LOW-LEVEL BURIAL GROUNDS TRENCHES 31 & 34

ADDENDUM C
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C OPERATING UNIT GROUP 17 OPERATIONS
1 Operating Group 17 consists of Low Level Burial Ground Trenches 31 & 34, and two associated
2 container storage units. The LLBG Trenches 31 & 34 were constructed in 1994 under interim status.
3 USDOE subsequently informed Ecology on August 27, 1999, of the intent to begin waste disposal
4 operations at Trenches 31 & 34 as of September 15, 1999.
5
C.1 Operating Unit Group Description and General Provisions
6 The Low Level Burial Ground (LLBG) Trenches 31 & 34 are located within 218-W-5 Burial Ground in
7 the 200 West Area. LLBG Trenches 31 & 34 provide storage and disposal for treated and LDR compliant
8 mixed waste. There are also two associated waste storage pads that provide storage of treated and LDR
9 compliant containerized mixed waste prior to disposal. Background and process description of all the
dangerous waste management units in this operating unit group are provided below. A more detailed
discussion of waste types is provided in Addendum B, Waste Analysis Plan. Table C.1 below provides a
summary of Storage and Disposal design capacities for LLBG Trenches 31 & 34 and the associated
storage units.

Table C.1 Summary of Storage and Disposal Capacity for LLBG Trenches 31 & 34 and Associated Container Storage Units

<table>
<thead>
<tr>
<th>UNIT</th>
<th>STORAGE</th>
<th>DISPOSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trench 31</td>
<td>N/A</td>
<td>21,408 m³ (28,000 yd³) per trench*</td>
</tr>
<tr>
<td>Trench 34</td>
<td>N/A</td>
<td>21,408 m³ (28,000 yd³) per trench*</td>
</tr>
<tr>
<td>Trench 31 Waste Storage Pad</td>
<td>690 m³ (902 yd³)**</td>
<td>N/A</td>
</tr>
<tr>
<td>Trench 34 Waste Storage Pad</td>
<td>690 m³ (902 yd³)**</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Based on trench floor dimensions of 76 m (250 ft) long by 31 m (100 ft) wide and a depth of 9 m (30 ft). Also assumes a 4.9-m (16-ft) final cover thickness over the final volume of disposed waste.

**Based on an area 45.7 m (150 ft) wide by 45.7 m (150 ft) long.

C.1.1 LLBG Trenches 31 & 34 Description
15 LLBG Trenches 31 & 34, each are large rectangular excavations in the southwest corner of the 218-W-5
16 Burial Ground operated as units for disposal of dangerous and/or mixed waste. The LLBG Trenches 31
17 & 34 are constructed with polyethylene liners and leachate collection system, discussed in more detail in
18 Section C.2.
19 All mixed waste destined for disposal in LLBG Trenches 31 & 34 must meet land disposal restriction
20 (LDR) requirements [40 CFR Part 268, incorporated by reference by WAC 173-303-140] or a site
21 specific treatability variance approved by Ecology. Mixed waste to be disposed in LLBG Trench 31 & 34
22 may include bulk waste, long length contaminated equipment. A diverse range of waste containers can be
23 disposed at Trenches 31 & 34 and the associated container storage units including, but not limited to,
24 containers/drums, waste boxes, and miscellaneous equipment.
25 At the top of the trenches, LLBG Trenches 31 & 34 are approximately 137 m (450 ft) long by 91 m
26 (300 ft) wide, and approximately 9 m (30 ft) in depth. The trenches are rectangular with 3H:1V
27 (horizontal: vertical) side slopes. The trench floors are approximately 76 m (250 ft) long by 31 m (100 ft)
28 wide.
C.1.1.1 LLBG Trench 31 & 34 Process Design Capacities
The process design capacity for disposal of mixed waste is approximately 21,408 m$^3$ (28,000 yd$^3$) per trench. The disposal volume is based on trench floor dimensions of 76 m (250 ft) long by 31 m (100 ft) wide and a depth of 9 m (30 ft).

C.1.2 Description of Container Storage
The Trench 31 Waste Storage Unit and the Trench 34 Waste Storage Unit are constructed with an asphalt base. Each area has a total area of approximately 2,090 sq meters (22,500 sq ft) [45.7 meters (150 ft) wide by 45.7 meters (150 ft) long]. The corner of each pad near the ramp measuring approximately 30.4 meters (100 ft) by 30.4 meters (100 ft) is constructed over the corner of the trench liner. The storage design capacity for each of these storage areas is 690 m$^3$ (902 yd$^3$). Dangerous and/or mixed waste stored in the Trench 31 Waste Storage Unit and the Trench 34 Waste Storage Unit will be containerized. The containerized waste must meet LDR requirements. While the containerized waste is stored at one of the pads, the containers will meet the container management standards described in Section C.2.

C.1.3 List of Wastes
Dangerous and/or mixed waste disposed in the LLBG Trenches 31 & 34 consists of listed waste, characteristic waste, and state-only dangerous waste (Addendum A, Part A Permit). Examples of waste disposed in the LLBG Trenches 31 & 34 include containerized or bulk waste such as contaminated soil, decommissioned pumps, pressure vessels, macro-encapsulated debris and macro-encapsulated long-length contaminated equipment, and mixed waste that has been treated to meet LDR requirements. A database tracking system has been developed and shall be maintained that tracks mixed waste that has been disposed of within LLBG Trenches 31 & 34. This database tracking system meets WAC 173-303-380(1)(b).
Figure C.1  Low-Level Burial Grounds Trenches 31 & 34 in the 200 West Area.

C.2  Process Information

This section discusses the processes that shall be followed to store and dispose mixed waste in LLBG Trenches 31 & 34, and includes a discussion of the design and function of the following.

- Containers
• Disposal trenches and liner system
• Process design capacities
• Leak detection system
• Leachate collection and removal system.
• Waste management process

C.2.1 Containers

All newly generated mixed waste accepted for disposal at LLBG Trenches 31 & 34 will be packaged in approved containers (U.S. Department of Transportation and/or U.S. Department of Energy), unless alternate packages are dictated by the size, shape, or form of waste [49 CFR 173] (e.g., metal boxes). Free liquids will not be accepted unless the requirements of WAC 173-303-140 (4) (b)(ii) are met. Waste containers accepted for disposal at Trenches 31 & 34 must be at least 90 percent full.

Free liquids are addressed further in Addendum B, Waste Analysis Plan.

C.2.1.1 Description of Containers

Containers vary in shape, size, and strength depending on the form and weight of the waste. The most common containers are galvanized or aluminized 208-liter (55-gallon) containers. Nominal 1.2-meter by 1.2-meter by 2.4-meter (4 feet by 4 feet by 8 feet) steel boxes are used frequently. Waste containers can be lined to further contain the mixed waste. Liners consist of coatings to the interior of the containers, e.g., minimum 4 mil plastic liners or 90 mil polyethylene liners. Selection of the liner is driven by the properties of the waste.

Dangerous and/or mixed waste containers stored will be marked for major risk in accordance with WAC 173-303-630(3) requirements. Before receipt for storage or disposal at Operating Unit Group 17 DWMUs, all containers will be closed by means of a neoprene gasket, steel lid, locking ring, locking ring bolt, and a lock nut torqued tight or by other available methods to meet requirements of WAC 173-303-630(5)(a). The container packaging and container handling for LLBG Trenches 31 & 34 are designed to maintain containment of the waste and limit human exposure to mixed waste. On receipt, each container will be inspected by operations personnel (refer to Addendum B, Waste Analysis Plan). The condition of containers while in storage will meet the requirements of WAC 173-303-630(2).

The identification of containers while in storage will comply with the requirements of WAC 173-303-630(3).

The compatibility of waste with the containers while in storage will comply with WAC 173-303-630(4).

A container of waste in storage will not be opened, handled, or stored in a manner that may rupture the container or caused it to leak [WAC 173-303-630(5)(b)].

C.2.1.2 Containment Requirements for Storing Containers

Dangerous and/or mixed waste stored in the Trench 31 Waste Storage Pad or the Trench 34 Waste Storage Pad will meet the requirements for containment systems are set forth in WAC 173-303-630(7).

Subsection C.2.4.5 provides a discussion on secondary containment system design and construction for LLBG Trenches 31 & 34.

The Trench 31 Waste Storage Pad and the Trench 34 Waste Storage Pad are constructed out of asphalt (See Section C.2.4.10). While being stored over the asphalt area that is not over the trench liner, containers requiring secondary containment will be provided with a containment device meeting the requirements of WAC 173-303-630(7).

Subsection C.2.4.2 provides a discussion on containment system capacity for LLBG Trenches 31 & 34.

Section C.4 provides a discussion on control of run-on for LLBG Trenches 31 & 34.
C.2.1.3 Removal of Liquids from Containment System

Sections C.2.4.2 and C.2.4.5 provide a discussion on containment systems for LLBG Trenches 31 & 34. Liquids can collect in portable containment systems on the Trench 31 and Trench 34 Waste Storage Pads that are capable of collecting and holding spills and leaks in accordance with WAC 173-303-630(7). If water from a known source (e.g., rainwater or snowmelt) accumulates in a portable containment sump the following will be performed:

- Liquid will be inspected visually for signs of contamination (e.g., signs of oil sheen, discoloration, solids, or abnormal indications, etc.).
- If no evidence is noted, the water can be removed from the system and discharged to the environment.
- If visual indicators from inspection of liquid are present, perform field analysis of pH.
- When the field analysis confirms pH is greater than or equal to 4.5 and less than or equal to 7.5 the water can be removed from the system and discharged to the environment.

When pH results are outside of the acceptable range, the water accumulated in the portable containment sump will be removed and containerized and placed into storage (not in the trenches) pending treatment and disposal. Containerized waste will be considered LLBG Trenches 31 & 34 Generated Waste and will be designated in accordance with WAC 173-303-070 through -100.

Specific actions to be taken in response to a spill or discharge are detailed in Addendum J, Contingency Plan.

C.2.2 Containers without Free Liquids

Testing for free liquids will be performed in accordance with the waste analysis plan (Addendum B, Waste Analysis Plan) for dangerous and/or mixed waste accepted for disposal in LLBG Trenches 31 & 34.

C.2.3 Prevention of Reaction of Ignitable, Reactive, and Incompatible Waste in Containers

Confirmation and verification processes to ensure that ignitable, reactive, and incompatible waste is not disposed in the LLBG Trenches 31 & 34 are described in the waste analysis plan (Addendum B, Waste Analysis Plan).

C.2.4 LLBG Trenches 31 & 34 Liner System Process Description

The liner system is designed to prevent migration of leachate out of the lined trenches during its active life. The active life consists of the operational period and the closure period. The liner system is designed to meet the dangerous waste landfill requirements in WAC 173-303-665 and technical guidance documents (e.g., EPA 1985). In addition, the liner system incorporates the following general functional requirements:

- Range of Operating Conditions--year-round operation, withstand construction and long-term stresses.
- Degree of Reliability--function safely and effectively throughout operating and postclosure period with minimum maintenance.
- Intended Life--operational phase plus 30 years postclosure monitoring phase.

The trench liner systems for LLBG Trenches 31 & 34, comply with requirements for dangerous waste landfills. Figure C.2 shows a typical design and includes the following components (from top to bottom).

- Operations layer: nominal amount [0.9-m (3-ft) -thick] of native soil. This layer provides a working surface for equipment, protects the liner from mechanical damage, and prevents freezing of the underlying low-permeability soil layer.
Primary leachate collection system that contains at least one of the following:

1. A geotextile/geonet composite, with a minimum transmissivity value of $3 \times 10^{-5}$ m$^3$ (3 x $10^{-4}$ ft$^3$) per second
2. A minimum 0.3-m (1-ft) -thick drainage gravel layer with a hydraulic conductivity of at least $1 \times 10^{-2}$ cm per second (sometimes including drainage pipes)
3. A geonet, with a minimum transmissivity value of $3 \times 10^{-5}$ m$^2$ (3 x $10^{-4}$ ft$^2$) per second.

The primary leachate collection system collects and conveys leachate to the primary sump for removal and includes the following components.

- Primary geomembrane liner: generally consisting of high-density polyethylene because of its excellent resistance to chemicals. Minimum 60-mil thickness; can be textured (to improve stability against sliding) or smooth. The geomembrane acts as a moisture barrier. The primary leachate collection system includes perforated pipe that helps collect and guide water into the primary sump.
- Primary admix liner: a minimum 0.46-m (1.5-ft) -thick layer of compacted soil/bentonite admixture with a permeability of $1 \times 10^{-7}$ cm (4 x $10^{-8}$ in.) per second or less. This layer acts as an additional primary moisture barrier directly under the primary geomembrane.
- The secondary leachate collection system collects and conveys leachate to the secondary sump for removal and includes the following components. Secondary leachate collection system: same as primary system, except that pipes are not needed because very high flow capacities are not required. The purpose of this system is to collect any leachate that leaks through the primary liner system and convey the leachate to the secondary sump for removal. The secondary leachate collection system also serves as the leak detection system.
- Secondary geomembrane liner: same as primary geomembrane liner.
- Secondary admix liner: a minimum 0.9-m (3-ft) -thick layer of compacted soil/bentonite admixture with a permeability of $1 \times 10^{-7}$ cm (4 x $10^{-8}$ in.) per second or less. This layer acts as an additional moisture barrier directly under the secondary geomembrane.

In accordance with U.S. Environmental Protection Agency (EPA) guidance, all areas of the lined trench floor (except sump bottoms) are graded at a slope of at least 1 percent to facilitate drainage and avoid ponding on the liners. In practice, floor slopes are designed with minimum slopes of 1.5 percent to accommodate slight variations associated with construction techniques. Grading tolerances are established so that the actual slope is at least 1 percent at all locations.

**C.2.4.1 Operations Layer**

The purpose of the operations layer is to protect the underlying liner components from damage by equipment during lined trench construction and operation. On the sideslopes, this layer also protects the admix layer from freezing and desiccation cracking.

Previous research and experience has shown that desiccation cracks can occur under geomembrane liners when either the liner is not in close contact with the compacted admix or when the liner is subjected to wide temperature fluctuations (Corser and Cranston 1991). The operations layer acts as a weight to keep the geomembrane in contact with the admix, thereby reducing the potential for water vapor to form in an underlying airspace. The operations layer also acts as an insulating layer, together with the dead air space trapped in the geocomposite drainage layers.

The operations-layer material typically consists of onsite granular soil that is reasonably well graded and conforms to one of the following Unified Soil Classification System designations, ASTM D2487: GM, GC, SW, SM, SP, or SC. Material has a maximum particle size limit of 10.2 centimeters (4 inches) or less, depending on the strength of the underlying layers.
C.2.4.2 Primary Leachate Collection System

The LLBG Trenches 31 & 34 are each supported by aboveground less-than-90-day leachate collection tanks operated in accordance with the generator provisions of WAC 173-303-200. The leachate collection tanks are aboveground, carbon steel tanks, internally coated with an amine-cured epoxy. The leachate collection tanks are provided with secondary containment. All feed piping is also provided with secondary containment. The leachate collection tanks have a current design capacity of 37,850 L (10,000 gal), per tank.

The primary leachate collection system is located below the operations layer and provides a flow path for the leachate flowing into the primary sump. Between the operations layer and the underlying drainage gravel, a geotextile layer functions as a filter separation barrier. The geotextile prevents migration of fine soil and clogging of the drainage gravel. The gravel is a minimum 0.3-meter (1 foot) thick layer of washed, rounded to subrounded stone, with a permeability of at least $1 \times 10^{-2}$ centimeters ($4 \times 10^{-3}$ inches) per second, as required by RCRA regulations. In addition, perforated high-density polyethylene drainage pipe is placed within the drainage gravel to accelerate leachate transport into the primary sump during high precipitation events. The gravel layer is underlain by a geotextile/geonet drainage layer resting on the primary high-density polyethylene geomembrane. The geonet provides additional drainage capacity for high-precipitation events and acts as a redundant drainage system. Geocomposite is used on the sideslopes to avoid problems associated with placement of clean granular material on slopes, and thereby minimizing the potential for damaging the underlying liner system.

The purpose of the leachate collection and removal system is to provide sufficient storage volume to collect and retain, in a timely manner, fluids falling on or moving through the waste. The primary leachate collection and removal system provides the preferential path along which the leachate flows into the primary sump. The secondary leachate collection and removal system (also called the leak detection system) is located between the primary and secondary geomembranes. The secondary leachate collection and removal system provides the preferential path along which any fluids leaking through the primary liner system flow to the secondary sump.

The collected leachate is pumped to a leachate collection tank, screened and/or sampled, and transferred to tanker trucks using methods and equipment developed to avoid accidental spills. The tanker truck is parked on an epoxy coated tanker loadout pad designed to capture and contain any possible spill of leachate. During loading operations, the leachate level in the leachate collection tank is monitored with level indicating equipment. The tanker trucks subsequently transport the leachate to a TSD unit.

LLBG Trenches 31 & 34 are operated in a way that ensures the bottom liner is maintained as dry as possible, and the head on the top liner is less than 30.5 cm (12 in.). In extreme conditions (i.e., a 25-year storm event), the head on the top liner could exceed 30.5 cm (12 in.) for short durations. However, even in extreme conditions, the head on the bottom liner will not exceed 30.5 cm (12 in.). The operating methodology, described in the following paragraphs, ensures that liquids on the bottom liner are removed continuously before the liquids can accumulate.

Both leachate collection systems can be operated either manually or automatically. When operated automatically, liquid level sensors cycle the pumps on and off, in response to rising and falling leachate levels. Collected leachate from the secondary leachate collection system can be either pumped back to the primary leachate collection system or to the leachate collection tank. The leachate collection and removal system design complies with RCRA Subtitle C requirements and guidance.

Each sump has a thick layer of gravel designed to provide high permeability and storage capacity. Leachate is removed from the sumps by a pump installed in either vertical or sideslope riser pipes. Pressure transducers and/or floats are used to monitor leachate level in the sumps and provide appropriate signals to the pump control system. All pumps, transducers, and/or floats are removable for maintenance, and related activities.
The base of the primary leachate collection and removal system is defined by the primary geomembrane.

On the floor of the lined trenches, the primary geomembrane is overlain by geonet, geocomposite, and/or granular drainage layers. A granular drainage layer is used and pipes are located at regular intervals to increase flow capacity. Geotextile layers at the top of the leachate collection and removal system prevent migration of fine soil particles into the gravel or geonet, thus prevent clogging. On the sideslopes, a geocomposite layer is used over the geomembrane. The geocomposite includes bonded geotextiles on both sides that increase the interface shear strength, and allow this material to be used on the sideslopes.

The primary leachate collection and removal system is covered by the operations layer. The layer is a minimum 0.9 m (3 ft) thick, and provides protection for the underlying liner and drainage materials.

The operations layer covers both the trench floor and the sideslopes.

The primary leachate collection and removal system is designed, operated, and maintained to control run-on during a 25-year storm [WAC 173-303-665(2)(c)] and run-off during a 25-year, 24-hour storm [WAC 173-303-665(2)(d)]. The primary leachate collection and removal system, will be emptied and or otherwise managed “expeditiously” after the storm event in accordance with WAC 173-303-665(2)(e).

The liner system covers all soils underlying the lined trench and extends over the crest of the sideslopes into the anchor trenches. In addition, the truck unloading areas at the top of the access ramps are lined with 90-mil high-density polyethylene geomembranes. All surface water run-off from the truck unloading areas drains into the primary leachate collection systems.

Should a greater than 25-year, 24-hour storm event occur, the primary leachate collection and removal system sump is designed to temporarily store leachate at a depth greater than 30.5 cm (12 in.), as opposed to the alternative of constructing an excessively large leachate collection tank.

The primary leachate collection and removal system sump is equipped with two sump pumps. One pump is a high capacity pump capable of rapid removal of large volumes of leachate and is suitable for the transfer of batch quantities of leachate and can handle the larger volumes of leachate anticipated from the 25-year, 24-hour storm event. The other pump is a low-capacity submersible pump located in the base of the primary sump. The pumps are fabricated from stainless steel or other corrosion resistant material.

Once the temporary or final cap is placed over the trench, the high-capacity pump would be shut down.

**C.2.4.3 Primary Geomembrane Liner**

The primary geomembrane liner acts both as an impermeable leachate barrier and as a flow surface, routing leachate to the primary sump. High-density polyethylene is used because of its high resistance to chemical deterioration. However, other materials are acceptable provided these materials can achieve or exceed the performance specifications established for high-density polyethylene. Generally, textured (roughened) geomembrane is used to maximize shear strength along adjacent interfaces and to reduce the potential for sliding of the liner system.

**C.2.4.4 Primary Admix Liner**

A primary admix liner, consisting of a minimum 0.46-meter (1.5 feet) thick compacted soil/bentonite admixture, could be installed immediately beneath the primary high-density polyethylene liner on the floor of the lined trench only. The purpose of this liner is to provide extra protection in the case of deterioration (such as stress cracking) of the primary geomembrane in those lined trenches that might be open for several years. In lined trenches that are closed after only a few years, this layer might not be necessary. The need for this layer is evaluated on a case-by-case basis during detailed design of the particular lined trench.

When used, the admix liner typically consists of silty sand from local borrow sources mixed with a nominal 12-percent sodium bentonite, by dry weight. The in-place permeability of the admix liner is $1 \times 10^{-7}$ centimeters ($4 \times 10^{-8}$ inches) per second or less, consistent with RCRA requirements for secondary soil liners. The upper surface of the admix liner is trimmed to the design grades and tolerances as shown on the construction drawings. To prepare a smooth uniform surface on which to place the
overlying geomembrane liner, the surface is rolled with a smooth steel-drum roller to remove all ridges and irregularities.

C.2.4.5 Secondary Leachate Collection System

The base of the secondary leachate collection and removal system is formed by the secondary geomembrane. The secondary leachate collection and removal system is similar to the primary leachate collection and removal system except that pipes are not included. The pipes are not needed because high flow capacity is not required for the low leachate volumes.

The secondary leachate collection and removal system drains to the secondary sump, which is located immediately below the primary sump. Because of the low volumes, the secondary leachate collection and removal system is equipped with only one low-capacity submersible pump.

The secondary leachate collection system provides the flow path for the leachate flowing into the secondary sump. The secondary leachate collection system has drainage gravel on the floor, with an additional geotextile/geonet layer and a geocomposite layer on the sideslopes. These materials and their configuration are similar to the primary leachate collection system described above, except for the absence of a perforated drainage pipe system on the floor of the lined trench. The secondary leachate collection system channels leachate that penetrates the primary liner system into the secondary sump.

The secondary leachate collection system also serves as the leak detection system. Leachate collected in the secondary sump is measured to determine the leakage rate through the primary liner.

C.2.4.6 Secondary Geomembrane Liner

The secondary high-density polyethylene liner, located underneath the secondary leachate collection system, is placed directly against the secondary compacted admix liner. The secondary liner is similar to the primary geomembrane described in Section C.2.4.3.

C.2.4.7 Secondary Admix Liner

The secondary admix liner has a minimum 0.9-meter (3 feet)-thick compacted soil/bentonite admixture located immediately beneath the secondary high-density polyethylene liner, as required by RCRA regulations. The secondary admix liner typically consists of silty sand from local borrow sources mixed with a nominal 12 percent sodium bentonite, by dry weight. The in-place permeability of the admix liner is $1 \times 10^{-7}$ centimeters (4 x $10^{-8}$ inches) per second or less, consistent with RCRA requirements for secondary soil liners. The upper surface of the admix liner is trimmed to the design grades and tolerances. The surface is rolled with a smooth, steel-drum roller to remove all ridges and irregularities. The result is a smooth uniform surface on which to place the overlying geomembrane liner.

C.2.4.8 Subgrade/Liner System Foundation

The lined trenches in the LLBG Trenches 31 & 34 are founded in undisturbed native soils, generally ranging from silty sands to well-graded gravels. The liner system foundation is discussed in further detail in Section C.2.3.4.

C.2.4.9 Access Ramp

Each lined trench has an access ramp. The access ramp also includes the liner system components previously described. However, some of the components are thickened and a top-course layer is installed to support traffic. These enhancements prevent damage to the liner system from vehicle traffic into the lined trench. Access ramp design can vary depending on the location of a trench and the type and frequency of traffic into the trench.

C.2.4.10 Truck Unloading Area Liner System

A truck unloading area is located at the top of the access ramp to provide an area for transfer of containerized waste from over-the-road trucks to forklifts or other vehicles/equipment that place the waste in the lined trench. The truck unloading area is lined with a high-density polyethylene geomembrane.
Typically, a geotextile cushion and top-course aggregate is placed over the geomembrane. The high-density polyethylene drainage pipe can be included at the base of the aggregate to enhance drainage. The truck unloading area is paved with asphalt to facilitate cleanup of any accidental spills. Both the asphalt surface and the underlying drainage system of the unloading area direct all surface run-off into the primary leachate collection system of the lined trench.

C.3 Liner System Engineering Analysis and Environmental Assessment
This section provides information and descriptions of engineering analyses, environmental assessments, liner system foundation, various loads on liner system, seismic conditions, and laboratory testing data.

C.3.1 Liner System Location Relative to High Water Table
The groundwater level (seasonal high water table) is located 61.0 to 91.4 meters (200 to 300 feet) below the ground surface in the LLBG Trenches 31 & 34. It is anticipated that the deepest point of the liner system will be no greater than 21.3 meters (70 feet) below ground surface. Consequently, the liner systems are at least 39.7 meters (130 feet) above groundwater. The liner systems are not affected by the water table because of this large elevation difference.

C.3.2 Loads on Liner System
The liner system experiences several types of stresses during construction, operation, and postclosure periods. These stresses are analyzed during the detailed design of each lined trench. The following sections discuss the types of stresses and potential analytical methods.

C.3.2.1 Stresses from Installation or Construction Operations
The sideslope geosynthetic liner components experience some stress during installation and before placing waste in the lined trench. A high-density polyethylene liner is temperature sensitive, expanding and contracting as liner temperatures increase and decrease. Thermally induced stresses can develop in the liner if deployment and anchoring occur just before a significant decrease in the liner temperature. The maximum potential liner thermal stress typically occurs during construction before placement of the operations layer. The high-density polyethylene liner is sufficiently thick so that this stress remains well below the yield strain and stress.

The drainage gravel has the potential to produce localized stress on the geomembrane liner during gravel placement with construction equipment. A geotextile cushion (and possibly a geonet) is placed at the base of the drainage gravel to the underlying geomembrane. A puncture analysis is performed to select a sufficiently thick geotextile. This analysis incorporates expected construction vehicle ground pressures and assumed drainage gravel gradation listed in the construction specifications. A safety factor of three is used when evaluating puncture stress.

Tension induced by liner-component load transfer is not anticipated to occur, because the liner interface coefficients of friction are higher than the sideslope angles. The liner component interface strengths are determined by laboratory direct shear tests. Both static and dynamic stability analyses are performed, using standard methods, design accelerations, and factors of safety.

Stresses on the geomembrane in the anchor trench also are evaluated during detailed design. Wind uplift and thermal expansion and contraction can cause stress in the geomembrane during construction.

However, these stresses are not a problem, because these stresses are relatively low as compared to the tensile strength of the liner. The stresses are not present after construction, because of the weight and insulating properties of the operations layer.

C.3.2.2 Stresses Resulting From Operating Equipment
Loads on the liner system due to operating equipment are expected to be less severe than those generated by construction equipment for two reasons. One, operations equipment typically is lighter than construction equipment, and two, the 0.9-meter (3 feet) thick operations layer dissipates stresses produced by the operating equipment.
The lined trenches are filled in a way that maintains adequate factors of safety against sliding. Stability analyses are performed during detailed design, once the lined trench geometry and liner system properties have been determined. The analyses establish operational parameters such as waste lift thickness and temporary operating slope angles.

Stability of the liner system components under the access ramp is analyzed separately. The analysis considers both static and dynamic (moving vehicle) conditions.

C.3.2.3 Stresses from Maximum Quantity of Waste, Cover, and Proposed Postclosure Land Use

When the lined trench is full and the cover system is in place, the liner system experiences a static load from the overlying waste, backfill, and cover materials. No significant increase in stresses on the liner system is anticipated from postclosure land use. The maximum design load of material overlying the liner system includes an allowance for the cover system (Addendum H: Closure). Analyses include puncture resistance of the geomembranes and decrease in transmissivity of geocomposite drainage layers. Materials are specified based on the ability of the materials to perform adequately under postclosure loading conditions.

Dynamic stresses on the liner system result primarily from ground accelerations during seismic events. Both static and dynamic analyses are performed on the subgrade and liner components based on the finished configuration of the empty trench. Under postclosure conditions, the waste, backfill, and cover materials will tend to buttress the liner system, resulting in greater stability relative to the operational phase.

C.3.2.4 Stresses Resulting From Settlement, Subsidence, or Uplift

The subgrade settlement produced by waste loading is essentially elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade rebounds during the excavation phase of construction and settles as the trench is filled. The compacted admix liner consolidates under waste loads. The total settlement is a combination of the subgrade elastic and the admix consolidation settlements. These settlements are analyzed with standard methods during detailed design of each lined trench. In general, differential settlements are expected to occur primarily across the lined trench sideslopes as the thickness of waste decreases from maximum to zero. Because geosynthetic liner components are highly elastic, the anticipated strains are not likely to produce any appreciable stresses in the liner system.

The potential for subsidence-induced stress is believed to be negligible based on the following information.

- The soils underlying the LLBG Trench 31 & 34 tend to be coarse-grained sands and gravels that are not subject to piping effects that can transport soil resulting in subsidence.
- The groundwater level is deep, at least 39.7 meters (130 feet) below the base of the deepest lined trenches, and does not affect bearing soils.
- No mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater below the lined trenches.
- The native soils are well graded and relatively dense.

The potential for stresses resulting from uplift on the liner system also is expected to be negligible. The seasonal groundwater level is very deep, and higher-elevation perched groundwater is unlikely to develop because of the absence of aquitards in the coarse-grained Hanford formation underlying the LLBG Trenches 31 & 34. The coarse-grained nature of the Hanford formation also promotes rapid, primarily vertical, infiltration, which means it is unlikely that infiltration from outside the lined trench boundary will be transported laterally underneath the trench liner. Gas pressures are similarly unlikely to develop because of the absence of any noted subsurface gas generation (from organic material decomposition) and the coarse-grained, highly permeable sands and gravels underlying the landfill.
C.3.2.5 Internal and External Pressure Gradients

Pressure gradients across the liner caused by liquids or gases are expected to be negligible. Internal pressures due to liquids are controlled by the leachate collection and removal systems. Because leachate is removed from the sump in a timely manner, there is minimal liquid head on the liner [less than 30.5 centimeters (12 inches) in accordance with WAC 173-303-665(2)(h)]. Any gas that is generated internally before closure is vented either through the waste or the leachate collection system. The closure cover design will consider gas venting.

External pressures on the liner system are expected to be minimal. Gas pressures are negligible because the subgrade soil contains no gas-producing materials and is highly permeable, readily venting any potential gas to the atmosphere. External pressure from liquids is not anticipated because of the deep groundwater table and the highly permeable foundation soils.

C.3.3 Liner System Exposure Prevention

No geosynthetic or admix components of the liner system are exposed to the atmosphere. The minimum 0.9-meter (3 feet) thick operations layer covers the entire lined trench surface. This layer serves both as a physical protective barrier and as thermal insulation, protecting the admix layer from desiccation and frost damage.

The operations layer will be inspected weekly for erosion. Excessive erosion, such as gullying, will be repaired by replacing the eroded soil. Dust suppression agents could be used to prevent excessive wind erosion. The dust suppression agents bind the surface of the operations layer and minimize wind entrainment of soil.

C.3.4 Liner System Foundation and Its Engineering Analysis

Surficial deposits within the LLBG Trenches 31 & 34 generally consist either of recent eolian sands or the coarse-grained glaciofluvial flood sequence of the Hanford formation, which has an interstratified deposit of coarse sand, gravelly sand, and/or sandy gravel. Where eolian sands are present, these sands are underlain by the Hanford formation. Subsequent units underlying the Hanford formation are the early-Palouse soil, the Plio-Pleistocene unit, the middle Ringold unit, and the Elephant Mountain Member of the Columbia River Basalt Group.

The two geologic units pertinent to the lined LLBG Trenches 31 & 34 are summarized as follows.

- Recent eolian sand: The sand is light olive gray in color and has a density that is loose at the surface but becomes compact with depth. The sand has a fine to medium grain size and includes little to some nonplastic silt-sized fines. The deposit is homogeneous except for a distinguishable layer of volcanic ash in some locations.

- Glaciofluvial flood deposit: This deposit has well graded mixtures of sands and gravels with trace to little nonplastic silt-sized particles. The density of the deposit ranges from compact to very dense. The gravel content can vary with depth, and the deposit predominantly can become gravel. This coarse-grained deposit is part of the Cold Creek Bar, which was formed during the Pleistocene Epoch by glacial outburst flooding.

The subgrade settlement produced by waste loading is essentially elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade rebounds during the excavation phase of construction and settles as the trench is filled. An elastic settlement analysis using standard methods is performed to determine the magnitude of the total and differential settlement.

The bearing capacity of the subgrade soil needs to support structures such as leachate collection tanks. The construction specifications typically require that the upper portion of the subgrade soil and all structural fill be moisture conditioned and compacted to at least 95 percent of the maximum modified Proctor dry density (ASTM D1557). Maximum allowable bearing capacities for foundations are established using standard geotechnical methods. Bearing capacities for the types of soils expected in the
LLBG Trenches 31 & 34 are typically greater than the maximum expected loads from the support structures. The lined trenches are constructed in eolian sand and the underlying coarse-grained Hanford formation. In granular, cohesionless, and drained soils such as these, the stability of the slope is related primarily to the maximum slope angle. Therefore, an infinite slope or other suitable analysis method is used to determine both static and dynamic sideslope stability. A more detailed discussion on lined trench slope stability is provided in Appendix 4B (Application).

Because the seasonal high-water level is at least 39 meters (128 feet) below the base of the deepest lined trench, no external hydrostatic pressure is expected from this source. Because of the coarse-grained nature of the foundation soils, any infiltration of surface water around the perimeter of the lined trench is expected to travel primarily downward. Therefore, infiltration should not cause substantial pressure on the exterior of the liner system. Internal hydrostatic pressure from leachate is negligible because the leachate is removed from the lined trench to limit head on the liner.

Gas pressure exerted externally on the liner system is expected to be negligible, because no gas-generating material (i.e., organic material) is expected in the foundation soils. If any gas were generated below the liner system, little pressure buildup would occur because of the unsaturated coarse-grained nature of the foundation soils, which would vent the gas to the atmosphere. Internal gas pressure buildup is not anticipated, because the leachate collection system is vented to the atmosphere and dissipates any gas.

Potential hazards from seismic events include faulting, slope failure, and liquefaction. Disruption of the lined trench by faulting is not considered a significant risk because (1) no major faults have been identified in the LLBG Trenches 31 & 34 (DOE/RW-0164) and (2) only one central fault at Gable Mountain on the Hanford Site shows evidence of movement within the last 13,000 years (WHC-SD-ER-TI-0003). The potential for slope failure is considered low, because granular materials typically have high strengths relative to the maximum sideslope angles expected for the lined trenches. Liquefaction occurs in loose, poorly graded granular materials that are subjected to shaking from seismic events. Saturated soils are most susceptible because of high dynamic pore pressures that temporarily lower the effective stress. During this process, the soil particles are rearranged into a more dense configuration, with a resulting decrease in volume. The foundation materials at the LLBG Trenches 31 & 34 are not considered susceptible to liquefaction because the materials are well graded, unsaturated, and relatively dense.

Subsidence of undisturbed foundation materials is generally the result of dissolution, fluid extraction (water or petroleum), or mining. The potential for subsidence is negligible based on the following.

- Soils underlying the LLBG Trenches 31 & 34 are coarse-grained sands and gravels, which are not subject to piping that can cause transport of soil and resulting subsidence.
- The groundwater level is deep, at least 39.7 meters (130 feet) below the base of the lined trenches, and does not affect bearing soils.
- Soil and rock types below the LLBG Trenches 31 & 34 are not soluble.
- No mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater table below the lined trenches.
- Soils are well graded and relatively dense.

Extensive borings in and around the LLBG Trenches 31 & 34 have not identified any soluble materials in the foundation soils or underlying sediments. Consequently, the potential for any sinkhole development is negligible.
C.3.5 Liner Strength and Compatibility Data

The synthetic liners act as an imperrmeable barrier for leachate migration. The synthetic liners consist of high-density polyethylene material, which makes the liners resistant to chemical deterioration. During detailed design of a lined trench, the composition of the expected leachate is estimated. Expected leachate composition is based on known waste composition, process information, leachate from operating lined trenches, and similar sources of data. Leachate constituents are compared to manufacturers’ chemical compatibility data for synthetic liner components. In addition, the results of previous chemical compatibility testing and studies are evaluated against leachate composition. Information gained from this evaluation is used to select a liner that will be compatible with the expected leachate.

During landfill operation, the compatibility of waste receipts with the liner will be ensured by the waste analysis plan (Addendum B, Waste Analysis Plan). The compatibility of the waste constituents with the liner material will be established by laboratory testing. Such tests follow the procedures of EPA Method 9090A or other appropriate methods. Test results are evaluated using statistical methods and industry-accepted criteria for liner/leachate compatibility.

A waste constituent not listed in the waste acceptance criteria can be accepted into the LLBG Trenches 31 & 34, provided the 9090A test results or other analytical data provided, demonstrates the waste constituent is compatible with the liner. The liner system experiences loads from several sources. During the detailed design process for each lined trench, the strength of liner system materials is evaluated against these loads. If an analysis shows an inadequate factor of safety, a stronger material is specified or the design is modified. Seams in geomembranes are a critical area of concern. However, with correct installation methods the seams are stronger than the surrounding material. Detailed installation requirements are included in the construction specifications to ensure that the most appropriate methods are used. In addition, procedures are established to demonstrate adequate seam strength is achieved during installation.

Seaming requirements for the geotextiles, geonet, and geocomposite drainage materials are not as critical. These materials are overlapped sufficiently to provide complete areal coverage, and relatively light seams are used to hold the panels in position during construction. After the lining system has been completed, seam strength requirements for these materials are negligible.

C.3.6 Soil Liners and Strength

The LLBG mixed waste lined trenches are lined with a minimum 0.9-meter (3 feet) thick layer of compacted soil/bentonite mixture (admix) under the secondary flexible membrane liner. This layer has an in-place permeability of less than $1 \times 10^{-7}$ centimeters (4 x $10^{-8}$ inches) per second. The soil component of the admix is silty fine eolian sand or similar material from areas near the LLBG Trenches 31 & 34. Approximately 12 percent bentonite by dry weight added to the fine soil to achieve sufficiently low permeability; however, the percent might vary depending upon design.

Laboratory testing is performed on soil liner materials to provide input parameters for engineering analyses and for preparing material and construction specifications. The following tests are performed:

- Particle size distribution (ASTM D422)
- Atterberg limits (ASTM D4318)
- Permeability (ASTM D5084)
- Moisture-density relationships (ASTM D698 or D1557)
- Strength (ASTM D4767)
- Consolidation (ASTM D2435).

Other types of tests might be performed if determined necessary for design or specification purposes.

Before constructing the lined trench, a full-scale test fill of the admix material was constructed. The primary purpose of the test fill was to verify that the specified soil density, moisture content, and...
permeability values can be consistently achieved using proposed compaction equipment and procedures. In-place density is measured using both the nuclear gauge (ASTM D2922) and rubber balloon (ASTM D2167) or sand cone (ASTM D1556) methods. In-place permeability is determined from a sealed double-ring infiltrometer test (ASTM D5093), which measures infiltration over a 27.6 square meter area. Admix permeability is estimated from thin-wall tube samples (ASTM D1587) obtained from the test fill and tested in the laboratory (ASTM D5084). Details of the test fill are developed during detailed design. During construction, field density (e.g., ASTM D2922, D2/67, and/or D1556) and moisture content (ASTM D2216) periodically are measured. Thin-wall tube samples (ASTM D1587) are taken at regular intervals and tested for permeability (ASTM D5084). Additional details of field testing during construction are developed during the design process.

Dispersion and piping in the admix are not considered likely, because the permeability, and thus the flow velocity, is very low, making it difficult to move the soil particles or otherwise disrupt the soil fabric. In addition, the admix is well graded, so the component particles tend to hold each other in place. Therefore, testing for these characteristics is not necessary.

Expected leachate composition is determined as part of detailed trench design. The results of previous chemical compatibility testing and studies are evaluated against leachate composition to determine the effect of leachate on soil liner composition or permeability. If potential problems are indicated, the need for leachate specific compatibility tests is evaluated. The tests follow the procedures of (ASTM D5084) (flexible wall parameter) and California State guidelines (CSWRCB 1984), and consider the effects of radiation on the soil liner materials. If necessary, the composition of the soil liner admix is modified until satisfactory performance is achieved.

Calculations have been performed to evaluate the effectiveness of the soil liner as a barrier to leachate. The following assumptions were used in the analysis.

- The soil liner is 0.9-meter (3 feet) thick and has a permeability of $1 \times 10^{-7}$ centimeters ($4 \times 10^{-8}$ inches) per second.
- The average annual precipitation entering the lined trench is the difference between the total precipitation and the moisture lost by evapotranspiration. These values were derived from HELP modeling (WHC-MR-0376; EPA 1989) and are considered conservative because no run-off is allowed and no vegetation is assumed (i.e., bare ground conditions). On this basis, the net infiltration to the lined trench is 4.11 centimeters (1.6 inches) per year.
- The net infiltration acts immediately on the soil liner. This is a very conservative assumption, as travel time through and storage within the cover soil and waste are ignored.
- There is no flexible membrane liner (this is a very conservative assumption).
- The primary and secondary leachate collection and removal systems stop functioning after the lined trenches have been filled (this is also a very conservative assumption).
- The lined trench is exposed to infiltration for 10 years before a cover is constructed.
- Darcian flow occurs within the soil liner. Diffusion and adsorption mechanisms are not considered.

The analysis shows that leachate penetrates about 7.62 centimeters (3 inches) into the soil liner over the 10-year period. This is less than 10 percent of the total thickness of the secondary liner and suggests that the liner has a significant margin of excess performance, particularly given the conservative assumptions, noted previously.

Significant stresses in the soil liner that must be considered are (1) internal stresses from the weight of the liner system, (2) stresses on the interface with the overlying materials, and (3) stresses during construction.

Internal stresses are present on the sideslopes from the weight of the operations layer and soil liner itself. Using material properties determined from laboratory testing, the stability of the soil liner is evaluated.
under both static and dynamic loading conditions. Standard methods of slope stability analysis are used.

Interface strength is evaluated using laboratory test data and slope stability methods.

The primary concern during construction is bearing failure caused by the weight of overlying soil components of the liner system (e.g., drainage gravel on the floor) and the construction equipment used to spread these materials. Strength parameters developed from laboratory testing and standard analytical methods are used to determine bearing capacity.

If any of these analyses indicate unacceptable performance, the soil liner or geosynthetic design is changed to increase factors of safety to acceptable levels.

An engineering report is prepared for each lined trench as part of the definitive design document package. The report describes the design of the liner system and includes supporting calculations. The engineering report is prepared and signed by a professional civil engineer registered in Washington State.

C.3.7 Grading and Drainage

In accordance with EPA guidance, all areas of the lined trench floor (except possibly sump bottoms) are graded at a slope of at least 1 percent to facilitate drainage and avoid ponding on the liners. In practice, floor slopes are designed with minimum slopes of 1.5 percent to accommodate slight variations associated with construction techniques. Grading tolerances are established so that the actual slope is at least 1 percent at all locations.

C.3.8 Maximum Leachate Head

The maximum head on the primary liner is less than 30.5 centimeters (12 inches), except for rare storm events as discussed in Section C.2.4.2. The sump is sized and designed to provide adequate surge storage to prevent leachate build up on the primary liner.

C.3.9 System Compatibility

The primary and secondary leachate collection and removal systems are composed of inert geologic materials (sand and gravel), high-density polyethylene, and other geosynthetic materials such as polypropylene. As described in Section C.3.6, the geosynthetics will be evaluated for compatibility with the expected leachate. To ensure that the geosynthetics used in the lined trenches are chemically similar to those evaluated, manufacturers are required to submit quality control certificates and other manufacturing information and conformance tests performed on all materials.

Before a waste constituent is allowed in the lined trench, the waste constituent is evaluated for compatibility with the liner (e.g., identified in 9090A test results, testing, etc.). Other materials could contact the leachate, for example:

- Stainless steel, used for piping and wetted parts of pumps.
- Rubber coatings for pump impellers and cases.
- Polyvinyl chloride and other plastics in miscellaneous uses.
- Epoxy or other materials used as tank coatings.

Compatibility of these materials with the expected leachate is considered in the trench liner system design. Compatibility of these materials is of lesser concern, because items that are comprised of these materials are entirely located within the containment area. Failure of these items would not result in a dangerous waste release, and the materials would be replaced or repaired.

C.3.10 System Strength

Stability of drainage layer, strength of piping, and prevention of clogging are discussed in the following sections.
C.3.10.1 Stability of Drainage Layers
As described in Sections C.3.4 and C.3.6, the stability of the liners and leachate collection and removal system on the sideslopes is evaluated as part of detailed design. To provide sufficiently high shear strengths at the interfaces between geosynthetic components, textured geomembranes and thermally bonded geocomposites can be used.

Bearing capacity of the drainage and sump gravels is expected to be adequate, based on typical strength values for granular materials. Standard bearing capacity analyses are performed during detailed design to verify this assumption.

The transmissivity of the drainage layers under the combined load of the waste and cover was addressed in the design and is adequate to support leachate removal.

C.3.10.2 Strength of Piping
The drain pipes in the primary drainage and sump gravel and sideslope riser pipes are high-density polyethylene pipe, or equal. During detailed design, the required wall thickness of the pipe is determined according to the manufacturer's recommendations and standard analytical methods used by the piping industry. In these analyses, the ultimate load (derived from the estimated weight of the waste cover) is used, the allowable deflections are limited to 5 percent, and conservative values for soil modulus and lateral confinement are assumed. The calculations evaluating the pipe loads, required thickness, and strengths are presented in the definitive design report for each lined trench.

C.3.11 Prevention of Clogging
The geotextiles that separate the drainage layers from adjacent soil layers are selected based on the ability of the geotextiles to retain the soil and prevent the soil from entering the leachate collection and removal system. Standard methods are used to determine the allowable range of opening sizes in the textiles. In addition, the amount of fine material in the drainage and sump gravels is limited by specification to less than a few percent, and is not expected to cause clogging problems. Because the waste disposed in the lined trench is required to satisfy LDR [40 CFR 268], the amount of organic material is minimal, and consequently biologic clogging is not a problem.

C.3.12 Liner Repairs During Operations
Because of the 0.9-meter (3 feet) thick operations layer, damage to the liner system is not expected. If damage does occur, the operations layer will be removed laterally as far as required. Underlying geosynthetic and gravel layers will be removed until an undamaged layer is encountered. The damaged layers will be repaired and replaced from the lowest layer upwards using similar procedures to those employed during construction. Most repairs to the geomembranes will be performed using a patch, which will be placed, welded, and tested by construction quality assurance personnel.

C.4 Run-On and Run-Off Control Systems
Because of the sandy soils, small drainage area, and arid climate at the LLBG, storm water run-on and run-off are not expected to require major engineered structures. Interceptor and drainage ditches are adequate for run-on and run-off control. The 25-year, 24-hour precipitation event is the design storm used to size the lined trench systems. Beyond this, surface water evaluation is highly site-specific, and appropriate analyses are performed as part of detailed design for each lined trench.

C.4.1 Run-On Control System
Run-on is controlled by berms around the perimeter of the lined trench. Any overland flow approaching the trench is intercepted by the berms and conveyed to suitable discharge points. All the berms are designed to handle the peak 25-year flow from the potential drainage area.

The drainage for LLBG Trenches 31 & 34 are designed and constructed such that the paved truck unloading area drains into the trenches and all other areas beyond the crest of the trenches drain outward,
away from the trenches. The pavement in the truck staging area drains away from the trenches. Between
the trench crest and the perimeter road, the area was graded to provide drainage toward the perimeter
road. The perimeter road is sloped outward, at a grade of approximately 1 percent, to provide drainage
away from the trenches. On the outside of the perimeter road, on the north and west sides of the trenches,
drainage ditches were excavated to provide drainage away from the trenches.

C.4.1.1 Design and Performance
Design and performance details are determined for each lined trench as part of the detailed design process
(Appendix 4B, Application).

C.4.1.2 Calculation of Peak Flow
Computation of design discharge for the berms is performed using standard analytical methods, such as
the Rational Method or the computer program HEC-1 (USACE 1981). The 25-year, 24-hour precipitation
depth is 4.0 centimeters (1.6 inches), based on precipitation data recorded from 1947 to 1969
(PNL-4622). The tributary area for each section of the berms depends on local topography.

C.4.2 Run-Off Control System
There is no run-off from the lined trenches because the trenches are constructed below grade. Any
precipitation falling on the trenches is removed by either evapotranspiration or the leachate collection and
removal systems. Therefore, a run-off control system is not needed.

C.4.3 Maintenance
The berms require periodic maintenance to ensure proper performance. The most frequent maintenance
activity, beyond periodic inspection, is cleaning the berms to remove obstructions caused by windblown
soil and vegetation, (e.g., tumbleweeds). After rare storm events, regrading of the berm might be required
to repair erosion damage. This is expected to occur infrequently; however inspections will be conducted
within seven days after significant storm events or at least annually.

C.5 Control of Wind Dispersal
The LLBG Trenches 31 & 34 use varied methods to prevent wind dispersal of mixed waste, depending on
the waste form. Methods to prevent wind dispersal include containerizing, stabilizing, grouting, spray
fixitants, and backfill. Sometimes the natural form of the waste precludes the need for wind dispersal
protection, (i.e., scrap piping and other solid debris). In other instances, the operating contractor
implements a wind speed restriction during handling, and immediately backfills the waste to prevent wind
dispersal.

C.6 Other Environmental Permits
All environmental permits that are required to support operation of the LLBG Trenches 31 & 34 are
identified in Addendum A, Part A.

C.7 Construction Schedule
There will not be any new construction for LLBG Trenches 31 & 34.
Figure C.2. Example Liner System.