CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

PLANT WANSLEY COAL COMBUSTION RESIDUALS (CCR) LANDFILL EXPANSION HEARD COUNTY, GEORGIA

FOR

Georgia Power

DECEMBER 2025

REVISED OCTOBER 2026

GEORGIA REGISTERED NO. 27185 PROFESSIONAL ENGINEER R. BRANT LANE 10/7/26

HNT ENVIRONMENTAL CONSULTANTS

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
Approved
Solid Waste Management Program
Approved By: Tammy Buchli Digitally signed by Tammy Buchli Date: 2026.10.15 14:03:46 -04'00'

Hodges, Harbin, Newberry & Tribble, Inc.
3920 Arkwright Road, Suite 101 | Macon, Georgia | Phone: (478) 743-7175 | Fax: (478) 743-1703

TABLE OF CONTENTS

1. GENERAL 1
2. GRADING 6
3. COMPACTED CLAY LINER 12
4. REINFORCED GEOSYNTHETIC CLAY LINER (GCL) 18
5. BOTTOM LINER GEOMEMBRANE 22
6. LEACHATE COLLECTION GEOCOMPOSITE DRAINAGE MEDIA (GDM) 29
7. PROTECTIVE SAND LAYER/PRIMARY FILTER AND GRANULAR DRAINAGE LAYER 32
8. LEACHATE COLLECTION SYSTEM 35
9. TESTING OF PIPING SYSTEMS 38
10. FINAL CLOSURE SUBGRADE AND TACK-ON BERMS 41
11. FINAL COVER SYSTEM GEOMEMBRANE (CLOSURETURF®) 43
12. FINAL COVER ENGINEERED TURF (CLOSURETURF®) 49
13. FINAL COVER SYSTEM SAND INFILL (CLOSURETURF®) 51
14. FINAL COVER SYSTEM HYDROBINDER® INFILL (CLOSURETURF®) 53
15. CERTIFICATION 54

1. GENERAL

This Construction Quality Assurance Plan (CQA Plan) has been prepared as part of the site's CCR permit application per Rule 391-3-4-.10(9)(c)1(v) and provides the Construction Quality Assurance (CQA) and Construction Quality Control (CQC) standards, procedures, and minimum acceptance criteria for earthwork and construction of the liners, leachate collection, and final cover systems at the Plant Wansley CCR Landfill.

This CQA Plan addresses those areas of construction pertaining to environmental protection including the necessary earthwork required for construction of the bottom liner and the leachate management and final cover systems. As each cell of the disposal facility is constructed or closed, Georgia Power Company (Georgia Power) will submit a Construction Certification Report to the Georgia Environmental Protection Division (EPD) Solid Waste Program that includes a registered engineer's certification that the cell under consideration was constructed or closed within the limitations of and according to the approved permit.

Georgia Power will notify EPD of each major cell construction or closure event prior to initiating construction. CQA services will be provided by consulting engineering firms specializing in the inspection and testing of soils and geosynthetics. The services of the CQA firms required during construction and installation of all landfill components are described in this document. Grading, earthwork, and stockpiling of earthen materials subject to this CQA Plan will comply with the Georgia Soil and Water Conservation Commission 'Manual for Erosion and Sediment Control in Georgia', latest edition.

The project team will consist of the following:

1. Construction Quality Assurance and Construction Quality Control: In the context of this document, construction quality assurance and construction quality control are defined as follows:

    a. Construction Quality Assurance (CQA) - A planned and systematic pattern of actions taken by an organization that operates separately from the Contractor and the Owner (i.e., independent party) to verify that construction materials and/or services achieve compliance with technical (i.e., design), contractual, and regulatory requirements. This generally involves observation, review of submitted test results by others, and conducting independent testing to verify conformity of the various components of the Project with the requirements of the Permit Drawings and this CQA Plan.

    b. Manufacturer Quality Control/Construction Quality Control (MQC/CQC) – A planned system of actions taken by the Contractor, Manufacturers, and Installers to monitor, check, and control the quality of their own work (verify that they are supplying materials and providing the workmanship as required by the permit documents). In some cases, CQC services may be performed "in-house" by the Contractor, and other times CQC services are subcontracted to an outside consultant hired by the Contractor. MQC refers to QC functions performed by

Manufacturers, and CQC refers to QC functions performed by construction contractors and installers.

2. CQA Engineer: The CQA Engineer is the party, retained by the Owner, but not affiliated with the Owner or the Contractor, responsible for observing and documenting CQC activities, reviewing CQC/MQC submittals prepared by the Contractor/Manufacturer related to the Project, and performing CQA activities as described in this CQA Plan. The qualifications and responsibilities of the CQA Engineer are described below. Resumes and qualifications, including experience with projects of similar type, size, and complexity, will be provided to the Owner for their review and approval.

   a. The CQA Engineer will have specialized experience in the design of geo-environmental infrastructure involving earthwork, waste materials management, geosynthetics and piping installations, project-site water management, revegetation, containment (lining) systems, final cover systems, and CQA of these components; possess the equipment, personnel, and licenses necessary to conduct the monitoring required by the permit and this CQA Plan; be experienced in the review of Contractor submittals for conformance with the Project requirements and in the resolution of non-conformances; and be experienced in the preparation and/or review of CQA documentation including CQA plans, field documentation, field testing procedures, laboratory testing procedures, permit documents, and CQA certification reports. The CQA organization will be led by the CQA Certifying Engineer (CQA Engineer), who will be a Professional Engineer registered to practice in the state of Georgia. The CQA Site Manager will be the on-site representative of the CQA Engineer and will have experience in construction activities required for the Project.

      The CQA Engineer will be responsible for reviewing the permit documents prior to the start of the construction; monitoring the compliance of construction materials and manufactured products (e.g., geosynthetics) delivered to the site with the CQC/MQC submittals and conformance requirements and/or shop drawings previously reviewed and approved by the Design Engineer; monitoring that the Contractor's construction methods and workmanship are performed in accordance with the permit documents; performing on-site field and/or laboratory QA testing; maintaining calibration certificates of field-testing equipment in the CQA Engineer's on-site project file; reviewing field and laboratory CQC/MQC test results in a timely manner so as not to impede or delay construction activities; and promptly notifying the Owner of any nonconformances of the Contractor's work with any requirements of the Project, including those requirements related to the prompt delivery of CQC/MQC results.

   b. The specific duties of the CQA (Certifying) Engineer are:

      i. Reviews the permit documents;

      ii. Attends scheduled meetings related to Project construction quality activities;

iii. Administers the CQA program (i.e., assigns and manages all on-site CQA personnel, reviews all field reports, provides engineering review of all CQA-related activities);

iv. Provides quality control of CQA documentation; reviews and documents changes to the design during construction; and

v. Prepares and seals the final CQA Certification Report.

c. The specific duties of the CQA Site Manager are:

i. Serves as the on-site representative of the CQA Engineer and Certifying Engineer;

ii. Familiarizes all CQA field technicians with the site, permit documents, and the CQA requirements;

iii. Manages the daily activities of the CQA field technicians;

iv. Attends regularly scheduled CQA-related meetings on-site;

v. Reviews the ongoing preparation of the construction record drawings;

vi. Reviews test results, certifications, and documentation provided by the Contractor, Geosynthetics Manufacturer, and Installer and makes appropriate recommendations;

vii. Reviews the CQA field technicians' daily notes and logs; prepares a daily report for the Project;

viii. Reviews the results of field and laboratory testing and makes appropriate recommendations;

ix. Reports any unresolved deviations from the CQA Plan and permit documents to the Construction Manager and CQA Certifying Engineer;

x. Assists with the preparation of the final CQA Certification Report; reviews the Geosynthetics MQC documentation; and performs duties of CQA field technician, as needed.

d. The specific duties of the CQA Engineering Technicians (Technicians) include:

i. Monitor material stockpiles for any deterioration of materials;

ii. Monitor surface-water drainage in the areas of soil and geosynthetic material stockpiles;

iii. Monitor and test foundation improvement and earthwork placement and compaction operations;

iv. Monitor the unloading, storage, and on-site handling of the geosynthetics;

v. Monitor geosynthetic material deployment and installation operations;

vi. Monitor geosynthetic repair operations;

vii. Assist with the collection and shipping of laboratory test samples;

viii. Document any on-site activities that could result in damage to the soils or geosynthetic components of the construction and report them as soon as practical to the CQA site manager;

ix. Prepare notes and logs; and report problems to the CQA site manager.

3. Design Engineer: Responsible for providing interpretations and clarifications of the permit documents, reviewing and approving shop drawings, and rejecting defective work. The Design Engineer will be a registered professional engineer licensed in Georgia.

4. CQC Engineer: Responsible for CQC monitoring, testing and documentation for all field work performed during the construction of the facility. The Contractor will have the responsibility for providing for all field CQC testing by the CQC Engineer, or their representative, for all work performed. Reference to the CQC Engineer, for the purpose of this document, will include the CQC Engineer and their designated representatives.

5. Contractor: The term "Contractor" refers to the General Contractor (i.e., the Prime Contractor) who is retained by the Owner to perform the construction of the landfill cells and landfill closures. In this role, the Contractor will be responsible for earthwork activities, installation of lined cells and their leachate management systems, installation of the final cover system, and constructing associated surface water management features and other related site work. The Contractor may subcontract with various parties to conduct certain portions of the Project (e.g., geosynthetic Installer(s)). The Owner will select a Contractor qualified for this Project through experience constructing projects involving similar work elements, and with personnel and equipment availability as needed to execute a project of this magnitude. During construction, the Contractor will work with the Owner to develop an approved schedule, execute the work according to that schedule, and communicate the timing of key milestones/activities with appropriate project parties (e.g., CQA Engineer). Note that the preceding description of the Contractor's roles and responsibilities is only a general summary and does not represent the comprehensive scope of work required of the Contractor.

6. Geosynthetics Manufacturers and Installers: Geosynthetics are manufactured materials. The Manufacturers who will supply geosynthetic materials for this Project (either procured by the Contractor or procured by the Owner, as established for the scope of work set forth in the permit documents) are responsible for the manufacture/fabrication of such materials and for quality control during manufacture/fabrication. The Manufacturer(s) of the geomembrane components of the liner system and final cover system should have experience manufacturing at least ten million square feet of such geomembranes. The geosynthetic Manufacturers must implement an MQC program. MQC refers to actions taken at their manufacturing facility (i.e., prior to shipment to the jobsite) to control the quality of their products and to monitor/verify that the materials and workmanship of the geosynthetics meet the Project requirements as set forth herein and in the permit documents. The MQC program will be conducted by MQC personnel who are stationed at the manufacturing facility (i.e., employed or contracted by the Manufacturer), and overseen by an MQC manager. Manufactured geosynthetics products are placed and installed in the field by an Installer, who will be subcontracted by the Contractor. The Installer responsible for the installation of the liner system and final cover

system geomembrane components should have experience installing at least five million square feet of such geomembranes.

7. As-Built Surveyor: As required by specific sections of this CQA Plan, a registered professional land surveyor licensed in Georgia will perform the required as-built certification surveys on the components of the liner, leachate collection and/or final cover systems being constructed.

2. GRADING

A. GENERAL

The CQA Engineer will observe and document all earthwork grading (excavation/fill placement) activities and test the compaction of in-situ materials and structural fill. The CQA Engineer is responsible for certifying that the materials and construction of the earthworks are in accordance with the Permit Drawings and this CQA Plan. If, during excavation of the site, any springs or seeps are detected, EPD will be notified immediately, and protective designs will be incorporated into the facility's D&O plans, such that sampling of the spring or seep can be incorporated into the groundwater monitoring plan.

B. EARTHWORKS MATERIALS

The physical properties and construction procedures of all earthworks will be in accordance with this CQA Plan.

C. ROCK REMOVAL BY BLASTING

1. In the event rock is encountered during subsurface preparation of the landfill which is too hard and cannot be ripped and excavated by conventional methods, the rock may be broken apart using blasting methods. The Contractor shall develop and submit for review a written blasting plan to the Owner no less than seven (7) days prior to blasting operations. Criteria for the program shall be the prevention of damage to existing structures, adjacent CCR cells and foundation soils, and the prevention of any interruption of their services. The blasting methods will follow the outlined procedures listed below:

    a. Prepare a pre-blast report, which shall include the following:
    - Blasting company, company license number, date, and location.
    - Scalable map or figure showing the distance and direction from shot to the nearest structure or cell, including description of structure.
    - Type of shot with minimum planned scaled distance or regression data.
    - Maximum and minimum borehole depth, borehole diameter, and maximum charge weight at closest distance.
    - Blasting products, type of rock, locations, pattern with burden and spacing, inclination of blast holes, and powder factor per hole and per blast.
    - Stemming feet, stemming type, and stemming length ratio relative to burden.
    - The sequence and pattern of delays, if any.
    - Cover/existing overburden with amount and type, and direction to open face.
    - Date of bulk explosive truck calibration (if used).

- Description of blast conditions, noting high fly rock potential, including but not limited to over confined shots, lift shots, outfall/wet conditions, spacing and burden exceeding the depth of any borehole in shot, and/or hole deviation. Document measures taken to compensate for high fly rock potential.

b. Contractor to Monitor the peak particle velocity at the location of the nearest existing landfill cell, groundwater monitoring well, earthen containment structures, CCR stockpiles or stacks, and in the direction of the nearest residence at the permit boundary. The peak particle velocity shall not exceed 1.0 inch per second at 40 Hz or greater. At lower frequencies use the established limits in the vibration criteria as presented in the U.S. Bureau of Mines RI 8507.

c. Immediately prior to the blast, all landfill and construction traffic shall be stopped, and all construction and landfilling activities shall cease until the blast is complete and it is safe to enter the area.

d. A post-blast report which shall include the drilling log, record of vibration monitoring, approximate volume, and location(s) shall be provided by Contractor to be included in the CQA report for the cell construction for each blasting occurrence.

e. Conduct all blasting activities and handling of explosives in accordance with the Georgia Blasting Standards Act, and the Georgia Rules and Regulations for Explosives and Blasting Agents.

f. Rock will be removed to provide for the minimum 5’ of compacted earth fill or alternate engineered layer as defined in the facility site limitations between the top of bedrock and bottom of the compacted clay liner, as defined in the permit drawings.

D. SUBGRADES

1. During construction, the CQA Engineer will test the subgrade soil materials. The CQA Engineer will monitor and document proofrolling of areas that are excavated to achieve grade. Soil placed to achieve the grades indicated on the Permit Drawings will be tested by the CQA Engineer in accordance with the test methods and frequencies listed herein to verify that the compacted fill materials used by the Contractor comply with this CQA Plan. Areas of proofrolling or compacted fill that do not meet the requirements of this CQA Plan will be delineated and reported to the Contractor. The CQA Engineer will document that these areas are reworked by the Contractor and retested until passing results are achieved.

2. The CQA Engineer will monitor and document any subgrade that is damaged by excess moisture (causing softening), insufficient moisture (causing desiccation and shrinkage), or by freezing. When such conditions exist, the CQA Engineer will evaluate the suitability of the subgrade by one or more of the following methods:

a. Moisture / density testing;

b. Continuous visual inspection during proofrolling; and

c. Other test methods identified herein.

3. The CQA Engineer will inform the Contractor and will document when the Contractor repairs areas damaged as indicated above. The CQA Engineer will retest the repaired areas until passing results are achieved.

E. STRUCTURAL FILL

1. No earth fill shall be placed on any part of the foundation until such areas have been proof-rolled and been inspected and approved in writing.

2. Earth fill shall be placed in uniform layers of six (6) to eight (8) inches, nominal thickness, loose measurement, for one (1) foot beyond the fill width of the fill on each side. Upon completion of compaction, the slopes shall be cut back to the final slope.

3. The compacted surface of each lift shall provide a proper bonding surface for the succeeding layer.

4. The structural fill shall not contain any roots or other organic matter, rocks greater than 3", largest dimensions, or any other deleterious debris. Rocks greater than 3" in diameter may be approved on a case-by-case basis by the Design engineer.

5. Structural earth fill material shall be compacted to 95% of the relative maximum dry density as determined by the Standard Proctor compaction test (ASTM D698). The moisture content of the earth fill at the time of placement shall be between -4% and +4% of the optimum moisture obtained by Standard Proctor compaction test.

6. Earth fill which cannot be compacted with the roller equipment because of inadequate clearances shall be spread in four (4)-inch layers and compacted with hand-guided power tampers to the extent required by these Specifications. Rocks two (2) inches and greater, in any dimensions, roots, and debris shall be removed from the fill and disposed of in an appropriate manner.

7. The location, lift designation, and elevation or depth of the field density and moisture tests (passing, failing and retests) shall be recorded and noted on the respective test records.

8. If the construction of the embankment is interrupted, the surface of the last lift shall be shaped and smoothed to provide a surface that will shed as much water as possible during the interruption. When the work is resumed, the surface lift shall be leveled, scarified and compacted before placing additional layers.

F. CONFORMANCE TESTING

1. The CQA Engineer will observe and test the structural fill soils to confirm that they are uniform and meet or exceed the requirements of this CQA Plan. For soil materials obtained from on-site or off-site borrow areas, the CQA Engineer will perform visual inspections and conformance tests prior to the materials being used to confirm that only soil materials meeting the requirements of this CQA Plan are transported to the site. For both on-site and off-site borrow areas containing non-uniform materials, the Contractor and the CQA Engineer will coordinate excavation, monitoring, and proper segregation of soil materials. The CQA Engineer will notify the Contractor and will document when the Contractor removes materials that fail to meet the requirements of this CQA Plan from the project site.

2. The CQA Engineer will observe soils for deleterious materials, (e.g., roots, stumps, rocks, and large objects). When necessary, the visual-manual procedure for the description and identification of soils will be conducted by the CQA Engineer in accordance with test method ASTM D2488.

G. TEST METHODS AND FREQUENCY

1. All soil testing performed to confirm compliance with the requirements of this CQA Plan will be conducted in accordance with this CQA Plan. The field-testing methods used to evaluate the suitability of soils during their placement will be performed by the CQA Engineer in accordance with current ASTM test procedures indicated in Table 2-1, Minimum Testing Requirements for Structural Fill.

2. Documentation and reporting of the test results will be the responsibility of the CQA Engineer.

3. The Standard Proctor Test (ASTM D698) will be used for the determination of moisture/density relationships unless otherwise indicated. In-place moisture/density testing will be by nuclear test method ASTM D6938 or ASTM D8167, the sand cone test method ASTM D1556 or drive cylinder test method ASTM D2937. The sand cone test method ASTM D1556 or drive cylinder test method ASTM D2937 will be used to establish correlations of moisture and density in cases of uncertainty, and as a check of the nuclear surface moisture/density gauge calibration.

4. The minimum construction testing frequencies are presented in Table 2-1 below. The frequency may be increased at the discretion of the CQA Engineer if variability of the materials is observed by the CQA Engineer. Sampling locations will be selected by the CQA Engineer. If necessary, the location of routine in-place density tests will be determined using a non-biased sampling approach.

Table 2-1
Minimum Testing Requirements for Structural Fill

Test	Frequency	Acceptance Criteria
Laboratory Moisture-Density/ASTM D698	1 test for each type of soil encountered	[1]PI < 30 [1]Maximum dry density ≥ 90 pcf
Liquid Limit, Plastic Limit, Plasticity Index/ASTM D4318	1 test for each type of soil encountered & 1 per 5,000 cy	
Sieve Analysis/ASTM D6913	1 test for each type of soil encountered & 1 per 5,000 cy	
Field Density and Moisture Content/Sand Cone, ASTM D1556; Drive Cylinder, ASTM D2937; Nuclear, ASTM D6938, ASTM D8167; ASTM D2216	1 test per 1,000 cy of structural fill	See Table 2-2

1. Exceptions to the plasticity index and maximum dry density requirements may be provided by the Design Engineer based on the specific construction application.

5. A special testing frequency will be used at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential change in soil conditions.

H. COMPACTION

The CQA Engineer will confirm that representative test locations of the structural fill conforms to compaction requirements as follows:

Table 2-2
Compaction Testing Requirements

Description	General Compaction	Top 12”
• Landfill foundations, compacted fill and embankments; • Sediment pond foundations and embankments; • Road shoulders and embankments; • Utilities under structures; and other areas	≥ 95% max. dry density ±4% opt. moisture content	≥ 95% max. dry density ±4% opt. moisture content
• Roadways	≥ 95% max. dry density ±4% opt. moisture content	≥ 98% max. dry density ±4% opt. moisture content

I. PROTECTION OF SUBGRADES AND COMPACTED FILL SURFACES

The CQA Engineer will monitor newly graded areas to verify the Contractor is protecting these areas from traffic and erosion until construction is complete.

3. COMPACTED CLAY LINER

A. GENERAL

The CQA Engineer will certify the compacted clay liner materials and installation are in accordance with the Permit Drawings and this CQA Plan.

B. MINIMUM REQUIREMENTS

The compacted clay liner will consist of cohesive soils from the borrow area or from existing stockpiles, synthetically improved soils, or imported cohesive soils meeting the remolded permeability criteria of $k \leq 1 \times 10^{-5}$ cm/sec.

C. PRE-CONSTRUCTION MATERIAL EVALUATION

1. All material to be used to construct the compacted clay liner will be sampled and tested by the CQA Engineer in advance of being placed. Such testing can be performed during excavation of the borrow area or from existing stockpiles.

2. The procedure for pre-construction testing during excavation and stockpiling of material to be used for the compacted clay is outlined below:

    a. The CQA Engineer will examine each load of soil either at the borrow source or the stockpile area. Soil that does not meet the permit requirements for compacted clay liner material will be rejected or routed to separate stockpiles.

    b. The following tests will be performed at the frequencies listed in Table 3-1, Compacted Clay Liner Construction Quality Assurance Requirements, prior to placement of any compacted clay liner material:

        i. Method for Particle - Size Analysis of Soils, ASTM D6913 (Mechanical Sieve Method Only),

        ii. Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D2216,

        iii. Test Method for Liquid Limit, and Plasticity Index of Soils, ASTM D4318,

        iv. Moisture-Density Curve (ASTM D698), and

        v. Remolded permeability testing (ASTM D5084 - Measurement of Permeability *of Saturated Porous Materials using a Flexible Wall Permeameter*).

3. Reports for compacted clay liner will be prepared by the CQA Engineer and will include:

    a. Summary of laboratory test data, and

b. A summary of construction, sampling and testing method, and recommendations for compaction moisture content to achieve the required permeability.

D. SUBGRADE

1. The CQA Engineer will verify that the compacted liner subgrade is constructed in accordance with this CQA Plan.

2. The CQA Engineer will document that the subgrade is scarified to a depth of 6 inches and compacted to a density of 95% or more as determined by the Standard Proctor Test, ASTM D-698.

3. The CQA Engineer will document that the subgrade is reasonably free of large rocks, large roots, stumps, and other debris.

E. TEST PAD CONSTRUCTION

1. The CQA Engineer will document the construction of a test pad prior to, or coinciding with, the beginning of construction of the compacted clay liner.

2. The CQA Engineer will sample and test soil samples obtained from the constructed test pad to confirm that the material and the Contractors' placement and compaction methods used can consistently produce a compacted clay liner layer that meets the requirements of this CQA Plan.

3. The CQA Engineer will confirm that the Contractor uses the same placement and compaction methods, equipment, and material to construct the remaining compacted clay liner.

F. CONSTRUCTION

1. Only soil from a source previously sampled, tested and confirmed to meet the requirements of this CQA Plan will be used to construct the compacted clay liner. The CQA Engineer will notify the Contractor when material does not meet the requirements of this CQA Plan and will document that this material will not be used for compacted clay liner construction.

2. The CQA Engineer will complete all required field density and moisture content tests before the overlying lift of compacted clay liner is placed.

3. The CQA Engineer will observe and document that the Contractor completes all surface preparation (e.g., wetting, drying, scarification, etc.) before placement of subsequent lifts.

4. The CQA Engineer will observe and document that loose lift thicknesses do not exceed 8 inches (unless otherwise required in this CQA Plan) for a final 6-inch compacted lift thickness.

5. The CQA Engineer will observe each lift visually for the presence of rocks, debris, plant materials, and other foreign material as well as for particle sizes or clods that exceed the requirements in this CQA Plan. The CQA Engineer will inform the Contractor if such materials are found and will document their removal.

6. The CQA Engineer will observe and document that the exposed surface of the compacted clay liner is rolled with a smooth drum roller or equivalent at the end of each workday or when required to protect the compacted soil liner from adverse weather conditions.

7. The CQA Engineer will observe and document that the exposed surface of the compacted clay liner is reasonably free of all rock, rock fragments, or loose materials. The CQA Engineer will observe and document that rock or other materials protruding more than ¼ -inch and other loose materials are removed, cracks or voids are filled, and the surface is made uniform.

8. The CQA Engineer will observe and document that the surface on which the geosynthetics is to be placed is maintained in a firm, clean, dry, and smooth condition before and during the geosynthetics installation. Additionally, the CQA Engineer will inform the Contractor when desiccation cracking is excessive and will document that all desiccation cracks are repaired as required by this CQA Plan.

9. The CQA Engineer will inspect the compacted clay liner and certify that it is in accordance with this CQA Plan and approved permit drawings. Placement of geosynthetics on any portion of the compacted clay liner surface by the geosynthetics installer will constitute their acceptance of the surface.

10. The CQA Engineer will document that the required as-built certification surveys are performed on the compacted clay liner prior to installing the overlying geosynthetics materials.

G. SAMPLING AND TESTING

1. Construction Quality Control field and laboratory testing will meet the minimum requirements indicated in Table 3-1 below.

Table 3-1
Compacted Clay Liner Construction Quality Assurance Requirements

Item	Testing	Minimum Frequency	Minimum Criteria
Compacted Clay Liner Material Borrow Source	Grain Size (ASTM D6913, Sieves Only)	1 per source or visual change in material type & 1 per 5,000 yd^3	See Table 3-2A (Cells 1-3) 3-2B (Cell 4) & 30% min passing the No. 200 sieve
	Moisture Content (ASTM D2216)	1 per source or visual change in material type & 1 per 5,000 yd^3	N/A
	Atterberg Limits (ASTM D4318)	1 per source or visual change in material type & 1 per 5,000 yd^3	N/A
	Moisture-Density Curve (ASTM D698)	1 per source or visual change in material type & 1 per 5,000 yd^3	N/A
	Permeability of Remolded Samples (ASTM D5084)	1 per source or visual change in material type & 1 per 10,000 yd^3	$k \leq 1 \times 10^{-5}$ cm/sec
Compacted Clay Liner During Construction	Density and Moisture-Nuclear, Sand Cone or Drive Tube (ASTM D6938, D8167, D1556 or D2937)	1 Test/ 10,000 sf/lift and 1 Test/Lift/200 lf of Sidewall	≥ 95% Standard Proctor @ moisture content per test fill (2-4% wet of OMC or wetter as required by CQA Engineer)
	Max. Particle Size (Cells 1-3)	1 test/1,500 cy	See Item No. 3.G.4. below
	Max. Particle Size (Cell 4)	1 test / 40,000 sf/lift	See Item No. 3.G.5. below
Laboratory Testing on Undisturbed Samples of the Constructed Compacted Clay liner	Permeability (ASTM D5084)	1 test/ 40,000 sf/lift and 1 test/lift/800 lf of sidewall	$k \leq 1 \times 10^{-5}$ cm/sec
	Dry Density (ASTM D7263)		≥ 95% Standard Proctor@ moisture content per test fill (2-4% wet of OMC or wetter as required by CQA Engineer)
	Moisture Content (ASTM D2216)		

2. The CQA Engineer will randomly determine the location of each test. All test holes will be patched with a mixture of compacted clay and sodium bentonite pellets hydrated and compacted in the holes.

3. The CQA Engineer will follow this procedure in the event of a density or permeability test failure. If the density does not meet minimum requirements of this CQA Plan, recompaction of the failed area (minimum 100 feet x 100 feet) will be performed and retested until the area meets or exceeds requirements outlined in this CQA Plan. If a permeability sample fails to meet the minimum permeability requirements outlined in this CQA Plan, the area of failing permeability (minimum 40,000 sf) will be reconstructed. Optionally, at least four (4) replicate samples will be obtained in the immediate vicinity of the failed test. Should the replicate samples confirm the failure of the soil to meet the requirements listed in this CQA Plan, the area of failure will be localized according to the results of the replicate samples and reconstructed. All areas of reconstruction will be retested as outlined in this CQA Plan.

4. The maximum particle size for Cells 1-3 clay liner material will be confirmed as described in this paragraph. The CQA Engineer will obtain a sample of compacted clay liner material for every 1,500 cubic yards of liner constructed and confirm that the maximum particle size criteria are met. The CQA Engineer may test the particle size distribution of the clay material via sieve in the field. The particle size of the compacted clay liner will meet the minimum requirements in Table 3-2A below.

Table 3-2A
Particle Size Criteria for Cells 1-3

Lower 18 inches Soil Liner	
Percentage of Material Passing (By Weight)	**Screen Size**
99% (Avg. of All Test)	1”
99.5% (Avg. of All Test)	1 ½”
99.8% (Avg. of All Test)	2”

Upper 6 inches Soil Liner	
Percentage of Material Passing (By Weight)	**Screen Size**
99% (Avg. of All Test)	1/2”
99.5% (Avg. of All Test)	3/4”
100% (Avg. of All Test)	1”

5. The maximum particle size for Cell 4 clay liner material will be confirmed as described in this paragraph. The CQA Engineer will screen material from a one square foot section of compacted clay liner for every 40,000 square feet per lift of liner constructed and confirm that the following particle size criteria is met. The CQA Engineer may test the particle size distribution of the clay material via sieve in the field. The particle size of the compacted clay liner will meet the minimum requirements in Table 3-2B below.

Table 3-2B Particle Size Criteria for Cell 4	
Lower 18 inches Soil Liner	
Percentage of Material Passing (By Weight)	**Screen Size**
99% (Avg. of All Test)	1”
99.5% (Avg. of All Test)	1 ½”
99.8% (Avg. of All Test)	2”

Upper 6 inches Soil Liner	
Percentage of Material Passing (By Weight)	**Screen Size**
98% (All Test)	1/4"
99.5% (Avg. of All Test)	3/4”
100% (Avg. of All Test)	1”

Should any sample fail the passing (98% passing 1/4 inches for the upper six (6") inches and 99% passing 1 inch for the lower 18"), then four (4) additional test areas within the 40,000 square foot test area will be selected by the CQA Engineer and tested in like manner. If the four (4) areas pass, then all test areas will be repaired, and the 40,000 square foot area accepted. If any one of the four (4) areas fails, then the 40,000 square foot area will be reworked and retested. Rocks or roots remaining on or protruding through the surface will be removed and the surface repaired.

4. REINFORCED GEOSYNTHETIC CLAY LINER (GCL)

A. GENERAL

The CQA Engineer will certify that the material and installation are in accordance with the Permit Drawings and this CQA Plan.

B. GCL MATERIAL PRE-DEPLOYMENT REVIEW

1. GCL PRODUCT DATA

The CQA Engineer will review the Contractor's submittals for conformance with this CQA Plan and/or the latest version of GRI-GCL3 – Standard Technical specification for "*Test Methods, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)*", whichever is more stringent, unless otherwise directed by the Design Engineer.

The CQA Engineer will verify that the GCL to be used is a reinforced Coal-Ash Resistant (CAR) product. Additionally, the CQA Engineer will verify that the GCL consists of a bentonite mat manufactured with a non-woven geotextile on each side, unless otherwise approved by the Design Engineer.

2. SHIPMENT AND STORAGE

The CQA Engineer will verify that all GCL delivered to the project site is stored in a dry area protected from precipitation and direct sunlight. The GCL will be individually wrapped in protective plastic and placed on pallets to assure drainage beneath the rolls. The GCL rolls will be completely covered with polyethylene, maintained in good condition, until the GCL is deployed. GCL which has become wet (gravimetric moisture content > 40%) prior to deployment will be rejected.

3. QUALITY CONTROL CERTIFICATES

The CQA Engineer will:

a. Verify that the manufacturer's quality control (QC) certificates have been provided at the specified frequency and that each certificate identified the rolls related to it, and

b. Review the manufacturer's QC certificates and verify that the certified properties meet the requirements in this CQA Plan or GRI-GCL3, whichever is more stringent.

4. GCL CONFORMANCE TESTS

The CQA Engineer will perform the Conformance Tests in accordance with and at the frequencies listed below. The sampling will be performed at the GCL manufacturing plant and the test results reviewed and accepted prior to delivery of the GCL to the project site.

Table 4-1
Required GCL Properties[1]

Property	Test Method	Units	Value	Test Frequency
Permeability	ASTM 5887	cm/sec	$k \leq 5.0 \times 10^{-9}$	Per GRI-GCL3
Internal Friction Test	ASTM D6243	Degrees	$\geq 26.4^{2,3,}$	1 per 10 acres (min. 2 per project) per interface
Interface Friction Test	ASTM D6243	Degrees	$\geq 26.4^{2,3,4,5}$	

Notes:

(1) In addition to the requirements listed in this table, the manufactured GCL will be tested and meet the requirements, values, and frequencies set forth in the latest version of the Geosynthetic Research Institute's technical specification GCL-3 (GRI-GCL3) for reinforced GCLs.

(2) Shear strength of GCL against the textured geomembrane and against the soil liner shall be equivalent to the strength of a friction angle of 26.4 degrees at 1,000 psf, 17.0 degrees at 10,000 psf, and 14.0 degrees at 15,000 psf. This would result in minimum shear strengths of 496 psf for 1,000 psf normal load, 3,057 psf for 10,000 psf normal load, and 3,739 psf for 15,000 psf normal load. Equivalent strength combination that provides satisfactory factors of safety may be approved by the Design Engineer.

(3) GCL internal shear cannot be the weakest / lowest peak shear strength. Due to the low large displacement internal shear strength of GCL, which is typically equal to the shear strength of bentonite clay, it is critical that the peak internal shear strength of the GCL be greater than the lowest peak interface shear strength of the other composite liner components.

(4) Tested at a normal pressure listed above, the GCL shall be hydrated under the applied load for 72 hours prior to shearing.

(5) Based on peak strength values.

Samples will be taken across the entire width of the roll and will not include the first linear 3 feet. Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow. All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing. Interface shear results should be reviewed by a geotechnical engineer specializing in solid waste landfills. If the minimum strengths are not achieved, supplemental stability evaluation may be warranted using a non-linear shear strength envelope, i.e. using the measured strengths at each normal load.

5. Material Conformance Test Failure:

The following procedure will apply whenever a sample fails a material conformance test:

a. The GCL manufacturer will replace the roll of GCL that is in non-conformance with this CQA Plan with a roll that meets the requirements of this CQA Plan.

b. The GCL manufacturer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to the requirements of this CQA Plan. If either of these samples fails, then the next numerical roll will be tested until a passing roll is found. If either of the two closest rolls fails, the CQA Engineer will dictate the frequency of additional testing. The CQA Engineer will document actions taken in conjunction with material control test failures.

C. GCL INSTALLATION

1. HANDLING AND PLACEMENT

The CQA Engineer will monitor and document the installation of the GCL according to this CQA Plan and the manufacturer's installation recommendations.

2. SEAMS AND OVERLAPS

The CQA Engineer will monitor and document that the GCL is seamed or overlapped in accordance with this CQA Plan.

3. REPAIRS

The CQA Engineer will observe and document the repair of any holes or tears in the GCL, according to this CQA Plan.

4. PLACEMENT OF OVERLYING MATERIAL

The CQA Engineer will monitor and document placement of materials located on top of the GCL in accordance with this CQA Plan.

D. DEFICIENCIES

The CQA Engineer will determine the extent and nature of all defects and deficiencies and report them to Georgia Power and to the Contractor. All defects and deficiencies will be properly documented by the CQA Engineer. The CQA Engineer will observe all retests on repaired defects

after the Contractor corrects the defects and deficiencies according to this CQA Plan and the permit documents.

5. BOTTOM LINER GEOMEMBRANE

A. GENERAL

The CQA Engineer will certify that the bottom liner geomembrane materials and installation are in accordance with the approved Permit Drawings and this CQA Plan.

B. MATERIAL

1. The geomembrane will be a minimum 60-mil thick Textured High-Density Polyethylene (HDPE) supplied and installed by firms approved by Georgia Power.

2. Seams for providing watertight joints will be extrusion or double hot wedge fusion seams.

3. The textured material shall have an interface shear resistance with contiguous liner components of 26.4 degrees at 1,000 psf, 17.0 degrees at 10,000 psf, and 14.0 degrees at 15,000 psf. This would result in minimum shear strengths of 496 psf for 1,000 psf normal load, 3,057 psf for 10,000 psf normal load, and 3,739 psf for 15,000 psf normal load.

    a. Equivalent strength combination that provides satisfactory factors of safety may be approved by the Design Engineer.

4. Manufacturer Quality Control (QC) will confirm that the material meets the minimum physical properties a 60-mil thick HDPE geomembrane as listed in the latest version of GRI-GM13- *Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes*.

C. GEOMEMBRANE MANUFACTURER AND INSTALLER

1. The Geomembrane Installer will submit the following information obtained from the Geomembrane Manufacturer to the CQA Engineer:

    a. Production Certification including project references

    b. Testing Program of Compound Ingredients

    c. Material Certification

    d. Test Data for Material and Resin

2. All of the above submittals will be reviewed and retained by the CQA Engineer. The Geomembrane Installer will submit the following information to the CQA Engineer at least 14 days prior to the installation:

a. Qualifications of Geomembrane Installer Superintendent and Foreman

b. Resumes of Geomembrane Contractor field crew

c. Six (6) sets of proposed geomembrane panel layout drawings

D. GEOMEMBRANE INSTALLATION

1. A pre-deployment CQA meeting will be held prior to installation of the geomembrane. The Contractor, the Geomembrane Installer, the CQA Engineer, and representatives of Georgia Power will attend. The following issues will be discussed and agreed upon by all parties and will be included in a report in the CQA documentation.

   a. Testing of welds.

   b. Characteristics of “good” weld, and

   c. Repair procedures

2. The CQA Engineer may obtain samples of the geomembrane rolls from the manufacturing plant prior to shipment to the site.

3. Random samples must be representative of the material supplied and exclude the outer wrap of geomembrane. Samples should be full roll width and at least two (2) feet long.

4. The laboratory testing of the samples selected will be coordinated by the CQA Engineer and will confirm conformance with the properties listed in Table 5-1 below:

Table 5-1
Geomembrane Conformance Testing Requirements

Property	Test Method	Units	Value	Minimum Testing Frequency
Density	ASTM D 1505 or ASTM D 792 Method B	g/cc	0.94	1 per 100,000 ft^2
Thickness [(1)]	ASTM D 5994	mils	60	1 per 100,000 ft^2
Tensile Strength at Yield	ASTM D 6693, Type IV	lb/in	126	1 per 100,000 ft^2
Tensile Strength at Break		lb/in	90	
Elongation at Yield		%	12	
Elongation at Break		%	100	
Carbon Black Content	ASTM D 4218 or ASTM D 1603	%	2.0-3.0	1 per 100,000 ft^2
Interface Shear Strength [(2)] (with GDM and GCL)	ASTM D5321	Degrees	≥ 26.4	1 per 10 acres (min. 2 per project) per interface

Notes:
(1) Geomembrane thickness will be an absolute minimum thickness of 60 mil.
(2) Testing parameters for interface shear strengths are provided in Section 5.B.3

5. The CQA Engineer will review the geomembrane thickness of each roll made for the project prior to shipment. Material that does not fall within acceptable thickness criteria will be rejected.

6. The CQA Engineer will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports.

7. Overheating of the geomembrane during welding will be monitored by the CQA Engineer. At the discretion of the CQA Engineer, coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation. The location and repair method of overheated areas will be recorded in the daily field reports. The method of repair will be determined in the field by the CQA Engineer.

8. During seaming, the CQA Engineer will observe the seams for the following:

   a. proper preparation,

   b. grinding technique, where applicable, and

   c. overheating

9. The CQA Engineer will observe the geomembrane during the coolest part of the day to check for slack. Any areas where excessive "trampolining" occurs will be marked by the CQA Engineer for repair by the Geomembrane Installer.

10. The CQA Engineer will mark all areas where the geomembrane indicates a protrusion from the compacted clay liner or GCL. The method of repair will be determined in the field by the CQA Engineer.

E. TEST SEAMS

1. The CQA Engineer will document and verify that the Geomembrane Installer performs a test seam for each welding machine in use every 4-5 hours, or at a minimum prior to start of construction work, and at midday. At least one test seam will be made for each machine in use for each seam. Should any postproduction test seam fail, the immediate prior production seam will be sampled for destructive testing in accordance with Section F below. The test seam should be approximately 5 feet long. The CQA Engineer will sample the test seam from the center 3 feet of the test sample.

    a. The date, time, and equipment, as well as welding temperature, and seaming parameters will be recorded for each test seam.

    b. A minimum of five (5) specimens for peel and for shear from each sample will be tested for the properties listed in the latest version of GRI-GM19, "*Standard Technical specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*" in accordance with test method ASTM D6392. Testing will be performed in the field by the Geomembrane Installer under full-time observation by the CQA Engineer.

    c. Untested portions of the test seam will be retained by the CQA Engineer for the project record and future testing as required. Samples will be retained until the CQA Report is approved by Georgia Environmental Protection Division.

2. All test seams must pass the field testing before production seaming is performed by the Geomembrane Installer.

F. FIELD DESTRUCTIVE TESTING

1. The Geomembrane Installer will obtain approximately 12" x 48" samples of field seams, suitable for testing, as indicated in Table 5-2 below. The date, time, equipment, and seam number will be marked on each sample and recorded by the CQA Engineer.

Table 5-2 Field Seam Testing Requirements		
TEST NAME	**TEST METHOD**	**MINIMUM TESTING FREQUENCY**
Seam Peel Strength	ASTM D 6392(1)	1 test per 500 feet of seam, 1 per day per seamer
Seam Shear Strength	ASTM D 6392(2)	1 test per 500 feet of seam, 1 per day per seamer

Notes:
(1) For double wedge fusion seams, both tracks will be tested in peel.
(2) For shear tests, the sheet will yield before failure of the seams.

2. Samples retained will be tested in the field by the Geomembrane Installer. A minimum of five (5) specimens from each sample for peel and for shear will be tested for the properties listed in latest version of GRI-GM19, "*Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*" in accordance with test method ASTM D6392.

3. The CQA Engineer or Georgia Power may require additional random samples to be taken for testing in areas that visually appear defective and not in accordance with this CQA Plan.

G. NON-DESTRUCTIVE TESTING

1. The Geomembrane Installer is responsible for the completion of non-destructive testing of the entire length of all field seams, verifying that said seam is airtight. Said testing can be a vacuum test, pressure test, or approved equal and will be described by the Geomembrane Installer and verified by the CQA Engineer in advance.

2. The CQA Engineer will observe all non-destructive testing on a full-time basis.

H. DESTRUCTIVE LABORATORY TESTING

1. Destructive seam samples will be laboratory tested by the CQA Engineer. Testing frequency will be a minimum average frequency of one (1) sample per 500 linear feet of field seam with at least one destructive test per seamer per day.

   a. Test samples will be at least 12 x 36 inches. A minimum of five (5) specimens will be tested for the properties listed in the latest version of GRI-GM19, "*Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane"* in accordance with test method ASTM D6392. These

test samples will be taken at the same locations as the contractor's destructive testing samples.

b. All laboratory specimens will be conditioned for a minimum of one (1) hour prior to testing at the standard atmosphere for testing geosynthetics, that is, air maintained at a relative humidity of 65 ±5% and a temperature of 21 ±2°C (70±3.5°F).

c. Peel tests will be performed on both sides of a double-wedge fusion seam.

2. The load and elongation at failure will be measured for each specimen. The CQA Engineer will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.

3. Passing criteria for strength, locus of break, and elongation shall be in accordance with the latest version of GRI-GM19. If unresolved discrepancies exist between the CQA Engineer and Contractor's test results, the archived sample may be tested by the CQA Engineer. Samples that do not pass the shear and peel tests will be resampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

4. Seams represented by a failing destructive field or laboratory test sample will be cut out and replaced or covered with a cap strip and the seam bounded by supplemental passing field and laboratory destructive test samples at both ends.

5. The CQA Engineer will verify and document that the strength and other properties of the 60-mil thick HDPE geomembrane seams meet or exceed the requirements set forth in the latest version of GRI-GM19, "*Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*".

I. LEAK LOCATION SURVEY (IF APPLICABLE)

1. If performed, Leak Location Survey(s) on the landfill bottom geomembrane liner will be observed and documented by the CQA Engineer. The work will be performed according to this CQA Plan.

2. The CQA Engineer will verify that the Leak Location Contractor has the following qualifications for conducting the Leak Location Survey:

a. The Leak Location Contractor shall have qualifications and experience in conducting the proposed survey method including having tested a minimum of 5,000,000 square feet of geomembrane liner within the previous five years.

b. The leak location surveys must be supervised by a professional or technician with a minimum of three (3) years of experience and 2,000,000 square feet of geomembrane installation and CQA experience.

c. The leak location supervisor must be on site full-time during the performance of the Leak Location Survey.

3. Leak Location Survey(s) will meet the requirements of:

a. ASTM D6747 – Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes; and

b. ASTM D7007 – Standard Practices for Locating Leaks in Geomembranes Covered with Water or Earth Materials.

c. ASTM D7953 – Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method.

The selected method will have the goal of identifying minimum 1-inch dimension penetrations in the geomembrane, unless otherwise specified in this CQA Plan.

4. The CQA Engineer will confirm and document that the Leak Location Survey is conducted after the protective cover materials are installed over the geomembrane liner to detect holes resulting from construction damage during placement of the protective cover layer.

5. The CQA Engineer will document the Leak Location Contractor's site inspection prior to commencing the survey to confirm all site preparations are completed and the site conditions are appropriate for conducting the Leak Location Survey. Any issues or concerns with the site conditions will be reported to the Contractor, the Geosynthetics Installers, Georgia Power, and documented by the CQA Engineer.

6. Leak Location Contractor will mark the locations of all identified or indicated leaks with flags, spray paint, or written coordinates. All liner repairs will be completed, observed and documented by the CQA Engineer. Liner repairs will be re-surveyed after repairs are completed to ensure repairs are properly performed.

7. The CQA Engineer will include the Leak Location Contractor's report in the project Construction Certification Report.

6. LEACHATE COLLECTION GEOCOMPOSITE DRAINAGE MEDIA (GDM)

A. GENERAL

The CQA Engineer will certify that the leachate collection geocomposite drainage media (GDM) materials and installation are in accordance with the Permit Drawings and this CQA Plan.

B. GDM MANUFACTURER AND INSTALLER

1. The CQA Engineer will review and verify the following submittals from the GDM manufacturer:
    A. Production Certification,
    B. Material Certification, and
    C. Test Data for Material.
2. The CQA Engineer will review and verify the following information prior to installation:
    A. Qualifications of installer superintendent, foreman, and field crew.
    B. Six sets of field installation drawings.

C. CONFORMANCE TESTING

CQA Conformance Testing will be performed by the CQA Engineer according to Table 6-1 below:

Table 6-1
GDM Conformance Testing Requirements

Property	Test Method	Units	Value	Minimum Testing Frequency (1)
Thickness (geonet only)	ASTM D5199	mil	330	1 test per 100,000 s.f.
Mass Per Unit Area (geotextile only)	ASTM D5216	Oz/yd^2	8	1 test per 100,000 s.f.
Transmissivity (2)	ASTM D4716 - Modified	m^2/sec	1.2×10^{-3}	1 test per 10 acres (minimum 2 per project)
Adhesion	ASTM D7005	lb/in	1.0 Min. Avg.	1 test per 100,000 s.f.
Resin Density	ASTM D1505 or D792 (method)	g/cm^3	0.94	1 test per 100,000 s.f.
Apparent Opening Size (AOS) (upper geotextile only)	ASTM D4751	U.S. Sieve	80	1 test per 100,000 s.f.

Table 6-1 GDM Conformance Testing Requirements				
Property	**Test Method**	**Units**	**Value**	**Minimum Testing Frequency [1]**
Interface Shear Strength [3] (with protective sand layer)	ASTM D5321	Degrees	Note 3	1 test per 10 acres (min. 2 per project)

Notes:
[1] Testing will be performed at a frequency of one per lot or at listed frequency, whichever is more frequent. A lot is defined by ASTM D4354.
[2] Transmissivity testing will be performed as described below:
Conduct CQA testing for transmissivity at the confining pressure of 5,500 PSF at a hydraulic gradient equal to 0.035. The boundary conditions are "Protective Sand Layer" on top and the specified geomembrane on the bottom of the GDM. The minimum required transmissivity tested under these conditions will be 1.2 x 10-3 m2/sec (testing between two steel plates is not acceptable). The duration of the transmissivity testing shall be 100 hours.
[3] The minimum interface shear strength between the GDM and other materials directly in contact with the geomembrane shall be 26.4 degrees at 1,000 psf, 17.0 degrees at 10,000 psf, and 14.0 degrees at 15,000 psf. This would result in minimum shear strengths of 496 psf for 1,000 psf normal load, 3,057 psf for 10,000 psf normal load, and 3,739 psf for 15,000 psf normal load.

Conformance testing for the individual components of the GDM (geotextile and the geonet) will be in accordance with this CQA Plan.

D. INSTALLATION

1. The CQA Engineer will verify that the installation of the GDM proceeds after he has provided certification of the geomembrane or a section thereof.

2. The CQA Engineer will monitor the installation of the GDM to verify there is no damage to the geomembrane liner. Should the geomembrane liner be damaged the CQA Engineer will inform the Contractor and document the repairs done.

3. The CQA Engineer will verify that adjacent rolls of GDM overlap a distance of at least three (3) inches and are secured using polyethylene ties every ten (10) feet for adjacent rolls and five (5) feet at end seams.

4. The CQA Engineer will verify that the overlaying GDM geotextile, where applicable, extends at least six (6) inches past the geonet joint and is permanently bonded by heat bonding or sewing.

5. The CQA Engineer will verify that any GDM that is torn, crushed, or punctured is repaired or replaced by the Contractor according to this CQA Plan.

6. The CQA Engineer will be present during all installation operations and will verify that all work is in accordance with the CQA Plan.

7. At the conclusion of this activity, the CQA Engineer will provide a written certification that the work has been installed according to the Permit Drawings and this CQA Plan.

7. PROTECTIVE SAND LAYER/PRIMARY FILTER AND GRANULAR DRAINAGE LAYER

A. GENERAL

The CQA Engineer will certify the protective sand layer/primary filter and granular drainage layer materials and installation are in accordance with the Permit Drawings and this CQA Plan.

B. MATERIALS

1. The protective sand layer/primary filter layer will be a loose granular material resulting from the disintegration of rocks, will be capable of 100% passing through a $^{3}/_{8}$-inch screen and will generally conform to the gradation presented in Table 7-3. The protective sand layer material will contain no aggregate rocks, debris, plant material, material with sharp edges, lignite, coal, ash, or carbonaceous material. By-products of industrial processes, with the exception of quarry grinding operations, will not be accepted.

2. The GDM on slopes of the cells will be covered with 12 inches of protective sand layer/primary filter under 12 inches of ASTM No. 3 stone or No. 4 stone.

3. Construction Quality Assurance Testing will meet the minimum requirements for the protective sand layer/primary filter and granular drainage layers in Table 7-1, 7-2, and 7-3 below:

Table 7-1
Protective Cover Sand Conformance Testing Requirements

Property	Test Method	Units	Value	Minimum Testing Frequency (1)
Particle Size Analysis	ASTM D6913 or C136	mm [US Sieve]	See table 7-2 below	1 per 1,500 yd^3
Permeability	ASTM D 2434	cm/sec	$\geq 1 \times 10^{-3}$	1 per 3,000 yd^3
Carbonate Content	ASTM D3042	%	≤ 5	1 per source or visual change in material type

Table 7-2 Granular Drainage Layer Conformance Testing Requirements				
Property	**Test Method**	**Units**	**Value**	**Minimum Testing Frequency (1)**
Carbonate Content	ASTM D3042	%	≤ 5	1 per source or visual change in material type

Table 7-3 Protective Cover Sand Particle Size Analysis Requirements	
Particle Size (mm) [US Sieve]	**Allowable Percent finer than (by mass)**
4.75 [4]	55 - 100
1.18 [16]	30 - 85
0.3 [50]	8 - 45
0.15 [100]	4 - 22
0.075 [200]	0 - 10

Notes:

1. Minor variations in particle size distribution associated with sand production are anticipated and may be acceptable to achieve the filter criteria upon review and approval by the design engineer.

C. STOCKPILING AND MATERIAL APPROVAL

1. All material to be used as protective sand layer/primary filter layer and granular drainage layer will be approved in advance by the CQA Engineer. The CQA Engineer must verify that the representative samples of sand and stone meet all the material requirements.

2. Verification can be accomplished during excavation and stockpiling or prior to use at existing stockpiles.

3. The CQA Engineer will prepare reports of all testing, analysis, and verification.

D. CONSTRUCTION

The CQA Engineer will verify the following information:

1. Approved material was used to construct the protective filter sand and granular drainage layers.

2. The underlying geosynthetics were not damaged during placement of the protective filter sand and granular drainage layers.

3. The protective filter sand and granular drainage material was placed in an uphill direction beginning at the toe of the slope.

4. The protective sand layer/primary filter and granular drainage layer was constructed in accordance with the approved Permit Drawings and this CQA Plan.

5. The required protective filter sand and granular drainage thicknesses were achieved, as determined by an as-built survey at certification points selected by the Design Engineer.

8. LEACHATE COLLECTION SYSTEM

A. GENERAL

The CQA Engineer will certify the leachate collection system corridor materials and installation are in accordance with the Permit Drawings and this CQA Plan.

B. MATERIALS

The CQA Engineer will verify that the leachate collection system trench materials delivered to the site are as follows:

1. Leachate collection piping in accordance with the Permit Drawings and this CQA Plan.

2. Gravel for leachate pipe encasement and for the leachate sump will be in accordance with the Permit Drawings this CQA Plan.

3. Cushion Geotextile will be a non-woven geotextile of polypropylene fibers or polyester yarns suitable for separation and cushioning. The cushion geotextile will be in accordance with The Permit Drawings.

The CQA Engineer will verify that all materials provided are those specified or are equal and are in accordance with the approved Permit Drawings, and this CQA Plan.

C. INSTALLATION

1. The CQA Engineer will verify and document that the installation of the leachate collection system proceeds after he/she has received/reviewed all of the destructive test results of the geomembrane liner and has reviewed and approved the geomembrane liner as-built survey.

2. The CQA Engineer will verify there is no damage to the underlying geosynthetic materials during the installation of the leachate collection system. If the CQA Engineer notices damage of the underlying geosynthetics, the CQA Engineer will inform the Contractor and will verify that the Contractor makes the required repairs.

3. The CQA Engineer will be present during all phases of the leachate collection system construction and will verify that work is in accordance with the approved Permit Drawings and this CQA Plan.

D. QUALITY ASSURANCE

The CQA Engineer will document and verify that the following submittals are provided and that the materials meet and are installed in accordance with the Permit Drawings and this CQA Plan.

1. HIGH DENSITY POLYETHYLENE PIPE

a. Submittals required for pipe:

i. Compliance with applicable ASTM standard

ii. Unit weight

iii. Diameter and SDR

iv. Physical dimensions

v. Method of jointing with instructions

vi. Nominal pipe joint lengths

vii. Recommended bedding and installation details

viii. Certification by manufacturer that material properties meet the values listed in the material properties sheet.

ix. Perforation diameter and spacing

b. The CQA Engineer will document and verify that the manufacturer certifies that the pipe supplied is represented by the quality assurance data.

c. The CQA Engineer will inform the Contractor when the pipe does not meet appropriate ASTM Standards.

d. The CQA Engineer will provide results of any samples taken for testing.

e. The CQA Engineer will witness and verify that jointing and installation are in accordance with manufacturer's recommendations and this CQA Plan.

f. The CQA Engineer will verify that leachate conduits external to the collection system are tested and demonstrated to be leak-proof.

2. PIPE ENCASEMENT GRAVEL

a. The CQA Engineer will review the Contractor's submittals on gravel for conformity to this CQA Plan including quarry's certification of gradation.

b. Construction Quality Assurance Testing will meet the minimum requirements for the encasement gravel as follows:

Table 8-1
Leachate Collection System Gravel Conformance Testing Requirements

Property	Test Method	Units	Value	Minimum Testing Frequency (1)
Particle Size Analysis	ASTM C136	mm [US Sieve]	ASTM No. 57 or No. 89	1 per 1,500 yd^3
Carbonate Content	ASTM D3042	%	≤ 5	1 per source or visual change in material type

c. The CQA Engineer will inform the Contractor when the gravel does not meet the requirements of this CQA Plan.

d. The CQA Engineer will provide results of any samples taken for testing.

e. The CQA Engineer will verify that the gravel encasement is in accordance with the Permit Drawings and this CQA Plan.

3. CUSHION GEOTEXTILE

a. The CQA Engineer will review the Contractor's submittals on geotextile for conformity to the Permit Drawings.

b. The CQA Engineer will inform the Contractor when the geotextile does not meet requirements in the Permit Drawings.

c. The CQA Engineer will provide results of any samples taken for testing.

9. TESTING OF PIPING SYSTEMS

A. GENERAL

1. The CQA Engineer will observe and document leak testing of leachate manholes, force mains, and non-perforated gravity piping.

2. If the specified rate of leakage is exceeded during the test, the CQA Engineer will document that the Contractor located the points of excessive leakage, instituted appropriate measure of correction, and observed all re-tests, until test requirements are met.

3. The CQA Engineer will observe and confirm that:

   a. Hydrostatic testing is performed on force mains and pressure leachate piping.

   b. Exfiltration testing is performed on manholes and gravity leachate piping.

B. EXFILTRATION TESTING

1. The CQA Engineer will verify and document that the exfiltration tests on all manholes and gravity leachate piping are conducted according to the following procedures:

   a. Plug each end of section or all openings to manhole to be tested with watertight bulkheads.

   b. Insert in each bulkhead at the top of the pipeline a two (2”) inch diameter pipe with 90º elbow that will extend four (4') feet vertically above the top of the pipeline or above the groundwater line, whichever is higher. Manhole will be tested at full depth with the water level at the cover ring.

   c. The elevations of the top of the two (2") inch diameter pipe at each bulkhead will be the same.

   d. Fill the pipeline with clear water until the water level is at the top of the two (2") inch diameter pipe at the upper end of section or at the manhole ring.

   e. Maintain the water level by adding accurately measured amounts of water for a period of thirty minutes, not allowing the lower pipe to overflow.

   f. The maximum length of a section of pipeline to be tested by means of an exfiltration test at one time will be limited to 1,000 linear feet.

g. The maximum permissible leakage determined by exfiltration will be the rate of 25 gallons per in. inside diameter of pipe per mile of pipe per 24 hours, inclusive of all appurtenances within the section such as manholes, valves, etc. The length of pipe used in the computation will be the horizontal distance between manhole centerlines of the section being tested. The maximum permissible leakage rate for manholes tested alone will be 0.01 gallons per vertical foot per day.

h. Once exfiltration is found to be within allowable limits, remove all bulkheads.

C. HYDROSTATIC TESTING

1. The CQA Engineer will observe and document all hydrostatic tests for the following piping systems:

   a. All pressure leachate piping and force mains.

   b. Do not test piping systems with water where water testing will be harmful to the system operation, such as for air and gas piping systems.

   c. All piping that will be considered inaccessible or impossible to repair after the completion of the work will be hydrostatically tested while still accessible.

      i. Examples of such piping are those near or under basins, paved roads, concrete structures, and concrete foundation.

   d. The CQA Engineer will document that all piping have reaction blocking (thrust blocks) in place before testing.

2. The CQA Engineer will verify and document that the hydrostatic tests are conducted according to the following procedures:

   a. Each section of pressure pipe or force main will be filled slowly with water and the specified test pressure, measured at the point of the lowest elevation, will be applied to the pipe in a satisfactory manner. The Contractor will furnish all test water and test equipment.

   b. Before applying the specified test pressure, all air will be expelled from the pipe. To accomplish this, taps will be made, if necessary, at points of highest elevation, and afterward tightly plugged.

   c. The test pressure will be maintained for a sufficient length of time prior to the test to allow for thorough examination of joints and elimination of leakage where necessary. The pipeline will be made watertight under the test pressure.

d. The Contractor and the CQA Engineer will inspect all exposed pipes, fittings, valves, hydrants, and joints during the test. Any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this pressure test will be removed and replaced with sound material and the test will be repeated to the satisfaction of the CQA Engineer.

e. Hydrostatic test pressures will be as follows:

Table 9-1
Hydrostatic Pressure Testing Requirements

System	Pressure Test Rating (psi)
Miscellaneous Pressure Pipe	100
Pressure Leachate Piping (force main)	100
Secondary Containment Piping	50*

a. The test section will be pressurized to the required test pressure.
b. The test will be conducted for a minimum of one (1) hour.
c. *During secondary containment pipe testing, the Contractor shall pressurize the carrier pipe as necessary to avoid exceeding the allowable safe external pressure rating of the carrier pipe as determined by the Manufacturer. The Contractor shall provide submittals from the Manufacturer specifying the maximum safe external pressure allowed for the applicable DR, resin material, temperature, and load duration.
d. The test section will not be accepted if it has any observed leakage, or the test pressure drops more than one (1) psi during the leakage test.
e. Pneumatic pressure testing is not permitted.

10. FINAL CLOSURE SUBGRADE AND TACK-ON BERMS

A. GENERAL

The CQA Engineer will certify that the final closure subgrade and tack-on berm materials and installation are in accordance with the Permit Drawings and this CQA Plan.

B. CLOSURE MATERIALS

1. The subgrade for the closure cap materials shall be successfully proofrolled with an unloaded haul truck or similar equipment. Prior to the construction of the closure cap, a test pad shall be performed on the closure slope surface to confirm the equipment can achieve the desired compaction and engineering properties. A test pad shall be performed at a minimum frequency of 1 per closure event and 1 per material type.

    a. Structural fill tack-on berms and the upper 2 feet of CCR shall be sampled and tested for shear strength in accordance with ASTM D4767 at a frequency of 1 test per test pad. A minimum compaction requirement shall be established from the test pad in order to achieve the following material shear strengths, as represented by a drained, Mohr-Coulomb envelope.

        i. Structural Fill for Tack-on Berms: ϕ' = 30 degrees, c' = 50 psf

        ii. Upper 2 feet of CCR: ϕ' = 32 degrees, c' = 0 psf

    b. The minimum compaction shall be 95% of the Standard Proctor maximum dry density or the value determined in Part B.1.a of this section, whichever is greater. The in-place moisture content shall be within 4% of the standard Proctor optimum.

C. CONFORMANCE TESTING

1. The CQA Engineer will observe and test the closure materials to confirm that they are uniform and meet or exceed the requirements of this CQA Plan. The CQA Engineer will notify the Contractor and will document when the Contractor removes materials that fail to meet the requirements of this CQA Plan from the project site.

D. TEST METHODS AND FREQUENCY

1. All material testing to confirm compliance with the requirements of this CQA Plan will be conducted in accordance with this CQA Plan. The field-testing methods used to evaluate the suitability of materials during their placement will be performed by the CQA Engineer in accordance with current ASTM test procedures indicated in Table 10-1, Minimum Testing Requirements for Closure Material.

2. Documentation and reporting of the test results will be the responsibility of the CQA Engineer.

3. In-place density testing for the CCR subgrade material for the closure system and tack-on berm structural fill shall be performed in accordance with the methods and frequencies in the table below.

Table 10-1
Minimum Testing Requirements for Closure Material

Test	Frequency	Acceptance Criteria
Field Density and Moisture Content/Sand Cone, ASTM D1556; Drive Cylinder, ASTM D2937; Nuclear, ASTM D6938	1 test per 10,000 sf per lift (CCR material) 1 test per 1,000 cy of compacted fill (tack-on berm)	See Section B.1

E. PROTECTION OF SUBGRADE AND COMPACTED FILL SURFACES

The CQA Engineer will monitor newly graded areas to verify the Contractor is protecting these areas from traffic and erosion until construction is complete.

11. FINAL COVER SYSTEM GEOMEMBRANE (CLOSURETURF®)

A. GENERAL

The CQA Engineer will certify the final cover system geomembrane materials and installation are in accordance with the approved Permit Drawings and this CQA Plan.

B. MATERIAL

1. The final cover system geomembrane will be a minimum 50-mil thick Linear Low-Density Polyethylene (LLDPE) AGRU Super Gripnet supplied and installed by firms approved by Georgia Power. A minimum 40-mil thick Linear Low-Density Polyethylene (LLDPE) AGRU Microspike may be utilized on slopes less than 5.0% at the Owner's discretion.

2. Seams for providing watertight joints will be extrusion or double hot wedge fusion seams using techniques approved by the CQA Engineer.

3. The textured material will have an interface shear resistance (friction angle plus cohesion) with contiguous final cover system components of 24.8 degrees or as directed by the Design Engineer. This interface shear is the minimum shear strength represented by a friction angle with an adhesion = 0 psf. Equivalent strength combinations that provide satisfactory factors of safety may be approved by the Design Engineer. The interface shear strength will be determined by direct shear testing conducted at the confining pressure of 250 PSF or as directed by the Design Engineer.

4. Manufacturer Quality Control will confirm that the material meets the minimum physical properties of a minimum 50 -mil or 40-mil thick textured LLDPE geomembrane as listed in the latest version of GRI-GM17, "*Test methods, test properties and testing frequency for Linear Low-Density Polyethylene (LLDPE) smooth and textured geomembrane*".

C. GEOMEMBRANE MANUFACTURER AND INSTALLER

1. The Geomembrane Installer will submit the following documents obtained from the Geomembrane Manufacturer to the CQA Engineer:

    a. Production Certification, including project references,

    b. Testing Program of Compound Ingredients,

    c. Material Certification, and

    d. Test Data for Material and Resin

All of the above submittals will be reviewed and retained by the CQA Engineer.

2. The Geomembrane Installer will submit the following documents to the CQA Engineer at least 14 days prior to installation:

   a. Qualifications of Geomembrane Installer Superintendent and Foreman,

   b. Resumes of Geomembrane Contractor field crew, and

   c. Six (6) sets of proposed geomembrane panel layout drawings.

D. GEOMEMBRANE INSTALLATION

1. A pre-deployment CQA meeting will be held prior to installation. The Contractor, the Geomembrane Installer, , the ClosureTurf® product representative, the CQA Engineer, and a representative of Georgia Power will be in attendance. The following issues will be discussed and agreed upon by all parties and will be included in a report in the CQA documentation.

   a. Testing of welds

   b. Characteristics of a "good" weld, and

   c. Repair procedures

2. The CQA Engineer will obtain samples of the geomembrane rolls from the manufacturing plant prior to shipment to the site.

3. Random samples must be representative of the material supplied and exclude the outer wrap of geomembrane. Samples should be full roll width and at least two (2) feet long.

4. The laboratory testing of the samples selected will be coordinated by the CQA Engineer and will confirm conformance with the properties listed in Table 11-1 below:

Table 11-1
Geomembrane Conformance Testing Requirements

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Density	ASTM D1505 or ASTM D792	1per 100,000 ft^2
Thickness	ASTM D5994	1per 100,000 ft^2

Table 11-1
Geomembrane Conformance Testing Requirements

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Tensile Strength at Break	ASTM D6693, Type IV	1per 100,000 ft^2
Elongation at Break		
Carbon Black Content	ASTM D1603[(1)] or ASTM D4218	1per 100,000 ft^2
Carbon Black Dispersion	ASTM D5596	1per 100,000 ft^2
Interface Shear Strength [(2)] (with ClosureTurf® and subgrade/CCR)	ASTM D5321	1 per 20 acres (minimum 2 per project) per interface

Notes:
(1) ASTM D1603 is acceptable if an appropriate correlation to ASTM D4218 can be established.
(2) Testing parameters for interface shear strengths are provided in paragraph B.3 of this section.

5. The CQA Engineer will review the geomembrane thickness of each roll made for the project prior to shipment. Material that does not fall within acceptable thickness criteria will be rejected.

6. The CQA Engineer will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports.

7. Overheating of the geomembrane during welding will be monitored by the CQA Engineer. At the discretion of the CQA Engineer, coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation. The CQA Engineer will monitor more closely while welding is occurring in areas where machine speed may vary resulting in a higher likelihood of overheating. The location and repair method of overheated areas will be recorded in the daily field reports. The method of repair will be determined in the field by the CQA Engineer.

8. During seaming, the CQA Engineer will observe the seams for the following:

   a. proper preparation,

   b. grinding technique, where applicable, and

   c. overheating.

9. The CQA Engineer will mark all areas where the geomembrane indicates a protrusion from the prepared CCR subgrade or intermediate cover soil. The method of repair will be determined in the field by the CQA Engineer.

E. TEST SEAMS

1. The CQA Engineer will document and verify that the Geomembrane Installer performs a test seam for each welding machine in use every 4-5 hours, or at a minimum prior to start of construction work, and at midday. At least one test seam will be made for each machine in use for each seam. Should any post-production test seam fail, the immediate prior production seam will be sampled for destructive testing in accordance with Section F below. The test seam should be approximately 5 feet long. The CQA Engineer will sample the test seam from the center 3 feet of the test sample.

    a. The date, time, and equipment, as well as welding temperature and seaming parameters, will be recorded for each test seam.

    b. A minimum of five (5) specimens for peel and for shear from each sample will be tested for the properties listed in the latest version of GRI-GM19, "*Standard Technical Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*" in accordance with test method ASTM D6392. Testing will be performed in the field by the Geomembrane Installer under full-time observation by the CQA Engineer.

    c. Untested portions of the test seam will be retained by the CQA Engineer for the project record and future testing as required.

2. All test seams must pass field-testing before production seaming is performed by the Geomembrane Installer.

F. FIELD DESTRUCTIVE TESTING

1. The Geomembrane Installer will obtain approximately 12" x 48" samples of field seams, suitable for testing, as indicated Table 11-2 below. The date, time, equipment, and seam number will be marked on each sample and recorded by the CQA Engineer.

Table 11-2 Field Seam Testing Requirements		
TEST NAME	**TEST METHOD**	**MINIMUM TESTING FREQUENCY**
Seam Peel Strength	ASTM D 6392[(1)]	1 test per 500 feet of seam, 1 per seamer per day
Seam Shear Strength	ASTM D 6392[(2)]	1 test per 500 feet of seam, 1 per seamer per day

Notes:

(1) For double wedge fusion seams, both tracks will be tested in peel.

(2) For shear tests, the sheet will yield before failure of the seams.

2. Samples retained will be tested in the field by the geomembrane installer. A minimum of five (5) specimens from each sample for peel and for shear will be tested for the properties listed in the latest version of GRI-GM19, "*Standard Technical Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*" in accordance with test method ASTM D6392.

3. The CQA Engineer or Georgia Power may require additional random samples to be taken for testing in areas that visually appear defective and not in accordance with this CQA Plan.

G. NON-DESTRUCTIVE TESTING

1. The Geomembrane Installer is responsible for the completion of non-destructive testing of the entire length of all field seams, verifying that said seam is airtight. Said testing can be a vacuum test, pressure test, or approved equal and will be described by the Geomembrane Installer and verified by the CQA Engineer in advance.

2. The CQA Engineer will observe all non-destructive testing on a full-time basis.

H. DESTRUCTIVE LABORATORY TESTING

1. Destructive seam samples will be laboratory tested by the CQA Engineer. Testing frequency will be a minimum average frequency of one (1) sample per 500 linear feet of field seam.

   a. Test samples will be at least 12 inches x 36 inches. A minimum of five (5) specimens will be tested for the properties listed in the latest version of GRI-

GM19, "*Standard Technical Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*" in accordance with test method ASTM D6392. These test samples will be taken at the same locations as the contractor's destructive testing samples.

b. All laboratory specimens of geomembrane will be conditioned for a minimum of one (1) hour prior to testing at the standard atmosphere, that is, air maintained at a relative humidity of 65 ±5% and a temperature of 21°C ± 2°C (70°C ± 3.5°F).

c. Peel tests will be performed on both sides of a double-wedge fusion seam.

2. The load and elongation at failure will be measured for each specimen. The CQA Engineer will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.

3. Passing criteria for strength, locus of break, and elongation shall be in accordance with the latest version of GRI-GM19. If unresolved discrepancies exist between the CQA Engineer and Contractor's test results, the archived sample may be tested by the CQA Engineer. Samples that do not pass the shear and peel tests will be resampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

4. Seams represented by a failing destructive field or laboratory test sample will be cut out and replaced or covered with a geomembrane strip and the seam bounded by supplemental passing field and laboratory destructive test samples at both ends.

5. The CQA Engineer will verify and document that the strength and other properties of the textured 40-mil thick LLDPE geomembrane seams meet or exceed the requirements set forth in the latest version of GRI-GM19, "*Standard Technical Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembrane*".

12. FINAL COVER ENGINEERED TURF (CLOSURETURF®)

A. GENERAL

The CQA Engineer will certify the final cover system engineered turf materials and installation are in accordance with the Permit Drawings, this CQA Plan and the Manufacturer's recommendations.

B. ENGINEERED TURF MANUFACTURER AND INSTALLER

1. The CQA Engineer will review and verify the following submittals from the Engineered Turf Manufacturer:

   a. Production Certification, and

   b. Material Certification

2. The CQA Engineer will review and verify the following documents prior to installation:

   a. Qualifications of the engineered turf installer superintendent, foreman, and field crew, and

   b. Six (6) sets of field installation drawings.

C. CONFORMANCE TESTING

1. CQA conformance testing will be performed by the CQA Engineer according to Table 11-1 below.

Table 12-1
Engineered Turf Conformance Testing Requirements

Property	Test Method	Units	Value	Minimum Testing Frequency (1)
Mass Per Unit Area (Total Product Weight)	ASTM D5261	oz/yd^2	>20	1 test per 100,000 s.f.
CBR Puncture	ASTM D6241	lb	1,500 (MARV)	1 test per 100,000 s.f.
Tensile Strength of Product (MD/XD)	ASTM D4595	lb/ft	2,100 MD/1,600 XD	1 test per 100,000 s.f.
Tensile Strength of Yarn	ASTM D2256	lb	15	1 test per 100,000 s.f.

D. INSTALLATION

1. The CQA Engineer will verify that the installation of the engineered turf proceeds after he has provided certification of the geomembrane or a section thereof.

2. The supporting surface (e.g., the geomembrane) shall be free of debris prior to the engineered turf placement.

3. During deployment of engineered turf, the CQA Engineer must observe the turf as it is deployed has the turf filaments facing upward and record defects and disposition of the defects (i.e., panel rejected, patch installed, etc.).

4. Turf panels shall be sewn or welded together. The CQA Engineer shall visually monitor for continuous seams and verify that the welds cannot be pulled apart by hand.

5. No equipment other than very-low (<5 psi) ground pressure, rubber-tired, four-wheel, ATV-type vehicles may traverse on the geomembrane or the engineered turf prior to sand infill on slopes less than 15 percent. Vehicles are prohibited on slopes greater than 15 percent.

6. The CQA Engineer shall confirm that all panels are deployed from the top of the slope in a way that the Engineered Turf filaments are pointing upslope after deployment is complete.

13. FINAL COVER SYSTEM SAND INFILL (CLOSURETURF®)

A. GENERAL

The CQA Engineer will verify that the final cover system sand infill and installation is placed in accordance with the approved Permit Drawings and this CQA Plan.

B. MATERIAL

1. Soil that meets all the following requirements will be classified as sand infill for use in the construction of the final cover system.

   a. Fine aggregate angularity shall be tested in accordance with ASTM C1252, Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading) Method A. Uncompacted void content shall be greater than or equal to 40%.

   b. Specific gravity shall be tested in accordance with ASTM C128, Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate. Bulk oven-dry specific gravity shall be greater than or equal to 2.40.

   c. Grain size distribution shall be tested in accordance with ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. The grain size distribution shall be verified for every 175 cubic yards to be installed and shall meet the gradation prescribed in the following table.

Particle Size (mm) [US Sieve]	Allowable Percent finer than (by mass)
9.5 [3/8]	100
4.75 [4]	90 - 100
2.36 [8]	50 - 85
1.18 [16]	25 - 65
0.6 [30]	10 - 45
0.3 [50]	0 - 30
0.15 [100]	0 - 10
0.075 [200]	0 - 5

C. STOCKPILING AND MATERIAL APPROVAL

1. All material to be used as final cover system sand infill will be sampled and tested in advance by the CQA Engineer. The CQA Engineer must verify the soil meets all the material requirements prior to use.

2. Verification can be accomplished from samples obtained at the supplier and/or from on-site stockpiles of delivered materials.

3. The CQA Engineer will prepare reports of all testing, analysis, and verification.

D. CONSTRUCTION

1. The method of sand infill deployment to be used will be explained in detail during the pre-construction meeting by the sand infill installer.

2. The sand infill layer shall be placed to a final thickness between 0.5 and 0.75-inch. Sand infill shall be worked into the synthetic yarn blades of the turf as it is placed.

    a. The CQA Engineer shall measure sand infill thickness at a minimum frequency of 20 measurements per acre.

3. CQA Engineer shall observe that the sand infill is worked into the Engineered Turf between the synthetic yarn blades in accordance with manufacturer's recommendations.

4. The CQA Engineer will confirm that:

    a. Previously installed ClosureTurf® components are not displaced or damaged as a result of the sand infill component installation.

    b. Sand infill placement does not occur with snow or ice on the Engineered Turf component.

14. FINAL COVER SYSTEM HYDROBINDER® INFILL (CLOSURETURF®)

A. GENERAL

HydroBinder® is a proprietary cementitious product used as alternate infill component of the ClosureTurf® system. This material will typically be installed in areas of concentrated stormwater flow (e.g., flumes, drainage ditches).

B. MATERIAL

1. The cementitious infill mix design will conform to the requirements of ASTM C387 for high strength mortars.

2. The cementitious infill mix design will have a minimum 28-day compressive strength of 5,000 psi per ASTM C109.

    a. Verification of the comprehensive strength will be completed by the manufacturer and a certified test report will be supplied with each batch/lot of HydroBinder® material delivered to the site.

C. STOCKPILING AND MATERIAL APPROVAL

1. The HydroBinder® cementitious infill material may be delivered in either pallet form of 80-pound bags or 3,000-pound bulk super sacks.

2. The CQA Engineer will verify that all HydroBinder® delivered to the project site is stored in a dry area protected from precipitation. The HydroBinder® will be placed on pallets to assure drainage beneath the rolls.

D. CONSTRUCTION

1. The method of HydroBinder® infill deployment to be used will be explained in detail during the pre-construction meeting by the sand infill installer.

2. The HydroBinder® infill layer shall be placed in a dry state and worked into the tufts, so the tufts are in an upright position.

3. HydroBinder® shall not be placed when the subgrade and the surface of the engineered turf are below a temperature of 36°.

4. The HydroBinder® infill layer shall be placed to a 0.75-inch minimum thickness and not exceed 1 inch thick.

15. CERTIFICATION

The CQA Engineer will provide, within 30 days of completion of cell construction or closure activities, written certification that the liner and leachate collection system, final cover, access roads, ditches, sediment ponds, and other associated ancillary facilities for the particular landfill area were constructed according to the approved Permit Drawings and this CQA Plan. Said certification will have the CQA Engineer's seal as a professional engineer registered in the State of Georgia.