ATTACHMENT C – SOIL AND LINER QUALITY CONTROL PLAN (SLQCP)

FIGURES

TABLES

1.0 INTRODUCTION

The Soil and Liner Quality Control Plan (SLQCP) presents engineering and quality control requirements for liner, final cover, and leachate collection system construction for the C.K. Facility to protect fresh water, public health, safety, and the environment. The SLQCP follows the requirements listed in NMAC 19.15.36. The SLQCP shall be used in conjunction with Attachment K - Site Operating Plan, Attachment B - Engineered Design Plan, and specifications provided during construction. The SLQCP shall address the following:

- A Quality Assurance Program and the Quality Assurance Procedures to be implemented during the liner and final cover construction include field observation, laboratory and field testing, and acceptance criteria for constructed work.
- Recording and documenting procedures to demonstrate the liner meets the requirements listed in the NMAC.
- Lines of communication, responsibilities and role of quality assurance team and other related project personnel.

The landfill liner system will consist of (from bottom to top):

- 6-inches of compacted subgrade
- Geosynthetic clay liner (GCL)
- 60-mil high density polyethylene (HDPE) geomembrane (GML) upper liner
- 200-mil HDPE geonet (floor)/200-mil HDPE geocomposite (side slopes)
- 60-mil HDPE geomembrane lower liner
- 200-mil HDPE geocomposite (floor/slope)
- 24-inches of protective soil layer

The evaporation pond liner system will consist of (from bottom to top):

- 6-inches of compacted soil subgrade
- Geosynthetic clay liner (GCL)
- 60-mil HDPE lower liner
- 200-mil HDPE geonet leak detection layer
- 60-mil HDPE upper liner

The stabilization and solidification area liner system will consist of (from bottom to top):

- 6-inches of compacted soil subgrade
- Geosynthetic clay liner (GCL)
- 60-mil HDPE lower liner
- 200-mil HDPE geonet leak detection layer

- 60-mil HDPE upper liner
- 5-feet of protective soil and operational layer.

The Owner/Operator shall notify the division a minimum of 72-hours before construction and installation of any liner system, to allow the division to witness installation.

1.1 DEFINITIONS

This section provides the definitions for terms used in this SLQCP.

A. Quality Control (QC)

Actions taken by the geosynthetic manufacturers and geosynthetic and soil contractor to ensure the geosynthetics materials and workmanship meet the requirements of project plans and specifications.

B. Quality Assurance (QA)

Actions taken by the Geotechnical Professional (GP) to assure conformity of the liner system production and installation with the Quality Assurance Plan, drawings, and specifications. QA is provided by a party independent of installation.

C. Work

All tools, equipment, supervision, labor, and material or supplies necessary to complete the project as specified herein and shown on the plans.

D. Geosynthetics

A generic classification given to synthetic (man-made plastic) materials used in geotechnical engineering applications. Included are geomembrane lining, geotextiles, geonets, geogrids, geocomposites and geocells.

E. Geomembrane Liner (GML)

Essentially an impermeable synthetic material used as an integral part of a lining system, sometimes referred to as a geomembrane, sheet, or panel. On the project, the GML will consist of a 60-mil, high density polyethylene (HDPE) material.

F. Geotextile

A permeable synthetic textile used with soil, rock, sand, gravel, or any other similar materials as an integral part of the composite lining system. This textile provides protection to the GML as a geosynthetic cushion and serves as a filter interface between two (2) types of soil materials.

G. Geosynthetic Clay Liners (GCL)

Geosynthetic clay liners (GCL) are factory-manufactured, hydraulic barriers typically consisting of bentonite clay or other very low permeability clay materials, supported by geotextiles and/or geomembranes held together by needling, stitching and/or chemical adhesives.

H. Manufacturer

Firm(s) responsible for the production of GML, GCL, geotextiles, geonets, and geocomposites.

I. Earthwork Contractor

The firm responsible for excavation and subgrade preparation under the liner and final cover installation. This firm may also be responsible for placing protective cover and granular drainage materials over the installed lining system.

J. GML Contractor

The firm responsible for handling, storing, placing, seaming, and other aspects of the installation of the GML, geosynthetics cushion, and geotextiles as part of the lining system.

K. Geotechnical Professional (GP)

Person(s) or firm(s) authorized by Owner to manage and oversee execution of the work. May also be referred to as the Professional of Record (POR). For work-related to clay liner construction, this includes a professional engineer registered in this state who possesses professional experience in geotechnical engineering, testing, and interpretations. The GP is responsible for observing, testing, and documenting activities related to liner quality assurance during the installation of the lining system, and for issuing the final report. All completed work is subject to approval of the GP. For liner construction work involving geosynthetics, the GP must be a professional engineer with experience in geosynthetics.

The GP or representative should be onsite for all liner construction and testing for soils, geosynthetic clay liners, geomembrane liners, geotextiles, and geocomposite materials. 100% of all non-destructive testing of seams for geomembrane liners should be directly observed by the GP or representative.

L. Owner

C.K. Disposal, LLC.

M. Qualified Engineering Technician

The qualified representative of the GP who is certified in Geotechnical Engineering Technology (NICET) at Level 2 or higher, an engineering technician with a minimum of four (4) years of directly-related experience, or graduate engineer/geologist with one (1) year of directly related experience.

N. Quality Assurance Laboratory

The firm responsible for conducting tests on samples of liner system components taken from the site. The laboratory shall be independent of the Owner, Manufacturer, Lining Contractor, and any party involved with the manufacturing and/or installation of any of the geosynthetics.

O. Project Plans and Specifications

All project-related plans and specifications including design modifications and "as-built" plans.

P. Project Documents

All contractor submittals, construction plans, "as-built" plans, construction specifications, QA plan, safety plan, and project schedule.

2.0 GEOSYNTHETIC CLAY LINER (GCL)

2.1 General

This section includes the requirements for selection, installation, and protection of GCL.

2.2 Submittals

A. Pre-installation

Submit the following to the GP for approval prior to GCL deployment.

1. Supplier of the GCL manufacturer results for standard tests described in Table C.1.
2. Written certification the GCL meets the properties listed in Table C.1.
3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table C.1. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

Table C.1 - STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL

Test	Item	Type of Test	Standard Test Method	Frequency of Testing
Manufacturer's Quality Control	Bentonite[A]	Swell Index[A]	ASTM D5890	per 100,000-lbs and every truck or railcar
		Moisture Content[A]	ASTM D4643	per 100,000-lbs and every truck or railcar
		Fluid Loss[A]	ASTM D5891	per 100,000-lbs and every truck or railcar
	Geotextile	Grab Tensile Strength[B]	ASTM D6496	per 200,000-ft^2
		Mass/Unit Area	ASTM D5261	per 200,000-ft^2
	GCL Product	Grab Tensile Strength[B]	ASTM D6496 ASTM D4632	per 200,000-ft^2
		Clay Mass/Unit Area[C]	ASTM D5993	per 40,000-ft^2
		Permeability[D]	ASTM D5084	per week for each production line[E]
		Lap Joint Permeability[D][F]	ASTM D5084	per each material and lap type
Conformance Testing by 3rd Party Independent Laboratory	GCL Product	Clay Mass/Unit Area[C]	ASTM D5993	at least one (1) test per 100,000-ft^2 and ASTM D4354 procedure A
		Permeability[D][F]	ASTM D5084	per 100,000-ft^2
		Direct Shear[F][G]	ASTM D5321	Per GCL/adjoining material type

Notes:

A - Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-ml.

B - Geotextiles shall meet minimum manufacturer criteria.

C - Minimum Test value - 0.75-lb/in MARV at 0% moisture content.

D - 1 x 10^{-8} $m^3/m^2/sec$ or as required by the permit.

E - Report last twenty (20) permeability values, ending on production data of supplied GCL.

F - Test at confining/consolidating pressures simulating field conditions.

G - Not applicable for slopes of 7H:1V or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both sides of GCL.

B. Installation

The GCL installation Contractor shall submit to the GP a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each covered directly by GCL as installation proceeds.

2.3 Delivery, Storage, and Handling

A. Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

1. Manufacturer's name.
2. Product identification.
3. Roll number.
4. Roll dimensions.
5. Roll weight.

B. Storage and Protection

The Contractor will provide an onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer. After Contractor mobilization, he shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

2.4 Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. All GCLs shall be evaluated for stability prior to use onsite and the evaluation included in the GCLER/GMLER submittal. The GCL shall have a coefficient of permeability of 1×10^{7}-centimeters/second (cm/sec) or less.

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

2.5 Manufacturer

A. Acceptable Manufacturers

The GCL shall be Bentoliner products as produced by GSE or an equivalent pre-approved by the GP.

B. Manufacturing Experience

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar GCL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

2.6 Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include defective product found in compliance with SLQCP requirements. The warranty shall include the supply of the replacement GCL material and shall not include the cost of re-installation, defects, or failures due to improper installation.

2.7 Execution

A. Examination

The GP or his representative will collect samples of delivered material to the site or designated by the Manufacturer by roll number to be delivered to the site for conformance testing.

B. Subgrade Preparation

The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

C. Installation

i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
2. Weight the GCL with sandbags or equivalent in the presence of wind.
3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
4. Prevent damage to underlying layers during placement of GCL.
5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
7. Do not place GCL in the rain or at times of impending rain.
8. Do not place GCL in areas of ponded water.
9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
10. In general, only deploy GCL that can be covered during the day by geomembrane.
11. For needle-punched GCLs, add granular bentonite to the overlapped areas at the manufacturer's specified rate.

12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
13. Avoid dragging GCL on the subgrade.
14. Vehicular traffic other than low contact pressure vehicles such as smooth-tired ATV's or glove carts must be allowed on deployed GCL.
15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

ii. Overlaps

Overlap GCL to the manufacturer's recommendations that will vary according to seam location and climatic conditions. For needle-punched GCLs, apply granular bentonite to the overlapped area at a rate required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

iii. Defects and Repairs

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

iv. Interface with Other Products

Ensure the following when deploying overlying material:

1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.
4. If necessary, approved adhesive can be used to keep overlap seams and patches in place during placement of overlying materials.

2.8 Equipment

A. Storage

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

B. Installation

1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar to prevent slings from damaging edges.
2. A 15-foot long, 3-inch outer diameter schedule 120 steel pipe will be inserted into roll core for lifting.
3. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
4. Place bentonite between overlapped panels, or as directed by project needs requirements.

5. Bentonite sealing compound and/or granular bentonite for securing around penetrations and structures as shown on the contract documents.
6. Anchor bolts for securing around concrete structures, if required.
7. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.
8. Use utility knives with cutter, hook blade, or other approved device. Keep replacement blades onsite to maintain clean cuts in GCL.

3.0 GEOMEMBRANE LINING (GML)

3.1 General

This section covers the work necessary to construct and test the geomembrane lining (GML) system which will consist of 60-mil HDPE material. The objective is to provide an effective lining system at the completion of the work. The GML shall generally conform to the testing requirements of GRI Standard GM13 – Test Properties, Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes, (Geosynthetic Research Institute; Folsom, PA; November 2014) except as modified herein. Textured GML will be used on the side slopes. Smooth GML will be used on floor.

3.2 Submittals

A. Manufacturer Certification of SLQCP Conformance

The Contractor shall submit written certification by the Manufacturer that the lining materials conform to the requirements of the SLQCP, are similar and of the same formulation as that for which certification is submitted, and demonstrated by actual usage to be satisfactory for the intended application.

B. Contractor and Manufacturer QC Program

The Manufacturer and the Contractor, shall each submit a complete description of the quality control program as applicable, for manufacturing, handling, installing, testing, repairing, and providing a completed lining in accordance with requirements of the SLQCP. The description shall include but not be limited to polymer resin supplier, product identification, acceptance testing, fabrication and production testing, installation testing, documentation of changes, alterations and repairs, retests, and acceptance. Each shall present documented evidence of its ability and capacity to perform this Work.

C. Contractor Installation Plan

The Contractor shall submit installation drawings, descriptions of installation procedures, and a schedule for performing/completing the Work. Installation drawings shall show a lining panel layout with proposed size, number, position, and sequence of placing all panels and indicating the location of all field seams. Installation drawings shall also show complete details and/or methods for anchoring the lining at the perimeter, making field seams, and making anchors/seals to pipes and structures.

The Contractor shall submit a complete description of welding procedures for making field seams and repairs. The welding procedures shall conform to the latest procedures recommended by the lining Manufacturer and to the SLQCP.

The Contractor shall submit for approval by the GP certification that the surface(s) on which the lining will be placed is acceptable. Installation of the lining shall not commence until certification is furnished to the GP.

D. Manufacturer's Warranty

The lining Manufacturer shall furnish a written lining material warranty as described in GRI GM13. The warranty shall be against manufacturing defects or workmanship and against deterioration due to ozone, ultraviolet, or other normal weather aging. The warranty shall be limited to replacement of material only and shall not cover installation of said material. The warranty shall not cover damage due to vandalism, acts of animals, or supernatural acts of God. The warranty shall be for 5 years from the date of GML installation.

E. Contractor's Warranty

The Contractor shall furnish a written guarantee that the entire lining work constructed by him is free of defects in material and workmanship and installed pursuant to the SLQCP for 2 years following the date of acceptance of the work by the GP. During the 23rd month, a pre-guarantee expiration inspection will be conducted to identify any necessary repair work covered by the guarantee. The Contractor shall agree to make any repairs or replacements made necessary by defects in materials or workmanship in the Work which become evident within said guarantee period. The Contractor shall make repairs and/or replacements promptly, the Owner may do so, and the Contractor shall be liable to the Owner for the cost of such repairs and/or replacements.

3.3 Quality Assurance

Prior to start of work, the lining Manufacturer and the Contractor shall each submit for approval by the GP documented evidence of the ability and capacity to perform this Work. Each shall have successfully manufactured and/or installed a minimum of 2-million/sq/ft of similar lining material in waste and/or liquid processing containment structures. The Contractor can meet these criteria by teaming with a subcontractor who is identified in the bid and the firm's experience.

The Contractor shall submit the name and qualifications of the project superintendent on the project whenever lining materials are being handled/installed plus the names and qualifications of senior installation personnel on the project.

The Quality Control Plan(s) to be implemented for the Work by the lining Manufacturer and the Contractor shall be in accordance with applicable paragraphs of the SLQCP.

The Manufacturer shall provide onsite technical supervision and assistance at all times during installations of the lining system. The Manufacturer and Contractor, as applicable to each, shall submit for approval by the GP written certification that the lining system was installed in accordance with the Manufacturer's recommendation, the SLQCP, project specification and drawings, and approved submittals.

The GP will initiate a pre-installation meeting with the Manufacturer and Contractor prior to installation of the lining system. Topics for review/discussion shall include, as a minimum, project plans and specifications, approved submittals, training and qualification procedures for Contractor personnel, and demonstration of making field-welded seam(s) included peel and shear tests.

Prior to installation of the lining system, the Contractor shall instruct the hazards of installation workers on handling sheets of lining material in high winds, use of equipment, application of solvents, adhesives and caulks, and walking on lining surfaces. Work gloves, safety glasses, hard hats, and smooth-soled shoes are minimum safety wear requirements when working on the GML. Safety shoes must be worn when handling heavy objects.

The GP shall have authority to order an immediate work stoppage because of improper installation procedures, safety infractions, or for any reason resulting in a defective liner.

3.4 Deliver, Storage, and Handling

The Contractor shall submit for approval by the GP method(s) for handling and storage of lining material(s) delivered to the project site. These materials shall be stored in accordance with the Manufacturer's recommendation. Lining materials delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The storage area shall be such that all materials are protected from mud, soil, dirt, and debris. The stacking of lining shall not be higher than two (2) rolls. Under no circumstances shall the lining be subjected to materials, sandbags, equipment, or other items dragged across the surface. Nor shall workers and others slide down slopes atop the lining. All scuffed surfaces resulting from abuse of any kind caused by the Contractor in performance of the work shall be repaired at GP direction.

The Contractor shall be completely responsible for shipping storage, handling, and installation of all lining materials in compliance with SLQCP.

3.5 Products

HDPE lining materials shall be new, first quality products designed and manufactured specifically for the purposes of the Work and have satisfactorily demonstrated by prior use to be suitable and durable for such purposes. The geomembrane shall be unmodified HDPE containing no plasticizers, fillers, chemical additives, reclaimed polymers, or extenders. For ultraviolet resistance, the GML material shall contain not less than 2.0% carbon black as determined by ASTM D1603. The only other compound ingredients added to the GML shall be antioxidants and heat stabilizers required for manufacturing. The GML shall be supplied as a single-ply continuous sheet with no factory seams and in rolls with a minimum width of 15-feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest field seams.

The GML lining materials shall be as manufactured by GSE Lining Systems, Inc., Houston, Texas; Poly-America, Inc., Grand Prairie, Texas; National Seal Company, Galesburg, Illinois; or approved equal.

The standard tests described in Table C.2 will be performed on the GML material.

Table C.2 - STANDARD TESTS ON HDPE GML MATERIAL

Test	Type of Test	Standard Test Method	Frequency of Testing
Resin	Melt Flow Index	ASTM D1238	per 100,000-ft^2 and every resin lot
	Specific Gravity/Density	ASTM D1505	per 100,000-ft^2 and every resin lot
Manufacturer Quality Control	Thickness	ASTM D5199 or ASTM D5994	per 100,000-ft^2 and every resin lot
	Specific Gravity/Density	ASTM D1505	per 100,000-ft^2 and every resin lot
	Carbon Black Content	ASTM D1603	per 100,000-ft^2 and every resin lot
	Carbon Black Dispersion	ASTM D5596	per 100,000-ft^2 and every resin lot
	Tensile Properties	ASTM D6693, Type IV	per 100,000-ft^2 and every resin lot
	Tear	ASTM D1004	per 100,000-ft^2 and every resin lot
	Puncture	ASTM D4833	per 100,000-ft^2 and every resin lot
Conformance Testing by 3rd Party Independent Laboratory	Thickness	ASTM D5199 or ASTM D5994	per 100,000-ft^2 and every resin lot
	Specific Gravity/Density	ASTM D1505	per 100,000-ft^2 and every resin lot
	Carbon Black Content	ASTM D1603	per 100,000-ft^2 and every resin lot
	Carbon Black Dispersion	ASTM D5596	per 100,000-ft^2 and every resin lot
	Tensile Properties	ASTM D6693, Type IV	per 100,000-ft^2 and every resin lot

Note: NSF 54 modified with 2-inch initial gauge length assumed for elongation at break.

Extrusion resin used for fusion welding with extrudate to make field seams between GML sheets and for repairs shall be HDPE-produced and the same as HDPE sheet resin. Physical properties shall be same as HDPE lining sheets.

3.6 Installation Procedures

Prior to installation of the GML, a site inspection will be conducted by the GP and Contractor to verify measurements, structures, and surface conditions to support the GML. The Contractor will provide written documentation to the GP that surfaces to receive the GML have been inspected and acceptable for installation of the lining.

Before the work begins, the Contractor will inspect all lining materials for damage from transit. Materials that cannot be repaired will be rejected and removed from the work area and site. During unwrapping of lining materials for use and placement, the Contractor will visually inspect all materials, particularly surfaces of lining sheets, for imperfections and faulty areas. All such defective places will be marked and repaired in accordance with approved methods.

The GML will be installed as shown on the project plans and approved installation drawings. Placement of the GML will be done such that good fit, without bridging, is a provided on all covers and grade changes. Excessive slack will be avoided to minimize rippling during the

soil cover operation. Sheets of GML materials will be of such lengths and widths and will be placed in such a manner as to reduce field seaming to a minimum. The lining will be anchored according to details shown on approved plans and drawings. The lining will be anchored and sealed to structures, pipes, and other types of penetrations, (if any), in accordance with details shown on approved plans and drawings. All changes in approved installation drawings and procedures must be approved by the GP.

Extreme care will be taken during installation of the lining to be certain no damage is done to any part of the lining. Dragging of the GML material on the GCL or subgrade will be avoided. Installation personnel are prohibited from smoking. All handling and installation procedures will be performed by workers wearing shoes with smooth soles. Shoes with patterned soles in relief are prohibited. No foot traffic is allowed on lining. All motor-driven equipment using fuel will have spark arrestors. No gasoline-driven generators or cans of gas or solvent will be place directly on the lining material. Under no circumstances will the lining be used as a work area to prepare patches or to store tools and supplies. If needed, a tarpaulin of approved material will be spread out as a work area.

During installation, the Contractor will be responsible for protecting the lining against adverse effects of high winds such as uplift. Sand bags with sufficiently close-knit to preclude fines from working through the bottom, sides or seams, will be used as required to hold the lining material in position during installation. Paper bags used as sand bags, whether or not lined with plastic, will not be permitted. Burlap bags, if used, must be lined with plastic. Bags will contain not less than 40-pounds, nor more than 60-pounds of sand having 100% passing a number 8 screen and tied closed after filling, using only plastic ties. Bags that are split, torn, or otherwise losing the contents will be immediately removed from the work area and any spills immediately cleaned up. Metal or wire tires will not be used.

During installation, water shall not be allowed to pond on the GML material. The Contractor shall have available appropriate pumps to immediately remove ponding water.

The GML material will not be installed under adverse climatic conditions, unless Contractor can demonstrate his installation techniques adequately compensate for such adverse conditions and quality of workmanship is not compromised. Adverse climatic conditions occur when the air temperature measured 6-inches above the GML surface is less than 32°F and decreasing or more than 90°F, when relative humidity is more than 80%, when raining or frost on the ground, or during conditions of excessive winds.

GML field seams will be lap seams as shown on approved plans and drawings. The lap seams will be formed by lapping the edges of GML sheets a minimum of 4-inches. The contact surfaces of the sheets will be wiped clean to remove dirt, dust, moisture, and other foreign materials. For fillet weld seams, bevel edge of GML and clean oxidation from surfaces to extrudate by disk grinding or equivalent not more than one (1) hour before seaming. Lap seam intersections involving more than three (3) thicknesses of lining material will be avoided and all seam intersections will be offset at least 2-feet. Non-horizontal field seams will be allowed on the slope and sheets of lining material on the slopes will extend down slope out onto bottom a minimum of 5-feet from the toe of slope. Field seams between sheets of GML material will be made using approved fusion welding systems, equipment, and

techniques. Approved fusion welding systems include fillet weld using extrudate, lap weld using extrudate, and lap weld using single or double wedge welder. If the wedge welder is used, excess free edge of the seam (wider than 3-inches) of the top sheet will be removed without affecting the integrity of the seam. Any necessary repairs to the GML will be made with the lining material itself, using approved fusion welding systems, equipment, and techniques. The patch size will be 4-inches larger in all directions than the area to be patched. All corners of the patch will be rounded with a 1-inch minimum radius. All seams and seals of the GML will be tightly bonded on completion of the work. Any lining surface showing injury due to scuffing or penetration by foreign objects or showing distress will be replaced or repaired as directed by the GP.

Cleanup within the work area will be an ongoing responsibility of the Contractor. Particular care will be taken to ensure no trash, tools, or other unwanted materials are trapped beneath the lining. Care will be taken to guarantee all scraps of lining materials are removed from the work area prior to completion of the installation.

3.7 Field Quality Control

Inspection and testing will involve fulltime observation of the installation of the GML, including the making and testing of lining seams, patches, and period measurement of the liner material thickness to ensure compliance. Field thickness measurements must be taken for each panel before seamed. The material thickness shall be checked using a micrometer at a minimum frequency of one (1) measurement per 5-feet along the leading edge of each panel with a minimum of five (5) measurements along the leading edge of the panel. No single measurement shall be less than 10% below the required nominal thickness for the panel to be accepted. In addition, the average of all measurements along the edge must be at least 60-mils.

Test seams will be made to verify that adequate conditions exist for field seaming to proceed. Each seamer will produce a test seam at the beginning of each shift to determine the peel and tensile strength of the seam. The GP may require a sample field seam be made at any time during seaming production to verify equipment/operator performance and seam integrity. In addition, if a seaming operation is suspended for more than 0.5-hour or if a breakdown of seaming equipment occurs, a test seam will be produced prior to resumption of seaming operations.

The trial weld sample must be a minimum of 3-feet long and 1-foot wide with the seam centered lengthwise The GP must observe all trial welding operations, quantitatively test each trial weld for peel and shear, and record the results. A minimum of two (2) peel and two (2) shear tests will be performed per trial seam. Double wedge weld trial seams shall have a minimum of four (4) peel tests performed. The trial weld shall be completed under the same conditions for which the panels will be welded. The trial weld must meet the requirements for peel and shear as stated in the following paragraph and the break must be ductile or a film tearing bond (FTB) for a wedge weld or extrusion weld.

During the field seaming operation, destructive samples will be removed from field seams by the Contractor at locations selected by the GP. Field seam repairs will be made according to repair procedures specified in the SLQCP. The samples will have a width of 12-inches

plus the seam width and length of 42- to 48-inches. A minimum of one (1) stratified sample per 500-feet of field seam will be made. All field seams will have a film tear bond in peel and shear and a minimum 1-pound/inch width seam strength in shear when tested as specified in this SLQCP. At the very least, the peel adhesion and bonded shear strength must be 62% and 95% respectively of the strength of the parent material, but not less than 78-ppi and 120-ppi respectively. A sufficient amount of the seam must be removed to conduct field testing, independent laboratory testing, and archiving of enough material to retest the seam when necessary. The archived material will be kept at the independent laboratory. Field testing shall include at least two (2) peel tests per sample, but four (4) when possible for testing both tracks on dual-track fusion welded seams. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the GML. Capped sections shall be non-destructively tested. Additional destructive test samples may be taken if deemed necessary by the GP or his representative.

All field-tested samples from a destructive-test location must be passing in both shear and peel for the seam to be considered passing in both shear and peel. The independent laboratory testing must confirm these field results. The passing criterion for independent laboratory testing is four (4) of five (5) samples from each dual track fusion welded seam, when possible to test each seam, must be passing before the seam is considered as passing. Sample testing conducted by an independent testing agency will save all test samples including specimens tested until notified by the GP relative to the disposal. All specimens which have failed under test will be shipped immediately by express delivery to the GP for determination or corrective measure to be taken, including retest or repair of failed section.

For destructive samples which failed the passing criterion, the Contractor will reconstruct all field seams between any two (2) previously-passed seam locations which include the failed seam, or will go on both sides of the failed seam location (10-feet minimum), take samples from each side, and test both. If both pass, the Contractor will repeat the process of taking samples for test. In all cases, acceptable field seams must be bound by two (2) passed test locations. The GP decision will be final.

If capping of a field seam is required, the Contractor will use a cover strip of the same thickness as the lining (and from the same roll, if available) and of 8-inches minimum width. It will be positioned over the center of the field seam and welded to the lining using a fillet weld on each side.

All GML sheets, seams, anchors, seals, and repairs will be visually inspected by the Contractor for defects. In addition, all seams and repairs will be further checked by a metal probe. Depending on seam welding equipment used, all seams and repairs will be tested by a vacuum testing device, a spark testing device and/or air pressure. A visual inspection of the lining sheets, seams, anchors, and seals will be made by the Contractor as the installation progresses and again on completion of the installation. Defective and questionable areas will be clearly marked and repaired. Final approval of repairs will be given by the GP.

The Contractor will run a metal probe, such as a dull-pointed ice pick, along the length of all seams and repairs to ensure the seam is continuous and absent of leak paths. Defects will be clearly marked and repaired.

If the fillet weld, extrusion lap weld, or single hot-wedge fusion weld is used to weld seams, the Contractor will further test all seams and repairs in the GML by vacuum box. All vacuum box testing will be done in the presence of the GP. The testing area will be cleaned of all dust, debris, dirt, and other foreign matter. A soap solution will be applied to the test area with a paint roller and the vacuum of 3-psi air pressure will be induced and held at least ten (10) seconds to mark for repair of any suspicious areas as evidenced by bubbles in the soap solution.

If the fillet weld is used to weld seams, the Contractor will further test all seams and repairs in the GML by using a high voltage spark detector if vacuum box or air pressure methods cannot be performed. The setting of the detector will be 20,000-volts. To conduct this test, all test seams will be provided with not less than gauge 24-30 copper wires properly embedded in the seams and grounded. All spark testing will be done in the presence of the GP and all defective areas marked for repair.

If the double hot-wedge is used, the Contractor will further test all seams in the GML by using the air pressure test which consists of inserting a needle with gauge in the air space between the welds. Air will be pumped into space to 35-psi and held for 5-minutes. If pressure is not maintained, then the seam is unacceptable.

All costs of retesting of the GML including reruns of field weld tests and all repairs is at the Contractor's expense.

The Contractor will retain responsibility for the integrity of the GML system until acceptance by the GP. The GML will be accepted by the GP when:

a) Written certification letters including "as built" drawings are received by the GP.
b) Installation is completed.
c) Documentation of completed installation, including all reports, is complete.
d) Verification of adequacy of field seams and repairs, including associated testing, is complete.

Acceptance of the competed work will include receipt of all submittals and all work completed to the satisfaction of the GP.

4.0 LEACHATE COLLECTION SYSTEM

4.1 Granular Drainage Media

A leachate collection system (LCS) will be placed above the GML. The LCS will consist of a heat bonded HDPE geonet/geotextile drainage composite (geocomposite) on the floor and side slopes with granular (gravel) embedded leachate collection pipes in the sump and pipe trench areas. The leachate collection pipes will consist of 6-inch diameter pipe with 3/8-inch diameter holes on 6-inch centers. To avoid piping losses into the collection pipes, the granular drainage layer shall consist of rounded, river-run gravel meeting the requirements of ASTM C33 for coarse aggregate. Crushed material will not be acceptable. The gravel should meet gradation requirements of Sine No. 6 (nominal size 3/4-inch to 3/8-inch) or coarser. The maximum gravel size shall not exceed 2-inches. The required thickness of drainage materials will be verified by survey methods on an established grid system with not less than one (1) verification point per 5,000-sq/feet of surface area.

The gravel will have a permeability of $1x10^{-2}$ cm/sec and the percent calcium carbonate by weight shall not exceed 15%. A minimum 8-ounce non-woven geotextile will be placed around the gravel drainage components to prevent intrusion of fines. All geotextile materials will be hand placed.

4.2 Geocomposite Drainage Materials

The geocomposite will be formed of two (2) non-woven geotextiles heat bounded to a geonet core. The geotextile on both sides of the geonet will be a minimum 8-ounce non-woven material meeting the standard test requirements in Table C.3. The protective cover will be carefully spread on top of the geocomposite to avoid damage to the liner system.

4.3 Leachate Chimneys

Leachate chimneys will be installed through the protective cover to allow a direct hydraulic conduit between the lowest waste layers and the LCS. A minimum 8-ounce geotextile will completely encase the pipe embedment gravel layer with a full-width geotextile overlap where the chimney daylights through the protective cover. The geotextile overlap will be covered by a maximum 6-inch thick layer of the granular material used as the pipe embedment.

4.4 Drainage Layer Placement

Placement of granular drainage materials over GML will generally not proceed at ambient temperatures below 32°F or above 104°F, but should not be conducted at the coolest part of the day to minimize the development of wrinkles or folding of the geosynthetic materials. A minimum of 1-foot of material is required between low ground pressure dozers (i.e. track pressure less than 5-psi) and the geomembrane. Greater material thickness must be maintained above the geomembrane to support heavier spreading equipment and hauling vehicles. In such cases, a minimum of 2-feet of drainage material thickness will be used unless otherwise specified in the design. The placement of the LCS will be controlled to avoid damage to the liner; however, the drainage layer does not need to be density controlled.

Granular drainage materials will be selected to meet the described specifications. At least one (1) set of pre-construction tests will be conducted for each drainage media from each proposed source. Gravel and sand sources will include a complete grain-size analysis, including Minus No. 200 sieve, by ASTM D4222. Hydraulic conductivity may be correlated from the grain-size distribution to determine the gravel or sand suitability. Granular drainage materials selected for use will be tested at regular interval for conformance during construction. Minimum testing frequency will be on grain-size analysis for every 3,000-cubic/yards, or portion thereof, for each material being used.

The geotextile materials will include an 8-ounce fabric around the leachate chimneys and a minimum 8-ounce nonwoven fabric on both sides of the geonet forming the geocomposite layer. The following tests described in Table C.3 will be required on the geotextile materials. The geotextile will be bonded on both sides of the geonet. Geonet tests are described in Table C.4.

Table C.3 - STANDARD TESTS ON GEOTEXTILE MATERIALS

Test	Type of Test	Standard Test Method	Frequency of Testing
Manufacturer's Quality Control	Mass per Unit Area	ASTM D5261	per 100,000-ft^2
	Grab Tensile Strength (%)(MD/CD)[1]	ASTM D4632	per 100,000-ft^2
	Grab Elongation (%)(MD/CD)[1]	ASTM D4632	per 100,000-ft^2
	Puncture Strength	ASTM D4833	per 100,000-ft^2
	Trapezoidal Tear Strength	ASTM D4533	per 100,000-ft^2
	Apparent Opening Size	ASTM D4751	per 100,000-ft^2
	Permittivity	ASTM D4491	per 100,000-ft^2
	UV Light Resistance	ASTM D4355	per 100,000-ft^2
	Burst Strength	ASTM D3786	per 100,000-ft^2
Conformance Testing by 3rd Party Independent Laboratory	Thickness	ASTM D5199	per 100,000-ft^2
	Mass per Unit Area	ASTM D5261	per 100,000-ft^2
	Grab Tensile Strength (%)(MD/CD)[1]	ASTM D4632	per 100,000-ft^2
	Grab Elongation (%)(MD/CD)[1]	ASTM D4632	per 100,000-ft^2
	Puncture Strength	ASTM D4833	per 100,000-ft^2
	Trapezoidal Tear Strength	ASTM D4533	per 100,000-ft^2
	Apparent Opening Size	ASTM D4751	per 100,000-ft^2
	Permittivity	ASTM D4491	per 100,000-ft^2
	Burst Strength	ASTM D3786	per 100,000-ft^2

Note: MD/CD = MD - Machine Direction/CD - Cross Direction

Table C.4 - STANDARD TESTS FOR GEOCOMPOSITE MATERIALS

Test	Type of Test	Standard Test Method	Frequency of Testing
Manufacturer's Quality Control	Thickness	ASTM D5199	per manufacturer's quality control specifications
	Mass per Unit Area	ASTM D3776 (Option C)	per 100,000-ft^2 and every resin lot
	Ply Adhesion	ASTM D7005	per 100,000-ft^2 and every resin lot
	Transmissivity	ASTM D4716	per 100,000-ft^2 and every resin lot
Conformance Testing by 3rd Party Independent Laboratory	Thickness	ASTM D5199	per 100,000-ft^2 and every resin lot
	Mass per Unit Area	ASTM D3776 (Option C)	per 100,000-ft^2 and every resin lot
	Carbon Black Content	ASTM D4218	per 100,000-ft^2 and every resin lot
	Tensile Strength	ASTM D7179	per 100,000-ft^2 and every resin lot

Note: Geotextiles used in Geocomposite shall be tested in accordance to Table C.3

5.0 LEAK DETECTION SYSTEM

A leak detection system (LDS) will be placed between the upper and lower GML layers. The LDS consists of an HDPE geonet on the floor and a geocomposite on the side slopes. A 6-inch leak detection pipe will be placed at each sump between the two GML layers. An HDPE boot will be placed around the leak detection pipe above the upper GML penetration and extrusion welded to the GML to create a seal and maintain the integrity of the liner system. The geonet and geocomposite will meet the requirements listed above in Section 4.0.

5.1 Installation

On the side slopes, the geocomposite material shall be anchored in the anchor trench then rolled down the slopes, ensuring no excessive slack is maintained in the geocomposite. The geocomposite shall extend 5-feet onto the floor before transitioning to the geonet. All panels (geonet/geocomposite) shall overlap a minimum of 6-inches. A plastic cable tie shall connect geocomposite and geonet panels at an interval of one (1) per every five (5) feet in the machine direction and one (1) per every foot in the transverse direction. Overlapping geocomposite panels shall have their upper geotextile component sewn or heat bonded to one another per project specifications.

6.0 BALLAST/PROTECTIVE COVER

6.1 General

This section addresses the need for soil or waste ballast at the landfill and covers the work necessary for construction of the protective cover system over the LCS. The protective cover system proposed for use at the landfill uses available soil onsite as the cover material, as described in Section 6.3.

6.2 Ballast

Based on the measured groundwater depths, the excavated landfill cells will be well above the seasonal high water table. As a result, ballasting of the cells against hydrostatic uplift will not be required at this facility.

6.3 Protective Cover

A minimum 2-foot thick protective cover will be placed above the LCS. The protective cover may use onsite soils in combination with the chimneys described in Section 4.3. The maximum gravel size shall not exceed 2-inches. Pre-construction and conformance testing for the protective cover soils will include maximum size gradation with a minimum conformance testing frequency of one grain-size analysis (ASTM D422) per 5,000-cubic/yards (or fraction thereof) of in-place material.

Protective cover does not require compaction control; however, it should be stable for construction and disposal after traffic. Care will be used in placement so as not to shift, wrinkle, or damage the underlying geosynthetic layers, and placement methods will be documented. Protective cover will be placed such that the top surface, while spreading, is at least 2-feet above the geosynthetic layers at all times, unless low-ground pressure dozers are used (i.e. track pressure less than 5-psi). 1-foot minimum should be retained between the low-ground pressure dozer and the geosynthetic layer. A greater thickness will be maintained to support loaded hauling trucks and trailers for turning areas. Drivers will proceed with caution when on the overlying soil and prevent spinning of tires on sharp turns.

Protective cover will generally be placed in an up-slope direction for sidewalls as long as the same material is being used. Where the top few feet of sidewalk (typically less than 5-feet vertically) is to be protected by a different soil type, (such as clay for tying in the final cover soil liner), this material may be placed from the top if adequate care is taken to protect the synthetic liner components.

The required thickness of protective cover will be verified by survey methods on an established grid system with not less than on verification point per 5,000-sq/feet of surface.

7.0 GCLER, GMLER, AND CONSTRUCTION DOCUMENTATION

Upon completion of all required liner construction and evaluation, the GP will prepare and submit both the Soil Liner Evaluation Report (GCLER) and Geomembrane Liner Evaluation Report (GMLER) to the division for review and approval. These will be submitted along with a construction documentation report. Multiple submittals of the reports or documentation during the project may be made if they may facilitate review of the project. The GCLER and GMLER will be signed and sealed by Professional Engineer registered in the State of New Mexico and who has applicable expertise in liner engineering.

The construction documentation will contain a narrative describing the conduct of work and testing programs required by the SLQCP, as-built or record drawings, and appendices of field and laboratory data. Because the volume of data of these projects can be quite large, the documents may be subdivided for ease of review. The preferred document format will include the GCLER, GMLER, narrative, as-built drawings, and summaries of test results in a single volume. The remaining appendices will be placed in accompanying volumes. Specifically, the construction documentation report will contain or discuss the following information, at a minimum, for GML:

- Roll shipment and receipt information.
- Manufacturer quality control certificates and results.
- Storage and handling information.
- Conformance test sampling and test results.
- Seamer names and resumes of experience and qualifications.
- Subgrade acceptance.
- Anchor trench preparation and backfilling.
- Seam preparation, orientation, and identification
- Weather and ambient/sheet temperatures.
- Equipment placed or operated on geomembrane.
- 100% visual inspection for defects, damage, etc.
- Trial seam tests for each combination of seaming equipment and personnel.
- Seaming methods, times, temperature, and equipment shutdowns and startups.
- Continuous 100 percent non-destructive seam testing, methods, criteria and results
- Destructive testing methods criteria and results.
- Repairs, including preparation and procedures, failure delineation, patch size and shape, and retesting.
- Material properties and placement of drainage materials and protective covers.