions and observations, such as a preliminary site description. Some activities (e.g., test boring and well logging) include both types of data in that the data recorded in the field are descriptive but can be characterized and subsequently reduced using standardized lithologic coding systems.

Field personnel should record field data on standardized forms or in notebooks. At the completion of daily activities, field data forms and logs should be checked for completeness by field personnel. For field measurement data that require reduction using calculations to obtain final concentrations/values, reduction activities should be conducted in accordance with applicable FOPs. The required equations, calculations, documentation, checking, and reporting should be specified in the FOPs. Field technical data should be reduced to tabular form wherever possible, by entering into electronic data management programs (e.g., data bases, spreadsheets). Input data should be verified against the original data source to minimize transcription errors. Subjective data shall be filed in the SNL/NM Environmental Operations Records Center as hard copies for incorporation into technical reports as appropriate.

Occasionally, a field measurement may result in an outlier with a value significantly outside the expected range for most field conditions. When identified, an outlier is recorded as would any other field measurement, and whenever possible at least two additional measurements should be made and recorded to verify or invalidate the suspected outlier. When appropriate, field instrumentation and calibration should be checked following the appropriate FOP(s) and the parameter remeasured. If after this check, the value remains the same, it is considered a valid measurement. However, if instrument malfunction is suspected as the source of anomalous data, appropriate steps should be taken to verify instrument performance. Equipment failure should be documented by a Nonconformance Corrective Action Report (NCAR) (Form SF 2042 NCA [1094]), as described in Chapter 13.0 of this QAP (see AOP 94-18).

8.1.2 Laboratory Data Reduction

At the completion of a set of laboratory analyses, all calculations are completed and reviewed by the analyst. Calculations using raw data to obtain final concentrations are performed according to the procedures described in the specified analytical method and the laboratory's QA manual. Data reduction calculations may be performed manually or electronically if the analytical instrument is interfaced with a microprocessor.
The associated QC check data (e.g., laboratory duplicates and replicates, surrogate and matrix spike, and QC reference sample data) shall be used to verify that data are within the control limits specified for the analytical method. If results are not within the limits, corrective actions shall be taken as per the specified analytical method and the laboratory's QA Program. Typically, if all data are acceptable, the data is entered into the analytical laboratory computer system, and data summaries (including raw data) are submitted to the analytical laboratory QC reviewer for laboratory validation. Following the QC review, a hard-copy data summary shall be reviewed and signed by supervisory or management person at the laboratory.

8.2 Data Verification and Validation

Data verification is a systematic process of reviewing a body of data for documentation completeness, attainment of contractual and SAP requirements. Data validation is a systematic process of reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use (EPA, 1983). The validation criteria depend upon the type(s) of data involved and the purpose for which data are collected. The data validation process will result in qualifiers of the data as to whether it is acceptable, conditional, or unacceptable. Data verification and validation requirements are specified below in the following subsections. Detailed procedures for performing data verification and validation are provided in the "Verification and Validation of Chemical and Radiochemical Data" (SNL/NM, 1994c).

8.2.1 Field Technical Data Verification

Field technical data verification and validation should consider, as applicable

- Qualification and training of personnel collecting data
- Results of field audits
- Completeness and reasonableness of the field documentation
- Completeness of sample collection and field measurement data
- Compliance with FOPs that relate to field technical data collection
- Verification of the results recorded on field forms with the final reported results

Verification of objective field technical data should be performed at two different levels. On the first level, field personnel should see that FOPs are followed at the time of data collection, all data are recorded, and that appropriate QC checks are performed. At the second level, data should be validated by a technical peer not involved directly with data collection, who should review the data to evaluate that the correct information and units have been included. After data has been reduced into tables or arrays, the technical peer should review data sets for anomalous values. Any inconsistencies or anomalies discovered by the reviewer should be resolved immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data. Deficiencies that cannot readily be resolved should be documented by an NCAR, as described in Chapter 13.0 of this QAP.

Subjective field technical data should be validated by a technically qualified peer not involved directly with data collection, who should review field reports for reasonableness and completeness. In addition, scheduled and unscheduled audits of sampling and field conditions should be conducted. Whenever possible, peer review should be incorporated into the data verification and validation process, particularly for subjective data, to maximize consistency among field personnel.
8.2.2 Laboratory Data Verification and Validation

The initial responsibility for monitoring the quality of analytical data lies with the analytical laboratory analyst. In this pursuit, the analyst shall verify that all QC procedures specified for each analytical method are followed and that the results of QC check sample analyses are within the acceptance criteria established for the method.

Beyond the analytical laboratory, SMO personnel are responsible for data verification and, when requested by the Project Leader, validation. The data validation process is specified in an SMO Technical Operating Procedure (TOP) for Verification and Validation of Chemical and Radiochemical Data (TOP 94-03). This TOP defines the levels of data verification and validation to be used for the validation of chemical and radiochemical data. The level(s) of verification/validation to be used and the required frequency of verification and validation should be specified in the SAP.

The project-specific verification/validation requirements should document that, as applicable

- The appropriate FOPs were used during sample collection
- Samples were preserved and handled in accordance with applicable OPs
- The appropriate number and type of field and laboratory QC check samples were collected
- Data packages were complete, as per the analytical laboratory SOW
- Analyses were performed by the methods specified in the work plan, and any deviations from specified analytical methods are documented (case narrative)
- Field and laboratory QC checks met the established acceptance criteria

In general, the specific criteria to be reviewed in the laboratory data validation process depend on the sample matrix, analytical method, and applicable regulatory requirements.

8.3 Data Reporting

Level III laboratory data may be reported on magnetic media and in hard copy data reports. All analytical laboratory data report packages for each type of analysis should contain a case narrative that, on the given set of samples, summarizes as applicable

- The date of issue
- The contents of the laboratory report with page count
- The project name and number
- The laboratory analysis performed
- A reference to the analytical method
- Any deviations from the stated analytical method
- The laboratory batch number
- Unique sample identification
- The number of samples and sample matrix
- The state of the samples received (e.g., whether preserved and packaged properly)
- Whether sample holding times were met, and identification of those that were not
• Any observations that may have had an impact on the analyses
• Any technical problems or nonconformances affecting the analysis and corrective actions taken
• Laboratory QC checks that did not meet the project/method criteria and/or laboratory criteria (include any corrective actions taken and any known possible reasons for the results)
• Analytical laboratory supervisor or management's signature approving the issuance of the data package

Complete data packages including raw sample and calibration data may be required based on the use of the data. Laboratory reporting requirements and report format should be specified in an SMO administrative OP and in laboratory SOWs. The following subsections identifies minimum reporting requirements for analytical data packages.

8.3.1 Chemical Analytical Data
The standard analytical laboratory data reports for chemical analysis data should consist of a transmittal letter and, as applicable,
• Case narrative that summarizes the information discussed above (Section 8.3)
• Copies of the analysis request and chain-of-custody forms
• Sample analytical results and QC summaries
• All laboratory QC data including, reagent blank, LCS, matrix spike, laboratory duplicate or spike duplicate, and surrogate recovery data and associated control limits
• Method quantitation limits for all parameters and dilutions

Organic analytical results (VOCs, SVOCs, pesticides/PCBs, and herbicides) should be reported in micrograms per liter (µg/L) for aqueous samples and in micrograms per kilogram (µg/kg) for soil/sediment samples.

The standard analytical laboratory data reports for inorganic data should consist of a transmittal letter and
• Case narrative that summarizes the information discussed above (Section 8.3)
• Copies of the analysis request and chain-of-custody forms
• Sample analytical results and QC summaries and associated laboratory control limits
• All laboratory QC data including, reagent blank, LCS, matrix spike and spike duplicate, and laboratory duplicate

Inorganic (metals) analytical results should be reported in µg/L for aqueous samples and in milligrams per kilogram (mg/kg) for soil/sediment samples.

Miscellaneous analyte parameters should be reported in milligrams per liter (mg/L) for aqueous samples and in mg/kg for soil/sediment samples. All laboratory analytical reports shall be archived by the SNL/NM Environmental Operations Records Center.
8.3.2 Radiochemical Analytical Data

- Analytical laboratory data packages for radiochemical analyses should consist of a transmittal letter and, as applicable,
- Case narrative that summarizes the information discussed above (Section 8.3)
- Copies of the analysis request and chain-of-custody forms
- Actual sample results including the critical level, determination level, and quantitation level as defined by (Currie, 1968) and associated 2-sigma error
- Instrument calibration information (including date, time, technician)
- All laboratory radiochemical QC data including reagent blank, laboratory duplicate, spiked samples (matrix spikes), standard reference materials, corresponding laboratory control limits

Radiochemical analytical results should be reported in picocuries per liter (pCi/L) for aqueous samples and in picocuries per gram (pCi/g) for soil/sediment samples. Total uranium should be reported in μg/L for aqueous samples and micrograms per grams (μg/g) for soil/sediment samples. Tritium should be reported in pCi/L for both aqueous and solid samples. All laboratory analytical reports shall be archived by the SNL/NM Environmental Operations Records Center.

8.3.3 Non-analytical Data Reporting

Non-analytical data should consist of physicochemical results for tests performed on soil and sediment samples (see Appendix B, Table B-7). Data packages for these tests should include a case narrative that contains all applicable components, as discussed above (Section 8.3). The results of each test should be reported in the units consistent with the method.
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9.0 INTERNAL QUALITY CONTROL CHECKS

Field sampling and laboratory analytical activities should be subjected to QC checks by the introduction of QC samples. These samples should be introduced into the analytical stream in order to assess the overall quality of the data produced. The QC samples should be used to evaluate precision, accuracy, and sample contamination associated with the sampling/analytical process. Chapter 8.0 of this QAP discusses the evaluation of QC samples. The types of QC samples to be utilized and the frequency of collection and analysis are described in the following sections. Specific QC samples to be collected during a sampling effort must be identified in project specific SAPs.

9.1 Field Sampling

QC checks for field sampling provide a means of evaluating the accuracy of the overall sample collection and analysis system. Field blanks, trip blanks, equipment (rinsate) blanks, and field duplicate samples should be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Blank samples should be analyzed to check for contamination related to sampling procedures and ambient conditions at the site that may have caused sample contamination. Duplicate samples should be analyzed to check for sampling and analytical reproducibility. A detailed definition of each type of QC sample is provided in Appendix A of this QAP.

A recommended level of QC for non-radiological samples is summarized in Table 9-1. For radiological constituents, two types of field QC samples, field duplicates and equipment blanks, should be collected and analyzed. Table 9-2 describes these samples and the acceptance criteria to be used to evaluate the resulting radiological data obtained from their analysis. Guidance for determining the appropriate types of QC samples to collect and analyze is discussed below.

For the purposes of the SMO, duplicate samples taken at the appropriate level will be used as an indication of the precision of the selected sampling and analysis procedures for the designated medium. The level of precision required is dependent on the DQO process and must be determined prior to any decision making based on the resultant data. Specific QC checks for the collection of soil or water samples are described in the following subsections.

9.1.1 Soil Sampling

QC checks for field soil sampling activities should follow guidance provided in the EPA Soil Sampling Quality Assurance User's Guide (EPA, 1989b). Tables 9-1 and 9-2 presents the recommended frequency of QC for soil sampling activities. Field duplicate soil samples should be given a unique numeric identifier and submitted to the analytical laboratory as a blind sample (i.e., unidentifiable to the laboratory as a duplicate sample). Field duplicate soil samples will be identified on the appropriate field forms. Analysis of a field soil blank for VOC should be included in the sampling plan whenever the possibility for VOC contamination from field or laboratory activities is a concern.
Table 9-1
Recommended Field Quality Control Samples
for Non-radiological Sampling

<table>
<thead>
<tr>
<th>Type</th>
<th>Applicable Matrix</th>
<th>Purpose of Sample</th>
<th>Frequency</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Blank</td>
<td>Water</td>
<td>To evaluate reagent and ambient contamination</td>
<td>1 with each sample batch sent to the laboratory or 1 per 20 samples</td>
<td>If contaminants are detected, the data should be evaluated in order to determine probable source and impact on sample results</td>
</tr>
<tr>
<td>Equipment Blank</td>
<td>Water</td>
<td>To evaluate decontamination procedures and cross sample contamination by sampling equipment</td>
<td>1 with each sample batch sent to the laboratory or 1 per 20 samples</td>
<td>If contaminants are detected, the data should be evaluated in order to determine probable source and impact on sample results</td>
</tr>
<tr>
<td>Trip Blank</td>
<td>Water and Soil</td>
<td>To evaluate VOC contamination originating from sample, transport, shipping, and site conditions</td>
<td>1 per cooler containing VOC samples</td>
<td>If contaminants are detected, the data should be evaluated in order to determine probable source and impact on sample results</td>
</tr>
<tr>
<td>Field Duplicate</td>
<td>Soil, Sediment, and Water</td>
<td>To evaluate the overall precision of the sampling and analysis system</td>
<td>1 with each sample batch sent to the laboratory or 1 per 20 samples</td>
<td>RPD* less than or equal to 20 percent (guidance only, RPDs for low concentration constituents and soil may exceed 20 percent)</td>
</tr>
</tbody>
</table>

*RPD = relative percent difference.
### Table 9-2
Field Radiological Quality Control Samples

<table>
<thead>
<tr>
<th>Type</th>
<th>Applicable Matrix</th>
<th>Purpose of Sample</th>
<th>Frequency</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Blank</td>
<td>Water</td>
<td>To evaluate decontamination procedures</td>
<td>1 with each sample batch sent to the laboratory or 1 per 20 samples</td>
<td>If radiological constituents are detected, the data should be evaluated in order to determine probable source and impact on sample results.</td>
</tr>
<tr>
<td>Field Duplicate</td>
<td>Soil, Sediment, Water</td>
<td>To evaluate the overall precision of the sampling analysis system</td>
<td>1 with each sample batch sent to the laboratory or 1 per 20 samples</td>
<td>RPD(^a) less than or equal to 20 percent (guidance only, RPDs for low concentration radionuclides and soils may exceed 20 percent)</td>
</tr>
</tbody>
</table>

\(^a\)RDP = relative percent difference

#### 9.1.2 Water Sampling

Field QC checks for surface-water and groundwater sampling activities should include the recommended types of samples presented in Tables 9-1 and 9-2. Field duplicate water samples should be given a unique numeric identifier and submitted to the laboratory blind, (i.e., unidentifiable to the laboratory as a duplicate sample). These samples should serve as blind field collocated samples (collected as close as possible) and are used to evaluate field and analytical laboratory reproducibility. Field duplicate water samples should be identified on the appropriate field forms.

#### 9.2 Field Measurements

The Administrative Operating Procedure for Preparing Sampling and Analysis Plans, Site-Specific Sampling Plans, and Field Operating Procedures (SNL/NM, 1994a) describes the QC checks for the measurement of field data. These include functional checks and calibration of equipment and associated documentation.

#### 9.3 Analytical Laboratory

Laboratory QC requirements for analyses performed by EPA SW-846 protocols are specified in the methods for organic and inorganic analyses (EPA, 1986a; EPA 1986b; EPA 1987b). Table 9-3 presents a summary of the analytical laboratory QC checks to be performed. The analytical laboratory shall use QC sample results to evaluate the accuracy and precision of analytical data (Chapter 3.0 of this QAP), and SNL/NM SMO personnel shall use QC sample results, as required, to validate laboratory data (Chapter 8.0 of this QAP). All analytical laboratory QC programs shall meet the requirements of the appropriate regulatory program (see Table 3-1) and the laboratory's statement of work. QC samples include matrix spikes, reagent blanks,
surrogate compounds, QC reference samples, replicate samples, and subsamples, where applicable. Matrix spikes provide information about the effect of the sample matrix on the analytical methodology. Matrix spike analysis should be performed on SNL/NM samples. Specific samples to be spiked and subsampled shall be identified on the ARCOC forms.

Subsampling should be performed whenever heterogeneous samples are encountered. When the entire content of sample containers is subjected to analysis by a given method, subsampling is not required. When more than the analytical sample size is collected; however, processing and subsampling is recommended. SAPs shall address the following:

- Minimizing the possibility of subsample bias and nonrepresentative sampling
- Assure that the processing and subsampling is completed correctly
- Assure that samples analyzed are representative of the material of interest
- Subsampling duplicate requirements shall be indicated on the ARCOC Record.

Surrogate spike and QC reference samples provide checks of the methodology, technique, standards, or percent recovery. Surrogate compounds shall be introduced into every sample subjected to organic analysis by gas chromatography, including duplicates and QC reference samples (EPA, 1987b).

Laboratory reagent blanks are prepared and analyzed by the laboratory whenever the method requires sample preparation using chemical reagents. Reagent blank results are evaluated by the laboratory to determine whether or not laboratory introduced contamination is contributing to sample results.

Replicate samples are analyzed in the laboratory in each analytical batch to monitor analytical precision in each sample matrix. Samples for replicate analysis are selected by the laboratory and are independent of field collected duplicate samples.

A more detailed summary of analytical laboratory QC checks, including laboratory calibration requirements and QC acceptance criteria, shall be specified in the analytical laboratory SOW. (A detailed definition of each laboratory QC sample is provided in Appendix A of this QAP.)
<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Applicable Methods</th>
<th>Purpose of Sample</th>
<th>Sample Frequency</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrix Spike Sample</td>
<td>Inorganic</td>
<td>To evaluate the effect of the sample matrix on analytical performance.</td>
<td>For each sample matrix, 1 per analytical batch or 1 per 20 samples, whichever is more frequent.</td>
<td>75 to 125 percent recovery and 0 to 50 percent RPD&lt;sup&gt;a&lt;/sup&gt; for metals matrix spiked samples; for other analytes, see Chapter 3.0</td>
</tr>
<tr>
<td></td>
<td>organic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reagent Blank</td>
<td>Inorganic</td>
<td>To correct for contamination due to sample preparation or processing.</td>
<td>Every blank, standard, and environmental sample (including duplicates, quality control reference samples, and check standards) shall be spiked with surrogate compounds prior to purging or extraction.</td>
<td>If contaminants are detected, the laboratory shall evaluate data and make corrections if necessary.</td>
</tr>
<tr>
<td></td>
<td>organic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surrogate Compounds</td>
<td>Organic</td>
<td>To evaluate the effect of the sample matrix on analytical performance.</td>
<td>1 per analytical batch or 1 per 20 samples, whichever is more frequent.</td>
<td>See Chapter 3.0 or specific method, otherwise ±20 percent</td>
</tr>
<tr>
<td>Quality Control Reference Sample</td>
<td>Inorganic</td>
<td>An independent check on technique methodology and standards.</td>
<td>1 per analytical batch or 1 per 20 samples, whichever is more frequent.</td>
<td>See Chapter 3.0, method-specific</td>
</tr>
<tr>
<td></td>
<td>organic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replicate Sample</td>
<td>Inorganic</td>
<td>To evaluate laboratory precision.</td>
<td>1 replicate set per analytical batch or 1 per 20 samples, whichever is more frequent.</td>
<td>±20 percent for metals; for other analytes, see Chapter 3.0</td>
</tr>
<tr>
<td></td>
<td>organic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-sample Duplicate</td>
<td>Inorganic</td>
<td>To evaluate subsample precision (representative ness)</td>
<td>1 duplicate per sample type or whenever high variability is suspected</td>
<td>See Chapter 3.0, project-specific</td>
</tr>
<tr>
<td></td>
<td>organic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>RPD = relative percent difference.
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10.0 ASSESSMENTS AND SURVEILLANCES

This section addresses the planning, implementation and reporting of performance assessments, system assessments, and surveillances. Assessments and surveillances are conducted to monitor the capability and performance of the total measurement system(s). Procedures for performing field and laboratory assessments are described in SMO OPs for contract laboratory management (SNL/NM, 1994b). Assessments consist of two types, performance assessments and system assessments:

- Performance assessments indicate whether the results of project activities are capable of meeting project requirements and show that the system in place functions properly. Performance assessments typically focus on one or more project activities in real time.
- A system assessment determines whether appropriate project systems (e.g., qualified personnel, procedures, equipment, and instruments) are in place. System assessments qualitatively evaluate on-site project activities, such as documentation of data collection, for compliance with established QA program and procedure requirements.

Surveillances verify compliance with selected aspects of project and QA program requirements. Less rigorous in nature than assessments, surveillances are intended to provide rapid feedback to project staff and to facilitate prompt corrective actions.

10.1 Performance Assessments

Acceptable performance for SMO related data generation activities is defined as compliance with the requirements of this QAP; any associated administrative OPs; sampling and analysis plans; waste management plans; and applicable and relevant regulations. Performance assessments are conducted as field or off-site data are generated, reduced, and analyzed during the course of the project. As appropriate to a specific project, types of performance assessments include:

- Field performance assessments with respect to applicable OPs
- Laboratory performance assessments with respect to the analytical SOW and applicable methods

10.1.1 Field Performance Assessments

Field performance assessments ensure that the methods and protocols detailed in this QAP, work plans, SAPs, waste management plans, and analytical SOW are being consistently adhered to in the field and field laboratories. Field performance assessments should include, but are not limited to, a review of:

- The completeness of data logbooks, forms, and equipment calibration records
- Working knowledge of project specific plans (e.g., QAPs, work plans, OPs) and pertinent program documents
- Field measurements and field screening results
- Adherence to drilling and sampling procedures
- Compliance with sample container labeling, handling, and custody procedures
- Completeness of sample chain-of-custody/request for analysis documentation
- The number and type of QC samples collected.
10.1.2 Laboratory Performance Assessments

Laboratory performance assessments determine the accuracy of laboratory measurement systems. All laboratories providing support to the SNL/NM environmental and waste management activities shall be subject to performance assessment requirements as specified in the laboratory's SOW. A laboratory performance assessment evaluates activities specific to the investigation. At a minimum, the laboratory's performance will be assessed to include:

- Implementation and follow-through of the laboratory QC program
- Sample custody and handling
- Sample preparation
- Sample tracking
- Analytical methods
- Data reduction
- Internal data validation
- Instrument calibration
- Documentation of data analysis/data reduction

Laboratories shall participate in analysis of performance evaluation samples or assessment samples as required by the SMO, EPA, and/or the State of New Mexico performance evaluation programs (if required in the future). Analysis results should be compared to predetermined or calculated acceptance limits. Records of performance evaluation samples shall be maintained and any problems shall be identified, corrective actions taken, and performance re-evaluated prior to analysis of additional applicable samples.

10.2 System Assessments

System assessments verify the application of the QC system and evaluate the level of compliance with the system. System assessments for SNL/NM SMO projects cover, as appropriate, field operations and documentation, laboratory activities, and final reports. Work areas, activities, activity documentation, and QA/QC procedures and the effectiveness of their implementation are evaluated. System assessments may include, but are not limited to:

- Conformance of sampling activities to QC systems, specified OPs and QA requirements
- Subcontractor performance to stated contracts
- Field operations records
- Laboratory testing records
- Equipment calibration records
- Identification and control of samples and other data
- Numerical analyses of the data
- Transmittal of information (e.g., report preparation)
- Record control and retention
- Personnel training records
- Document control procedures
- Technical peer review documentation

10.2.1 Project System Assessments

Project system assessments evaluate whether the requirements of this QAP are being met. The Director of the Environmental Operations Center, Department Managers, Task and Project...
Leaders, or the Quality Assurance and Compliance Department may request that an assessment be conducted in addition to those which are regularly scheduled.

10.2.2 Laboratory System Assessments

A laboratory system assessment may include, but is not limited to reviewing the laboratory

- QA Plan
- Instrumentation and/or analytical system developed for the analyses of interest
- Sample handling, log-in, and custody procedures
- Sample preparation methods
- Data reduction and reporting procedures
- Internal data validation procedures
- Instrument calibration procedures
- QC program developed for the methods
- Conformance with the contract SOW

Prior to implementation of new off-site analytical services contracts, a pre-award assessment visit to the laboratory(s) shall be performed. Laboratory system assessments during the course of a contract shall include an on site visit of the laboratory(s) by SNL/NM representatives or designees

Technical assessments to verify adherence to requirements of this QAP as stated in the contract SOW shall be conducted at all laboratories generating levels 3 and 4 data and at field laboratories generating level 2 data used for regulatory compliance and decision making purposes will also be assessed.

10.3 Surveillances

Surveillances can consist of the evaluating some of the same project and system elements as performance or system assessments. Surveillances are less formal than an assessment and more limited in scope. Scheduling, planning, conducting, and reporting of surveillances will follow accepted practices.

10.4 Assessment/Surveillance Personnel

The SMO assessment/surveillance team shall include personnel with the necessary expertise and knowledge of field and laboratory operations to address the requirements established in this QAP and other relevant requirements. The SMO Project Leader, or designee, functions as the team leader and is responsible for the selection of assessment/surveillance team members. All assessors shall be independent of any direct responsibility for performance of the activities which they assess.

10.5 Frequency of Assessments and Surveillances

Assessments will be regularly executed as part of SMO routine operations. The SMO Project Leader should participate in system and performance assessments of each contract laboratory at least once during the contract term. Surveillances may be conducted at anytime as determined by the project requirements or in response to conditions perceived as possible adverse to quality.
10.6 Assessment Documents

Assessment records shall include plans, reports, corrective action requests (if necessary), written replies, and a record of completion of corrective actions. An individual assessment plan shall be developed to provide a basis for each assessment. The assessment team shall develop and document a plan that identifies

- The assessment scope
- Requirements
- Personnel
- Activities to be assessed
- Organizations to be notified
- Applicable documents
- Schedule
- Written procedures and assessment plates

Assessment questions are developed by the SMO Project Leader, or designee, and an assessment plate is used to provide a complete review and document results. Assessment results shall be formally documented by personnel and reported by the Project Leader in a report. An assessment report contains any observations, findings, and associated corrective actions. The Project Leader, or designee, signs the report which typically includes

- A description of the assessment scope
- Names of the assessors
- Names of persons contacted during the assessment
- A summary of results
- A statement on the effectiveness of the contractor's QA program elements
- Findings with sufficient detail to determine the cause and to enable corrective action by the assessed organizations

In the event that the lead assessor is not the SMO Project Leader, the assessment report shall be approved by the SMO Project Leader. Assessment reports are maintained as part of the program files and in the EORC. Assessment and surveillance reports are considered public documents.

When corrective actions are required, it is the responsibility of the analytical laboratory to provide a Corrective Action Report that details planned action to correct the findings and a schedule for completion. The Project Leader, or designee, shall certify that all assessment findings are resolved and the appropriate corrective actions implemented in a timely manner. The Project Leader shall attempt to resolve any disagreements or disputes related to assessment or surveillance findings. If a satisfactory resolution cannot be reached, the issue will be elevated to the next level of management.
11.0 PREVENTIVE MAINTENANCE

Proper preventive maintenance of field and laboratory equipment is a necessary element for achieving equipment reliability. All field and laboratory instruments and equipment used to collect samples and generate analytical data should be maintained to manufacturer's recommendations and specifications. Instruments and equipment should be checked periodically, on a schedule specified by the manufacturer, to provide confidence that equipment is in proper working condition. Maintenance should be performed according to manufacturer's specifications for routine maintenance or when the instrument will not Adequately tune, calibrate, or is providing sporadic results. Professional judgment of the equipment operator should be used to determine when additional maintenance checks may be necessary.

11.1 Field and Analytical Equipment

Equipment should be properly calibrated, charged, and in good general working condition before it is used on each work day. FOPs define the required equipment operational checks and calibration requirements for each type of field equipment. Field equipment which does not meet the operational checks or calibration requirements should be taken out of service until acceptable performance can be verified. Non-operational field equipment will be removed from service and returned to the supplier, and a replacement obtained. Equipment that is removed from service should be appropriately tagged or segregated from operational equipment to preclude inadvertent use.

All field instruments should be properly protected against inclement weather conditions during environmental investigations. At the end of each working day, all field equipment (except self-propelled equipment) should be taken out of the field and placed in appropriate storage.

11.2 Laboratory Equipment

Each analytical laboratory shall be responsible for performing or managing both the maintenance and preventive maintenance of their analytical equipment. Maintenance requirements, a spare parts list, and instructions shall be included in individual methods or in the laboratory QA Manual.

11.3 Preventive Maintenance Documentation

Instrument maintenance and calibration should be documented, and the records maintained, for each instrument used. Each instrument should be assigned a unique identifier or serial number which is affixed to the instrument. Unique identifiers or serial numbers should be used on all related documentation. This numbering system should enable the tracking of instrument records. Minimum information for each entry will typically include the

- Date performed
- Description of maintenance performed including parts replaced
- Standard used to calibrate equipment (i.e., lot number and type)
- Name of person performing maintenance

These records should be reviewed prior to equipment use to ensure that instrument maintenance and calibration are up to date.
For each piece of equipment, an individual is responsible for maintaining the equipment usage sign-out log and ensuring that the scheduled maintenance is performed at the appropriate time. The equipment custodian maintains the equipment usage/sign-out log and performs the scheduled maintenance at the appropriate times. If equipment is serviced by the manufacturer, objective documentation shall be required to confirm its performance (e.g., certificate of calibration).
12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA QUALITY PARAMETERS

This chapter presents the specific routine procedures used to assess analytical data quality. To ensure that data quality is assessed in terms of the Chapter 3.0 requirements in a consistent manner, instructions are given in the following sections for the evaluation of blanks and the quantification of precision, accuracy, and completeness. Procedures for assessing data quality shall comply with applicable regulatory and SMO requirements. Analytical precision and accuracy shall be calculated and reported by the laboratory for every data set. Chapter 9.0 of this QAP discusses the QC samples that are collected and analyzed in support of data quality assessment. Where possible, the routine procedures discussed in this chapter should be followed for assessment of the quality of field measurement data and data obtained by nonstandard methods.

12.1 Blank Evaluation

Trip, laboratory reagent, and equipment rinsate blank sample results should be evaluated for contamination. Contamination of a blank is defined as a concentration that causes a difference in an observed sample concentration that is greater than or equal to the smallest significant digit. If blank contamination is encountered, the suspected procedures (i.e., sample collection, shipment, and/or laboratory analysis) should be reviewed. If a laboratory reagent blank in addition to a trip, field, or equipment rinsate blank exhibits contamination, the source is probably within the analytical laboratory. Contamination of trip and field blanks may also be due to contaminated sample containers or cross contamination due to sample leakage. Collection of field blank samples is only necessary when ambient contamination of samples is a concern (e.g., volatile organic compounds are present). Contamination of field and rinsate blanks may indicate ambient contamination of the sampling environment or the presence of contaminants in the solution used for decontamination, respectively. Rinsate blanks that exhibit contamination may be indicative of sample cross contamination due to improper or incomplete decontamination procedures. Actions of the analytical laboratory in response to laboratory blank contamination shall be specified in the laboratory SOW.

12.2 Precision

Precision is expressed as a standard deviation among a group of measurements or as a RPD. Standard deviation is defined as follows:

\[ s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \]

where,

\[ s = \text{Standard deviation} \]
\[ \bar{x} = \text{Mean of replicate measurements} \]
\[ x_i = \text{Measured value of the } i^{\text{th}} \text{ replicate} \]
\[ n = \text{Number of replicates}. \]

The mean is calculated as follows:
\[
\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}
\]

where,
- \(\bar{x}\) = Mean of replicate measurements
- \(x_i\) = Measured value of the \(i^{th}\) replicate
- \(n\) = Number of replicates.

RPD is calculated as follows:
\[
RPD = \left| \frac{D_1 - D_2}{(D_1 + D_2)/2} \right| \times 100\%
\]

where,
- \(RPD\) = Relative percent difference
- \(D_1\) = First sample value
- \(D_2\) = Second sample value (duplicate).

12.3 Accuracy

Analytical accuracy (bias) is expressed as the percent recovery of a known amount of analyte that is added to a sample prior to analysis. If the spike is added to an environmental sample, percent recovery is determined as follows:
\[
p = \frac{(A - B)}{T} \times 100\%
\]

where,
- \(p\) = Percent recovery
- \(A\) = Concentration of sample after spiking
- \(B\) = Background concentration (environmental sample result)
- \(T\) = Reference value of the spike.

If the spike is added to a QC reference sample, percent recovery is calculated as follows:
\[
p_s = \frac{(A)}{T} \times 100\%
\]

where,
- \(p_s\) = Percent recovery
- \(A\) = Measured concentration
- \(T\) = True value of the spike.
Subtraction of background is not necessary if the QC reference sample is prepared with ASTM Type II reagent water.

12.4 Completeness

Completeness is expressed as the percent of all measurements that are determined to be valid. The percent completeness for sample collection or field measurements is defined as follows:

\[ c_F = \left( \frac{V_F}{n_F} \right) \times 100\% \]

where,

- \( c_F \) = Percent completeness
- \( V_F \) = Number of samples collected or valid field measurements taken
- \( n_F \) = Total number of critical samples or field measurements required to achieve a specified statistical level of confidence in decision making.

The percent completeness for laboratory data is expressed as follows:

\[ c_L = \left( \frac{V_L}{n_L} \right) \times 100\% \]

where,

- \( c_L \) = Percent completeness
- \( V_L \) = Number of valid data points
- \( n_L \) = Total number of laboratory data points necessary to achieve a specified statistical level of confidence in decision making.

Completeness shall be calculated and reported for individual analytical parameters. Samples with unusual matrices should not be included in completeness calculations.
13.0 CORRECTIVE ACTION

Corrective action is required to correct deficiencies resulting from an unauthorized deviation from documented procedures, practices, standards, or a defect in an item that could lead to the degradation of quality. The resulting deficiencies require review to determine what, if any, corrective action may be required to correct the problem. All SMO personnel are responsible for identifying and reporting deficiencies, and initiating the corrective action process. Documentation of nonconforming items or processes will typically be on a NCAR or other forms intended to detail the circumstances of the deviation.

13.1 Initiating Corrective Action

Deficiencies shall be reported and corrective action initiated by the SMO or contracted laboratories if any of the following conditions arise:

- Specific requirements of the analysis method or OPs are not met
- Data quality measurements for precision, accuracy and completeness are not achieved
- Lab or field data review indicates that data are incomplete or that improper calculation, methodology or technique was employed, or that an instrument malfunction has occurred

Each SAP and project specific QAP should identify predetermined limits for data acceptability beyond which corrective action is required. If a deficiency is found, the SMO Project Leader and Task Leader should determine if the data in question may impact project quality objectives. If the data are critical, the SMO and Task/Project Leader shall identify the individual(s) responsible for implementation and approve the appropriate corrective action to be taken. Efforts shall be taken to evaluate the root cause(s) of the deficiency. Corrective actions taken should be designed to preclude the re-occurrence of nonconforming items or processes. Corrective action may include one or more of the following:

- Additional information or recalculations are supplied.
- Instrument operation and calibration are checked. Calibration standards are checked and new standards obtained if necessary. Instrument malfunctions are corrected.
- Personnel receive training specific to the correction action.
- Personnel repeat the task using the correct procedure.
- A different individual repeats the task using the correct procedure.
- Samples are re-analyzed (if holding times expire, data may be further qualified).
- Sampling and/or analytical procedures are evaluated and amended.
- Personnel repeat the task using a new or modified procedure.
- If practical, a new sample is collected and analyzed.

After the above steps are taken, the person responsible for implementing the corrective action will evaluate whether the deficiency was resolved. If the deviation was not resolved the data are reported with qualifying statements. In some cases, depending on the nature and degree of deviation, no data may be reported.

Corrective actions may also be initiated as a result of other QA activities, to include performance assessments, systems assessments, or outside agency assessment activities.
13.2 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements and observations lies with the field personnel. The field team leader is responsible for verifying that all QC procedures are followed. This requires that the correctness of field methods and the ability of those methods to meet QA objectives be assessed. All field project staff have the responsibility to report observed deficiencies that might jeopardize the integrity of the project or cause some specific QA objective not to be met. Field project staff shall report all such suspected deficiencies to the SMO Project Leader.

13.3 Laboratory Corrective Action

The responsibility for monitoring the quality of analytical systems lies with the contract laboratory personnel. All corrective activities resulting from deficiencies occurring at the analytical laboratory shall comply with that analytical laboratory's QA Program. Additionally, the analytical laboratory must notify the SMO of the deficiency and, if possible, identify potential causes and corrective action.
14.0 QA REPORTS TO MANAGEMENT

Management should be kept apprised of project status and events impacting quality, both informally and formally. Open channels of communication should be fostered among SMO participants and management at all times. Additionally, any regularly scheduled status reports shall include a discussion of quality activities, if any.

14.1 Sample Management Reports

The SMO should provide reports of the results of any QA/QC activities and documentation associated with the handling, shipping and analysis of samples to the Task/Project Leaders and Department Managers.

14.2 QA Reports to Management

The SNL/NM SMO Project Leader shall provide the Environmental Operations Center Department Managers with a summary and analysis of the results of system and performance assessments and data review activities on a quarterly basis. Any programmatic QA issues identified that adversely affect the quality of data generated shall be reported to the Department Managers immediately.
15.0 REFERENCES


DOE, see United States Department of Energy.

EPA, see United States Environmental Protection Agency.


SNL/NM, see Sandia National Laboratories/New Mexico.


United States Environmental Protection Agency, Office of Solid Waste, Permits and State Programs Division, Washington, D.C.


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APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS
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QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS

Accuracy
The degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system. Accuracy is assessed by means of reference samples and percent recoveries.

Analytical Batch
The basic unit for analytical quality control is the analytical batch. The analytical batch is defined as samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition (e.g., ground water, sludge, ash, etc.).

Blank or Sample
A sample of a carrying agent (gas, liquid, or solid) normally used to selectively capture a material of interest.

Calibration
Establishment of a relationship between various calibration standards and the measurements of them obtained by a measurement system or portions of the system.

Calibration Standard
A standard used to quantify the relationship between the output of a sensor and a property to be measured. Calibration standards should be traceable to standard reference materials, certified reference materials, or a primary standard.

Certified Reference Materials
A material produced in quantity when certain properties have been certified to the extent possible to satisfy its intended use by the National Institute of Standards and Technology or other agencies.

Chain-of-Custody
Inventory control information that, when documented, attests to the integrity of data (sample[s]) collected.

Check Standard
A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process.

Comparability
The confidence with which one data set can be compared to another.

Completeness
A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

Customer
Ultimate user, requestor, consumer, client, beneficiary or second party.

Data Quality
The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are: accuracy, precision, completeness, representativeness, and comparability.

Data Quality Objectives
Qualitative and quantitative statements specified to ensure that data of known and appropriate quality are obtained to support specific decisions or regulatory actions.
QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS (Continued)

Data Validation
A systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, certification, and review.

Defensibility
Ability to defend, through documented objective evidence, the origin, chain-of-custody, matrix of scientifically-acceptable operations performed, reduction and transcription of data, so that limitations, representativeness, and applicability are clearly known.

Environmental Samples
An environmental sample or field sample is a representative sample of any material (aqueous, non-aqueous, or multi-media) collected from any source for which determination of composition or contamination is requested or required.

Environmentally Related Measurements
A term used to describe essentially all field and laboratory investigations that generate data involving (1) the measurement of chemical, physical, or biological parameters in the environment, (2) the determination of the presence or absence of criteria or priority pollutants in waste streams, (3) assessment of health and ecological effect studies, (4) conduct of clinical and epidemiological investigations, (5) performance of engineering and process evaluations, (6) study of laboratory simulation of environmental events, and (7) study or measurement of pollutant transport and fate, including diffusion models.

Equipment (Rinsate) Blank
Usually an organic or aqueous solution that is as free of analyte as possible and is transported to the site, opened in the field, and poured over or through the sample collection device, collected in a sample container, and returned to the laboratory. This serves as a check on the sampling device cleanliness. One equipment blank should be analyzed with each analytical batch or every 20 samples, whichever is greater.

Field Blank
Usually an organic or aqueous solution that is as free of analyte as possible and is transferred from one vessel to another at the sampling site and preserved with the appropriate reagents. This serves as a check on reagent and environmental contamination. One field blank should be analyzed with each analytical batch or every 20 samples, whichever is more frequent.

Field Duplicate Samples
Multiple separate samples taken from the same source but placed in separate containers and analyzed independently. Independent samples collected in such a manner that they are co-located samples equally representative of the sample matrix at a given location and time. Field duplicates will be indistinguishable from other analytical samples so that the personnel performing the analyses are not able to determine which samples are duplicates. Field duplicates determine total random error.

Field Soil Blank
Clean native soil, dried and prepared for use as a field blank to assess contamination by volatile organic compounds.

Grab Sample
A discrete aliquot which is representative of a specific location at specific time.
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<td>A standard composed of the analyte(s) of interest from a different source than that used in the preparation of standards for use in the standard curve.</td>
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<td>Laboratory (Reagent) Blank</td>
<td>A sample which is prepared and analyzed by the laboratory, prior to and during analysis of each sample batch, to demonstrate that identified compound concentrations do not reflect laboratory contamination.</td>
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<td>Laboratory Control Sample (LCS)</td>
<td>A known matrix spiked with compound(s) representative of the target analytes. This is used to document laboratory performance.</td>
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<td>Laboratory Duplicates</td>
<td>Two aliquots taken in the laboratory from the same sample container with one of the aliquots identified as the duplicate and the other aliquot the original sample. Also referred to as laboratory subsamples. Each aliquot is treated identically through the laboratory analytical procedure.</td>
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<td>Matrix Spike</td>
<td>A predetermined quantity of stock solutions of certain analytes that is added to a sample matrix prior to sample extraction/digestion and analysis in order to obtain a measure of accuracy for an analytical method. The concentration of the spike should be at the regulatory standard level or the Practical Quantitation Limit (PQL) for the method. When the concentration of the analyte in the sample is greater than 0.1 percent, no spike of the analyte is necessary.</td>
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<tr>
<td>Method Blank</td>
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<tr>
<td>Method Detection Limit (MDL)</td>
<td>The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero.</td>
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<td>Minimum Detectable Level (Limit of Detection)</td>
<td>The limit of detection for an analytical method is the minimum concentration of the constituent or species of interest that can be observed by the instrument and distinguished from instrument noise with a specified degree of probability.</td>
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<tr>
<td>Practical Quantitation Limit (PQL)</td>
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<td>Precision</td>
<td>A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions.</td>
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<tr>
<td>Quality Assurance</td>
<td>A system for integrating the quality planning, quality assessment, and quality improvement efforts to meet user requirements.</td>
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<tr>
<td>Quality Control</td>
<td>The routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.</td>
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<tr>
<td>Quality Control Reference Sample</td>
<td>A sample prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range.</td>
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QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS (Continued)

Quality Control Samples
Samples used to check the operation of a measurement system to obtain a measure of the quality of the data generated. Include the following:
- Blank samples
- Duplicate samples
- Split (replicate [4]) samples
- Matrix spike samples.

Reagent Blank
Usually an organic or aqueous solution that is as free of analyte as possible and contains all the reagents in the same volume as used in the processing of the samples.

Replicate Analysis
Repeated, but independent, analyses of the same sample by the same analyst, at essentially the same time and under the same conditions.

Replicate Samples
Multiple aliquots taken from the same sample container and analyzed independently.

Representativeness
The degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Reproducibility
The precision, usually expressed as a standard deviation, measuring the variability among results of a measurement on the same sample at different laboratories.

Sensitivity
The degree to which an instrument (or method) can detect a particular compound.

Shall
Denotes activities that are mandatory to the SNL/NM ER program.

Should
Denotes activities that are recommended for the SNL/NM ER program.

Spiked Sample
A normal sample of material (gas, liquid, or solid) to which is added a known amount of some substance of interest.

Standard Curve
A curve which plots concentrations of known analyte standards versus the instrument response to the analyte.

Surrogate
Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples.

System Audit
A review of the Quality Control system to ensure that a comprehensive set of Quality Control methods, procedures, reviews, and sign-off approvals are established or in place. Such audits may be either planned or unannounced.

Traceability
A documented chain of comparisons connecting a working standard to a national standard, such as a standard maintained by the National Institute of Standards and Technology.
QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS (Continued)

**Trip Blank**
Usually an organic or aqueous solution that is as free of analyte as possible and is transported to the sampling site and returned to the laboratory without being opened. A trip blank consists of a sample that is prepared by the laboratory prior to the sampling event. The trip blank is contained in the actual sample containers and is kept with the investigative samples throughout the sampling event. Trip blanks are handled and packaged for shipment in the same manner as other investigative samples. This serves as a check on sample contamination originating from sample transport, shipping, and from the site conditions. One trip blank should be analyzed with each analytical batch or every 20 samples, whichever is greater. Trip blanks are generally used only in volatile organic sampling and shipping activities.

**Water**
Any reference to water in the EPA SW-846 Method refers to American Society for Testing and Materials (ASTM) Type II reagent water (unless otherwise specified) which is free of contaminants that may interfere with the analytical test in question.

**Vendor Certification**
A process used to evaluate and confirm a vendor's ability to meet specified or contractual requirements.
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APPENDIX B

ANALYTICAL METHODS, QUANTITATION LIMITS, AND ACCEPTANCE CRITERIA
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Quality Control Acceptance Criteria for Sample Data from Volatile Organic Analysis by United States EPA Method 8240\textsuperscript{a,b}

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Refer to footnotes at end of table.
Table B-1 (Concluded)

Quality Control Acceptance Criteria for Sample Data from Volatile Organic Analysis by United States EPA Method 8240\textsuperscript{a,b}

| Parameter                | Limit for \( s \)\textsuperscript{c} (\( \mu g/L \)) | Range for \( x \)\textsuperscript{d} (\( \mu g/L \)) | Range for \( p \)\textsuperscript{e} (% Recovery) |
|--------------------------|----------------------------------------------------|---------------------------------------------------|-------------------------------------------------
| Trichlorofluoromethane   | 10.0                                               | 8.9-31.5                                          | 17-181                                           |
| Vinyl chloride           | 20.0                                               | D-43.5                                            | D-251                                            |

\textsuperscript{a}EPA, 1987.

\textsuperscript{b}Based on analysis of a quality control reference sample that contains 20 micrograms per liter (\( \mu g/L \)) of each analyte.

\textsuperscript{c}s = Standard deviation of four recovery measurements, in \( \mu g/L \).

\textsuperscript{d}x = Average of four recovery measurements, in \( \mu g/L \).

\textsuperscript{e}p = Percent recovery measured.

\textsuperscript{f}D = Detected; result must be greater than zero.
Table B-2
Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by United States EPA Method 8270<sup>a,b</sup>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for s&lt;sup&gt;2&lt;/sup&gt; (µg/L)</th>
<th>Range for χ&lt;sup&gt;2&lt;/sup&gt; (µg/L)</th>
<th>Range for ρ&lt;sup&gt;b&lt;/sup&gt; (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>27.6</td>
<td>60.1-132.3</td>
<td>47-145</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>40.2</td>
<td>53.5-126.0</td>
<td>33-145</td>
</tr>
<tr>
<td>Aldrin</td>
<td>39.0</td>
<td>7.2-152.2</td>
<td>D&lt;sup&gt;1&lt;/sup&gt;-166</td>
</tr>
<tr>
<td>Anthracene</td>
<td>32.0</td>
<td>43.4-118.0</td>
<td>27-133</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>27.6</td>
<td>41.8-133.0</td>
<td>33-143</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>38.8</td>
<td>42.0-140.4</td>
<td>24-159</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>32.3</td>
<td>25.2-145.7</td>
<td>11-162</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>39.0</td>
<td>31.7-146.0</td>
<td>17-163</td>
</tr>
<tr>
<td>Benzo(ghi)perylene</td>
<td>58.9</td>
<td>D-195.0</td>
<td>D-219</td>
</tr>
<tr>
<td>Benzyl butyl phthalate</td>
<td>23.4</td>
<td>D-139.9</td>
<td>D-152</td>
</tr>
<tr>
<td>β-BHC</td>
<td>31.5</td>
<td>41.5-130.6</td>
<td>24-149</td>
</tr>
<tr>
<td>δ-BHC</td>
<td>21.6</td>
<td>D-100.0</td>
<td>D-110</td>
</tr>
<tr>
<td>Bis(2-chloroethyl)ether</td>
<td>55.0</td>
<td>42.9-126.0</td>
<td>12-158</td>
</tr>
<tr>
<td>Bis(2-chloroethoxy)methane</td>
<td>34.5</td>
<td>49.2-164.7</td>
<td>33-184</td>
</tr>
<tr>
<td>Bis(2-chloroisopropyl)ether</td>
<td>46.3</td>
<td>62.8-138.6</td>
<td>36-166</td>
</tr>
<tr>
<td>Bis(2-ethylhexyl)phthalate</td>
<td>41.1</td>
<td>28.9-136.8</td>
<td>8-158</td>
</tr>
<tr>
<td>4-Bromophenyl phenyl ether</td>
<td>23.0</td>
<td>64.9-114.4</td>
<td>53-127</td>
</tr>
<tr>
<td>2-Chloronaphthalene</td>
<td>13.0</td>
<td>54.5-113.5</td>
<td>60-118</td>
</tr>
<tr>
<td>4-Chlorophenyl phenyl ether</td>
<td>33.4</td>
<td>38.4-144.7</td>
<td>25-158</td>
</tr>
<tr>
<td>Chrysene</td>
<td>48.3</td>
<td>44.1-136.9</td>
<td>17-168</td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>31.0</td>
<td>D-134.5</td>
<td>D-145</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>32.0</td>
<td>19.2-119.7</td>
<td>4-136</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>61.6</td>
<td>D-170.6</td>
<td>D-203</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>70.0</td>
<td>D-199.7</td>
<td>D-227</td>
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<tr>
<td>Di-n-butyl phthalate</td>
<td>16.7</td>
<td>8.4-111.0</td>
<td>1-118</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>30.9</td>
<td>48.6-112.0</td>
<td>32-129</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>41.7</td>
<td>16.7-153.9</td>
<td>D-172</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>32.1</td>
<td>37.3-105.7</td>
<td>20-124</td>
</tr>
<tr>
<td>3,3'-Dichlorobenzidine</td>
<td>71.4</td>
<td>8.2-212.5</td>
<td>D-262</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>30.7</td>
<td>44.3-119.3</td>
<td>29-136</td>
</tr>
<tr>
<td>Diethyl phthalate</td>
<td>26.5</td>
<td>D-100.0</td>
<td>D-114</td>
</tr>
<tr>
<td>Dimethyl phthalate</td>
<td>23.2</td>
<td>D-100.0</td>
<td>D-112</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>21.8</td>
<td>47.5-126.9</td>
<td>39-139</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^c$ (µg/L)</th>
<th>Range for $x^2$ (µg/L)</th>
<th>Range for $p^b$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,6-Dinitrotoluene</td>
<td>29.6</td>
<td>68.1-136.7</td>
<td>50-158</td>
</tr>
<tr>
<td>Di-n-octylphthalate</td>
<td>31.4</td>
<td>18.6-131.8</td>
<td>4-146</td>
</tr>
<tr>
<td>Endosulfan sulfate</td>
<td>16.7</td>
<td>D-103.5</td>
<td>D-107</td>
</tr>
<tr>
<td>Endrin aldehyde</td>
<td>32.5</td>
<td>D-188.8</td>
<td>D-209</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>32.8</td>
<td>42.9-121.3</td>
<td>26-137</td>
</tr>
<tr>
<td>Fluorene</td>
<td>20.7</td>
<td>71.6-108.4</td>
<td>59-121</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>37.2</td>
<td>D-172.2</td>
<td>D-192</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>54.7</td>
<td>70.9-109.4</td>
<td>26-155</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>24.9</td>
<td>7.8-141.5</td>
<td>D-152</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>26.3</td>
<td>37.8-102.2</td>
<td>24-116</td>
</tr>
<tr>
<td>Hexachloroethane</td>
<td>24.5</td>
<td>55.2-100.0</td>
<td>40-113</td>
</tr>
<tr>
<td>Indeno(1,2,3-cd)pyrene</td>
<td>44.6</td>
<td>D-150.9</td>
<td>D-171</td>
</tr>
<tr>
<td>Isophorone</td>
<td>63.3</td>
<td>46.6-180.2</td>
<td>21-196</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>30.1</td>
<td>35.6-119.6</td>
<td>21-133</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>39.3</td>
<td>54.3-157.6</td>
<td>35-180</td>
</tr>
<tr>
<td>N-Nitrosodipropylamine</td>
<td>55.4</td>
<td>13.6-197.9</td>
<td>D-230</td>
</tr>
<tr>
<td>PCB-1260</td>
<td>54.2</td>
<td>19.3-121.0</td>
<td>D-164</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>20.6</td>
<td>65.2-108.7</td>
<td>54-120</td>
</tr>
<tr>
<td>Pyrene</td>
<td>25.2</td>
<td>69.6-100.0</td>
<td>52-115</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>28.1</td>
<td>57.3-129.2</td>
<td>44-142</td>
</tr>
<tr>
<td>4-Chloro-3-methylphenol</td>
<td>37.2</td>
<td>40.8-127.9</td>
<td>22-147</td>
</tr>
<tr>
<td>2-Chlorophenol</td>
<td>28.7</td>
<td>36.2-120.4</td>
<td>23-134</td>
</tr>
<tr>
<td>2,4-Chlorophenol</td>
<td>26.4</td>
<td>52.5-121.7</td>
<td>39-135</td>
</tr>
<tr>
<td>2,4-Dimethylphenol</td>
<td>26.1</td>
<td>41.8-109.0</td>
<td>32-119</td>
</tr>
<tr>
<td>2,4-Dinitrophenol</td>
<td>49.8</td>
<td>D-172.9</td>
<td>D-191</td>
</tr>
<tr>
<td>2-Methyl-4,6-dinitrophenol</td>
<td>93.2</td>
<td>53.0-100.0</td>
<td>D-181</td>
</tr>
<tr>
<td>2-Nitrophenol</td>
<td>35.2</td>
<td>45.0-166.7</td>
<td>29-182</td>
</tr>
<tr>
<td>4-Nitrophenol</td>
<td>47.2</td>
<td>13.0-106.5</td>
<td>D-132</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>48.9</td>
<td>38.1-151.8</td>
<td>14-176</td>
</tr>
<tr>
<td>Phenol</td>
<td>22.6</td>
<td>16.6-100.0</td>
<td>5-112</td>
</tr>
<tr>
<td>2,4,6-Trichlorophenol</td>
<td>31.7</td>
<td>52.4-129.2</td>
<td>37-144</td>
</tr>
</tbody>
</table>

"EPA, 1987."

Refer to footnotes at end of table.
Table B-2 *(Concluded)*

Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by United States EPA Method 8270\textsuperscript{a,b}

\textsuperscript{b}Based on analysis of a quality control reference sample that contains 100 micrograms per liter (µg/L) of each analyte.

\(c_e\) = Standard deviation of four recovery measurements, in µg/L.

\(\bar{X}\) = Average of four recovery measurements, in µg/L.

\(^*p\) = Percent recovery measured.

\(\text{ID}\) = Detected; result must be greater than zero.
## Table B-3
Quality Control Acceptance Criteria for Sample Data from Organochlorine Pesticide and PCB Analysis by United States EPA Method 8080\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for ( s^c ) (µg/L)</th>
<th>Range for ( x^d ) (µg/L)</th>
<th>Range for ( p^e ) (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>0.42</td>
<td>1.08-2.24</td>
<td>42-122</td>
</tr>
<tr>
<td>α-BHC</td>
<td>0.48</td>
<td>0.98-2.44</td>
<td>37-134</td>
</tr>
<tr>
<td>β-BHC</td>
<td>0.64</td>
<td>0.78-2.60</td>
<td>17-147</td>
</tr>
<tr>
<td>δ-BHC</td>
<td>0.72</td>
<td>1.01-2.37</td>
<td>19-140</td>
</tr>
<tr>
<td>γ-BHC</td>
<td>0.46</td>
<td>0.86-2.32</td>
<td>32-127</td>
</tr>
<tr>
<td>Chlordane</td>
<td>10.0</td>
<td>27.6-54.3</td>
<td>45-119</td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>2.8</td>
<td>4.8-12.6</td>
<td>31-141</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>0.55</td>
<td>1.08-2.60</td>
<td>30-145</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>3.6</td>
<td>4.6-13.7</td>
<td>25-160</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.76</td>
<td>1.15-2.49</td>
<td>36-146</td>
</tr>
<tr>
<td>Endosulfan I</td>
<td>0.49</td>
<td>1.14-2.82</td>
<td>45-153</td>
</tr>
<tr>
<td>Endosulfan II</td>
<td>6.1</td>
<td>2.2-17.1</td>
<td>D\textsuperscript{f}-202</td>
</tr>
<tr>
<td>Endosulfan sulfate</td>
<td>2.7</td>
<td>3.8-13.2</td>
<td>26-144</td>
</tr>
<tr>
<td>Endrin</td>
<td>3.7</td>
<td>5.1-12.8</td>
<td>30-147</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.40</td>
<td>0.86-2.00</td>
<td>34-111</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>0.41</td>
<td>1.13-2.63</td>
<td>37-142</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>12.7</td>
<td>27.8-55.5</td>
<td>41-126</td>
</tr>
<tr>
<td>PCB-1016</td>
<td>10.0</td>
<td>30.5-51.5</td>
<td>50-114</td>
</tr>
<tr>
<td>PCB-1221</td>
<td>24.4</td>
<td>22.1-75.2</td>
<td>15-178</td>
</tr>
<tr>
<td>PCB-1232</td>
<td>17.9</td>
<td>14.0-98.5</td>
<td>10-215</td>
</tr>
<tr>
<td>PCB-1242</td>
<td>12.2</td>
<td>24.8-69.6</td>
<td>39-150</td>
</tr>
<tr>
<td>PCB-1248</td>
<td>15.9</td>
<td>29.0-70.2</td>
<td>38-158</td>
</tr>
<tr>
<td>PCB-1254</td>
<td>13.8</td>
<td>22.2-57.9</td>
<td>29-131</td>
</tr>
<tr>
<td>PCB-1260</td>
<td>10.4</td>
<td>18.7-54.9</td>
<td>8-127</td>
</tr>
</tbody>
</table>

\( ^a \)EPA, 1987.

\( ^b \)Based on analysis of a quality control reference sample prepared as per Method 8080.

\( ^c \)S = Standard deviation of four recovery measurements, in micrograms per liter (µg/L).

\( ^d \)\( \bar{x} \) = Average of four recovery measurements, in µg/L.

\( ^e \)p = Percent recovery measured.

\( ^f \)D = Detected; result must be greater than zero.
Table B-4
Surrogate Spike Recovery Limits for Sample Data from Volatile Organic Analysis by United States EPA Method 8240\textsuperscript{a}

<table>
<thead>
<tr>
<th>Surrogate Compound</th>
<th>Low/Medium Concentration Water Samples (% Recovery)</th>
<th>Low/Medium Concentration Soil/Sediment Samples (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Bromofluorobenzene</td>
<td>86-115</td>
<td>74-121</td>
</tr>
<tr>
<td>1,2-Dichloroethane-\textsubscript{d\textsubscript{4}}</td>
<td>76-114</td>
<td>70-121</td>
</tr>
<tr>
<td>Toluene-\textsubscript{d\textsubscript{8}}</td>
<td>88-110</td>
<td>81-117</td>
</tr>
</tbody>
</table>

\textsuperscript{a}EPA, 1987.
Table B-5  
Surrogate Spike Recovery Limits for  
Sample Data from Semivolatile Organic Analysis  
by United States EPA Method 8270a

<table>
<thead>
<tr>
<th>Surrogate Compound</th>
<th>Low/Medium Concentration Water Samples (% Recovery)</th>
<th>Low/Medium Concentration Soil/Sediment Samples (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrobenzene-d$_5$</td>
<td>35-114</td>
<td>23-120</td>
</tr>
<tr>
<td>2-Fluorobiphenyl</td>
<td>43-116</td>
<td>30-115</td>
</tr>
<tr>
<td>p-Terphenyl-d$_{14}$</td>
<td>33-141</td>
<td>18-137</td>
</tr>
<tr>
<td>Phenol-d$_6$</td>
<td>10-94</td>
<td>24-113</td>
</tr>
<tr>
<td>2-Fluorophenol</td>
<td>21-100</td>
<td>25-121</td>
</tr>
<tr>
<td>2,4,6-Tribromophenol</td>
<td>10-123</td>
<td>19-122</td>
</tr>
</tbody>
</table>

### Table B-6
Analysis Methods for Aqueous Samples

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organics</strong></td>
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</tr>
<tr>
<td>Volatile organics</td>
<td>EPA SW-846 Method 8240&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Semivolatile organics</td>
<td>EPA SW-846 Method 8270&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Organochlorine pesticides and PCBs</td>
<td>EPA SW-846 Method 8080&lt;sup&gt;b,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Explosives residues</td>
<td>EPA SW-846 Method 8330&lt;sup&gt;b,g&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chlorinated herbicides</td>
<td>EPA SW-846 Method 8150&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Radionuclides</strong></td>
<td></td>
</tr>
<tr>
<td>Americium-241</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Curium-244</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gamma spectroscopy (all peaks reported)</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gross alpha</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gross beta</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Isotopic plutonium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>(plutonium-238, 239/240)</td>
<td></td>
</tr>
<tr>
<td>Isotopic thorium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>(thorium-228, 230, 232)</td>
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</tr>
<tr>
<td>Isotopic uranium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>(uranium-233/234, 235/236, 238)</td>
<td></td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Radium-226, 228</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Strontium-89, 90</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total uranium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tritium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Inorganics</strong></td>
<td></td>
</tr>
<tr>
<td>Metals&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>EPA SW-846 Method 7060</td>
</tr>
<tr>
<td>Lead</td>
<td>EPA SW-846 Method 7421</td>
</tr>
<tr>
<td>Mercury</td>
<td>EPA SW-846 Method 7470</td>
</tr>
<tr>
<td>Potassium</td>
<td>EPA SW-846 Method 7610</td>
</tr>
<tr>
<td>Selenium</td>
<td>EPA SW-846 Method 7740</td>
</tr>
<tr>
<td>Thallium</td>
<td>EPA SW-846 Method 7841</td>
</tr>
<tr>
<td>Boron</td>
<td>EPA SW-846 Method 6010&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>EPA SW-846 Method 7197&lt;sup&gt;b,k&lt;/sup&gt;</td>
</tr>
<tr>
<td>Silicon</td>
<td>EPA SW-846 Method 6010&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table B-6 (Concluded)
Analysis Methods for Aqueous Samples

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity, as CaCO₃</td>
<td>EPA Method 310.1</td>
</tr>
<tr>
<td>Ammonia, as N</td>
<td>EPA Method 350.1 or 350.2</td>
</tr>
<tr>
<td>Bromide</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Cyanide (total)</td>
<td>EPA SW-846 Method 9010 or 9012</td>
</tr>
<tr>
<td>Fluoride</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Nitrate, as N</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Nitrate/Nitrite, as N</td>
<td>EPA Method 353.2 or 353.3</td>
</tr>
<tr>
<td>Nitrite, as N</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Phosphate, as P</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Sulfate</td>
<td>EPA Method 300.0</td>
</tr>
<tr>
<td>Sulfide</td>
<td>EPA Method 376.1</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>Total organic carbon (TOC)</td>
<td>EPA Method 415.2</td>
</tr>
<tr>
<td>Total organic halides (TOX)</td>
<td>EPA SW-846 Method 9020</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>EPA Method 160.2</td>
</tr>
</tbody>
</table>

aRefer to Table B-8 for list of volatile organic compounds.
cRefer to Table B-9 for list of semivolatile organic compounds.
dRefer to Table B-10 for list of organochlorine pesticides and PCBs.
EPA, 1986a.
EPA, 1986b.
Refer to Table B-11 for list of explosives residue compounds.
Refer to Table B-12 for list of chlorinated herbicides.
Analycal-laboratory-specific methods will be in accordance with standard DOE-approved methods.
Refer to Table B-13 for complete list of metals.
EPA, 1986b.
EPA, 1983.
EPA, 1986c.
<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organics</strong></td>
<td></td>
</tr>
<tr>
<td>Volatile organics&lt;sup&gt;a&lt;/sup&gt;</td>
<td>EPA SW-846 Method 8240&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Semivolatile organics&lt;sup&gt;c&lt;/sup&gt;</td>
<td>EPA SW-846 Method 8270&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Organochlorine pesticides and PCBs&lt;sup&gt;d&lt;/sup&gt;</td>
<td>EPA SW-846 Method 8080&lt;sup&gt;b,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Explosives residues&lt;sup&gt;f&lt;/sup&gt;</td>
<td>EPA SW-846 Method 8330&lt;sup&gt;b,g&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chlorinated herbicides&lt;sup&gt;h&lt;/sup&gt;</td>
<td>EPA SW-846 Method 8150&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Radionuclides</strong></td>
<td></td>
</tr>
<tr>
<td>Americium-241</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Curium-244</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gamma spectroscopy (all peaks reported)</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gross alpha</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gross beta</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Isotopic plutonium&lt;sup&gt;i&lt;/sup&gt; (plutonium-238,-239/240)</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Isotopic thorium&lt;sup&gt;i&lt;/sup&gt; (thorium-228,-230,-232)</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Isotopic uranium&lt;sup&gt;i&lt;/sup&gt; (uranium-233/234,-235/236,-238)</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Radium-226</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Strontium-89,-90</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total uranium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tritium</td>
<td>Analytical laboratory statement of work&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Inorganics</strong></td>
<td></td>
</tr>
<tr>
<td>Metals&lt;sup&gt;j&lt;/sup&gt;</td>
<td>EPA SW-846 Method 6010 and 7000 series&lt;sup&gt;b,k&lt;/sup&gt;</td>
</tr>
<tr>
<td>Arsenic</td>
<td>EPA SW-846 Method 7060</td>
</tr>
<tr>
<td>Lead</td>
<td>EPA SW-846 Method 7421</td>
</tr>
<tr>
<td>Mercury</td>
<td>EPA SW-846 Method 7471</td>
</tr>
<tr>
<td>Potassium</td>
<td>EPA SW-846 Method 7610</td>
</tr>
<tr>
<td>Selenium</td>
<td>EPA SW-846 Method 7740</td>
</tr>
<tr>
<td>Thallium</td>
<td>EPA SW-846 Method 7841</td>
</tr>
<tr>
<td>Boron</td>
<td>EPA SW-846 Method 6010&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>EPA SW-846 Method 7197&lt;sup&gt;b,k&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table B-7 *(Concluded)*

*Analysis Methods for Soil/Sediment Samples*

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>EPA Method 300.0(^{1})</td>
</tr>
<tr>
<td>Cyanide (total)</td>
<td>EPA SW-846 Method 9010 and 9012(^{b,m})</td>
</tr>
<tr>
<td>Fluoride</td>
<td>EPA Method 300.0(^{1})</td>
</tr>
<tr>
<td>Nitrate, as N</td>
<td>EPA Method 300.0(^{1})</td>
</tr>
<tr>
<td>Phosphate, as P</td>
<td>EPA Method 300.0(^{1})</td>
</tr>
<tr>
<td>Sulfate</td>
<td>EPA Method 300.0(^{1})</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
</tr>
<tr>
<td>Total inorganic carbon</td>
<td>EPA SW-846 Method 9060(^{m})</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>EPA SW-846 Method 9060(^{m})</td>
</tr>
<tr>
<td><strong>Physiochemical Tests</strong></td>
<td></td>
</tr>
<tr>
<td>Atterberg limits</td>
<td>ASTM D4318 (1984)(^{n})</td>
</tr>
<tr>
<td>Capillary-moisture</td>
<td>ASTM D2325 (1981)(^{n})</td>
</tr>
<tr>
<td>Cation exchange capacity</td>
<td>EPA SW-846 Method 9081(^{m})</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D4254 (1983)(^{n})</td>
</tr>
<tr>
<td>Grain size</td>
<td>ASTM D422 (1972)(^{n})</td>
</tr>
<tr>
<td></td>
<td>ASTM D1140 (1971)(^{n})</td>
</tr>
<tr>
<td>Moisture content</td>
<td>ASTM D2216 (1980)(^{n})</td>
</tr>
<tr>
<td>Permeability</td>
<td>ASTM D2434 (1974)(^{n})</td>
</tr>
<tr>
<td>Porosity</td>
<td>ASTM D4645 (1987)(^{n})</td>
</tr>
</tbody>
</table>

\(^{a}\)Refer to Table B-8 for list of volatile organic compounds.

\(^{b}\)EPA, 1987.

\(^{c}\)Refer to Table B-9 for list of semivolatile organic compounds.

\(^{d}\)Refer to Table B-10 for list of organochlorine pesticides and PCBs.

\(^{e}\)EPA, 1986a.

\(^{f}\)Refer to Table B-11 for list of explosives residue compounds.

\(^{g}\)EPA, 1990.

\(^{h}\)Refer to Table B-12 for list of chlorinated herbicides.

*Analytical-laboratory-specific methods will be in accordance with standard DOE-approved methods.*

\(^{k}\)EPA, 1986b.

\(^{l}\)EPA, 1991.

\(^{m}\)EPA, 1986c.

\(^{n}\)ASTM, 1989.
### Table B-8

Practical Quantitation Limits for Volatile Organics in Water and Soil/Sediment by United States EPA

**SW-846 Method 8240**

<table>
<thead>
<tr>
<th>Volatile Organic Compound</th>
<th>CAS Number</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>67-64-1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>75-05-8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Allyl chloride</td>
<td>107-05-1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Benzyl chloride</td>
<td>100-44-7</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>75-27-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bromoform</td>
<td>75-25-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>74-83-9</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2-butanol</td>
<td>78-93-3</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>75-15-0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>56-23-5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>108-90-7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Chlorodibromomethane</td>
<td>124-48-1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Chloroethane</td>
<td>75-00-3</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2-chloroethyl vinyl ether</td>
<td>110-75-8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Chloroform</td>
<td>67-66-3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>74-87-3</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>126-99-8</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2-dibromo-3-chloropropane</td>
<td>96-12-8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1,2-dibromoethane</td>
<td>106-93-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dibromomethane</td>
<td>74-95-3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,4-dichloro-2-butene</td>
<td>764-41-0</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Dichlorodifluoromethane</td>
<td>75-71-8</td>
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<td>5</td>
</tr>
<tr>
<td>1,1-dichloroethane</td>
<td>75-34-3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2-dichloroethene</td>
<td>107-06-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,1-dichloroethene</td>
<td>75-35-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>trans-1,2-dichloroethene</td>
<td>156-60-5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2-dichloropropane</td>
<td>78-87-5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>cis-1,3-dichloropropene</td>
<td>10051-01-5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>trans-1,3-dichloropropene</td>
<td>10051-02-6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>100-41-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ethyl methacrylate</td>
<td>97-63-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2-hexanone</td>
<td>591-78-6</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Isobutyl alcohol</td>
<td>78-83-1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Methacrylonitrile</td>
<td>126-98-7</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
## Table B-8 (Concluded)

**Practical Quantitation Limits for Volatile Organics in Water and Soil/Sediment by United States Environmental Protection Agency SW-846 Method 8240**

<table>
<thead>
<tr>
<th>Volatile Organic Compound</th>
<th>CAS Number</th>
<th>Practical Quantitation Limits&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment&lt;sup&gt;d&lt;/sup&gt; (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylene chloride</td>
<td>75-09-2</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Methyl iodide</td>
<td>74-88-4</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Methyl methacrylate</td>
<td>80-82-6</td>
<td></td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>4-methyl-2-pentanone</td>
<td>108-10-1</td>
<td></td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Pentachloroethane</td>
<td>76-01-7</td>
<td></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Propionitrile</td>
<td>107-12-0</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Styrene</td>
<td>100-42-5</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,1,1,2-tetrachloroethane</td>
<td>630-20-6</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,1,2,2-tetrachloroethane</td>
<td>79-34-5</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>127-18-4</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,1,1-trichloroethane</td>
<td>71-55-6</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,1,2-trichloroethane</td>
<td>79-00-5</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>79-01-6</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2,3-trichloropropene</td>
<td>96-18-4</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Vinyl acetate</td>
<td>108-05-4</td>
<td></td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>75-01-4</td>
<td></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Xylene (total)</td>
<td>1330-20-7</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA, 1987.

<sup>b</sup>CAS Number = Chemical Abstracts Service Registry Number.

<sup>c</sup>Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.

<sup>d</sup>PQLs listed for soil/sediment are based on wet weight. Normally data are reported on a dry weight basis; therefore, PQLs will be higher, based on the percent moisture in each sample.
Table B-9
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number (^b)</th>
<th>Practical Quantitation Limits(^c)</th>
<th>Low-Level Soil/Sediment (^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water (μg/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>83-32-9</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>208-96-8</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Acetophenone</td>
<td>98-66-2</td>
<td>10</td>
<td>ND (^e)</td>
</tr>
<tr>
<td>2-acetylaminofluorene</td>
<td>53-95-3</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>1-acetyl-2-thiourea</td>
<td>591-08-2</td>
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Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270

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<th>Semivolatile Organic Compounds</th>
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<th>Low-Level Soil/Sediment</th>
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Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics
in Water and Soil/Sediment by United States EPA
SW-846 Method 8270

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Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270

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<th>Semivolatile Organic Compounds</th>
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<td>ND</td>
</tr>
<tr>
<td>2-nitroaniline</td>
<td>88-74-4</td>
<td>50</td>
<td>3300</td>
</tr>
<tr>
<td>3-nitroaniline</td>
<td>99-09-2</td>
<td>50</td>
<td>3300</td>
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<tr>
<td>4-nitroaniline</td>
<td>100-01-6</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>5-nitro-o-anisidine</td>
<td>99-59-2</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Nitrobenzene</td>
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<td>660</td>
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<tr>
<td>4-nitrobenzaldehyde</td>
<td>92-93-3</td>
<td>10</td>
<td>ND</td>
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<td>Nitrofen</td>
<td>1836-75-5</td>
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<td>ND</td>
</tr>
<tr>
<td>2-nitrophenol</td>
<td>88-75-5</td>
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<td>660</td>
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<tr>
<td>4-nitrophenol</td>
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<td>3300</td>
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<tr>
<td>5-nitro-o-toluidine</td>
<td>99-55-8</td>
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<tr>
<td>4-nitroquinoline-1-oxide</td>
<td>56-57-5</td>
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<td>ND</td>
</tr>
<tr>
<td>N-nitrosodibutylamine</td>
<td>924-16-3</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>N-nitrosodiethylamine</td>
<td>55-18-5</td>
<td>20</td>
<td>ND</td>
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</table>

Refer to footnotes at end of table.
### Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number</th>
<th>Practical Quantitation Limits&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Low-Level Soil/Sediment&lt;sup&gt;d&lt;/sup&gt; (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Water (µg/L)</td>
<td></td>
</tr>
<tr>
<td>N-nitrosodiphenylamine</td>
<td>86-30-6</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>N-nitroso-di-n-propylamine</td>
<td>621-64-7</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>N-nitrosopiperidine</td>
<td>100-75-4</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>N-nitrosoglycolamide</td>
<td>930-55-2</td>
<td>40</td>
<td>ND</td>
</tr>
<tr>
<td>Octamethyl pyrophosphoramide</td>
<td>152-16-9</td>
<td>200</td>
<td>ND</td>
</tr>
<tr>
<td>4,4'-oxydianilane</td>
<td>101-80-4</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Parathion</td>
<td>56-38-2</td>
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<td>ND</td>
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<td>Pentachlorobenzene</td>
<td>603-93-5</td>
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<td>ND</td>
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<tr>
<td>Pentachloronitrobenzene</td>
<td>82-68-8</td>
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<td>ND</td>
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<tr>
<td>Pentachlorophenol</td>
<td>87-86-5</td>
<td>50</td>
<td>3300</td>
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<tr>
<td>Phenacetin</td>
<td>62-44-2</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>85-01-8</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>50-06-6</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Phenol</td>
<td>108-95-2</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>1,4-phenylenediamine</td>
<td>106-50-3</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Phorate</td>
<td>298-02-2</td>
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<td>ND</td>
</tr>
<tr>
<td>Phosalone</td>
<td>2310-17-0</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>Phosmet</td>
<td>732-11-6</td>
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<td>ND</td>
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<tr>
<td>Phosphamidon</td>
<td>13171-21-6</td>
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<td>ND</td>
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<td>Phthalic anhydride</td>
<td>85-44-9</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>2-picoline</td>
<td>109-06-8</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Piperonyl sulfide</td>
<td>120-62-7</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>Pronamide</td>
<td>23950-58-5</td>
<td>10</td>
<td>ND</td>
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<td>Propytiouracil</td>
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<td>ND</td>
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<tr>
<td>Pyrene</td>
<td>129-00-0</td>
<td>10</td>
<td>660</td>
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<tr>
<td>Pyridine</td>
<td>110-86-1</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Resorcinol</td>
<td>108-46-3</td>
<td>100</td>
<td>ND</td>
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<tr>
<td>Saffrole</td>
<td>94-59-7</td>
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<td>ND</td>
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<tr>
<td>Strychnine</td>
<td>57-24-9</td>
<td>40</td>
<td>ND</td>
</tr>
<tr>
<td>Sulfanilate</td>
<td>95-06-7</td>
<td>10</td>
<td>ND</td>
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Refer to footnotes at end of table.
Table B-9 (Concluded)

Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270<sup>a</sup>

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment&lt;sup&gt;d&lt;/sup&gt; (µg/kg)</th>
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<tbody>
<tr>
<td>Terbufos</td>
<td>13071-79-9</td>
<td>20</td>
<td>ND</td>
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<tr>
<td>1,2,4,5-tetrachlorobenzene</td>
<td>95-94-3</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>2,3,4,6-tetrachlorophenol</td>
<td>58-90-2</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Tetrachlorvinphos</td>
<td>961-11-5</td>
<td>20</td>
<td>ND</td>
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<tr>
<td>Tetraethyl pyrophosphate</td>
<td>107-49-3</td>
<td>40</td>
<td>ND</td>
</tr>
<tr>
<td>Thionazine</td>
<td>297-97-2</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Thiophenol (benzenethiol)</td>
<td>108-98-5</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Toluene diisocyanate</td>
<td>584-84-9</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>o-toluidine</td>
<td>95-53-4</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>1,2,4-trichlorobenzene</td>
<td>120-82-1</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>2,4,5-trichlorophenol</td>
<td>95-95-4</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>2,4,6-trichlorophenol</td>
<td>88-06-2</td>
<td>10</td>
<td>660</td>
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<td>Trifluralin</td>
<td>1582-09-8</td>
<td>10</td>
<td>ND</td>
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<tr>
<td>2,4,5-trimethylaniline</td>
<td>137-17-7</td>
<td>10</td>
<td>ND</td>
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<td>Trimethyl phosphate</td>
<td>512-56-1</td>
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<td>ND</td>
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<td>1,3,5-trinitrobenzene</td>
<td>99-35-4</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Tris(2,3-dibromopropyl) phosphate</td>
<td>126-72-7</td>
<td>200</td>
<td>ND</td>
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<tr>
<td>Tri-p-tolyl phosphate (h)</td>
<td>78-32-0</td>
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<td>ND</td>
</tr>
<tr>
<td>0,0,0-triethyl phosphorothioate</td>
<td>126-68-1</td>
<td>ND</td>
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</tr>
</tbody>
</table>

<sup>a</sup>EPA, 1987.

<sup>b</sup>CAS Number = Chemical Abstracts Service Registry Number.

<sup>c</sup>Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.

<sup>d</sup>PQLs listed for soil/sediment are based on wet weight. Normally data is reported on a dry weight basis, therefore, PQLs will be higher, based on the percent moisture in each sample.

<sup>e</sup>ND = Not determined.

<sup>f</sup>NA = Not applicable.

<sup>g</sup>NT = Not tested.
Table B-10
Practical Quantitation Limits for Organochlorine Pesticides and PCBs in Water and Soil/Sediment by United States EPA SW-846 Method 8080\(^a\)

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Number(^b)</th>
<th>Practical Quantitation Limits(^c)</th>
<th>Water(^d) (µg/L)</th>
<th>Low-Level Soil/Sediment(^e) (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>309-00-2</td>
<td></td>
<td>0.04</td>
<td>2.68</td>
</tr>
<tr>
<td>(\alpha)-BHC</td>
<td>319-84-6</td>
<td></td>
<td>0.03</td>
<td>2.01</td>
</tr>
<tr>
<td>(\beta)-BHC</td>
<td>319-85-7</td>
<td></td>
<td>0.06</td>
<td>4.02</td>
</tr>
<tr>
<td>(\delta)-BHC</td>
<td>319-86-8</td>
<td></td>
<td>0.09</td>
<td>6.03</td>
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<tr>
<td>(\gamma)-BHC (lindane)</td>
<td>58-89-9</td>
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<td>0.04</td>
<td>2.68</td>
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<tr>
<td>Chlordane (technical)</td>
<td>57-74-9</td>
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<td>0.14</td>
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<tr>
<td>4,4'-DDD</td>
<td>72-54-8</td>
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<td>0.11</td>
<td>7.37</td>
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<tr>
<td>4,4'-DDE</td>
<td>72-55-9</td>
<td></td>
<td>0.04</td>
<td>2.68</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>50-29-3</td>
<td></td>
<td>0.12</td>
<td>8.04</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>60-57-1</td>
<td></td>
<td>0.02</td>
<td>1.34</td>
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<tr>
<td>Endosulfan I</td>
<td>959-98-8</td>
<td></td>
<td>0.14</td>
<td>9.38</td>
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<tr>
<td>Endosulfan II</td>
<td>33213-65-9</td>
<td></td>
<td>0.04</td>
<td>2.68</td>
</tr>
<tr>
<td>Endosulfan sulfate</td>
<td>- 1031-07-8</td>
<td></td>
<td>0.66</td>
<td>44.22</td>
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<tr>
<td>Endrin</td>
<td>72-20-8</td>
<td></td>
<td>0.06</td>
<td>4.02</td>
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<tr>
<td>Endrin aldehyde</td>
<td>7421-93-4</td>
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<td>0.23</td>
<td>15.41</td>
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<tr>
<td>Heptachlor</td>
<td>76-44-8</td>
<td></td>
<td>0.03</td>
<td>2.01</td>
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<tr>
<td>Heptachlor epoxide</td>
<td>1024-57-3</td>
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<td>0.83</td>
<td>55.61</td>
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<tr>
<td>Methoxychlor</td>
<td>72-43-5</td>
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<td>1.76</td>
<td>117.92</td>
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<tr>
<td>Toxaphene</td>
<td>8001-35-2</td>
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<td>2.40</td>
<td>160.80</td>
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<tr>
<td>Aroclor-1016</td>
<td>12674-11-2</td>
<td>ND(^f)</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Aroclor-1221</td>
<td>11104-28-2</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Aroclor-1232</td>
<td>11141-16-5</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Aroclor-1242</td>
<td>53469-21-9</td>
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<td>43.55</td>
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<td>Aroclor-1248</td>
<td>12672-29-5</td>
<td>ND</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Aroclor-1254</td>
<td>11097-69-1</td>
<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>Aroclor-1260</td>
<td>11096-82-5</td>
<td>ND</td>
<td>ND</td>
<td></td>
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</tbody>
</table>

Refer to footnotes at end of table.

\(^a\)EPA, 1986a.
\(^b\)CAS Number = Chemical Abstracts Service Registry Number.
\(^c\)Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.
Table B-10 (Concluded)
Practical Quantitation Limits for Organochlorine Pesticides and PCBs in Water and Soil/Sediment by United States EPA SW-846 Method 8080

The PQLs for water equal the individual compound method detection limit times a factor of 10.
The PQLs for low-level soil/sediment equal the individual compound method detection limit times a factor of 670.
ND = Not determined.
<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Number</th>
<th>Practical Quantitation Limits&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octahydro-1,3,5,7-tetranitro-1,3,5,7-</td>
<td>2691-41-0</td>
<td>Water (µg/L) 13.0, Low-Level Soil/Sediment (µg/kg) 2.2</td>
</tr>
<tr>
<td>tetrazocine (HMX)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexahydro-1,3,5-trinitro-1,3,5-triazine</td>
<td>121-82-4</td>
<td>Water (µg/L) 14.0, Low-Level Soil/Sediment (µg/kg) 1.0</td>
</tr>
<tr>
<td>(RDX)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene (TNB)</td>
<td>99-35-4</td>
<td>Water (µg/L) 7.3, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene (DNB)</td>
<td>99-65-0</td>
<td>Water (µg/L) 4.0, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>Methyl-2,4,6-trinitrophenylnitramine (Tetryl)</td>
<td>479-45-8</td>
<td>Water (µg/L) 44.0, Low-Level Soil/Sediment (µg/kg) 0.65</td>
</tr>
<tr>
<td>Nitrobenzene (NB)</td>
<td>98-95-3</td>
<td>Water (µg/L) NA&lt;sup&gt;d&lt;/sup&gt;, Low-Level Soil/Sediment (µg/kg) 0.26</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene (TNT)</td>
<td>118-96-7</td>
<td>Water (µg/L) 6.9, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene (2DNT)</td>
<td>121-14-2</td>
<td>Water (µg/L) 5.7, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>2,6-Dinitrotoluene (26DNT)</td>
<td>686-20-2</td>
<td>Water (µg/L) 9.4, Low-Level Soil/Sediment (µg/kg) 0.26</td>
</tr>
<tr>
<td>o-Nitrotoluene (2NT)</td>
<td>88-72-2</td>
<td>Water (µg/L) 12.0, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>m-Nitrotoluene (3NT)</td>
<td>99-08-1</td>
<td>Water (µg/L) 7.9, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
<tr>
<td>p-Nitrotoluene (4NT)</td>
<td>99-99-0</td>
<td>Water (µg/L) 8.5, Low-Level Soil/Sediment (µg/kg) 0.25</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA, 1990.
<br><sup>b</sup>CAS Number = Chemical Abstracts Service Registry Number.
<br><sup>c</sup>Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.
<br><sup>d</sup>NA = Not available.
Table B-12
Practical Quantitation Limits for Chlorinated Herbicides in Water and Soil/Sediment by United States EPA SW-846 Method 8150a

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Numberb</th>
<th>Practical Quantitation Limitsc</th>
<th>Waterd (μg/L)</th>
<th>Low-Level Soil/Sedimente (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>94-75-7</td>
<td></td>
<td>12</td>
<td>240</td>
</tr>
<tr>
<td>2,4-DB</td>
<td>94-82-6</td>
<td></td>
<td>9.1</td>
<td>182</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>93-76-5</td>
<td></td>
<td>2.0</td>
<td>40</td>
</tr>
<tr>
<td>2,4,5-TP (silvex)</td>
<td>93-72-1</td>
<td></td>
<td>1.7</td>
<td>34</td>
</tr>
<tr>
<td>Dalapon</td>
<td>75-99-0</td>
<td></td>
<td>58</td>
<td>1,160</td>
</tr>
<tr>
<td>Dicamba</td>
<td>1918-00-9</td>
<td></td>
<td>2.7</td>
<td>54</td>
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<tr>
<td>Dichlorprop</td>
<td>120-36-5</td>
<td></td>
<td>6.5</td>
<td>130</td>
</tr>
<tr>
<td>Dinoseb</td>
<td>88-85-7</td>
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<td>0.7</td>
<td>14</td>
</tr>
<tr>
<td>MCPA</td>
<td>94-74-6</td>
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<td>2,490</td>
<td>49,800</td>
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<tr>
<td>MCPP</td>
<td>93-65-2</td>
<td></td>
<td>1,920</td>
<td>38,400</td>
</tr>
</tbody>
</table>

bCAS Number = Chemical Abstracts Service Registry Number.
cSample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.
dThe PQLs for water equal the individual compound method detection limit times a factor of 10.
eThe PQLs for low-level soil/sediment equal the individual compound method detection limit times a factor of 200.
Table B-13
Method Detection Limits for Metals in Water and Soil/Sediment
by United States EPA SW-846 Method 6010 and 7000 Series\textsuperscript{a}

<table>
<thead>
<tr>
<th>Element</th>
<th>CAS Number\textsuperscript{b}</th>
<th>Method Detection Limit\textsuperscript{c}</th>
<th>Water (μg/L)</th>
<th>Soil/Sediment (μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>7429-90-5</td>
<td></td>
<td>45</td>
<td>4.5</td>
</tr>
<tr>
<td>Antimony</td>
<td>7440-36-0</td>
<td></td>
<td>32</td>
<td>3.2</td>
</tr>
<tr>
<td>Arsenic</td>
<td>7440-38-2</td>
<td></td>
<td>53</td>
<td>5.3</td>
</tr>
<tr>
<td>Barium</td>
<td>7440-39-3</td>
<td></td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Beryllium</td>
<td>7440-41-7</td>
<td></td>
<td>0.3</td>
<td>0.03</td>
</tr>
<tr>
<td>Cadmium</td>
<td>7440-43-9</td>
<td></td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>Calcium</td>
<td>7440-70-2</td>
<td></td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>Chromium</td>
<td>7440-47-3</td>
<td></td>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>Cobalt</td>
<td>7440-48-4</td>
<td></td>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>Copper</td>
<td>7440-50-8</td>
<td></td>
<td>6</td>
<td>0.6</td>
</tr>
<tr>
<td>Iron</td>
<td>7439-89-6</td>
<td></td>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>Lead\textsuperscript{d}</td>
<td>7439-92-1</td>
<td></td>
<td>42</td>
<td>4.2</td>
</tr>
<tr>
<td>Lithium</td>
<td>7439-93-2</td>
<td></td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Magnesium</td>
<td>7439-95-4</td>
<td></td>
<td>30</td>
<td>3.0</td>
</tr>
<tr>
<td>Manganese</td>
<td>7439-96-5</td>
<td></td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Mercury</td>
<td>7439-97-6</td>
<td></td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>7439-98-7</td>
<td></td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Nickel</td>
<td>7440-02-0</td>
<td></td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>7723-14-0</td>
<td></td>
<td>51</td>
<td>5.1</td>
</tr>
<tr>
<td>Potassium</td>
<td>7440-09-7</td>
<td>e</td>
<td>e</td>
<td>e</td>
</tr>
<tr>
<td>Selenium</td>
<td>7782-49-2</td>
<td></td>
<td>75</td>
<td>7.5</td>
</tr>
<tr>
<td>Silver</td>
<td>7440-22-4</td>
<td></td>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>Sodium</td>
<td>7440-23-5</td>
<td></td>
<td>29</td>
<td>2.9</td>
</tr>
<tr>
<td>Strontium</td>
<td>7440-24-6</td>
<td></td>
<td>0.3</td>
<td>0.03</td>
</tr>
<tr>
<td>Thallium</td>
<td>7440-28-0</td>
<td></td>
<td>40</td>
<td>4.0</td>
</tr>
<tr>
<td>Vanadium</td>
<td>7440-62-2</td>
<td></td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Zinc</td>
<td>7440-66-6</td>
<td></td>
<td>2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

\textsuperscript{a}EPA, 1987.
\textsuperscript{b}CAS Number = Chemical Abstracts Registry Service Number.
\textsuperscript{c}The detection limits shown are given as a guide for an instrumental limit. The actual method detection limits (MDLs) are sample dependent and may vary with sample matrix.
\textsuperscript{d}The MDLs are based on the digestion of 1 gram of solid per 100 milliliters of liquid. Mercury analysis is based on 0.2 gram of solid per 100 milliliters.
\textsuperscript{e}Highly dependent on operating conditions and plasma position (EPA 1987).
Table B-14
Radionuclide Minimum Critical Levels for Water and Soil/Sediment

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Critical Level Activities</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water (pCi/L, unless noted)</td>
<td>Soil/Sediment (pCi/g, unless noted)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Americium-241</td>
<td>0.05</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Carbon-14</td>
<td>514</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Curium-244</td>
<td>0.05</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Gamma spectroscopy&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Gross alpha</td>
<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Gross beta</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Isotopic plutonium (Pu-238,-239/240)</td>
<td>0.15</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Isotopic thorium (Th-228,-230,-232)</td>
<td>0.15</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Isotopic uranium U-233/234,-235/236,-238</td>
<td>0.15</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>0.05</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Strontium-89</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Strontium-90</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Total Uranium</td>
<td>5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Tritium</td>
<td>200</td>
<td>195&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Target critical levels shown are consistent with SNL/NM standards for evaluating wastes originating in a Radioactive Materials Management Area.

<sup>b</sup>Based on Cesium-137 sensitivity.

<sup>c</sup>Units are micrograms per liter (mg/L).

<sup>d</sup>Units are micrograms per gram (µg/g).

<sup>e</sup>Units are pCi/L. Concentration in soil or sediment is dependent on the water content of the sample.
Table B-15
Method Detection Limits for Miscellaneous Analytes in Water and Soil/Sediment

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method Detection Limit (^b)</th>
<th>Water (mg/L)</th>
<th>Soil/Sediment (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>0.5</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>0.001</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.2</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Alkalinity, as CaCO(_3)</td>
<td>10</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Ammonia, as N</td>
<td>0.01</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Bromide</td>
<td>0.25</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.25</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Cyanide (total)</td>
<td>0.02</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Fluoride</td>
<td>0.25</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Nitrate, as N</td>
<td>0.25</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>Nitrate/Nitrite, as N</td>
<td>0.05</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Nitrite, as N</td>
<td>0.25</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Phosphate, as P</td>
<td>0.25</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Sulfate</td>
<td>1</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Sulfide</td>
<td>1</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Total inorganic carbon</td>
<td>NA</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>0.05</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Total organic halides</td>
<td>0.005</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>4</td>
<td></td>
<td>NA</td>
</tr>
</tbody>
</table>

\(^a\)See Tables B-6 and B-7 for method references.

\(^b\)Proposed method detection limits (MDLs); the MDLs listed are for guidance.

\(^c\)MDLs for soil and sediment will vary depending on matrix and sample size.

\(^d\)NA = Not applicable; see Table B-7.
APPENDIX B

REFERENCES


ASTM, see United States Environmental Protection Agency.

EPA, see United States Environmental Protection Agency.


APPENDIX B
ANALYTICAL METHODS, QUANTITATION LIMITS, AND ACCEPTANCE CRITERIA
Table B-1
Quality Control Acceptance Criteria for Sample Data from Volatile Organic Analysis by United States EPA Method 8240\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^\circ$ (µg/L)</th>
<th>Range for $x^\circ$ (µg/L)</th>
<th>Range for $p^\circ$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>6.9</td>
<td>15.2-26.0</td>
<td>37-151</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>6.4</td>
<td>10.1-28.0</td>
<td>35-155</td>
</tr>
<tr>
<td>Bromoform</td>
<td>5.4</td>
<td>11.4-31.1</td>
<td>45-169</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>17.9</td>
<td>D-41.2</td>
<td>D-242</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>5.2</td>
<td>17.2-23.5</td>
<td>70-140</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>6.3</td>
<td>14.4-27.4</td>
<td>37-160</td>
</tr>
<tr>
<td>2-Chloroethylvinyl ether</td>
<td>25.9</td>
<td>D-50.4</td>
<td>D-305</td>
</tr>
<tr>
<td>Chloroform</td>
<td>6.1</td>
<td>13.7-24.2</td>
<td>51-138</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>19.8</td>
<td>D-45.9</td>
<td>D-273</td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>6.1</td>
<td>13.8-26.6</td>
<td>53-149</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>7.1</td>
<td>11.8-34.7</td>
<td>18-190</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>5.5</td>
<td>17.0-28.8</td>
<td>59-156</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>7.1</td>
<td>11.8-34.7</td>
<td>18-190</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>5.1</td>
<td>14.2-28.4</td>
<td>59-155</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>6.0</td>
<td>14.3-27.4</td>
<td>49-155</td>
</tr>
<tr>
<td>1,1-Dichloroethene</td>
<td>9.1</td>
<td>D-42.3</td>
<td>D-234</td>
</tr>
<tr>
<td>trans-1,2-Dichloroethene</td>
<td>5.7</td>
<td>13.6-28.4</td>
<td>54-155</td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>13.8</td>
<td>3.8-36.2</td>
<td>D-210</td>
</tr>
<tr>
<td>cis-1,3-Dichloropropene</td>
<td>15.8</td>
<td>1.0-39.0</td>
<td>D-227</td>
</tr>
<tr>
<td>trans-1,3-Dichloropropene</td>
<td>10.4</td>
<td>7.6-32.4</td>
<td>17-183</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>7.5</td>
<td>17.4-26.7</td>
<td>37-162</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>7.4</td>
<td>D-41.0</td>
<td>D-221</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>7.4</td>
<td>13.5-27.2</td>
<td>46-157</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>5.0</td>
<td>17.0-26.6</td>
<td>64-148</td>
</tr>
<tr>
<td>Toluene</td>
<td>4.8</td>
<td>16.6-25.7</td>
<td>47-150</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>4.6</td>
<td>13.7-30.1</td>
<td>52-162</td>
</tr>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>5.5</td>
<td>14.3-27.1</td>
<td>52-150</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>6.8</td>
<td>18.5-27.6</td>
<td>71-157</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table B-2
Quality Control Acceptance Criteria for Sample Data from Semivolatile Organic Analysis by United States EPA Method 8270ab

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit for $s^2$ (µg/L)</th>
<th>Range for $x^2$ (µg/L)</th>
<th>Range for $p^8$ (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>27.6</td>
<td>60.1-132.3</td>
<td>47-145</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>40.2</td>
<td>53.5-126.0</td>
<td>33-145</td>
</tr>
<tr>
<td>Aldrin</td>
<td>39.0</td>
<td>7.2-152.2</td>
<td>D-166</td>
</tr>
<tr>
<td>Anthracene</td>
<td>32.0</td>
<td>43.4-118.0</td>
<td>27-133</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>27.6</td>
<td>41.8-133.0</td>
<td>33-143</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>38.8</td>
<td>42.0-140.4</td>
<td>24-159</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>32.3</td>
<td>25.2-145.7</td>
<td>11-162</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>39.0</td>
<td>31.7-148.0</td>
<td>17-163</td>
</tr>
<tr>
<td>Benzo(ghi)perylene</td>
<td>58.9</td>
<td>D-195.0</td>
<td>D-219</td>
</tr>
<tr>
<td>Benzyl butyl phthalate</td>
<td>23.4</td>
<td>D-139.9</td>
<td>D-152</td>
</tr>
<tr>
<td>β-BHC</td>
<td>31.5</td>
<td>41.5-130.6</td>
<td>24-149</td>
</tr>
<tr>
<td>δ-BHC</td>
<td>21.6</td>
<td>D-100.0</td>
<td>D-110</td>
</tr>
<tr>
<td>Bis(2-chloroethyl)ether</td>
<td>55.0</td>
<td>42.9-126.0</td>
<td>12-158</td>
</tr>
<tr>
<td>Bis(2-chloroethoxy)methane</td>
<td>34.5</td>
<td>49.2-164.7</td>
<td>33-184</td>
</tr>
<tr>
<td>Bis(2-chloroisopropyl)ether</td>
<td>46.3</td>
<td>62.8-138.6</td>
<td>36-166</td>
</tr>
<tr>
<td>Bis(2-ethylhexyl)phthalate</td>
<td>41.1</td>
<td>28.9-136.8</td>
<td>8-158</td>
</tr>
<tr>
<td>4-Bromophenyl phenyl ether</td>
<td>23.0</td>
<td>64.9-114.4</td>
<td>53-127</td>
</tr>
<tr>
<td>2-Chloronaphthalene</td>
<td>13.0</td>
<td>64.5-113.5</td>
<td>60-118</td>
</tr>
<tr>
<td>4-Chlorophenyl phenyl ether</td>
<td>33.4</td>
<td>38.4-144.7</td>
<td>25-158</td>
</tr>
<tr>
<td>Chrysene</td>
<td>48.3</td>
<td>44.1-139.9</td>
<td>17-168</td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>31.0</td>
<td>D-134.5</td>
<td>D-145</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>32.0</td>
<td>19.2-119.7</td>
<td>4-136</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>61.6</td>
<td>D-170.6</td>
<td>D-203</td>
</tr>
<tr>
<td>Dibenz[a,h]anthracene</td>
<td>70.0</td>
<td>D-199.7</td>
<td>D-227</td>
</tr>
<tr>
<td>Di-n-butyl phthalate</td>
<td>16.7</td>
<td>8.4-111.0</td>
<td>1-118</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>30.9</td>
<td>48.6-112.0</td>
<td>32-129</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>41.7</td>
<td>16.7-153.9</td>
<td>D-172</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>32.1</td>
<td>37.3-105.7</td>
<td>20-124</td>
</tr>
<tr>
<td>3,3'-Dichlorobenzidine</td>
<td>71.4</td>
<td>8.2-212.5</td>
<td>D-282</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>30.7</td>
<td>44.3-119.3</td>
<td>29-136</td>
</tr>
<tr>
<td>Diethyl phthalate</td>
<td>26.5</td>
<td>D-100.0</td>
<td>D-114</td>
</tr>
<tr>
<td>Dimethyl phthalate</td>
<td>23.2</td>
<td>D-100.0</td>
<td>D-112</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>21.8</td>
<td>47.5-126.9</td>
<td>39-139</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table B-2 (Concluded)
Quality Control Acceptance Criteria for
Sample Data from Semivolatile Organic Analysis
by United States EPA Method 8270$^a,b$

<table>
<thead>
<tr>
<th>Based on analysis of a quality control reference sample that contains 100 micrograms per liter (µg/L) of each analyte.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s$ = Standard deviation of four recovery measurements, in µg/L.</td>
</tr>
<tr>
<td>$\bar{x}$ = Average of four recovery measurements, in µg/L.</td>
</tr>
<tr>
<td>$p$ = Percent recovery measured.</td>
</tr>
<tr>
<td>$D$ = Detected; result must be greater than zero.</td>
</tr>
</tbody>
</table>
Table B-4
Surrogate Spike Recovery Limits for Sample Data from Volatile Organic Analysis by United States EPA Method 8240

<table>
<thead>
<tr>
<th>Surrogate Compound</th>
<th>Low/Medium Concentration Water Samples (% Recovery)</th>
<th>Low/Medium Concentration Soil/Sediment Samples (% Recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Bromofluorobenzene</td>
<td>86-115</td>
<td>74-121</td>
</tr>
<tr>
<td>1,2-Dichloroethane-d₄</td>
<td>76-114</td>
<td>70-121</td>
</tr>
<tr>
<td>Toluene-d₈</td>
<td>88-110</td>
<td>81-117</td>
</tr>
</tbody>
</table>

*aEPA, 1987.*
### Analysis Methods for Aqueous Samples

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organics</strong></td>
<td></td>
</tr>
<tr>
<td>Volatile organics(^a)</td>
<td>EPA SW-846 Method 8240(^b)</td>
</tr>
<tr>
<td>Semivolatile organics(^c)</td>
<td>EPA SW-846 Method 8270(^b)</td>
</tr>
<tr>
<td>Organochlorine pesticides and PCBs(^d)</td>
<td>EPA SW-846 Method 8080(^b,(g)</td>
</tr>
<tr>
<td>Explosives residues(^f)</td>
<td>EPA SW-846 Method 8330(^b,(g)</td>
</tr>
<tr>
<td>Chlorinated herbicides(^h)</td>
<td>EPA SW-846 Method 8150(^b)</td>
</tr>
<tr>
<td><strong>Radionuclides</strong></td>
<td></td>
</tr>
<tr>
<td>Americium-241</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Curium-244</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Gamma spectroscopy (all peaks reported)</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Gross alpha</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Gross beta</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Isotopic plutonium (plutonium-238,-239/240)</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Isotopic thorium (thorium-228,-230,-232)</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Isotopic uranium (uranium-233/234,-235/236,-238)</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Radium-226,-228</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Strontium-89,-90</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Total uranium</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td>Tritium</td>
<td>Analytical laboratory statement of work(^d)</td>
</tr>
<tr>
<td><strong>Inorganics</strong></td>
<td></td>
</tr>
<tr>
<td>Metals(^l)</td>
<td>EPA SW-846 Method 6010 and 7000 series(^b,(k)</td>
</tr>
<tr>
<td>Arsenic</td>
<td>EPA SW-846 Method 7060</td>
</tr>
<tr>
<td>Lead</td>
<td>EPA SW-846 Method 7421</td>
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<tr>
<td>Mercury</td>
<td>EPA SW-846 Method 7470</td>
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<tr>
<td>Potassium</td>
<td>EPA SW-846 Method 7610</td>
</tr>
<tr>
<td>Selenium</td>
<td>EPA SW-846 Method 7740</td>
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<tr>
<td>Thallium</td>
<td>EPA SW-846 Method 7841</td>
</tr>
<tr>
<td>Boron</td>
<td>EPA SW-846 Method 6010(^d)</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>EPA SW-846 Method 7197(^b,(k)</td>
</tr>
<tr>
<td>Silicon</td>
<td>EPA SW-846 Method 6010(^d)</td>
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Refer to footnotes at end of table.
# Table B-7
## Analysis Methods for Soil/Sediment Samples

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
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<tbody>
<tr>
<td><strong>Organics</strong></td>
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<tr>
<td>Volatile organics(^a)</td>
<td>EPA SW-846 Method 8240(^b)</td>
</tr>
<tr>
<td>Semivolatile organics(^c)</td>
<td>EPA SW-846 Method 8270(^b)</td>
</tr>
<tr>
<td>Organochlorine pesticides and PCBs(^d)</td>
<td>EPA SW-846 Method 8080(^b,(^e)</td>
</tr>
<tr>
<td>Explosives residues(^f)</td>
<td>EPA SW-846 Method 8330(^b,(^g)</td>
</tr>
<tr>
<td>Chlorinated herbicides(^h)</td>
<td>EPA SW-846 Method 8150(^b)</td>
</tr>
<tr>
<td><strong>Radionuclides</strong></td>
<td></td>
</tr>
<tr>
<td>Americium-241</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Curium-244</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Gamma spectroscopy (all peaks reported)</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Gross alpha</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Gross beta</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Isotopic plutonium (plutonium-238,-239/240)</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Isotopic thorium (thorium-228,-230,-232)</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Isotopic uranium (uranium-233/234,-235/236,-238)</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Radium-226</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Strontium-89,-90</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Total uranium</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td>Tritium</td>
<td>Analytical laboratory statement of work(^j)</td>
</tr>
<tr>
<td><strong>Inorganics</strong></td>
<td></td>
</tr>
<tr>
<td>Metals(^l)</td>
<td>EPA SW-846 Method 6010 and 7000 series(^b,(^k)</td>
</tr>
<tr>
<td>Arsenic</td>
<td>EPA SW-846 Method 7060</td>
</tr>
<tr>
<td>Lead</td>
<td>EPA SW-846 Method 7421</td>
</tr>
<tr>
<td>Mercury</td>
<td>EPA SW-846 Method 7471</td>
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<tr>
<td>Potassium</td>
<td>EPA SW-846 Method 7610</td>
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<tr>
<td>Selenium</td>
<td>EPA SW-846 Method 7740</td>
</tr>
<tr>
<td>Thallium</td>
<td>EPA SW-846 Method 7841</td>
</tr>
<tr>
<td>Boron</td>
<td>EPA SW-846 Method 6010(^b)</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>EPA SW-846 Method 7197(^b,(^k)</td>
</tr>
</tbody>
</table>

Refer to footnotes at end of table.
Table B-8
Practical Quantitation Limits for Volatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8240\textsuperscript{a}

<table>
<thead>
<tr>
<th>Volatile Organic Compound</th>
<th>CAS Number\textsuperscript{b}</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>67-64-1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>75-05-8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Allyl chloride</td>
<td>107-05-1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Benzyl chloride</td>
<td>100-44-7</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>75-27-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bromoform</td>
<td>75-25-2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>74-83-9</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2-butanone</td>
<td>78-93-3</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>75-15-0</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Carbon tetrachloride</td>
<td>56-23-5</td>
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<td>5</td>
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<tr>
<td>Chlorobenzene</td>
<td>108-90-7</td>
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<td>5</td>
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<tr>
<td>Chlorodibromomethane</td>
<td>124-48-1</td>
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<td>5</td>
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<tr>
<td>Chloroethane</td>
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<td>10</td>
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<tr>
<td>2-chloroethyl vinyl ether</td>
<td>110-75-8</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Chloroform</td>
<td>67-66-3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>74-87-3</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>126-99-8</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2-dibromo-3-chloropropane</td>
<td>96-12-8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1,2-dibromoethane</td>
<td>106-93-4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dibromomethane</td>
<td>74-95-3</td>
<td>5</td>
<td>5</td>
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<tr>
<td>1,4-dichloro-2-butene</td>
<td>764-41-0</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Dichlorodifluoromethane</td>
<td>75-71-8</td>
<td>5</td>
<td>5</td>
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<tr>
<td>1,1-dichloroethane</td>
<td>75-34-3</td>
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<td>5</td>
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<td>1,2-dichloroethane</td>
<td>107-06-2</td>
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<td>5</td>
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<td>1,1-dichloroethene</td>
<td>75-35-4</td>
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<tr>
<td>trans-1,2-dichloroethylene</td>
<td>155-60-5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1,2-dichloropropane</td>
<td>78-87-5</td>
<td>5</td>
<td>5</td>
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<tr>
<td>cis-1,3-dichloropropene</td>
<td>10061-01-5</td>
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<td>5</td>
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<tr>
<td>trans-1,3-dichloropropene</td>
<td>10061-02-6</td>
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<tr>
<td>Ethylbenzene</td>
<td>100-41-4</td>
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<tr>
<td>Ethyl methacrylate</td>
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<td>5</td>
</tr>
<tr>
<td>2-hexanone</td>
<td>591-78-8</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Isobutyl alcohol</td>
<td>78-83-1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Methacrylonitrile</td>
<td>126-98-7</td>
<td>100</td>
<td>100</td>
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</table>

Refer to footnotes at end of table.
Table B-9
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270a

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Numberb</th>
<th>Practical Quantitation Limitsc</th>
<th>Low-Level Soil/Sedimentd (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>63-32-9</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>208-96-8</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Acetophenone</td>
<td>98-86-2</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>2-acetylaminofluorene</td>
<td>53-96-3</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>1-acetyl-2-thiourea</td>
<td>591-08-2</td>
<td>1000</td>
<td>ND</td>
</tr>
<tr>
<td>2-aminoanthraquinone</td>
<td>117-79-3</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Aminoazobenzene</td>
<td>60-09-3</td>
<td>10</td>
<td>ND</td>
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<tr>
<td>4-aminobiphenyl</td>
<td>92-67-1</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Anilazine</td>
<td>101-05-3</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>o-anisidine</td>
<td>90-04-0</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Anthracene</td>
<td>120-12-7</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Aramite</td>
<td>140-57-8</td>
<td>20</td>
<td>ND</td>
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<td>Azinphos-methyl</td>
<td>85-50-0</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>Barban</td>
<td>101-27-9</td>
<td>200</td>
<td>ND</td>
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<tr>
<td>Benzoic acid</td>
<td>65-85-0</td>
<td>50</td>
<td>3300</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>56-55-3</td>
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<td>660</td>
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<td>Benzo(b)fluoranthene</td>
<td>205-99-2</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>207-08-9</td>
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<td>660</td>
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<td>Benzo(g,h,i)perylene</td>
<td>191-24-2</td>
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<td>660</td>
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<td>Benzo(a)pyrene</td>
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<td>660</td>
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<td>p-benzoquinone</td>
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<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>100-51-6</td>
<td>20</td>
<td>7300</td>
</tr>
<tr>
<td>bis(2-chloroethoxy)methane</td>
<td>111-91-1</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>bis(2-chloroethyl)ether</td>
<td>111-44-4</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>bis(2-chloroisopropyl)ether</td>
<td>108-60-1</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>bis(2-ethylhexyl)phthalate</td>
<td>117-81-7</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>4-bromophenyl phenyl ether</td>
<td>101-55-3</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Bromoxynil</td>
<td>1689-84-5</td>
<td>10</td>
<td>ND</td>
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<tr>
<td>Butyl benzyl phthalate</td>
<td>85-68-7</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Captatol</td>
<td>2425-06-1</td>
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<td>ND</td>
</tr>
<tr>
<td>Captan</td>
<td>133-06-2</td>
<td>50</td>
<td>ND</td>
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Refer to footnotes at end of table.
Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270a

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number</th>
<th>Practical Quantitation Limitsc</th>
<th>Low-Level Soil/Sedimentd (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,4-dichlorobenzene</td>
<td>106-46-7</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>3,3'-dichlorobenzidine</td>
<td>91-94-1</td>
<td>20</td>
<td>1300</td>
</tr>
<tr>
<td>2,4-dichlorophenol</td>
<td>120-83-2</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>2,6-dichlorophenol</td>
<td>87-65-0</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Dichlorvos</td>
<td>52-73-7</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Dichrotophos</td>
<td>141-55-2</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Diethyolphthalate</td>
<td>84-66-2</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>Diethylibesterol</td>
<td>56-53-1</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Diethyl sulfate</td>
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<td>Dimethoate</td>
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<tr>
<td>3,3'-dimethoxybenzidine</td>
<td>119-90-4</td>
<td>100</td>
<td>ND</td>
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<tr>
<td>Dimethylaminoazobenzene</td>
<td>60-11-7</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>7,12-dimethylbenz(a)anthracene</td>
<td>57-97-6</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>3,3'-dimethylbenzidine</td>
<td>119-93-7</td>
<td>10</td>
<td>ND</td>
</tr>
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<td>a,a-dimethylphenethylamine</td>
<td>122-09-8</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>2,4-dimethylphenol</td>
<td>105-57-9</td>
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<td>660</td>
</tr>
<tr>
<td>Dimethyl phthalate</td>
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<td>1,2-dinitrobenzene</td>
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<td>4,6-dinitro-2-methylphenol</td>
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<td>3300</td>
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<td>3300</td>
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<td>2,4-dinitrotoluene</td>
<td>121-14-2</td>
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<td>2,6-dinitrotoluene</td>
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<td>660</td>
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<td>Dinocap</td>
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<td>Dinoseb</td>
<td>88-85-7</td>
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<td>5,5-diphenylhydantoin</td>
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<td>Di-n-octyl phthalate</td>
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<td>Disulfoton</td>
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<td>EPN</td>
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Refer to footnotes at end of table.

QAP 95-01
Revision 01
April 1996
Table B-9 (Continued)
Practical Quantitation Limits for Semivolatile Organics
in Water and Soil/Sediment by United States EPA
SW-846 Method 8270a

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylmethanesulfonate</td>
<td>66-27-3</td>
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<td>ND</td>
</tr>
<tr>
<td>2-methylnaphthalene</td>
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<td>10</td>
<td>660</td>
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<tr>
<td>Methyl parathion</td>
<td>298-00-0</td>
<td>10</td>
<td>ND</td>
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<tr>
<td>2-methylphenol</td>
<td>95-48-7</td>
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<td>660</td>
</tr>
<tr>
<td>3-methylphenol</td>
<td>108-39-4</td>
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<td>ND</td>
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<tr>
<td>4-methylphenol</td>
<td>106-44-5</td>
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<td>660</td>
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<tr>
<td>Mevinphos</td>
<td>7786-34-7</td>
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<td>Mexacarbate</td>
<td>315-18-4</td>
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<td>ND</td>
</tr>
<tr>
<td>Mirex</td>
<td>2385-85-5</td>
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<td>ND</td>
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<td>Monocrotophos</td>
<td>6923-22-4</td>
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<td>ND</td>
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<td>Naled</td>
<td>300-76-5</td>
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<td>ND</td>
</tr>
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<td>Naphthalene</td>
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<td>660</td>
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<td>1,4-naphthoquinone</td>
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<td>ND</td>
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<tr>
<td>1-naphthylamine</td>
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<td>ND</td>
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<td>2-naphthylamine</td>
<td>91-59-8</td>
<td>10</td>
<td>ND</td>
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<td>Nicotine</td>
<td>54-11-5</td>
<td>20</td>
<td>ND</td>
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<td>5-nitroacenaphthene</td>
<td>602-87-9</td>
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<td>ND</td>
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<td>2-nitroaniline</td>
<td>88-74-4</td>
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<td>3-nitroaniline</td>
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<td>3300</td>
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<td>4-nitroaniline</td>
<td>100-01-6</td>
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<td>5-nitro-o-anisidine</td>
<td>99-59-2</td>
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<td>ND</td>
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<tr>
<td>Nitrobenzene</td>
<td>98-95-3</td>
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<td>660</td>
</tr>
<tr>
<td>4-nitrobiphenyl</td>
<td>92-93-3</td>
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<td>ND</td>
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<tr>
<td>Nitrofen</td>
<td>1836-75-5</td>
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<td>ND</td>
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<td>2-nitrophenol</td>
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<td>4-nitrophenol</td>
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<td>3300</td>
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<td>5-nitro-o-toluidine</td>
<td>99-55-8</td>
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<td>4-nitroquinoline-1-oxide</td>
<td>56-57-5</td>
<td>40</td>
<td>ND</td>
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<td>N-nitrosodibutylamine</td>
<td>924-16-3</td>
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<td>ND</td>
</tr>
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<td>N-nitrosodiethylamine</td>
<td>55-18-5</td>
<td>20</td>
<td>ND</td>
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Refer to footnotes at end of table.
Table B-9 (Concluded)

Practical Quantitation Limits for Semivolatile Organics in Water and Soil/Sediment by United States EPA SW-846 Method 8270*.

<table>
<thead>
<tr>
<th>Semivolatile Organic Compounds</th>
<th>CAS Number</th>
<th>Water (µg/L)</th>
<th>Low-Level Soil/Sediment (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terbufos</td>
<td>13071-79-9</td>
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<td>ND</td>
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<tr>
<td>1,2,4,5-tetrachlorobenzene</td>
<td>95-94-3</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>2,3,4,6-tetrachlorophenol</td>
<td>58-90-2</td>
<td>10</td>
<td>ND</td>
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<tr>
<td>Tetrachlorvinphos</td>
<td>961-11-5</td>
<td>20</td>
<td>ND</td>
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<tr>
<td>Tetraethyl pyrophosphate</td>
<td>107-49-3</td>
<td>40</td>
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<tr>
<td>Thionazine</td>
<td>297-97-2</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Thiophenol (benzenethiol)</td>
<td>108-98-5</td>
<td>20</td>
<td>ND</td>
</tr>
<tr>
<td>Toluene diisocyanate</td>
<td>584-84-9</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>o-toluidine</td>
<td>95-53-4</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>1,2,4-trichlorobenzene</td>
<td>120-82-1</td>
<td>10</td>
<td>660</td>
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<tr>
<td>2,4,5-trichlorophenol</td>
<td>95-95-4</td>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>2,4,6-trichlorophenol</td>
<td>88-06-2</td>
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<td>660</td>
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<tr>
<td>Trifluralin</td>
<td>1582-09-8</td>
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<td>2,4,5-trimethylaniline</td>
<td>137-17-7</td>
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<td>ND</td>
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<td>Trimethyl phosphate</td>
<td>512-56-1</td>
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<td>ND</td>
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<td>1,3,5-trinitrobenzene</td>
<td>99-35-4</td>
<td>10</td>
<td>ND</td>
</tr>
<tr>
<td>Tri(2,3-dibromopropyl) phosphate</td>
<td>126-72-7</td>
<td>200</td>
<td>ND</td>
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<tr>
<td>Tri-p-toly phosphate (h)</td>
<td>75-32-0</td>
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<td>ND</td>
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<tr>
<td>0,0,0-triethyl phosphorothioate</td>
<td>126-68-1</td>
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</table>


bCAS Number = Chemical Abstracts Service Registry Number.

Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.

PQLs listed for soil/sediment are based on wet weight. Normally data is reported on a dry weight basis, therefore, PQLs will be higher, based on the percent moisture in each sample.

ND = Not determined.

NA = Not applicable.

NT = Not tested.
Table B-10 (Concluded)
Practical Quantitation Limits for Organochlorine Pesticides
and PCBs in Water and Soil/Sediment by United States EPA
SW-846 Method 8080a

The PQLs for water equal the individual compound method detection limit times a factor of 10.
The PQLs for low-level soil/sediment equal the individual compound method detection limit times a
factor of 670.
ND = Not determined.
Table B-12
Practical Quantitation Limits for Chlorinated Herbicides in Water and Soil/Sediment by United States EPA SW-846 Method 8150a

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Numberb</th>
<th>Practical Quantitation Limitsc</th>
<th>Waterd (µg/L)</th>
<th>Low-Level Soil/Sedimente (µg/kg)</th>
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</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>94-75-7</td>
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<td>12</td>
<td>240</td>
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<tr>
<td>2,4-DB</td>
<td>94-82-6</td>
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<td>9.1</td>
<td>182</td>
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<tr>
<td>2,4,5-T</td>
<td>93-76-5</td>
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<td>2.0</td>
<td>40</td>
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<tr>
<td>2,4,5-TP (silvex)</td>
<td>93-72-1</td>
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<td>1.7</td>
<td>34</td>
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<td>Dalapon</td>
<td>75-99-0</td>
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<td>58</td>
<td>1,160</td>
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<td>Dicamba</td>
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<td>Dichloroprop</td>
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<td>MCPb</td>
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<td>1,920</td>
<td>38,400</td>
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</table>

bCAS Number = Chemical Abstracts Service Registry Number.
cSample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.
dThe PQLs for water equal the individual compound method detection limit times a factor of 10.
eThe PQLs for low-level soil/sediment equal the individual compound method detection limit times a factor of 200.
APPENDIX B
REFERENCES


ASTM, see United States Environmental Protection Agency.

EPA, see United States Environmental Protection Agency.


