TRC Environmental Solutions Inc.

# CELL 12 DESIGN REPORT

## VOLUME I

*Prepared for*

**US Ecology, Inc.**

Beatty, Nevada

*Prepared by*

**TRC Environmental Solutions, Inc.**

Irvine, California

Project No. 95-284
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REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA
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# 1.0 INTRODUCTION

## 1.1 GENERAL

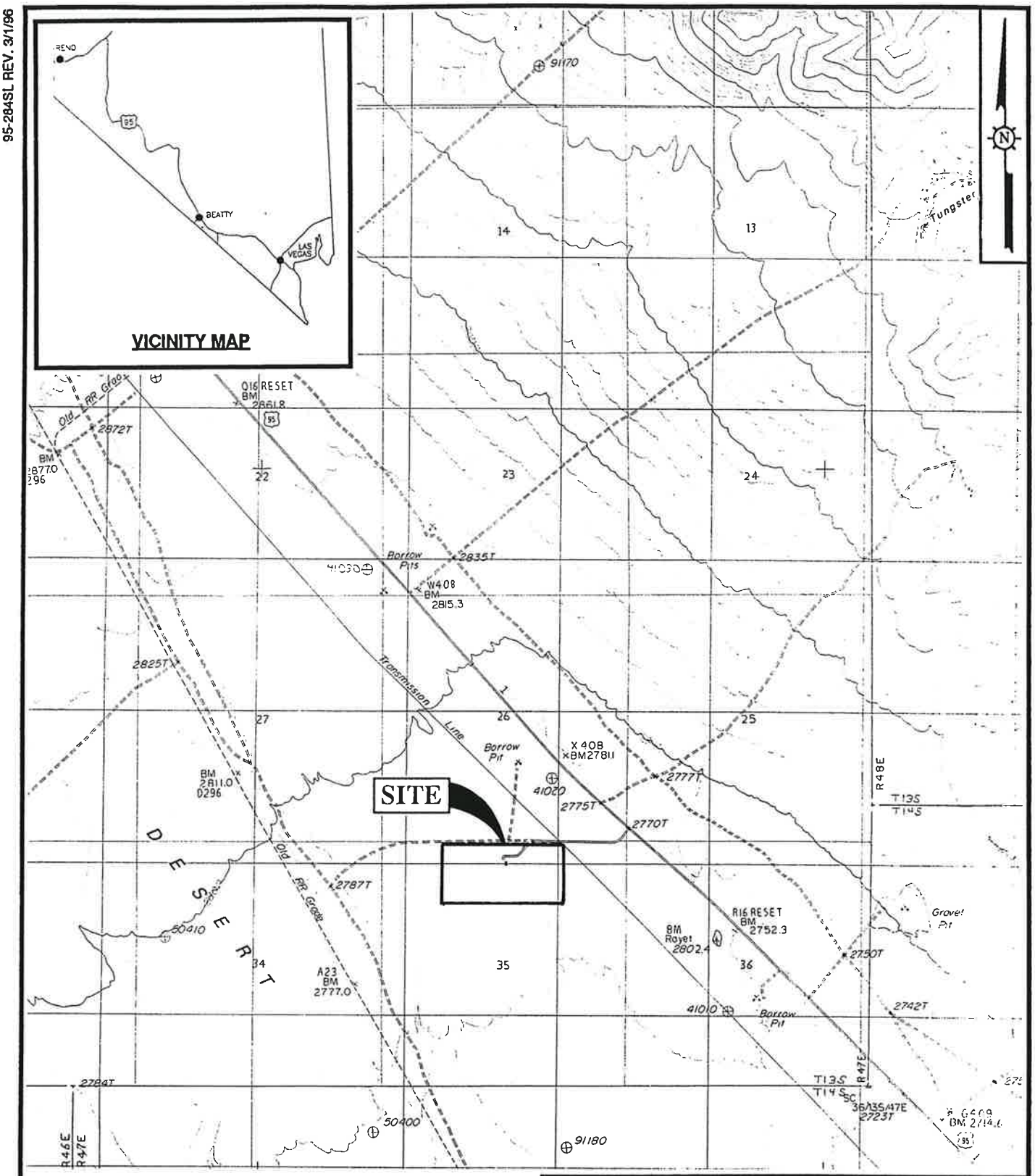
1. This report presents the design for the Cell 12 landfill at the US Ecology, Inc. (USE) hazardous waste management facility located outside of Beatty, Nevada (see Figure 1.1). This report is a supplement to *Section IV.D Landfill Report, US Ecology, Inc., Beatty, Nevada* (USE, 1994) which was previously provided to the Nevada Division of Environmental Protection (NDEP) as one component of a Part B permit renewal application for the facility.

2. This report is provided in response to an NDEP letter dated September 22, 1995 (NDEP, 1995) which requested certain additional information regarding the Cell 12 design. Correlation of the information provided in this report with that previously provided for both Cells 11 and 12 in the previous Section IV.D Landfill Report is outlined in Section 1.2 below.

3. The USE Beatty Nevada Hazardous Waste Management Facility is located approximately 100 miles northwest of Las Vegas in a remote and arid desert region. The facility is permitted to manage both Resource Conservation and Recovery Act (RCRA) and Toxic Substances Control Act (TSCA) wastes. Cell 11 is currently in operation for the disposal of waste. Cell 12 is planned as the next landfill phase. The adjacent low-level radioactive waste (LLRW) management units (see Trenches 1 through 22) to the south of Cell 12 shown in Drawing 002, Exhibit A) have been closed and are currently undergoing postclosure care and maintenance.

4. Cell 12 will be situated in the northwest corner of the site (see Drawing 002, Exhibit A). It will be approximately 1,350 feet long with a width that varies between approximately 180 and 350 feet. The cell will extend 75 feet below the original ground surface at 0.5H:1V slopes, and upon completion will rise 75 feet above the original ground surface at 2H:1V slopes over engineered sidewall berms and 3H:1V slopes over waste (up to a crown with 5 percent slopes). Cell 12 will have both primary and secondary liner systems, each with the capability for leachate collection and removal. The cell will have an ultimate capacity of approximately 1.2 million cubic yards of waste and cover material.

95-284SL REV. 3/1/96




0 3,000 6,000 FEET

SCALE

REFERENCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP OF CARRARA CANYON, NEVADA, PROVISIONAL EDITION 1987.

FIGURE 1.1

**SITE LOCATION MAP**

US ECOLOGY, INC.
BEATTY, NEVADA

**TRC ENVIRONMENTAL SOLUTIONS, INC.**

## 1.2 CORRELATION WITH SECTION IV.D LANDFILL REPORT

1. The previous Section IV.D Landfill Report component of the Part B permit renewal application included information related to both Cells 11 and 12. Portions of the previous report applicable to Cell 11 or unchanged aspects of Cell 12 are not repeated herein. Table 1.1 summarizes those portions of the Cell 12 design which are incorporated by reference from the previous report and those portions for which information is provided in the following sections of this Cell 12 Design Report.

## 1.3 CORRELATION WITH REGULATORY REQUIREMENTS

### 1.3.1 FEDERAL REGULATORY REQUIREMENTS

1. The U.S. Environmental Protection Agency (EPA) has various requirements for a Part B permit renewal application which are applicable to landfill design. These are found in the Code of Federal Regulations (CFR) at 40 CFR §270.21. Table 1.2 lists these requirements and shows where they are addressed within this Cell 12 Design Report.

### 1.3.2 STATE REGULATORY REQUIREMENTS

1. In general, the applicable State of Nevada regulatory requirements mirror those of the federal EPA. Section 444.8632 of the Nevada Administrative Code adopts (by reference) the applicable portions of the federal Title 40 regulations. Accordingly, this report conforms with state regulatory requirements via its conformance with federal EPA regulatory requirements as summarized in Table 1.2.

2. The State of Nevada controls[1] the land upon which the USE facility is located, and leases that land to USE. The lease agreement includes the requirement that hazardous waste not be buried within 150 feet from the exterior of LLRW cells nor 20 feet from the property line. In addition, the lease agreement also states that hazardous waste disposal cells may be up to 75 feet deep and a minimum of 15 feet above grade.

### 1.3.3 LOCAL REGULATORY REQUIREMENTS

1. Local regulatory requirements have not been identified which would have an impact on the design of Cell 12.

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(1) The State of Nevada is the lessee of a 400-acre parcel of land owned by the federal Bureau of Land Management, and in turn subleases an 80-acre portion of that parcel to USE.

## TABLE 1.1

## CORRELATION OF PREVIOUS SECTION IV.D LANDFILL REPORT TO THIS CELL 12 DESIGN REPORT
## US ECOLOGY, INC.
## BEATTY, NEVADA

| PREVIOUS SECTION IV.D LANDFILL REPORT CHAPTER OR APPENDIX | | STATUS RELATIVE TO THIS CELL 12 DESIGN REPORT | | | REFERENCE IN THIS CELL 12 DESIGN REPORT |
|---|---|---|---|---|---|
| No. | Name | Incorporated by Reference From Previous Section IV.D Landfill Report | Superseded by This Cell 12 Design Report | Not Applicable to Cell 12 | |
| 1.0 | List of Hazardous Waste | ● | | | (1) |
| 2.0 | Landfill Operating Procedures | ● | | | (1) |
| 3.0 | Wind Dispersal Control | ● | | | (1) |
| 4.0 | Run-On/Run-Off Control Systems | | ● | | Chapter 6.0 |
| 5.0 | Liner System Description | | ● | | Chapters 3.0 and 4.0 |
| 6.0 | Above Grade Design | | ● | | Chapter 5.0 |
| 7.0 | Inspection | ● | | | (1) |
| 8.0 | Closure | | ● | | Chapter 5.0 |
| A | Landfill Cell Design Plans | | ● | | Exhibit A |
| B | Waste Location Map and Grid System | | | ● | (2) |
| C | Drainage Diversion Ditches Drawings | ● | | | (1) |
| D | Drainage Diversion Ditches Design Calculations | ● | | | (1) |
| E | MTR Equivalency Demonstration | | ● | | Exhibit D |
| F | Method 9090 Compatibility Data | ● | | | (1) |
| G | Retrofitted Sump Riser Diagrams | | | ● | (3) |
| H | Leachate Monitoring and Recording Log | ● | | | (1) |
| I | Response Action Plan | ● | | | (4) |
| J | Leachate Removal Pump Specifications | | ● | | Exhibit B |
| K | Design Calculations for Loads | | ● | | Section 3.5 and Exhibit C.5 |
| L | Converse Consultants Foundation Soils Report | ● | | | (1) |
| M | Infiltration Test Method | | | ● | (3) |
| N | Permeability Test Method | | | ● | (3) |
| O | Factor of Safety Calculations for Side Slopes Using Law Engineering Strength Parameters | | | ● | (3) |
| P | Cell Specifications | | ● | | Exhibit B |
| Q | Slope Stability Analysis for Cell Above Grade Embankment | | ● | | Exhibit C.1 |
| R | Cell 12 Design Calculations | | ● | | Exhibit C |
| S | Geotechnical Investigation for Cell 12 | ● | | | (1) |
| T | Cell 11 Intermediate Cap | | | ● | (3) |

95-284 (3/8/96/dh)

(1) The applicable portion(s) of the design and/or procedures from the previous Section IV.D Landfill Report will be used.
(2) New grid map will be generated for Cell 12 operations.
(3) Applicable only to Cell 11.
(4) The Trench 11 Response Action Plan (USE, 1996) will be used, as revised by the Cell 12 ALR calculations provided in Exhibit C.9 of this Cell 12 Design Report.

TRC Environmental Solutions Inc.

# TABLE 1.2

## SATISFACTION OF EPA PART B PERMIT APPLICATION REQUIREMENTS APPLICABLE TO LANDFILL DESIGN US ECOLOGY, INC. BEATTY, NEVADA

| EPA REQUIREMENT(1) | | INFORMATION LOCATION |
|---|---|---|
| Cite(2) | Subject | |
| 270.21(b)(1)(i) | Liner System | Chapter 3.0 |
| 270.21(b)(1)(ii) | Double-Liner and LDS | Chapters 3.0 and 4.0 |
| 270.21(b)(1)(iii) | LDS in Saturated Zone | Section 2.3 |
| 270.21(b)(1)(iv) | CQA Plan | Exhibit B |
| 270.21(b)(1)(v) | Response Action Plan and ALR | (3) |
| 270.21(b)(2) | Control of Run-On | Chapter 6.0 |
| 270.21(b)(3) | Control of Runoff | Chapter 6.0 |
| 270.21(b)(4) | Management of SWM Collection and Holding Facilities | Chapter 6.0 |
| 270.21(b)(5) | Control of Wind Dispersal of Particulate Matter | (4) |

95-284 (3/1/96/lk)

(1) Various other EPA requirements are also applicable to a Part B permit application, but are not primarily applicable to landfill design. This table lists only the design-related requirements of 40 CFR §270.21.
(2) Cites are to sections within 40 CFR.
(3) Provided via the Trench 11 Response Action Plan (USE, 1996), as revised by the Cell 12 ALR calculations in Exhibit C.9 of this Cell 12 Design Report.
(4) Provided in Chapter 3.0 of the previous Section IV.D Landfill Report (USE, 1994).

LDS = Leachate Detection System
CQA = Construction Quality Assurance
ALR = Action Leakage Rate
SWM = Surface Water Management
CFR = Code of Federal Regulations

## 1.4 REPORT ORGANIZATION

1. The remaining chapters of this report are organized as follows:

   - Chapter 2.0 - Site Preparation
   - Chapter 3.0 - Liner System
   - Chapter 4.0 - Leachate Handling
   - Chapter 5.0 - Above-Grade Design and Cover System
   - Chapter 6.0 - Surface Water Management
   - Chapter 7.0 - References

2. This report also contains the following exhibits:

   - Exhibit A - Design Plans
   - Exhibit B - Specifications and Construction Quality Assurance Plan
   - Exhibit C - Calculations
   - Exhibit D - MTR Equivalency Demonstration

3. Unless otherwise specified, references made in the following chapters to drawings are to those provided in Exhibit A.

# 2.0 SITE PREPARATION

## 2.1 GENERAL

1. Cell 12 site preparation activities include upper, cohesionless soil layer reinforcement, cell excavation, cell subgrade and slope preparation (including slope riser trench excavation), and various ancillary construction preparation activities. The various ancillary construction preparation activities are briefly discussed in the paragraphs that follow. The remaining site preparation activities (i.e., other than the various ancillary activities) are discussed in the ensuing sections of this chapter.

2. The design of Cell 12 was developed to facilitate construction of the landfill in three phases, with the westernmost portion of the cell recommended as the initial phase, and the middle and easternmost portions recommended as the second and third phases (respectively). If the westernmost portion of Cell 12 is constructed as the initial landfill phase, construction staging will likely occur to the east and/or south of that phase. Construction of subsequent phases, or concurrent nonphased construction of the entire Cell 12, may involve construction staging in the offsite area located to the immediate north of Cell 12.

3. The eastern portion of the Cell 12 footprint overlies the existing site entrance, office, 20,000-gallon water storage tank and other facilities (see Drawing 002). The development of Cell 12 eventually includes the associated construction of a new site access road and entrance, and the relocation of certain existing impacted facilities to an area along the southern site boundary (between Cell 11 and Trenches 16 through 19).

## 2.2 COHESIONLESS SOIL REINFORCEMENT

1. Cell 12 includes excavated sidewalls at a 0.5H:1V slope which extend down to a depth of 75 feet (vertical) below existing ground surface. Based on the *Geotechnical Investigation for Cell 12 at the US Ecology Hazardous Waste Management Facility, Beatty, Nevada* (Grant Environmental, July 14, 1994) provided as Appendix S of the previous Section IV.D Landfill Report, the upper layer of the surface soil stratum is considered to be unstable at the proposed excavated slope. This upper soil layer is estimated to range from approximately 4 to 9 feet in depth below existing ground surface. The excavated 0.5H:1V slopes at depths below this surface soil stratum (i.e., below the upper 9 feet of excavation) are considered by Grant Environmental to be stable.

2. Calculations performed in Exhibit C.3 of this report conclude that the upper soil layer needs to achieve a cohesion value of approximately 1,000 pounds per square foot (psf) to be stable at 0.5H:1V slopes. Methods which could be used to achieve this cohesion value are:
   - Reinforce the upper soil layer with cement as recommended by Grant Environmental, at about 3 to 6 percent cement. Cement addition could occur via excavation and mixing, or via in-situ mixing of a cement grout.
   - Excavate the upper soil layer and construct an engineered soil-reinforced wall with high density polyethylene (HDPE) geogrids.

3. The selected soil reinforcement method is to add cement. The construction entity will be required to perform field soil reinforcement tests (see Exhibit B) to confirm the selected methodology for achieving the required cohesion value of approximately 1,000 psf.

4. Reinforcement of the cohesionless soil must be completed prior to excavating at depths below this upper layer.

## 2.3 EXCAVATION

1. The excavation plan and horizontal limits of grading for Cell 12 are provided as Drawing 003. The excavation slope stability is discussed in Section 3.6. Key excavation plan design features are discussed in the paragraphs that follow.

2. The maximum depth of finished excavation (or the bottom of the landfill cell) is 75 feet below the original ground surface. Maximum excavation depth points are located at the bottom of each of the three Leachate Detection System (LDS) sumps.(1) The maximum excavation depth conforms to the requirements of the USE lease agreement with the State of Nevada (see Section 1.3.2). The maximum excavation depth is also well above the ground water table, which is located approximately 285 feet below the original ground surface (or approximately 210 feet below the bottom of Cell 12).

3. A horizontal control line (HCL) provides the lateral limits of excavation as shown on Drawing 003. The HCL is determined from constraints on the lateral extent of waste

(1) As described in Chapter 4.0, note that the LDS is associated with the secondary (lower) liner system, while the Leachate Collection and Removal System (LCRS) is associated with the primary (upper) liner system.

placement, which are defined in the USE lease agreement with the State of Nevada (see Section 1.3.2) to be 20 feet from the permitted facility boundary and 150 feet from disposed LLRW. These constraints apply to the north, west and south boundaries of Cell 12. The HCL for the east boundary of Cell 12 is based on maintaining a 50-foot distance from the western limit of Cell 11. Note that the eastern limit of waste placement for the above-grade portion of Cell 12 will overlie a portion of the completed western slope of Cell 11 (see Drawing 004).

4. Sidewalls are designed with 0.5H:1V slopes, except at curved sections where constant-radius curves (which do not vary with elevation) are specified in order to facilitate efficient construction and a smooth transition for the lining system. The seven curved sections have either 50- or 150-foot radii, and are established from the HCL at the top of slope. The curved sections have various slopes; each flatter than 0.5H:1V.

5. Cell bottom grading is controlled by the elevation of the three LDS sumps, with minimum floor slopes of 1 percent in the westernmost and easternmost cell portions and 2 percent in the middle cell portion. Floor slopes facilitate leachate drainage into each of the three sumps. Cell bottom grading for the middle cell portion (2 percent) differs from that for the two adjoining portions (1 percent) because of geometry constraints (see Drawing 003).

6. Grades shown on Drawing 003 are those for the top of the subgrade which also corresponds approximately to the top of the liner (excluding the operations layer which will overlie the liner system).

7. Excavation spoil materials will be stockpiled offsite to the north of Cell 12, in the area of existing excavation spoil stockpiles.

## 2.4 CELL BOTTOM SUBGRADE PREPARATION

1. The excavated subgrade at cell bottom locations will be overlain by a 9-inch thick layer of compacted fine-grained material. The purposes of this 9-inch prepared soil layer are to provide: (1) a smooth bearing surface for the remaining geosynthetic components of the liner system; and (2) additional leachate adsorption capacity to supplement that of the geosynthetic liner components.

2. The 9-inch layer will be screened as necessary to achieve a gradation per the specifications (Exhibit B) with maximum material diameter of 0.75 inches in a soil matrix. The layer will then be placed and compacted to 90 percent of Modified Proctor (ASTM D1557) at optimum moisture content.

## 2.5 CELL SIDEWALL SUBGRADE PREPARATION

1. The excavated subgrade at cell sidewall locations will be smoothed with a dragged chain or other method approved by the designer of Cell 12. Angular rocks greater than 1 inch in diameter protruding more than one-half inch will be removed or, if found over a large area, will be smoothed with a layer of gunite (or similar material). In addition, sidewall depressions which are of sufficient size to have the potential to result in a cavity below the liner system will be filled with gunite (or similar material). Procedure which will be used to determine where gunite is used are provided in the Specifications (Exhibit B).

## 2.6 SLOPE RISER TRENCHES

1. Recessed trenches will be provided to house the LDS riser pipes which extend up the sideslope from each of the three LDS sumps (see Section 4.2) as shown on Drawing 008. The trench allows the primary liner system to be installed flush over the secondary liner system. These trenches will be cut by backhoe or excavator as cell excavation proceeds. Gunite (or similar material) will be used as necessary to create a suitable trench surface over which to place the secondary liner system. Details regarding construction of the liner system and placement of the riser pipes are provided in Chapters 3.0 and 4.0, respectively.

# 3.0 LINER SYSTEM

## 3.1 GENERAL

1. This chapter presents the results of calculations and design evaluations related to the liner system. The remainder of this chapter is organized into the following sections:

   - Section 3.2 - Liner System Component Descriptions and Rationale
   - Section 3.3 - Liner System Exposure Protection
   - Section 3.4 - Foundation Settlement Analysis
   - Section 3.5 - Liner System Stresses
   - Section 3.6 - Stability Analyses
   - Section 3.7 - Construction and Operations Considerations

   Calculations related to the leachate flow capacities of the liner system drainage layers are described in Chapter 4.0.

## 3.2 LINER SYSTEM COMPONENT DESCRIPTIONS AND RATIONALE

### 3.2.1 BASE LINER SYSTEM COMPONENTS

1. The cross section of the base liner system is shown in Detail 1 of Drawing 007, and includes the following components listed sequentially from top to bottom:

   - 2-foot operations layer
   - Double-sided geocomposite LCRS drainage layer (includes 3-inch diameter perforated pipes)
   - 100-mil HDPE flexible membrane liner (FML), textured on both sides
   - Double-sided geocomposite LDS drainage layer
   - 80-mil HDPE FML, textured on both sides
   - Geosynthetic clay liner (GCL)
   - 9-inch prepared subgrade (fine-grained soil)

2. The 2-foot operations layer will be clean soil and/or select waste, with the purpose of protecting the underlying liner components from damage due to heavy equipment or other operations activities. The layer must not contain large or angular elements which could damage the underlying liner system. The first foot of material placed should be of relatively small particle size material (e.g., sand and gravel). The second foot of material can have larger particles (e.g., up to 12 inches in diameter) provided they are encompassed in a soil matrix. No debris or drums are to be placed in this layer.

3. The upper double-sided geocomposite is the drainage layer of the LCRS. The 3-inch diameter leachate collection pipes augment flow capacity to accommodate infiltration from the 25-year, 24-hour storm event. Detail 2 of Drawing 010 shows the layout of these pipes and a typical

section. Supporting calculations indicating performance of this layer are found in Exhibit C.8. The geocomposite drainage layer and pipes discharge into the LCRS sumps. Further discussion of the LCRS sump and riser pipe is provided in Chapter 4.0.

4. The 100-mil HDPE FML is the low-permeability component of the primary liner system. The selected thickness provides additional puncture resistance (compared to a typical 60-mil FML). HDPE is selected for its demonstrated resistance to chemical degradation (see EPA Method 9090 tests in Appendix F of USE, 1994). The 100-mil HDPE FML will be textured on both sides to provide additional interface strength.

5. The lower double-sided geocomposite is the drainage layer for the LDS. Its function is to facilitate detection, collection and drainage of leachate into the LDS sump. Further discussion of the LDS sump and riser pipe is provided in Chapter 4.0.

6. The 80-mil HDPE FML is the upper low-permeability component of the secondary composite liner system. It is selected to provide additional puncture resistance (compared to a typical 60-mil FML), but is at a lesser thickness than the primary FML since the secondary FML is located further from operations activities and is underlain by a GCL. Textured HDPE on both sides is selected for the reasons stated above for the primary FML.

7. The GCL is the lower low-permeability component of the secondary composite liner system. It is selected because of the GCL's superior hydraulic barrier properties and suitability to an arid environment. If a clay liner was used, it would likely desiccate in the desert climate of the Beatty area, reducing its effectiveness as a hydraulic barrier. Exhibit D provides an evaluation which demonstrates how the GCL is equivalent or superior to compacted clay for this application.

8. The 9-inch prepared subgrade layer provides a smooth surface for installation of the geosynthetics materials providing protection of the overlying geosynthetic layers from puncture by angular materials in the subgrade. This layer also works in conjunction with the GCL above it to enhance its function as a hydraulic barrier and provides additional leachate adsorbtion capacity (see Appendix D).

### 3.2.2 SLOPE LINER SYSTEM COMPONENTS

1. A cross section of the liner system on the slopes of the cell (see Section 2.4) is shown in Detail 2 on Drawing 007, and includes the following components listed sequentially from top to bottom:

   - 2-foot operations layer (measured normal to the sidewall)
   - Sacrificial light colored 30-mil HDPE FML (to be removed prior to placement of operations layer)
   - Nonwoven geotextile filter fabric
   - Geonet LCRS drainage layer
   - 100-mil HDPE FML, smooth on the top side and textured on the bottom side
   - Double-sided geocomposite LDS drainage layer
   - 80-mil HDPE FML, textured on both sides
   - GCL (placed over smooth or specially prepared subgrade)

2. A 10-foot wide, 4-foot deep anchor trench is provided at the top of each slope as shown in Detail 1 on Drawing 009. Calculations which support the configuration of the anchor trench are provided in Exhibit C.6.

3. The 2-foot operations layer functions as stated in Section 3.2.1 for the landfill base. However, it is installed incrementally on the slopes as the waste fill is placed. Since the slopes are steep (0.5H:1V) the operations layer should be incrementally advanced at a maximum height of 5 feet above the waste fill height.

4. The sacrificial 30-mil HDPE FML is specified to provide exposure protection (see Section 3.3) for underlying geosynthetic materials. The light coloring results in reduced temperatures on the lining system. The layer will be removed prior to placement of the operations layer as waste filling proceeds (additional construction and operations discussions for this layer are provided in Sections 3.3 and 3.7).

5. The remaining components of the slope liner system and their functions are identical to their counterparts in the base liner system (see Section 3.2.1 above), with the following exceptions:

   - Weak interfaces are purposefully provided between the geonet and the nontextured surface of the 100-mil HDPE FML, and between the separate geotextile and the geonet of the primary liner system. Differential movement between these layers prevents settlement related loads from being transferred directly to the underlying low-permeability components of the primary and secondary liner systems.

- Since it would be impractical to construct a layer of cohesionless material on the 0.5H:1V slopes, subgrade preparation consists of smoothing with special equipment or select application of gunite (or similar material), where required (see discussion in Chapter 2.0).

### 3.2.3 CELL BOTTOM/SIDEWALL TRANSITION LINER SYSTEM COMPONENTS

1. The cross section of the liner system at cell bottom/sidewall transition locations is depicted in Detail 3 of Drawing 007. This detail shows how overlaps will be made for each drainage layer to assure continuity of the LCRS and LDS from the sideslope to the base of the landfill. The overlap extends from 3 feet above the floor to 3 feet onto the cell base. This provides a doubling of the flow capacity in this transition area.

## 3.3 LINER SYSTEM EXPOSURE PROTECTION

1. Exposure protection is necessary for the liner system components, both during construction as well as cell operations. Exposure issues include the following:
   - Ultraviolet (UV) Radiation: Some geosynthetic materials (without UV resistance additives) degrade when exposed to sunlight. For Cell 12, the HDPE materials (e.g., FML and geonet) are UV-resistant, hence protection from exposure to UV radiation is not necessary for these materials. Polyester geotextile materials, however are sensitive to UV radiation and must be protected during storage, construction and cell operations.
   - Precipitation/Water: The bentonite within GCLs may expand if exposed to moisture and allowed to hydrate in an unconfined condition (e.g., during material staging or placement). Thus GCLs must be protected during storage and construction.
   - Dust, Soil, Mud: Geonet materials can become ingrained with dust, soil or mud if not protected from wind and rain during storage and construction. This geonet must be protected during storage and construction.
   - Wind: High winds can lift geosynthetics that have not been properly anchored (e.g., during construction). This can result in damage (e.g., tears) or the material blowing away. Therefore temporary anchorage and repair/replacement procedures are needed during construction. Protection from wind during cell operations is also needed.

2. Exposure protection for geosynthetic materials during construction is included in the specifications (see Exhibit B). Materials requiring special handling during construction include:
   - GCLs: Store on pallets in delivered plastic packaging and cover with tarps. Protect from rain after installation.
   - HDPE FMLs: Store on pallets to avoid damage. Provide temporary anchorage to facilitate installation and prevent wind uplift. Follow inspection/repair/replacement procedure in specifications (Exhibit B) if wind damage has potentially occurred.
   - Geonets: Store on pallets and cover with tarps. Keep free of dust, soil and mud during installation.
   - Geotextiles: Store on pallets and cover with tarps. Place subsequent layer of liner systems within a reasonable period of time (e.g., within four to six weeks).
   - Geocomposites: Same as geotextiles.

3. Geosynthetics on the cell bottom are likely to be covered by the operations layer within a reasonable period of time (e.g., four to six weeks) after installation. No further protective measures are required for those elements.

4. The sideslope liner system incorporates a sacrificial light colored 30-mil HDPE FML. The sacrificial liner is installed over the slope liner during construction. During waste placement it is incrementally removed and replaced with the 2-foot operations layer prior to waste being filled against the slope. The sacrificial liner protects the slope liner during filling and specifically eliminates UV exposure of the primary nonwoven geotextile filter-fabric. The layer also prevents infiltration into the slope LCRS during precipitation. As discussed in Chapter 4.0, portions of the sacrificial liner are retained as rubsheets for the LCRS risers. Sand tubes and wind vents will be installed to secure the slope lining system and prevent uplift from wind. The requirements for the sand tubes and wind vents are provided in the Specifications (Exhibit B).

## 3.4 FOUNDATION SETTLEMENT ANALYSIS

1. Foundation settlement calculations are provided in Exhibit C.4. A part of that calculation evaluates the maximum expected foundation settlement at various points along a cross section taken through the widest part of the closed cell. The purpose of the calculations is to evaluate potential adverse effects on the lining system due to foundation settlement (e.g., excessive

liner stresses or reduction of bottom slope). The calculations also include an evaluation of maximum settlement with respect to the postclosure grading plan (see Chapter 5.0 for a discussion of cap settlement).

2. The calculations show that total settlement of the foundation from waste filling is negligible (e.g., about 1 inch). In addition, differential settlement of the foundation is also negligible and does not adversely affect the liner or bottom slope.

## 3.5 LINER SYSTEM STRESSES

1. Provided in Exhibit C.5 is an evaluation of tension and elongation of the slope liner system; calculated to confirm that the liner system can withstand anticipated loading. The evaluation includes consideration of loads on the slopes during installation and operations including the following:
   - Gravity elongation
   - Thermal expansion
   - Wind uplift
   - Seismic deformation
   - Settlement

2. To evaluate the worst-case condition, the strains due to each of the loads indicated above are calculated and summed to determine the cumulative strain that could be experienced by each component. Stresses are then determined from the modulus of the material. The calculated stresses are then compared to allowable stresses (e.g., ultimate strength reduced by appropriate factors of safety) for each component. Calculated stresses must be smaller than allowable stresses for each component of the system to be acceptable.

3. Evaluations presented in Exhibit C.5 indicate that calculated stresses in the selected components are smaller than the allowable stresses. The calculated strains due to gravity elongation, thermal expansion, seismic deformations result in small stresses in comparison to allowable values. Stress generated due to wind uplift are negligible since weights and sand tubes will be used to hold down the slope liner system. The largest strain (and corresponding stress) results from settlement. However, since a weak interface above the 100-mil HDPE FML layer is used, the effect of settlement is isolated to the geonet and geotextile layers of the LCRS. As shown in Exhibit C.5 the calculated stresses (including the effect of settlement) do not exceed the allowable stresses for those layers.

## 3.6 STABILITY ANALYSES

### 3.6.1 STABILITY OF EXCAVATED SIDE WALLS

1. Grant Environmental (July 14, 1994) performed a stability analysis utilizing a computer model (STABARM) on each of the four walls of the excavated cell, and determined factors of safety for failure surfaces at each distinct soil layer within the slope walls. Conclusions from that report indicate that except for the upper 4 to 9 feet of material, the excavation slopes will be statically stable. Reinforcement of the upper 4 to 9 feet of material is discussed in Chapter 2.0.

2. Grant Environmental (July 14, 1994) also evaluated the performance of the excavated slopes under seismic loading conditions using a seismic coefficient of 0.18g and concluded that the slopes would remain stable. Using maps completed by Algermissen, 1990, it is determined that there is a 10 percent probability that horizontal ground accelerations will not exceed 0.20g near the Beatty facility in 50 years (≅ 475-year return period). Since the cell is likely to be open for only about 10 years the conclusions reached in the Grant Environmental report are appropriate.

### 3.6.2 STABILITY DURING FILLING

1. Stability during filling was evaluated for the first phase of cell construction (12A). Calculations are provided in Exhibit C.2.

2. The design criteria for this evaluation is the following:
   - A static factor of safety using existing residual strength data of greater than 1.3 must be calculated for the temporary waste fill slopes and lining system.
   - A maximum seismic deformation of 6 inches from the 475-year return period earthquake is allowed in accordance with Seed and Bonaparte (1992).

3. The evaluation was completed using a 3H:1V slope from the 12A/12B phase line extending to a 70-foot thick temporary waste thickness. This configuration allows for "in pit" management of surface water since the waste remains below the crest of the lined perimeter. The evaluated cross section is a northerly slice of the waste fill and lining system which has the smallest passive block due to the orientation of the 12A/12B phase line. This geometry represents the worst-case condition.

4. As shown in Exhibit C.2 the static factor of safety is 1.46 which is greater than the required 1.3. The calculated seismic deformation with a seismic coefficient of 0.20g (Algermissen, 1990) is 1.6 inches which is less than the allowed deformation of 6 inches. As such, the selected configuration meets the design criteria and is acceptable.

5. Special considerations for filling (e.g., lift height and Phases 12B and 12C filling) are discussed in Section 3.7.

## 3.7 CONSTRUCTION AND OPERATIONS CONSIDERATIONS

### 3.7.1 CONSTRUCTION PHASING

1. The design of Cell 12 was developed to facilitate construction of the landfill in three phases. Each phase will have its own set of LCRS and LDS sumps as shown on Drawing 003. The westernmost portion of the cell is recommended as the initial phase (12A), while the middle (12B) and easternmost portions (12C) are recommended as the second and third phases.

2. Construction of the cell in phases is practical, in that it allows landfill capacity to better match demand. The basis for initiating construction with the westernmost phase (12A) and progressing eastward is threefold:
   - It will facilitate the unrestricted conclusion of operations in Cell 11 (including the construction of the cover system in that cell) while Phase 12A and potentially 12B are being constructed and operated.
   - It will not conflict with the relocation effort for the existing site entrance, office and other facilities.
   - Due to the "bottleneck" shape of the cell footprint, Phase 12B will have buttressed interim stability for placed waste along the open (eastern) edge of that phase. When Phase 12C is subsequently constructed and filled with waste, the entire below-grade waste fill will be confined laterally.

3. Initially, an access road will be cut through Phase 12B to support the excavation and construction of Phase 12A. After construction of Phase 12A is completed and it approaches its ultimate interim waste fill height, an access ramp for waste operations can be developed from the south perimeter of the cell. Phase 12B can then be constructed with an access road (on subgrade material) cut through the Phase 12C area. Filling of Phase 12B can continue via the south perimeter access road for Phase 12A. A construction access road for Phase 12C can be provided through Phase 12B on the south perimeter on clean fill placed over waste. Filling of Phase 12C can then continue utilizing this same access road after it is constructed.

4. Cell 12 could also be constructed as one concurrent nonphased effort, if considered appropriate. An access ramp would need to be designed along one of the sideslopes if this option was selected.

5. Regardless of how the cell is constructed, below-grade filling will occur in an appropriate fashion to maintain cell stability and manage precipitation. Assuming the cell is phased, waste fill slopes will be established at 3H:1V in 10-foot thick lifts from the edge of each phase line (e.g., 12A/12B; 12B/12C) to a maximum thickness of 70 feet (see discussion of stability in Section 3.6.2). If the cell is not phased, it will be filled in even 10-foot thick horizontal lifts along the entire cell base. Above-grade filling is discussed in Chapter 5.0.

6. Management of precipitation during below-grade filling will be handled as follows:
   - A 2-foot thick temporary cover soil material will be placed on the 3H:1V slopes that extend from each phase line. Precipitation that comes in contact with this clean fill slope will be allowed to run off to the adjacent area.
   - The active waste deck will be sloped away from the 3H:1V slopes so precipitation that contacts the active portion of the landfill will be contained. Water that ponds in this area will be removed and handled in accordance with approved site procedures.

# 4.0 LEACHATE HANDLING

## 4.1 LEACHATE COLLECTION AND REMOVAL SYSTEM SUMPS

### 4.1.1 DESIGN ELEMENTS

1. The LCRS is associated with the primary liner system. The function of the LCRS is to intercept leachate draining through the waste and to discharge it into the sumps for removal from the landfill. The typical sump configuration is shown in Detail 1 on Drawing 008. A grade break between 1 percent and 10 percent cell bottom slopes is the sump perimeter. The LCRS sump is 12 inches deep. Liquid is removed from the sump through a riser that is shown in Sections A and B on Drawing 008. The components of the LCRS sump are sized to accommodate the maximum anticipated leachate flows while maintaining fluid head above the primary liner at or below 1 foot. Design calculations for the LCRS sump and risers are provided in Exhibit C.7. Flow and pump sizing calculations are provided in Exhibit C.8.

2. Components used in the Cell 12 LCRS sumps are shown on the typical sump layout on Drawing 008, and Section A on Drawing 010. The components include:
   - Geocomposite (Texnet TN3002/1125, or equivalent): This is the principal LCRS drainage component (at cell bottom locations, see Section 3.2.1) that discharges directly to the drain rock at the edge of the sump.
   - 7.5-Ounce LCRS Filter Geotextile: This geotextile is used to separate the operations layer from the 1-inch diameter drain rock (described below). It is used over the entire sump area within the sump perimeter.
   - 3-Inch Diameter Perforated Corrugated Polyethylene Pipes: These pipes are secondary flow components that assist the LCRS in handling the maximum anticipated flow resulting from a 25-year, 24-hour storm event (see Section 4.1.2). The pipes discharge directly to a slip joint in the primary riser pipe (described below).
   - 1-Inch Diameter (Nominal) Drain Rock: This is a clean gravel conforming to the gradation included in the specifications (Exhibit B). The LCRS gravel fills the entire sump to the grade break.
   - 16-Ounce LCRS Cushion Geotextile: This is a nonwoven geotextile used to provide additional puncture protection to the liner system within the sump perimeter (see Sections A and C on Drawing 010).

3. Components of the LCRS riser system include the following (starting at the sump):
   - Slip Joint: Settlement of the riser system is accommodated by a slip joint which does not transfer stress to the liner system. As shown in Section A, Drawing 010, the slip joint is a 10-inch diameter SDR 17 HDPE pipe that is extrusion welded to a 1-inch thick, 20-inch square HDPE flatstock base. The pipe is perforated with 1/2-inch diameter holes 60 degrees apart on 3-inch centers (24 holes per foot). A 16-ounce geotextile cushion sheet is placed between the liner system and the slip

joint base. The slip joint extends a minimum of 6 inches into a riser support (discussed below). The lip of the slip joint pipe in the riser support will be built up with flatstock and then camfered to provide a smooth transition for pumps lowered into the sump.

- Riser Pipe Support: The riser pipe support consists of a concrete foundation block shown in Detail 2 on Drawing 008 which transfers the pipe and potential downdrag loads to the LCRS gravel and buttress (Section A on Drawing 010), thus preventing stress concentrations on the liner system. The riser pipe support is intended to be a cast-in-place unit built of 4,000 psi concrete, using Type V sulfate resistant cement. A 12-inch diameter, Schedule 80, Type 316 stainless steel welding stub will be cast in the concrete and secured with 1-inch diameter by 6-inch long expansion type anchor bolts. The riser pipe support will be positioned in the field such that the slip joint, support and LCRS long radius elbow (described below) are correctly aligned.
- LCRS Long Radius Elbow: This is a prefabricated elbow that provides the 6 inches of deflection required to place the LCRS riser pipe in the center of the riser support. The piece is 20 feet long and fabricated of 12-inch diameter, Schedule 80, Type 316 stainless steel. The bottom of the LCRS long radius elbow will be welded to the welding stub on the riser pipe support. The top will be welded directly to the LCRS riser pipe (described below).
- LCRS Riser Pipe: This is a 12-inch diameter, Schedule 40 carbon steel pipe. A 24-inch wide section of the 30-mil HDPE sacrificial liner (see Section 3.3) directly beneath the riser pipe will be left in place as a rubsheet to protect the slope liner system.
- Riser Pipe Slip Cover: The function of this component is to minimize the transfer of friction and downdrag loads on the riser pipe due to settlement of the waste. The riser pipe slip cover will be fabricated from a 12-inch diameter corrugated polyethylene pipe (Advanced Drainage Systems, or equivalent) that has been split longitudinally and placed over the riser as shown in Section C of Drawing 008. It is not necessary to join the individual pieces of the slip cover.
- Top of Slope Anchor: This is a concrete block with an adjustable U-bolt (shown in Detail 3 on Drawing 008). This component provides lateral restraint for the riser pipe while allowing vertical movement to accommodate settlement. When the starter berms and buttresses (Section 5.2) are constructed, the riser pipe will be extended and the top of slope anchor repositioned accordingly.
- Leachate Pump: Design calculations (Exhibit C.8) indicate the LCRS system could potentially see a maximum flow of approximately 2 gallons per minute (gpm). The pump must also be able to generate a total dynamic head (TDH) of approximately 126 feet. A Protec reciprocating pump, Model No. RP-2 or equivalent (see Exhibit C.8), provides acceptable performance (8 gpm and 200 feet TDH) for this purpose. The inlet on this type of pump is located at the bottom of the unit, providing the ability to remove all but a slight residual liquid level in the sump.

### 4.1.2 MAXIMUM LCRS FLOW

1. The design storm for this facility is the 25-year, 24-hour event which yields 2 inches of precipitation at the Beatty site (see Exhibit C.10). The critical operational time for the LCRS is after the 2-foot operations layer has been placed and waste filling operations have just begun. At that point, because there is some waste in the cell, collected precipitation is considered to be leachate (rather than stormwater), while at the same time the small amount of placed waste provides only a minimal amount of additional sorptive capacity, hence the potential for precipitation infiltration to the LCRS is greatest. This condition results in the largest potential flow in the LCRS.

2. The calculations in Exhibit C.8 show how the precipitation is distributed between direct runoff and infiltration. For the largest phase of the landfill (Cell 12A), it is estimated that 0.24 acre-feet (78,000 gallons) infiltrates and 0.35 acre-feet (114,000 gallons) is direct runoff. The direct runoff is a combination of the distributed precipitation falling on the cell bottom and the total precipitation falling on the slopes. As described in Section 6.2.2, the sacrificial liner prevents the slopes from contributing infiltration to the LCRS. Handling of direct runoff is described in Section 6.2.

3. The infiltration portion of the precipitation will be handled by the LCRS. The calculations (Exhibit C.8) conservatively estimate that the operations layer will have sufficient moisture to be at field capacity, which implies an addition of moisture will start gravity drainage. However, since the design quantity of infiltration fills only 34 percent of the estimated available pore space in the operations layer, drainage is controlled by unsaturated flow. Based on the calculations, the maximum drainage rate results in a flow of 2 gpm to the sump. The capacity of the recommended pump (8 gpm) provides a factor of safety equal to 4.

## 4.2 LEACHATE DETECTION SYSTEM SUMPS

### 4.2.1 DESIGN ELEMENTS

1. The LDS is associated with the secondary liner system. The functions of the LDS are to detect and remove liquid that may migrate through the primary liner system. The system is designed to accommodate flow up to the Action Leakage Rate (ALR, defined in Section 4.2.2), while fluid head above the secondary liner remains at or below 1 foot. Design calculations for the LDS sumps and risers are provided in Exhibit C.7. Flow and pump sizing calculations are provided in Exhibit C.9.

2. Components used in the Cell 12 LDS sumps are shown in the typical sump layout on Drawing 008, and Section B on Drawing 010. The components include:

   - Geocomposite (Texnet TN3002/1125, or equivalent): This is the principal LDS drainage component (at the cell bottom locations, see Section 3.2.1) that discharges to the geonet at or near the sump perimeter (see Section C on Drawing 010). In the vicinity of the sumps, multiple layers of geocomposite are used to provide additional flow capacity. See Detail 1 on Drawing 010 for deployment of multiple geocomposite layers around the sumps.
   - Geonet (Polynet 3000 or Equivalent): The geonet is a high capacity synthetic drainage layer. It is used within the grade break at each sump to convey liquid to the 15-inch deep sump area (see Detail 1 on Drawing 010). Geonet is also used around Sumps 12A and 12C to provide sufficient flow capacity for the design ALR.
   - 16-Ounce LDS Cushion Geotextile: This is a nonwoven geotextile used to provide additional puncture protection to the liner system within the sump perimeter (see Sections B and C on Drawing 010).
   - 1-Inch Diameter (Nominal) Drain Rock: A clean gravel conforming to the gradation included in the specifications (Exhibit B). As shown in Section B on Drawing 010, the LDS gravel fills only the 15-inch deep sump area.
   - LDS End Caps, Tee, Collection Pipes and Elbow: These pieces are all 12-inch diameter SDR 17 HDPE that is perforated to collect flow into the LDS sump. The pieces rest on a 1-inch thick piece of HDPE flatstock. The pieces also transfer the lateral load of the riser pipe to the sidewall of the LDS sump. A 1-inch thick piece of HDPE flatstock is used to evenly distribute the load from the HDPE tee and collection pipes to the sidewall (see Section B on Drawing 010). Additional lateral resistance is provided by the 4-foot thick operations layer placed directly over the sump (see Section A on Drawing 008).
   - 16-Ounce Lower LDS Cushion Geotextile: This is a nonwoven geotextile that provides puncture protection to the secondary liner system in the 15-inch deep portion of the sump as shown in Section B on Drawing 010.

3. Components of the LDS riser system include the following (starting at the sump):

   - LDS Riser: A 12-inch diameter SDR 17 HDPE pipe used for pump access.
   - LDS Riser Trench and Backfill: The LDS Riser (described above) is placed in a 24-inch wide by 18-inch deep trench cut into the sidewall during excavation. Gunite (or similar material) will be used as necessary to smooth the walls prior to placement of the secondary liner system (see Section 2.5). A 30-mil PVC rubsheet is used to separate the backfill material from the geocomposite and to provide additional cushion to the liner system. Backfill consists of lightweight concrete (25 pcf). The concrete must have a minimum strength of 200 psi and be quick setting. The construction entity must provide a forming plan for approval prior to construction.

- Top of Slope Anchor: See the LCRS Top of Slope Anchor description in Section 4.1.1 above since the units are identical.
- Leachate Pump: See the LCRS Leachate Pump description in Section 4.1.1 above since an identical unit will be used.

4.2.2 ACTION LEAKAGE RATE

1. As described in 40 CFR § 264.302(a), the ALR is "...the maximum design flow rate the LDS can remove without the fluid head on the bottom liner exceeding 1 foot." The ALR for each of the three sumps was determined by: (1) assuming a nominal design flow value; (2) determining a configuration of the LDS components that could satisfy the design flow; and (3) calculating the actual ALR resulting from that configuration.

2. Drainage into the LDS sumps is controlled by the flow rate of the LDS geocomposite and the minimum effective flow width of the LDS sumps. Since the effective width of flow narrows approaching the sumps, additional flow capacity is required in this vicinity. Geonets or double layers of geocomposite are used to provide the desired flow capacity. Layout configurations for those components are shown in Detail 1 on Drawing 010.

3. Calculations of the ALRs are provided in Exhibit C.9. The resulting ALR for each of the sumps is shown below:

| SUMP | CELL BASE AREA (acres) | ALR (gpad) |
|---|---|---|
| 12A | 3.49 | 200 |
| 12B | 2.45 | 185 |
| 12C | 2.87 | 212 |

gpad = gallons per acre-day

# 5.0 ABOVE-GRADE DESIGN AND COVER SYSTEM

## 5.1 GENERAL

1. The main construction activities required for placing waste in the portion of Cell 12 above the existing grade include construction of the following:

   - A starter berm along the north and west perimeters to initiate development of the 3H:1V slopes for sides of Cell 12.
   - A series of five lined, 10-foot-high starter berms and buttress fills along the south perimeter. These berms and buttresses will allow the prism to be extended to a height of 50 feet without having the waste extend into the 150-foot buffer from the LLRW trenches.
   - The final landfill cover.

   The general configuration of these items is shown in Sections B and C on Drawing 006. Details for each are described in Sections 5.2 and 5.3. Section 5.4 discusses stability and settlement calculations which have been performed for the above-grade portions of Cell 12.

## 5.2 STARTER BERMS AND BUTTRESS FILLS

1. As the capacity of the below-grade portion of the landfill is reached it will be necessary to begin placing waste above grade. To effectively manage surface water during filling and provide stability to the above-grade filling operation, starter berms of select waste or clean fill material will be constructed. The upper 3 feet of the starter berms will be constructed of clean fill so that temporary anchor trenches (see Details 2 and 3 on Drawing 009) for the geosynthetic cover components are not built on waste. The outer 2 feet of the starter berm face will also be clean fill. This is to preclude precipitation which falls onto the slope prior to cover installation from contacting waste. The starter berms will be compacted using procedures provided in the specifications (Exhibit B).

2. Only a single starter berm will be provided on the north and west perimeters of the cell since the waste surface slopes at 3H:1V for the full height of the waste prism (see Sections B and C on Drawing 006) in these areas. As the waste is placed above the inboard crest of the starter berm, a 2-foot thick layer of clean soil will be placed to contain rainfall in the disposal areas and for temporary erosion protection. This 2-foot-thick layer will ultimately form the cover system foundation layer for the 3H:1V slopes.

3. A series of five starter berms will be provided on the south side of the landfill to facilitate construction of the 0.5H:1V waste slope as shown on Drawing 006. Each of the 10-foot-high

starter berms will be buttressed by an earth fill comprised of site soils compacted to 90 percent relative density (ASTM D1557). Each 10-foot-high buttress will be placed after installation of geosynthetic materials on the outer face of each starter berm (see Detail 3 on Drawing 009). After the waste fill has reached the fill height facilitated by the fifth starter berm, waste will be placed at a 3H:1V slope to its final configuration. As on the north side, a 2-foot layer of clean soil (the ultimate cover system foundation layer) will be placed above the waste surface to contain rainfall in the disposal area and provide temporary erosion protection.

4. As provided for in Note 4 on Drawing 006, the waste level will always be kept below the crest of the inboard side of each starter berm to maintain control of surface water.

5. Anchor trenches will be constructed in the upper 3 feet of clean fill of each starter berm to facilitate installation of geosynthetic cover materials. Subsequent layers of geosynthetic materials will be overlapped and welded, as appropriate, to those on the adjacent lower starter berm to provide a continuous barrier. The temporary trench and geosynthetic material configurations are shown in Details 2 and 3 on Drawing 009 for the north and west, and south slopes, respectively.

## 5.3 COVER SYSTEM DETAILS

1. Once the waste fill has reached its ultimate configuration, the cell will be closed. A cover system will be constructed which includes the following layers (from bottom to top):
   - 2-foot thick foundation layer (placed during filling)
   - Geosynthetic barrier layer comprised of:
     - GCL
     - 60-mil textured HDPE FML
   - Geocomposite drainage layer
   - 2-foot thick cover protection layer comprised of:
     - 1.5 foot thick granular soil layer
     - 0.5 foot thick gravel, erosion-resistant layer

   Each of these components are discussed in the following subsections.

### 5.3.1 FOUNDATION LAYER

1. The foundation layer consists of the 2-foot thick layer of clean site soil which will be placed during waste filling, as discussed in Section 5.2. Prior to constructing the final cover system, this layer of soil will be checked for minimum thickness, augmented with additional soil or trimmed where necessary, and proof rolled with three passes of a sheepsfoot compactor.

2. After compaction, the foundation layer will be smoothed with a grader or other appropriate equipment to achieve the specified lines and grades (5 percent minimum on the top of the landfill) and to establish an appropriate surface for the geosynthetic cover components.

### 5.3.2 GEOSYNTHETIC BARRIER LAYER

1. The purpose of the geosynthetic barrier layer is to meet the requirements of 40 CFR 264.310(a)(5), which states that the final cover must:

> "(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present."

2. For landfills which have two FMLs in the liner system, EPA draft guidance (EPA, 1987) says that the cover system permeability requirement of 40 CFR 264.310(a)(5) does not mandate the installation of two cover system FMLs. The draft guidance states:

> "A single FML in the final cover that is equivalent to the thicker FML used in the double liner system will be considered to have an equivalent permeability."

?

3. The barrier components of the Cell 12 liner system are two FMLs and one GCL. Accordingly, in conformance with regulation and draft guidance, the barrier components of the Cell 12 cover system are one FML and one GCL. The Cell 12 cover system barrier component are described below, listed from the bottom up:

   - GCL ($K \leq 5x10^{-9}$ cm/sec)
   - 60-mil textured HDPE FML

   The Cell 12 cover system GCL is specified at the same maximum permeability as the liner system GCL. The Cell 12 cover system FML is specified at a thickness of 60 mils, rather than a thickness of 100 mils which represents the thicker of the two liner system FMLs, because the cover system is expected to experience significantly reduced loads, puncture potential and leachate exposure as compared to the liner system. This departure from draft guidance is considered to be appropriately justified by the design for Cell 12, especially in light of its location in an arid desert environment (e.g., lack of precipitation).

4. The GCL will be of the needle-punched or sewn variety to provide appropriate internal interface strengths with the foundation and barrier layers under hydrated conditions and the level of confinement achieved from 2 feet of overlying soil/gravel. The strengths for the materials used for construction will meet or exceed those used in the stability analyses discussed in Section 5.4.

### 5.3.3 GEOCOMPOSITE DRAINAGE LAYER

1. The selected drainage layer will remove infiltration water to prevent the cover soil from becoming saturated. The material will be comprised of nonwoven needle-punched polyester geotextile layers bonded to both sides of a HDPE geonet. This layer will be placed directly on top of the textured HDPE FML and below the soil/gravel cover protection layer. Calculations discussed in Section 5.4 shows that both of these interfaces have sufficient strength to remain stable.

### 5.3.4 COVER PROTECTION LAYER

1. The cover protection layer will be comprised of a 1.5-foot thick granular soil layer and a 0.5-foot thick gravel layer, the latter for erosion protection. The granular soil layer will be comprised of material from onsite excavations which has been processed such that particles greater than 1 inch in diameter have been removed. The material will be carefully placed over the geocomposite drainage layer to prevent damage during construction.

2. The gravel layer will be comprised of screened oversize material from onsite excavations, with particle sizes ranging from 3/4 to 3 inches. Calculations presented in Exhibit C.11 show that with the particle size distribution selected, adequate erosion control (e.g., less than 2 tons/acre-year) is achieved.

## 5.4 SLOPE STABILITY AND SETTLEMENT

### 5.4.1 STATIC AND SEISMIC STABILITY OF CLOSED CELL COVER SYSTEM

1. The calculations in Exhibit C.1 provide an evaluation of the static and seismic surficial stability of the closed cell cover system. That evaluation considers the following materials and interfaces which comprise the cover system:

   - Soil cover
   - Soil overlying geocomposite
   - Geocomposite overlying 60-mil textured HDPE
   - 60-mil textured HDPE overlying GCL
   - GCL (internal)
   - GCL overlying foundation materials
   - Foundation and buttress materials

   The stability calculations are based on interface and material strengths determined from past projects or the literature. Specifications (Exhibit B) require site-specific testing for the most critical elements.

2. The calculations evaluate the cover system configuration, materials and interfaces for static and seismic stability for the 3H:1V cover slopes and the 2H:1V south buttress slope. A peak horizontal ground acceleration (PHGA) of 0.42 g is used for the seismic calculations, based on considerations of the maximum credible earthquake (MCE) at the site location. Determination of the MCE and PHGA are provided in Exhibit C.1.

3. The calculations conclude that the waste fill and cover system are stable for the design slope configurations. The static factors of safety are in excess of 1.5 for the overall slopes, cover system and the south buttress.

4. The calculations also show that the waste fill, cover system and buttress are stable for seismic conditions. For the cover system and south buttress, the largest estimated deformations are approximately 2 and 3 inches, respectively. These calculated values are within the commonly accepted deformation range of 6 to 12 inches (Seed and Bonaparte, 1992).

### 5.4.2 SETTLEMENT

1. Calculations to quantify the settlement of the final cover system are provided in Exhibit C.4. The calculations account for settlement of each of the following materials along a typical cross section of the landfill:
   - Settlement of foundation soil
   - Settlement of waste
   - Settlement of the landfill cover system

2. The waste fill is assumed to be comprised of the following:
   - 85 percent soils and soil-like wastes
   - 10 percent containerized wastes
   - 5 percent noncompressible solid wastes

   The calculations include settlement of containerized wastes and reflect both the collapse of a partially-full container, as well as the compression of the waste itself within the container.

3. The maximum settlement at the crown of the closed cell (see Point D' in Figure 2 of Exhibit C.4) is estimated to be between 16 and 79 inches. The considerable range of these values results from assumptions on the compressibility of the soil-like waste. For even the more conservative value, the settlement is less than only 5 percent of the total fill height. Estimated differential settlement along the modeled cross section indicates that with the design slopes of 3H:1V and a minimum cap grade of 5 percent, the potential for low spots (e.g., spots which could cause ponding) to develop is nil.

# 6.0 SURFACE WATER MANAGEMENT

## 6.1 GENERAL

1. Surface water management (SWM) systems for the USE facility are designed to accommodate precipitation from the 25-year, 24-hour storm event. This storm is estimated to yield 2 inches of precipitation as determined by the National Oceanic and Atmospheric Administration (NOAA, 1973) .

2. The overall site drainage control has already been developed by USE (USE, 1994). The general configuration of existing site drainage controls is shown in Drawing 002.

3. This chapter describes how stormwater will be managed for Cell 12 operations and closure. The descriptions are provided in the following sections:
   - Section 6.2 - Control of Stormwater in the Disposal Area
   - Section 6.3 - Run-On Control
   - Section 6.4 - Cover Runoff Control

## 6.2 CONTROL OF STORMWATER IN THE DISPOSAL AREA

1. For the purposes of this discussion, precipitation which falls within the disposal area is grouped into the following three categories:
   - Stormwater from precipitation which has fallen on the 0.5H:1V cell sidewalls.
   - Stormwater from precipitation which has fallen on placed waste.
   - Stormwater from precipitation which has fallen on the outboard face of the 3H:1V in-landfill slopes(1) which comprise the temporary slopes from filling Phases 12A and 12B.

   The management of these three categories of stormwater is discussed in the paragraphs that follow and are consistent with the procedures discussed in Section 3.7.

2. Stormwater from precipitation which has fallen on the 0.5H:1V cell sidewalls will not have contacted waste. This stormwater has the option of being managed separate from that which has contacted waste. If cell sidewall stormwater is captured with a sidewall "rain gutter" (or similar) system, it can be diverted for discharge and/or evaporation together with other clean stormwater. A rain gutter system could readily be affixed to the sacrificial FML which

(1) This assumes that Cell 12 is constructed in three phases rather than one concurrent nonphased cell.

overlies the sidewall liner system. On the other hand, if allowed to commingle with stormwater which has contacted waste, cell sidewall stormwater will be managed following appropriate site protocols for contact water.

3. Stormwater from precipitation which has fallen on placed waste will be managed following appropriate site protocols for contact water. Placed waste will be graded so that collected stormwater is directed to an in-cell ponding point located against one of the cell sidewalls, from which it can be removed for proper management.

4. Stormwater from precipitation which has fallen on the outboard face of the 3H:1V in-landfill slopes will not have contacted waste. It will be discharged and/or evaporated together with other clean stormwater.

5. The calculations in Exhibit C.8 evaluate the expected stormwater flow volumes from the 25-year, 24-hour design storm event for two cell configurations: (1) when Cell 12A has just been constructed and waste filling operations commence; and (2) when all three constructed cells (i.e., Cells 12A, 12B and 12C) have been filled with waste up to 3 feet below existing ground surface. This latter configuration represents the largest potential exposed surface area of waste (approximately 8.9 acres). The calculations include the conservative assumption that sidewall stormwater is not diverted from that which has contacted waste. Calculation results are summarized below:
   - The 25-year, 24-hour design storm event over initial waste operations in Cell 12A would be expected to generate approximately 171,000 gallons of stormwater (including a 50 percent factor of safety).
   - The 25-year, 24-hour design storm event over the entire Cell 12 filled with waste up to 3 feet below existing grade would be expected to generate approximately 300,000 gallons of stormwater (including a 50 percent factor of safety).

6. Stormwater collection and holding facilities will be provided by USE. These facilities must be emptied or otherwise managed expeditiously after storms to maintain the design capacity of the system.

## 6.3 RUN-ON CONTROL

1. Run-on control at Cell 12 is required only during the period that disposal operations are occurring below grade. The requirement during that period will be to prevent rainfall outside of the cell area from entering into the excavation and potentially being exposed to the waste

disposal operations. This is accomplished by: (1) maintaining a minimum 2 percent slope away from the lined excavation as shown in Detail 1 on Drawing 009; and (2) keeping existing drainage paths away from Cell 12 in an open condition so that flow can occur.

2. Run-on control will not be necessary when the disposal operations extend above the existing grade. At that time, potential run-on will be restricted by earth berms constructed around the cell perimeter as discussed in Section 5.3 and shown on Drawings 006 and 007.

## 6.4 COVER RUNOFF CONTROL

### 6.4.1 GENERAL

1. Runoff control from the cover slopes during filling of the cell above existing grade and at closure will be provided by the following types of control components:
   - Bench drains (see Detail 4 on Drawing 009) along the cell cover to limit the length of slope exposed to sheet flow.
   - Downdrains (see Drawing 004 and Detail 5 on Drawing 009) spaced periodically along the cover slopes to discharge bench drain run off to the perimeter of the cell.
   - Perimeter ditches (see Details 3 and 4 on Drawing 010) to convey flow from the downdrains, bottom portions of the cover slopes and immediately adjacent areas to the overall site drainage system.

   These systems are described in the following paragraphs.

2. The bench drains are located to maintain slope erosion below 2 tons per acre-year required by EPA guidance (EPA, 1989). Calculations provided in Exhibit C.11 show that this requirement is satisfied with one bench drain on the 3H:1V north and west slopes and two bench drains on the 2H:1V south slope.

3. A minimum 3 percent slope is provided along each bench drain to promote flow and allow for some differential settlement without the potential for ponding to occur. The maximum calculated bench drain flow for the system shown on Drawing 004 is approximately 4 cfs (see Exhibit C.10). Detail 4 on Drawing 009 shows how each bench drain will include gunite or a similar (e.g., thick HDPE liner) erosion protection material.

4. Detail 6 on Drawing 010 shows how the bench drains will discharge into downdrains along the cover slope. The maximum flow expected to occur in a downdrain is about 4 cfs from the design storm (see Exhibit C.10). This magnitude of flow will be readily contained in the

4-foot wide downdrain configuration shown in Section 5 on Drawing 009. As shown, each downdrain will also be lined with gunite or a similar erosion protection material.

5. Drawing 004 shows that a concrete splash wall will be provided at the bottom of downdrains where needed to dissipate energy as the flowing water enters perimeter ditches. The design for each splash wall is provided in Detail 7 on Drawing 010.

6. The perimeter ditches consist of eight reaches shown on Drawing 004. Dimensions for the perimeter ditch reaches are shown in Details 3 and 4 on Drawing 010.

7. Reaches 1, 2 and 3 make up the perimeter ditches along the entire north perimeter of Cell 12. The V-ditch in these reaches are designed to be constructed within a small width between the cell cover slope and the property line. The flow will be from west to east, where Reach 3 will then discharge into a gravel swale constructed across the north site access road. The configuration of this swale is shown in Detail 5 on Drawing 010.

8. Reaches 4 through 7 will drain runoff from along the entire south perimeter of Cell 12. Reach 4 drains in an east-to-west direction, and Reaches 5 through 7 drain in a west-to-east direction. The discharge from Reach 7 will be into an existing north to south site drainage swale along the west side of Cell 11. As shown in Detail 3 on Drawing 010, the ditch in Reaches 4, 5 and 6 will be formed by the south buttress slope of Cell 12 and a 2 percent graded fill which slopes down from the presently closed LLRW trench cover. The ditches in these reaches will be protected with gunite (or a similar material). Reach 7, which passes through a more restricted topographical area, will be constructed as a V-ditch as shown in Detail 4 on Drawing 010.

9. Finally, Reach 8 represents the entire perimeter ditch along the west end of Cell 12. This V-ditch will discharge into a swale across the west access road. The design for this swale is also provided in Detail 5 on Drawing 010.

# 7.0 REFERENCES


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