Haley Griffith (adpce.ad)

Subject: RE: Submittal of Updated CQA Plan for Legacy Landfill

From: Paul Crawford <pcrawford@olsson.com>
Sent: Thursday, March 12, 2026 12:56 PM
To: Charles Hurt (adpce.ad) <charles.hurt@arkansas.gov>; Richard Bennett (adpce.ad) <richard.bennett@arkansas.gov>
Cc: Angela Sparks <angela@ccswda.com>
Subject: Submittal of Updated CQA Plan for Legacy Landfill

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Mr. Hurt,

Per your request in the approval for the construction of Cell 5 of the Craighead County Solid Waste Disposal Authority's Legacy Landfill (February 13, 2026; attached), the facility's updated CQA Plan is attached. The updates address the testing criteria for the facility's leachate drainage layer material, the leachate trench gravel material, the leachate sump gravel material, and geomembrane thickness testing for smooth HDPE liner material.

If you have any questions regarding this submittal, please contact me.

Thank you,

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CONSTRUCTION QUALITY ASSURANCE PLAN LEGACY LANDFILL

AFIN: 16-00199

Prepared for:

Craighead County Solid Waste Disposal Authority

Jonesboro, Arkansas

March 2026

Olsson Project No. 026-00073

Arkansas Certificate of Authorization No: 1010



03-12-2026

olsson

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1. GENERAL

1.1 Scope

This Construction Quality Assurance (CQA) Plan addresses the quality assurance and quality control of the installation of the soil and geosynthetic materials used in lining systems by Craighead County Solid Waste Disposal Authority (CCSWDA) for the Legacy Landfill (the Landfill) facility. This plan is applicable for lining systems that include bottom liner and final cover systems as shown on the facility Permit Drawings or construction project drawings. Extreme care and detailed documentation are required in the selection and installation of all materials used in lining systems for the Landfill.

This CQA Plan primarily addresses quality assurance and is directed toward the CQA Consultant. In the context of this manual, quality assurance refers to means and actions employed by the CCSWDA to assure conformity of the lining system production and installation with the project specifications, contractual, and regulatory requirements.

This CQA Plan contains all of the elements necessary to ensure that the project is constructed in accordance with project plans and specifications as well as Arkansas Pollution Control and Ecology Commission (APCEC) regulatory requirements. This plan does not address design guidelines, installation specifications, or selection of soils or geosynthetic materials.

The bottom liner and the final cover systems for the Landfill include the standard Class 1 landfill components, with an alternative final cover system option. The final cover alternative includes a geosynthetic clay liner (GCL) in place of the compacted clay cap. The construction project drawings for final cover system projects will identify which system is to be installed. This CQA Plan includes information for the standard and alternative components. The specifications for each construction project will provide information of each component of the lining system that is included in the design.

This CQA Plan includes references to test procedures and standards of ASTM, Corps of Engineers (COE), the Federal Test Method Standards (FTMS), and the Geosynthetic Research Institute (GRI).

1.2 Parties

The parties discussed in this section are associated with the ownership, design, installation, and quality assurance of a lining system. The definitions, responsibilities, qualifications, and submittals of these parties are outlined in the following subsections.

1.2.1 Owner

1.2.1.1 Definition

The Owner owns, and/or is responsible for, the facility including components constructed within the scope of this plan. Unless otherwise noted, the CCSWDA will be the owner of any liner/final cover system constructed in association with the Landfill.

1.2.1.2 Responsibilities

The CCSWDA will be responsible for negotiating contracts between the other CQA parities, and for ensuring that qualified agencies, firms, contractors are selected to satisfy the requirements of this CQA Plan and who will be responsible for ensuring that the project is completed in accordance with applicable construction Contract Documents, regulations, and permits.

1.2.2 CCSWDA Project Manager

1.2.2.1 Definition

The CCSWDA Project Manager (CCSWDA PM) is the official representative of the Owner. The CCSWDA PM is responsible for managing all aspects of a construction project for the Landfill, including planning, cost control, design, permitting, regulatory liaison, contract acquisitions, construction oversight, quality control, and certification. The CCSWDA PM will work closely with Design Engineer, the CQA Consultant, and the Earthwork Contractor. Other responsibilities include selection or approval of the Earthwork Contractor, the CQA Consultant, the Soil CQA Laboratory, the Geosynthetic Contractor (if necessary), and the Geosynthetic CQA Laboratory (if necessary).

1.2.2.2 Responsibilities

The CCSWDA PM will serve as a liaison between all parties involved in the project to ensure that communications are maintained. The CCSWDA PM will also be responsible for proper resolution of all quality assurance issues that arise during construction.

1.2.3 Design Engineer

1.2.3.1 Definition

The Design Engineer is the individual or firm that has prepared the Contract Documents associated with the construction project. The Design Engineer shall have no direct ties to the Owner, which could be construed as a conflict of interest.

1.2.3.2 Responsibilities

The Design Engineer is responsible for the design of the bottom liner or final cover system and preparation of the Contract Documents associated with the project. The Design Engineer shall review and approve all proposed revisions to the Contract Documents on behalf of the Owner.

1.2.4 Earthwork Contractor

1.2.4.1 Definition

The Earthwork Contractor is the firm that performs the site earthwork preparation and construction of the soil components of the Landfill. The Earthwork Superintendent is the individual responsible for the Earthwork Contractor's field crew. The Earthwork Superintendent may represent the Earthwork Contractor at all site meetings and acts as the Earthwork Contractor's spokesman on the project.

1.2.4.2 Responsibilities

The Earthwork Contractor is responsible for constructing soil components of the Landfill in conformance to the project plan and specifications. The Earthwork Contractor may also be responsible for supplying and transporting the required earth and granular materials, concrete, piping, and other work as outlined in the project specifications.

1.2.5 CQA Consultant

1.2.5.1 Definition

The CQA Consultant is the firm that observes and documents activities related to the quality assurance of the installation of the components of the lining system on behalf of CCSWDA.

In this CQA Plan, the term CQA Project Manager refers to the engineer employed by the CQA Consultant who is personally in charge of the quality assurance work. Although not located at the site, the CQA Project Manager will visit the site often enough to be familiar with the details of the project.

The personnel of the CQA Consultant also include the CQA Monitors who are located at the site for construction observation and documentation.

1.2.5.2 Responsibilities

The CQA Consultant is responsible for observing and documenting activities related to the quality assurance of the construction of all components of the lining systems. The CQA Consultant is responsible for the implementation of this plan. The CQA Consultant is also responsible for issuing a final CQA Report, sealed by an Arkansas-licensed Professional Engineer, as outlined in Section 2 of this CQA Plan. Other duties of the CQA Consultant will include overseeing the soil and geosynthetic laboratory testing.

The CQA Consultant will properly and adequately assess any differences of the CQA Consultant’s interpretation of the project plans and specifications from the Earthwork or Geosynthetic Contractor’s interpretation through discussion with the Earthwork or Geosynthetic Contractor. If such assessment indicates any actual or suspected work deficiencies, the CQA Consultant will inform the Earthwork or Geosynthetic Contractor and the CCSWDA PM of these deficiency issues.

1.2.6 Soil CQA Laboratory

1.2.6.1 Definition

The Soil CQA Laboratory is the firm that conducts testing on soil samples taken from the site.

1.2.6.2 Responsibilities

The Soil CQA Laboratory is responsible for conducting the appropriate laboratory tests as directed by the CQA Project Manager. The test procedures will be done in accordance with the test methods outlined in this plan and/or the project specifications. The Soil CQA Laboratory will be responsible for providing test results to the CQA Consultant.

1.2.7 Geosynthetic Contractor

1.2.7.1 Definition

The Geosynthetic Contractor is the firm that performs the installation of the geosynthetic components of the Landfill. The Superintendent is the individual responsible for the Geosynthetic Contractor's field crew. The Superintendent may represent the Geosynthetic Contractor at all site meetings and acts as the Contractor's spokesman on the project. The Earthwork Contractor and the Geosynthetic Contractor may be the same company.

1.2.7.2 Responsibilities

The Geosynthetic Contractor is responsible for installing the geosynthetic components of the Landfill in conformance to the project plan and specifications. The Geosynthetic Contractor may also be responsible for supplying and transporting the required geosynthetic materials, and other work as outlined in the project specifications.

1.2.8 Geosynthetic CQA Laboratory

1.2.8.1 Definition

The Geosynthetic CQA Laboratory is the firm that conducts tests on samples of geosynthetics taken from the site. The Geosynthetic CQA Laboratory and the Soil CQA Laboratory may be the same party.

1.2.8.2 Responsibilities

The Geosynthetic CQA Laboratory is responsible for conducting the appropriate laboratory tests as directed by the CQA Project Manager. The test procedures shall be done in accordance with the test procedures outlined in this CQA Plan and/or the project specifications. The Geosynthetic CQA Laboratory shall be responsible for providing test results to the CQA Consultant.

2. DOCUMENTATION

An effective CQA Plan depends largely on identification of those construction activities that require monitoring, and on assigning responsibilities for the monitoring of each activity. This is most effectively verified by the thorough documentation of quality assurance activities. The CQA Consultant will document that all requirements in the CQA Plan have been addressed and satisfied.

The CQA Consultant will provide the CCSWDA PM with signed descriptive remarks, data sheets, and checklists to verify that required monitoring activities have been carried out. The CQA Consultant will also maintain at the job site a complete file of all documents related to the construction activities including plans and specifications, this plan, checklists, test procedures, daily logs, and other pertinent documents.

2.1 Daily Reports

Each CQA Monitor will complete a daily report and/or logs on prescribed forms outlining all monitoring activities for that day. The report, at a minimum, will consist of field notes, observations, test data sheets, construction problems, and solution data sheets. A summary of all supporting data sheets along with final testing results and CQA Project Manager's approval of the work will be required upon completion of construction.

The CCSWDA PM will immediately be made aware of any nonconformance with the project specifications. In particular, the CCSWDA PM will be informed before the work in question is covered by overlying system layers. The CCSWDA PM will then determine its cause and direct or recommend appropriate changes. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specification will be approved in writing by CCSWDA PM.

2.2 Test Reports

The CQA Consultant will collate records of field and laboratory testing performed on the components of the bottom liner or final cover systems. A summary list of test results will be prepared by the CQA Consultant on an ongoing basis and submitted with the weekly progress reports.

2.3 Record Drawings

The CQA Consultant or surveyor will prepare record drawings. The record drawings will include, at a minimum, the following information for soil components:

1. Surveyed grade of the prepared subgrade,
2. Surveyed grade of top of the clay liner,
3. Surveyed grade of protective cover layer/leachate drainage layer,
4. Surveyed grade of the prepared top of interim cover layer prior to installation of final cover system,
5. Surveyed grade of the final cover liner (only if compacted clay layer installed; not necessary for GCL),
6. Surveyed grade of completed final cover system,
7. Information on stormwater control facilities,
8. Locations of all field tests and samples obtained for laboratory testing,
9. Locations of all repairs performed on soil or geosynthetic components, and
10. Locations of grade changes relative to site survey grid.

If necessary, for the purpose of clarity in the record drawings, separate sheets will be used to illustrate the locations of test sampling points. The record drawings will be shown in plan views. An Arkansas-licensed land surveyor will perform all surveying as approved by the CCSWDA PM.

2.4 CQA Report

Upon completion of the work, the CQA Consultant will submit a CQA Report to the Arkansas Department of Energy and Environment, Division of Environment Quality (DEQ) in accordance with Title 8, Part 60 (8 CAR 60), §60-428(i). The CQA Report will summarize the activities of the project, document all aspects of the quality assurance program performed, and will include the list of deliverables identified in §60-428(i).

3. LINING SYSTEM ACCEPTANCE

3.1 Soil Components Acceptance

Upon written recommendation by the CQA Consultant, the CCSWDA PM will consider accepting the soil components of the bottom liner and final cover system ("lining components"). The Earthwork Contractor will retain all ownership and responsibility for the soil lining components until acceptance by the CCSWDA PM. At the CCSWDA PM's discretion, the lining system may be accepted in sections or at points of substantial completion.

The CCSWDA PM will accept the soil components of the lining system when:

- The installation of the soil components is finished,
- Verification of the adequacy of the constructed components (including repairs, if any) is completed in accordance with this Plan and project specifications,
- All documentation of installation is completed, and
- The CQA Consultant is able to recommend acceptance.

Upon conclusion of the installation of soil components, the CQA Consultant will certify that installation of the soil components has been completed in accordance with the project specifications except as noted. This certification will be provided in the CQA Report as outlined in Section 2.4.

3.2 Geosynthetic Components Acceptance

Upon written recommendation by the CQA Project Manager, the CCSWDA PM shall consider accepting the geosynthetic components of the lining system. The Geosynthetic Contractor will retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the CCSWDA PM. At the CCSWDA PM's discretion, the lining system may be accepted in sections or at points of substantial completion.

The geosynthetic components of the lining system will be accepted by the CCSWDA PM when:

- The installation of the geosynthetic components is finished,
- Verification of the adequacy of all seams (including associated testing and repairs, if any) is completed in accordance with this Plan and project specifications,
- All documentation of installation is completed, and
- The CQA Project Manager is able to recommend acceptance.

Upon completion of installation of the geosynthetic components, the CQA Project Manager shall certify that installation has been performed in accordance with the project specifications except as noted to the CCSWDA PM. This certification shall be provided in the CQA Report as outlined in Section 2.4.

4. GENERAL EARTHFILL

4.1 Description and Applicability

General earthfill consists of random soils taken from on site or approved offsite excavations or stockpiles and used for non-lining system applications such as embankments, berms, or structural fill. General earthfill material consists of a broad range of soils that are relatively free of organics, debris, or other deleterious matter that can be used for the purpose of earthfill construction. Specific tests to determine the suitability of earth materials for use in general earthfill shall be included in the project specifications.

4.2 Quality Control Documentation

Prior to construction of the general earthfill, any required tests shall be performed to determine conformance with the project specifications. If the fill material is similar to the clay liner or clay cap material, then the pre-construction testing performed on the liner soil may be used for the general fill material. Any material from offsite sources or from borrow areas not previously tested, must be tested at the frequencies listed in Table 1. The Soil CQA Laboratory or other laboratory approved by the CCSWDA PM shall perform the testing.

Table 1. Testing requirements for general earthfill material.

Test	ASTM Method[1]	Minimum Frequency of Testing[2]	Minimum Test Standards[2]
Pre-Construction Testing			
Moisture Content	D 2216	1 test per source	No standard. Used to determine moisture condition of source.
Standard Proctor	D 698	1 test per source	No standard; used to determine density/moisture relationship with permeability.
Construction Testing			
In-Place Field Density and Moisture	D 6938	1 test per 10,000 square feet (sf) per lift, every 200 linear feet for berms and trenches, or as specified in the Project Specifications	90% maximum Standard Proctor dry density at ± 3% of optimum moisture content (OMC). Embankments within 2 ft of road: 95% maximum Standard Proctor dry density at ± 3% of OMC.

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

4.3 Construction Observation

The CQA Project Manager shall verify that the requirements of the project specifications are met.

The CQA Monitor shall monitor the following construction activities during placement of general fill material for assurance with project specifications:

- Preparation of subgrade surface,
- Placement of general fill material and thickness of lift, and
- Compaction and moisture conditioning activities.

The CQA Consultant shall report any nonconformance to the CCSWDA PM.

4.4 Defects and Repairs

4.4.1 Identification

If a defect is identified in the finished general earthwork, the CQA Project Manager shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Project Manager shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Project Manager deems appropriate.

4.4.2 Notification

After determining the extent and nature of the defect, the CQA Project Manager shall promptly notify the Earthwork Contractor and the CCSWDA PM. If necessary, a work deficiency meeting shall be held as needed between the Earthwork Contractor, CQA Project Manager, CCSWDA PM, and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

4.4.3 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to meet the project specifications. If a project specification criteria cannot be met, or unusual weather conditions hinder work, the CQA Consultant shall develop and present to the CCSWDA PM suggested solutions for his approval.

The CQA Monitor shall schedule appropriate retests, if any are required, when the defect has been repaired. All retests by the CQA Monitor must verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

5. COMPACTED CLAY LINER MATERIAL

5.1 Description and Applicability

The compacted clay liner material generally consists of compacted native cohesive soils with low hydraulic conductivity used as a barrier element in the bottom liner and final cover systems. Soils used for the compacted clay liner will consist of clean, select material free of debris, excessive coarse particles or other deleterious matter. Soils with a visibly identifiable organic content, or soils classified according to the Unified Soil Classification System (USCS) as organic silt or organic clay (OL, OH) will not be used.

5.2 Conformance Testing

Conformance testing of the compacted clay liner materials will be performed to ensure the consistency of the properties of the soil obtained from onsite borrow sources. These tests will be performed prior to placement, compaction, and any necessary conditioning of the compacted clay liner material.

Table 2 presents the required tests, the frequency of the tests, and the passing criteria for the materials.

The CQA Project Manager will examine all test results and report any nonconformance to the CCSWDA PM. The CCSWDA PM will accept or reject the soil based on this review and the requirements of the project specifications prior to construction.

5.3 Subgrade Preparation

The subgrade (foundation) layer provides a stable base for subsequent soil components. It will be prepared in accordance with the project specifications and should meet the same density requirements as the overlying layer.

The Earthwork Contractor will be responsible for preparing the subgrade soil for placement of overlying liner materials. The subgrade will be tested for compliance as outlined in the project specifications.

Table 2. Testing requirements for compacted clay liner material.

Test	ASTM Method[1]	Passing Criteria[2]
Pre-Construction Testing: One test per 20,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Zero to 6% above the OMC as determined by ASTM D 698
Particle Size	D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Maximum particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with PI ≥ 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory Hydraulic Conductivity at Specified Compaction and Moisture Content	D 5084	≤ 1 x 10^{-7} cm/sec at 95% Standard Proctor density and above OMC
Construction Testing: One test per 5,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Zero to 6% above the OMC as determined by ASTM D 698
Particle Size	D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Maximum particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with PI ≥ 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory Hydraulic Conductivity at Specified Compaction and Moisture Content	D 5084	≤ 1 x 10^{-7} cm/sec at 95% Standard Proctor density and above OMC
Field Testing: One test per 10,000 sf of liner constructed per compacted lift.		
In-place Density and Moisture Content	D 6938	≥ 95% Standard Proctor maximum dry density and moisture content 0 to 6%
Performance Testing: One test per 40,000 sf of liner constructed per compacted lift.		
Laboratory Hydraulic Conductivity	D 5084	≤ 1 x 10^{-7} cm/sec

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

Upon completion of subgrade preparation, the CQA Monitor will examine the subgrade. It will be surveyed for confirmation of design grades and tested by density/moisture testing using a nuclear densometer or proof-rolling for verification that it will be able to support the composite liner system.

At any time during construction of the compacted clay liner, the CQA Monitor will indicate to the CCSWDA PM any locations that are not adequate for placement of the clay liner. Such defects in the subgrade soil will be repaired by the Earthwork Contractor, at the direction of the CCSWDA PM, such that the properties of the repaired areas meet the project specifications.

5.4 Construction Observation

Observation of the clay liner construction will be coordinated with construction testing. Acceptance criteria for construction work will be as identified in Table 2 or the project specifications. At a minimum, the CQA Monitor will observe and record the following during the construction of clay liners:

1. The moisture content and consistency of the soil during processing, placement, and compaction;
2. The type and level of compaction effort;
3. The action of compaction equipment on the soil surface (sheepsfoot penetration, pump, cracking, etc.);
4. The maximum soil clod size (if required);
5. The loose and compacted lift thickness;
6. The method of bonding lifts together;
7. The dimensions of the working area; and
8. The areas where damage due to excess moisture, insufficient moisture, freezing, or excessive desiccation may have occurred.

5.5 Construction Testing

All CQA testing will be conducted in accordance with the project specifications, or as directed by the CCSWDA PM. All field and laboratory tests will be conducted on samples taken from the clay liner materials during the course of the construction work. Testing and sampling procedures will be observed and documented by the CQA Monitor. Documentation and reporting of test results will be in accordance with the requirements identified in this Plan.

5.5.1 Field Testing

Table 2 lists the required field tests for the construction of the compacted clay liner.

Nuclear density tests (ASTM D 6938) will be used for density and moisture testing. The locations of routine in-place density tests will be determined using a non-biased sampling plan based on random selection of testing locations. Questions concerning the accuracy of any single test will be addressed by retesting in the same general location.

Unless otherwise noted in the project specifications, or as directed by the CCSWDA PM, all perforations of the compacted clay liner will be backfilled. Perforations that must be backfilled will include, but not limited to, the following:

- Nuclear density test probe locations,
- Survey stake locations, and
- Hydraulic conductivity sampling locations.

All perforations will be backfilled with bentonite, or a mixture of bentonite and compacted clay liner material as specified in the project specifications. Compaction will be performed with a tamping rod, or a hand tamper as specified in the project specifications. At a minimum, the CQA Monitor will perform observations and routine tests on the backfilled areas to ensure a proper seal.

Based on recommendations from the CQA Project Manager and at the discretion of the CCSWDA PM, an increased frequency of testing may be required if one or more of the following conditions develop during construction:

1. The compaction equipment slips during operation,

2. The lift thickness is greater than specified,
3. The soil is at improper and/or variable moisture content,
4. Fewer than the specified number of roller passes are made,
5. The compaction equipment has clogged rollers,
6. The soil fails to meet the project specifications,
7. The clay liner materials differ substantially from those specified, and
8. The degree of compaction and remolding of the material is suspect.

Additional testing may also be considered when:

1. The weather conditions are adverse,
2. The compaction equipment have not used optimum ballast,
3. The equipment breaks down frequently,
4. At the beginning or completion of grading operations,
5. The material fails to meet specifications, and
6. The work area is reduced.

5.5.2 Laboratory Testing

Hydraulic conductivity tests (ASTM D 5084) will be performed to confirm that the soil in the compacted clay liner meets the project specifications. Unless specified in the project specifications, hydraulic conductivity of the compacted soil will be determined on undisturbed samples obtained from the constructed clay liner at the frequency listed in Table 2 and in the project specifications. Acceptability criteria will be as identified in Table 2 and the project specifications.

Laboratory hydraulic conductivity samples will be taken such that the sample tube is inserted into the liner perpendicular to the plane of the constructed surface. The tube will be inserted into the lift being tested by applying a gradually increasing pressure. The tube will be prepared and shipped to the Soil CQA Laboratory, as outlined in ASTM D 1587.

5.6 Test Pad

Depending on the experience of the Earthwork Contractor in completing similar landfill construction projects, a test pad may be required to be constructed. The purpose of the compacted clay liner test pad is to determine the required construction procedures to achieve the specified physical characteristics of the clay liner system. The requirement for test pad construction may be waived by DEQ if the Earthwork Contractor can demonstrate a minimum of 500,000 sf of clay liner construction consistent with the requirements of 8 CAR §60-428(c)(11)(b) during the previous three years. Regardless of the Earthwork Contractor's experience, the CCSWDA PM or regulatory agency may require a test pad to be constructed for verification of the relationship between density, moisture, construction methods and permeability of the clay material.

5.6.1 Test Pad Construction

The purpose of the test pad is to analyze the procedures to be used in the construction of the compacted clay liner system (bottom liner or final cover cap). The test pad construction allows the parties involved to become familiar with the materials and construction methods for the project.

The test pad program will include:

- The preparation of the subgrade, if not already done,
- The construction of the test pad,
- The monitoring and testing of the soil materials, and
- The sampling and laboratory testing of the soil materials.

The test pad will be constructed such that the final lift has dimensions of approximately 100 ft long and 60 ft wide to allow construction equipment to achieve normal operating speeds. The test pad will consist of at least four equal lifts of clay liner material for the bottom liner or three equal lifts of clay liner material for the final cover. The total thickness of the test pad will be at least 2 ft for the bottom liner or at least 18 inches for the final cover.

The procedures for construction of each of the compacted lifts vary to allow for determination of relationships between the compacted fill such as density, moisture content and permeability. The procedures are outlined below.

1. First Lift:
    a. Place the clay liner material in a uniform, loose lift of approximately 9 inches in thickness.
    b. Adjust the moisture of the clay material such that the moisture content is in the range of 0 to 6% above OMC. One half of test pad will have moisture content ranging between 0 to 3% above OMC, and the other half will have a moisture content ranging between 3 to 6% above OMC.
    c. Blend material through the use of a disc tractor, or similar equipment, to distribute water evenly.
    d. Compact the lift with two 1-way passes using compaction equipment to be used in construction of landfill clay liner.
    e. Allow the CQA Monitor to perform in situ density tests using a nuclear densometer as outlined below.
    f. Repair density testing holes.
    g. Recompact lift (second sequence) with two additional 1-way passes of same compaction equipment.
    h. Repeat testing and repair as outlined above at locations adjacent to the first set of tests.
    i. Recompact lift (third sequence) with two additional 1-way passes of same compaction equipment.
    j. Repeat the testing and repair as outlined above at locations adjacent to the first two sets of tests.
    k. Continue the sequence of compaction, testing, and repair until the specified criteria for compaction and permeability are attained.
    l. Collect permeability samples as outlined below.

2. Subsequent Lifts:
    a. Place the clay liner material in uniform, loose lifts of approximately 9 inches in thickness;
    b. The Earthwork Contractor will ensure that a good bond exists between the lifts, and the CQA Monitor will verify that the lifts are intermixed;
    c. Adjust the moisture of the clay material as necessary; and
    d. Compact, test, and repair the test holes similar to the first lift until the specified compaction and permeability of the clay liner are attained.

The test pad will be tested as follows:

1. For the first lift, the CQA Monitor will:
    a. Estimate the thickness of the loose lift;
    b. Count and record the numbers of compaction equipment passes and monitor the coverage of the test fill area;
    c. After every two passes, perform a minimum of four (two on each side of the pad) in situ moisture and density tests using a nuclear densometer;
    d. Compute the degree of compaction and moisture content; and
    e. Repair the testing holes.
2. For subsequent lifts, the CQA Monitor will:
    a. Verify that the thickness of the loose lift does not exceed the loose thickness determined from the testing of the first lift;
    b. Count the number of compaction equipment passes, determined from testing of the first lift, which are necessary to achieve the specified density, and monitor coverage of the test fill area; and
    c. Perform a minimum of four nuclear density tests per two passes of compaction equipment per lift until the specified density and moisture are met.

3. For the entire test fill, the CQA Monitor will:
    a. Collect a total of eight undisturbed Shelby tube samples (two per lift). Samples will be tested in laboratory for:
        i. Hydraulic conductivity,
        ii. Dry density,
        iii. Grain size distribution,
        iv. Atterberg limits, and
        v. Moisture content.

5.7 Defects and Repairs

5.7.1 Identification

If a defect is identified in the compacted clay liner, the CQA Monitor will determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Project Manager deems appropriate. If the compacted clay liner has been subject to adverse weather conditions during construction, the CQA Monitor will re-examine the layer for possible damage in overly wet, desiccated or windblown areas.

5.7.2 Notification

After determining the extent and nature of the defect, the CQA Monitor will promptly notify the Earthwork Contractor and the CCSWDA PM.

5.7.3 Repairs and Retesting

The Earthwork Contractor will correct all deficiencies to meet the project specifications. If project specification criteria cannot be met, or unusual weather conditions hinder work, the CQA Consultant will develop and present to the CCSWDA PM suggested solutions for his/her approval.

The CQA Monitor will schedule appropriate retests when the work defect has been corrected. All retests by the CQA Monitor must verify that the defect has been corrected before additional work is performed by the Earthwork Contractor in the area of the deficiency.

The CQA Monitor will observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

5.8 Record Drawings

The CQA Consultant shall arrange to have the subgrade and the completed compacted clay liner surface surveyed. The survey shall be conducted in accordance with Section 2 of this CQA Plan. A 100-ft grid shall be used for both surveys.

6. LEACHATE COLLECTION SYSTEM

6.1 Description and Applicability

The leachate collection system for each disposal cell consists of a geocomposite drainage blanket, leachate drainage layer, a leachate collection piping and trench, and a leachate collection sump. The geocomposite drainage blanket is placed above the geomembrane liner and beneath the leachate drainage layer and enhances the drainage of leachate to the collection trench and sump. The leachate drainage materials consist of highly permeable materials used for the leachate drainage layer. The materials shall consist of uniform fine to coarse aggregate as identified in the project specifications. The leachate collection trench consists of a perforated six-inch diameter HDPE pipe surrounded by washed gravel and wrapped with a non-woven geotextile filter fabric. The leachate collection sump consists of a washed coarse gravel wrapped with a non-woven geotextile filter fabric.

This section of the plan provides information on the leachate drainage material, the leachate collection trench gravel, and the leachate collection sump gravel. Information on the geotextile and the geocomposite materials is included in Sections 11 and 12 of this document.

6.2 Quality Control Documentation

Prior to the installation of the leachate drainage layer, leachate collection trench gravel, and the leachate collection sump gravel, source evaluation tests shall be performed to confirm the adequacy of the materials procured from each on or offsite source area. All material evaluation tests are to be performed in a geotechnical laboratory, which may be the Soil CQA Laboratory or another laboratory approved by the CCSWDA PM. The material shall be accepted or rejected by the CCSWDA PM according to the results of the analyses. At a minimum, the leachate drainage material, the leachate collection trench gravel, and the leachate collection sump gravel shall be tested as listed in Tables 3, 4 and 5, respectively.

Table 3. Testing requirements for leachate drainage material.

Test	ASTM Method[1]	Passing Criteria[2]
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 6913	Minimum of 75% passing ¾-inch sieve and less than 5% passing the No. 200 sieve
USCS Classification	D 2487	SW, SP, GW, or GP
Permeability	D 2434	Minimum of 1 x 10^{-3} cm/sec
Calcium Carbonate Content	D 3042	Maximum 15%
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 6913	Minimum of 75% passing ¾-inch sieve and less than 5% passing the No. 200 sieve
USCS Classification	D 2487	SW, SP, GW, or GP
Permeability	D 2434	Minimum of 1 x 10^{-3} cm/sec
Calcium Carbonate Content	D 3042	Maximum 15%

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

Table 4. Testing requirements for leachate collection trench gravel.

Test	ASTM Method[1]	Passing Criteria[2]
Pre-Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum of 70% passing 1-inch sieve and less than 5% passing the No. 200 sieve
USCS Classification	D 2487	GW or GP
Aggregate Classification	D 448	Size Number 57 standard gradation
Calcium Carbonate Content	D 3042	Maximum 15%

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

Table 5. Testing requirements for leachate collection sump gravel.

Test	ASTM Method[1]	Passing Criteria[2]
Pre-Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	2-½ inch to 1-inch size stone with less than 5% passing the No. 200 sieve
USCS Classification	D 2487	GW or GP
Aggregate Classification	D 448	Size Number 23 standard gradation
Calcium Carbonate Content	D 3042	Maximum 15%

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

Unless otherwise specified in the project specifications, one series of these tests shall be performed per source, or upon visually observable changes in the material type. If identification or additional drainage material sources becomes necessary during construction, the same material qualification and consistency checking procedures shall be applied to each such source.

6.3 Conformance Testing

Conformance testing of the leachate collection system materials shall be performed to ensure the consistency of the material properties obtained from the borrow source. Tables 3, 4, and 5 list the frequency and requirements of the granular materials to be used for the leachate collection system. The frequency of the testing of the materials may be increased by the CCSWDA PM.

The CQA Project Manager shall examine all test results and report any nonconformance to the CCSWDA PM. The CCSWDA PM shall accept or reject the material based on this review and the requirements of the project specifications prior to construction.

6.4 Construction Observation

The CQA Monitor shall observe the procedures used by the Earthwork Contractor during placement of the leachate collection system materials, and to ensure that the materials and thickness of the leachate drainage layer meet the project specifications. An Arkansas-licensed

land surveyor will verify the thickness of the drainage layer following completion of placement of the material.

6.5 Defects and Repairs

6.5.1 Identification

If a defect is identified in the installation of the leachate collection system, the CQA Monitor shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Project Manager deems appropriate.

6.5.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Earthwork Contractor and the CCSWDA PM. If necessary, a work deficiency meeting shall be held as required between the Earthwork Contractor, CQA Project Manager, CCSWDA PM, and other appropriate parties to assess the problem, review alternative solutions, and implement an action plan.

6.5.3 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to meet the project specifications. If project specification criteria cannot be met, or unusual weather conditions hinder work, the CQA Project Manager shall develop and suggest solutions to the CCSWDA PM for his approval.

The CQA Monitor shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Monitor shall verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

6.6 Record Drawings

The CQA Consultant shall arrange to have the completed leachate drainage layer surface surveyed. The survey shall be conducted in accordance with Section 2 of this CQA Plan. A 100-ft grid shall be used for the survey.

7. PROTECTIVE COVER LAYER

7.1 Description and Applicability

Protective cover material generally consists of general fill soils that will be placed over the geomembrane liner on the side slopes of the bottom liner system and under the geosynthetic clay liner (GCL) when used as a replacement for compacted clay as the barrier layer as part of the final cover system.

The material for the protective cover layer shall be obtained from onsite stockpiles, excavated soil within the landfill area, or a combination of these. The material shall be free of all deleterious materials such as roots, large stones, debris, stumps and other foreign material.

7.2 Quality Control Documentation

When the protective cover soil is used in a final cover system application, required tests shall be performed to determine conformance with the project specifications. Protective cover soils for the bottom liner system do not have to be tested. If the protective cover soil material is similar to the clay cap material, then the pre-construction testing performed on the liner soil may be used for the protective cover material. Any material from offsite sources or from borrow areas not previously tested, must be tested at the frequencies listed in Table 6. Testing shall be performed by the Soil CQA Laboratory or other laboratory approved by the CCSWDA PM.

Table 6. Testing requirements for protective cover soil material used in final cover system.

Pre-Construction Testing			
Test	**ASTM Method[1]**	**Minimum Frequency of Testing[2]**	**Minimum Test Standards[2]**
Moisture Content	D 2216	1 test per source	No standard; used to determine moisture condition of source.
Standard Proctor	D 698	1 test per source	No standard; used to determine density/ moisture relationship with permeability.
Field Testing			
In-Place Field Density and Moisture	D 6938	1 test per 10,000 SF per lift.	90% maximum Standard Proctor dry density at ± 3% of OMC.

Notes:
(1) Latest version of testing methods shall be used.
(2) All minimum standards and frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.

7.3 Construction Observation

7.3.1 Bottom Liner System Applications

The protective cover layer shall be placed over the completed and certified geomembrane liner and spread to the specified thickness. The protective cover layer shall be prepared as outlined in the project specifications. Special care shall be taken not to damage the underlying geosynthetic materials during the installation of the soil material.

The CQA Consultant shall report any nonconformance to the CCSWDA PM.

7.3.2 Alternative Final Cover System Applications

The CQA Project Manager shall verify that the requirements of the project specifications are met. The CQA Monitor shall observe and document the installation of the protective cover layer material for conformance with the Construction Documents, including:

1. Preparation of the subgrade surface (top of interim cover).
2. Placement of protective cover layer soil material and thickness of lift.
3. Compaction and moisture conditioning activities.

7.4 Construction Testing for Final Cover System Applications

All CQA testing will be conducted in accordance with the project specifications, or as directed by the CCSWDA PM. All field and laboratory tests will be conducted on samples taken from the protective cover layer soil materials during the course of the construction work. Testing and sampling procedures will be observed and documented by the CQA Monitor. Documentation and reporting of test results will be in accordance with the requirements identified in this Plan.

7.4.1 Field Testing

Table 6 lists the required field tests for the construction of the protective cover layer material.

Nuclear density tests (ASTM D 6938) will be used for density and moisture testing. The locations of routine in-place density tests will be determined using a non-biased sampling plan based on random selection of testing locations. Questions concerning the accuracy of any single test will be addressed by retesting in the same general location. In the event that the nuclear density device cannot acquire accurate data due to interference from the underlying waste materials, an alternative method for compaction testing (e.g., Sand Cone Method, ASTM D 1556 or proof-rolling) may be used, as approved by the CQA Project Manager and the CCSWDA PM.

Unless otherwise noted in the project specifications, or as directed by the CQA Project Manager, all perforations of the protective cover layer will be backfilled. Perforations that must be backfilled will include, but not limited to, the following:

- Nuclear density test probe (or sand cone test) locations, and
- Survey stake locations.

All perforations will be backfilled with bentonite, or a mixture of bentonite and clayey soil material as specified in the project specifications. Compaction will be performed with a tamping rod, or a hand tamper as specified in the project specifications. At a minimum, the CQA Monitor will perform observations and routine tests on the backfilled areas to ensure a proper seal.

7.5 Defects and Repairs

7.5.1 Identification

If a defect is identified in the protective cover layer, the CQA Monitor shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Project Manager deems appropriate. If the protective cover layer has been subject to adverse weather conditions during construction, the CQA Monitor shall re-examine the layer for possible damage in overly wet, desiccated or windblown areas.

7.5.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Earthwork Contractor and the CCSWDA PM. If necessary, a work deficiency meeting may be held as needed between the Earthwork Contractor, CQA Project Manager, CCSWDA PM and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

7.5.3 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to meet the project specifications. If project specification criteria cannot be met, or unusual weather conditions hinder work, the CQA Project Manager shall develop and present to the CCSWDA PM suggested solutions for his approval.

The CQA Monitor shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Monitor must verify that the defect has been corrected before the Earthwork Contractor performs additional work in the area of the deficiency.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

7.6 Record Drawings

The CQA Consultant shall arrange to have the completed protective cover layer surface surveyed. The survey shall be conducted in accordance with Section 2 of this CQA Plan. A 100-ft grid shall be used for the survey.

8. VEGETATIVE SOIL COVER

8.1 Description and Applicability

Vegetative soil cover material generally consists of soils capable of supporting vegetative growth. The material for the vegetative soil cover shall be obtained from onsite stockpiles or from excavated topsoil within the landfill area. The material shall be well-drained soil, free of all deleterious materials such as roots, large stones, debris, stumps, and other foreign material.

8.2 Quality Control Documentation

Prior to the construction of a vegetative layer, any tests required by the project specifications for the soil, the seed or the soil additives shall be conducted to verify that proposed sources meet the project specifications. The Soil CQA Laboratory or other laboratory approved by the CCSWDA PM shall perform the testing.

The Earthwork Contractor shall submit the results of these tests to the CCSWDA PM. The CCSWDA PM shall accept the material based on these test results.

8.3 Construction Observation

The vegetative cover layer shall be placed in 6-inch lifts and spread to the thickness specified in the project specifications. The vegetative cover layer shall be prepared and seeded as identified in the project specifications.

The CQA Consultant shall:

- Ensure that care is taken in the vicinity of protrusions to prevent physical damage by the construction equipment.
- Observe the quantity and the uniformity of any soil amendment incorporated within the tilled depth before seeding.

- Ensure that the seeding application equipment is appropriate for the job. The rate of seed and mulch application, amount and uniformity of coverage, and watering instructions as provided in the project specifications shall be closely observed.
- Examine the perimeter areas to ensure that no unseeded areas remain.

The CQA Consultant shall report any nonconformance to the CCSWDA PM.

8.4 Defects and Repairs

8.4.1 Identification

If a defect is identified in the vegetative soil layer, the CQA Monitor shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Project Manager deems appropriate. If the vegetative layer has been subject to adverse weather conditions during construction, the CQA Monitor shall re-examine the vegetative layer for possible damage in overly wet, desiccated or windblown areas.

8.4.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Earthwork Contractor and the CCSWDA PM. If necessary, a work deficiency meeting may be held as needed between the Earthwork Contractor, CQA Project Manager, CCSWDA PM and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

8.4.3 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to meet the project specifications. If project specification criteria cannot be met, or unusual weather conditions hinder work, the CQA Project Manager shall develop and present to the CCSWDA PM suggested solutions for his approval.

The CQA Monitor shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Monitor must verify that the defect has been corrected before the Earthwork Contractor performs additional work in the area of the deficiency.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

8.5 Record Drawings

The CQA Consultant shall arrange to have the completed vegetative soil cover surface surveyed. The survey shall be conducted in accordance with Section 2 of this CQA Plan. A 100-ft grid shall be used for the survey.

9. GEOMEMBRANE LINER

9.1 Definition and Applicability

The bottom liner and final cover systems for the Landfill include geomembrane liners. The bottom liner system includes a 60-mil high density polyethylene (HDPE) geomembrane liner and the final cover system includes a 40-mil linear low-density polyethylene (LLDPE) or HDPE geomembrane liner. This section provides general information on the geomembranes, but the specifics (materials and installation procedures) of geomembrane liners, if used, shall be specified in the project specifications.

9.2 Quality Control Documentation

Prior to the installation of any geomembrane, the Manufacturer or Geosynthetic Contractor shall provide the CQA Project Manager with the following information:

1. The origin and quality control certificates from the supplier of the resin used to manufacture the geomembrane, and certification that the properties of the resin meet the requirements for the project.
2. A specification for the geomembrane that includes all properties published by the Manufacturer measured using the appropriate test methods.
3. Written certification that the Manufacturer guarantees minimum values given in the specification.
4. Quality control certificates for the geomembrane, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. At a minimum, results shall be given for:
    - Density,
    - Carbon black content,
    - Carbon black dispersion,
    - Thickness, and
    - Tensile properties.

Unless otherwise specified in the project specifications, the quality control tests shall be performed in accordance with the test methods on every roll for thickness and tensile properties and every fifth roll for density, carbon black content, and carbon black dispersion.

The Manufacturer shall identify all rolls of geomembrane with the following:

1. Manufacturer's name,
2. Product identification,
3. Lot number,
4. Material thickness,
5. Roll number,
6. Roll dimensions, and
7. Roll weight.

The CQA Project Manager shall review these documents and shall report any discrepancies with the above requirements to the CCSWDA PM. The CQA Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum roll properties meet the project specifications.
6. Project specifications and the CQA Plan were submitted by the CCSWDA PM to the Geosynthetic Contractor.

9.3 Conformance Testing

9.3.1 Sampling Procedures

If possible, the CQA Project Manager shall arrange to have conformance test samples sent from the Manufacturer to the Geosynthetic CQA Laboratory prior to shipment of the materials to the project site. Otherwise, upon delivery of the rolls of geomembrane, the CQA Monitor shall ensure that conformance test samples are obtained.

Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 3 ft long by the roll width. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, the CQA Monitor may designate a lot based upon a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of one per lot or one per 100,000 sf of geomembrane, whichever is greater. These samples shall then be forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance with the project specifications.

9.3.2 Conformance Tests

At a minimum, the following tests shall be performed:

1. Density,
2. Carbon black content,
3. Carbon black dispersion,
4. Thickness,
5. Tensile properties, and
6. Tear resistance.

The geomembrane materials shall meet the minimum requirements listed in Tables 7 (HDPE) and 8 (LLDPE) below. Other conformance tests may be required by the project specifications.

Table 7. Conformance testing requirements for HDPE geomembrane liner material.

Property	Units	Frequency[1]	ASTM Method[2]	Minimum Average Roll Value	
				60-mil Smooth	60-mil Textured
Thickness	mils	100,000 sf	D 5199 (Smooth) D 5994 (Textured)	60 (3)	60 (4)
Resin Density	g/cm^3	100,000 sf	D 792 or D 1505	0.94 (material) 0.932 (resin)	0.94(material) 0.932 (resin)
Carbon Black Content	%	100,000 sf	D 1603 or D 4218	2.0-3.0	2.0-3.0
Tensile Strength at Yield	lbs/in	100,000 sf	D 6693	126	126
Tensile Strength at Break	lbs/in	100,000 sf	D 6693	228	90
Elongation at Yield	%	100,000 sf	D 6693	12	12
Elongation at Break	%	100,000 sf	D 6693	700	100
Tear Resistance	lbs	100,000 sf	D 1004	42	42
Carbon Black Dispersion	Category	100,000 sf	D 5596	1 or 2	1 or 2

Note:
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.
(3) Lowest individual of 10 tests greater or equal to 54 mils.
(4) Lowest individual for 8 of 10 tests: -10%; and, lowest individual of all tests: -15%.

Table 8. Conformance testing requirements for LLDPE geomembrane liner material.

Property	Units	Frequency[1]	ASTM Method[2]	Minimum Average Roll Value	
				40-mil Textured	60-mil Textured
Thickness	mils	100,000 sf	D 5994	40 (3)	60 (4)
Resin Density	g/cm^3	100,000 sf	D 792 or D 1505	0.94 (material) 0.932 (resin)	0.94(material) 0.932 (resin)
Carbon Black Content	%	100,000 sf	D 1603 or D 4218	2.0-3.0	2.0-3.0
Tensile Strength at Break	lbs/in	100,000 sf	D 6693	60	90
Elongation at Break	%	100,000 sf	D 6693	250	250
Tear Resistance	lbs	100,000 sf	D 1004	22	33
Carbon Black Dispersion	Category	100,000 sf	D 5596	1 or 2	1 or 2

Note:
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.
(3) Lowest individual of 10 tests greater or equal to 36 mils for 40-mil and 54 mils for 60-mil material.
(4) Lowest individual for 8 of 10 tests: -10%; and, lowest individual of all tests: -15%.

9.3.3 Test Results

All conformance tests shall be reviewed and accepted or rejected by the CQA Project Manager prior to the deployment of the geomembrane. The CQA Project Manager shall examine all results from laboratory conformance testing and shall report any nonconformance to the CCSWDA PM. The CQA Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that the failing tests may be the result of the Geosynthetic CQA Laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic CQA Laboratory. Alternatively, the Manufacturer may have the sample retested at two different Owner-approved Geosynthetic CQA Laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic CQA Laboratory's results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CCSWDA PM.

9.4 Geomembrane Installation

During shipment and storage, the geomembrane shall be protected from mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geomembrane rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

The CQA Monitor shall observe the rolls upon delivery at the site. Any apparently damaged or improperly wrapped rolls shall be reported to the CCSWDA PM. The Geosynthetic Contractor shall ensure that geomembrane rolls are not damaged during handling. The CQA Monitor shall note any noncompliance and report it to the CCSWDA PM.

9.4.1 Subgrade Preparation

The subgrade for the installation of the geomembrane shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane. The Geosynthetic Contractor and the CQA Monitor shall walk over the surface to be covered with geomembrane on each day's operations prior to placement of geomembrane. The Geosynthetic Contractor shall provide to the CQA Monitor written acceptance daily for the surface to be covered by geomembrane in that day's operations. The surface shall be maintained as acceptable during geomembrane installation.

Subgrade damaged by construction equipment during the geomembrane deployment operation shall be repaired prior to placement of the geomembrane. The CQA Monitor shall approve repairs. Subgrade damaged by erosion, rutting, or other means following geomembrane deployment shall be exposed and the damage repaired.

9.4.2 Geomembrane Placement

9.4.2.1 Panel Nomenclature

A field panel is defined as unit of geomembrane that is to be seamed in the field. A field panel is a roll or a portion of a roll cut in the field. The CQA Monitor shall be responsible to ensure that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as

possible and shall be agreed upon by the CCSWDA PM, Geosynthetic Contractor, and CQA Project Manager.

The CQA Monitor shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

9.4.2.2 Deployment Weather Conditions

Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment. Geomembrane shall be deployed during normal ambient temperature between 32°F and 104°F. Geomembrane shall not be deployed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

The CQA Consultant shall inform the CCSWDA PM of any weather-related problems that may not allow geomembrane placement to proceed. The CCSWDA PM will determine if the installation is to be stopped or special procedures are to be used.

The CQA Project Manager may allow cold weather seaming as explained in Section 9.4.3.6 of this CQA Plan.

9.4.2.3 Method of Deployment

The CQA Monitor shall verify the following:

1. Equipment used does not damage the geomembrane or underlying subgrade by handling.
2. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.
3. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.
4. Personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities that could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting roll.
6. The method used to place the panels minimizes wrinkles especially differential wrinkles between adjacent panels.
7. Adequate temporary lading and/or anchoring (such as sand bags or tires), not likely to damage the geomembrane, are placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.
8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where repeated traffic use may be expected.
9. Liner has been promptly anchored in trench, where applicable.

The CQA Project Manager shall notify the CCSWDA PM if the above conditions are not fulfilled.

9.4.2.4 Damage and Defects

The CQA Monitor shall examine each panel, after placement and prior to seaming, for damage and/or defects. The CQA Project Manager shall advise the CCSWDA PM which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the CQA Project Manager. Repairs shall be made using procedures described in Section 9.4.6.

9.4.2.5 Writing on the Geomembrane Liner

To avoid confusion, the Geosynthetic Contractor and the CQA Consultant shall each use different colored markers (e.g., Geosynthetic Contractor uses white and CQA Consultant uses yellow) or other materials approved by the CCSWDA PM that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane.

9.4.3 Geomembrane Seaming

9.4.3.1 Seam Layout

Before installation begins, the Geosynthetic Contractor shall provide the CQA Consultant with a panel layout drawing. The drawing shall present all the proposed seams of the lining system at the facility. The CQA Consultant shall review the panel layout drawing and verify that it is consistent with accepted industry standards.

In general, seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft from the toe or crest of the slope, or from areas of potential stress concentrations, unless otherwise authorized by the CCSWDA PM.

The CQA Consultant shall use a seam numbering system compatible with the panel numbering system.

9.4.3.2 Seaming Equipment

Acceptable methods for seaming geomembrane liner include fusion (hot wedge) and extrusion welding. Proposed alternate processes shall be submitted to the CQA Project Manager and may be used only with the approval of the CCSWDA PM. Only seaming equipment that has been approved by make and model shall be used for the project.

The CQA Monitor shall log ambient, seaming apparatus and geomembrane surface temperatures at appropriate intervals and report any noncompliance to the CCSWDA PM. In addition, the CQA Monitor shall verify that:

1. The Geosynthetic Contractor maintains an onsite spare operable seaming apparatus.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. The electrical generator is placed on a smooth base such that no damage occurs to the geomembrane and any fuel spills are promptly cleaned up. Fuel shall not be stored on the liner surface.
4. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

5. A movable protective layer is used as required by the Geosynthetic Contractor directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.
6. In general, the geomembrane panels shall be aligned to have an overlap of 4 to 6 inches for fusion welding and 3 inches for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
7. Prior to beginning a seam, the extruder seaming machine is purged until all heat-degraded extrudate has been removed from the barrel.
8. Clean and dry welding rods or extrudate pellets are used.
9. Grinding is completed no more than 1 hour prior to seaming.
10. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instances shall exposed grinding marks extend more than ¼ inch from the finished seamed area.
11. No solvent or adhesive is used.
12. The geomembrane is protected from damage in heavy traffic areas.

9.4.3.3 Seam Preparation

The CQA Consultant shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the CQA Consultant must ensure that the process is completed according to the Manufacturer's instructions within 1 hour of the seaming operation, and in a way that does not damage the geomembrane. The CQA Consultant shall also verify that seams are aligned with the fewest number of wrinkles and "fishmouths."

9.4.3.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once every 5 hours, for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams.

The trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with the seam centered lengthwise. Two specimens shall be cut from the sample with 1-inch wide die. The specimens shall be cut by the Geosynthetic Contractor at locations selected randomly along the trial seam sample by the CQA Monitor.

The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. They should not fail in the seam as described in Section 9.4.5.3. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The CQA Monitor shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be retained until project completion in the CQA Consultant's archives for possible laboratory testing. Each sample shall be assigned a number and marked accordingly by the CQA Monitor, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

If agreed upon by the CCSWDA PM and the CQA Project Manager, and documented by the CQA Monitor in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing as indicated in Section 9.4.5.4. If a trial seam sample fails a test conducted by the Geosynthetic CQA Laboratory, then a destructive seam test sample shall be taken from each of the seams completed by the seamer during the shift related to the subject trial seam. These samples shall be forwarded to the Geosynthetic CQA Laboratory and, if they fail the tests, the procedure indicated in Section 9.4.5.5 shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

9.4.3.5 General Seaming Procedures

During general seaming, the CQA Monitor shall ensure the following:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.
2. If seaming operations are carried out at night, adequate illumination shall be provided.
3. Seaming shall extend to the outside edge of panels placed in the anchor trench.
4. All cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.
5. For fusion welding, a moveable protective layer of geomembrane may be required underneath overlapping sheets prior to seaming to prevent moisture buildup between sheets and debris from entering seam.

The CQA Monitor shall verify that the above seaming procedures or any other procedures agreed upon are followed, and shall inform the CCSWDA PM of any nonconformance.

9.4.3.6 Cold Weather Conditions

The CQA Project Manager may allow cold weather (below 32°F) seaming if the following conditions are met:

1. Geomembrane surface temperatures shall be determined by the CQA Monitor at intervals of at least once per 100 ft of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F.
2. For fusion welding, preheating may be waived by the CQA Project Manager, if the Geosynthetic Contractor demonstrates to his/her satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the CQA Monitor shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.
4. Care shall be taken to confirm that wind chill does not adversely affect the preheating requirements specified for welding. It may be necessary to provide wind protection for the seam area.
5. The CQA Project Manager shall approve all preheating devices prior to use.
6. Sheet grinding may be performed before preheating, if applicable.
7. Trial seaming, as described in Section 9.4.3.4, shall be conducted under the same ambient temperature conditions as the production seams. At the option of the CQA Consultant, additional destructive tests may be required for any suspect areas.

9.4.4 Nondestructive Seam Testing

The Geosynthetic Contractor shall nondestructively test all field seams over their full length using an air pressure test (for double fusion seams only), a vacuum test, or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. For all seams, the CQA Monitor shall:

- Observe nondestructive testing procedures;
- Record location, data, test unit number, name of tester, and outcome of all testing; and
- Inform the Geosynthetic Contractor and CCSWDA PM of any required repairs.

9.4.4.1 Air Pressure Testing

Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space. The equipment for air pressure testing shall consist of the following:

- An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure of at least 30 psi and mounted on a cushion to protect the geomembrane.
- A rubber hose with fittings and connections.
- A sharp hollow needle, or other approved pressure feed device.

The following procedures shall be followed:

1. Seal both ends of the seam to be tested.
2. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
3. Insert a protective cushion between the air pump and the geomembrane.
4. Pressurize the air channel to a pressure of approximately 30 psi. Close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
5. If loss of pressure exceeds the maximum permissible pressure differential as outlined in the project specifications or does not stabilize, locate faulty area and repair in accordance with Section 9.4.6.3.
6. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seam the cut end of the air channel.
7. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

9.4.4.2 Vacuum Testing

Vacuum testing is applicable to extrusion welding and to non-seam areas of the liner. The equipment shall consist of the following:

1. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
2. A pump assembly equipped with a pressure controller and pipe connections.
3. A rubber pressure/vacuum hose with fittings and connections.

4. A soapy solution (CQA Monitor shall ensure solution makes bubbles when air is passed through. Windshield washer fluid shall be used as anti-freeze in cold weather).
5. A bucket and wide paint brush, or other means of applying the soapy solution.

The following procedures shall be followed:

1. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
2. Place the box over the wetted area.
3. Close the bleed valve and open the vacuum valve.
4. Ensure that a leak-tight seal is created.
5. Energize the vacuum/venturi pump and reduce the applied pressure to approximately 5 psi (10 inches of Hg) gauge.
6. For a minimum of 10 seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.
7. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.
8. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 9.4.6.3.

9.4.4.3 Test Failure Procedures

The Geosynthetic Contractor shall complete any required repairs in accordance with Section 9.4.6.3. For repairs, the CQA Monitor shall:

- Observe the repair and testing of the repair.
- Mark on the geomembrane that the repair has been made.
- Document the repair procedures and test results.

9.4.5 Destructive Seam Testing

The purpose of destructive tests is to evaluate seam strength. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

Destructive testing involves analyzing the strength of the seam two ways: shear and peel (ply adhesion). Shear testing applies a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing involves pulling the top sheet back against the overlapped edge of the bottom of the sheet in order to observe how separation occurs. The peel test determines if the sheets are continuously and homogeneously connected through the seam.

9.4.5.1 Location and Frequency

The CQA Consultant shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

- A minimum frequency of one test location per 500 ft of production seam length performed. This frequency is to be determined as an average taken throughout the entire facility.
- Test locations shall be determined during seaming at the CQA Monitor's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, offset welds exists.
- The Geosynthetic Contractor shall not be informed in advance of the locations where the seam samples will be taken.

9.4.5.2 Sampling Procedures

The Geosynthetic Contractor shall cut samples at locations chosen by the CQA Monitor as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The CQA Monitor shall:

- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly;
- Record sample location on layout drawing; and

- Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 9.4.6.3 immediately following receipt of successful test results. The continuity of the new seams in the repaired area shall be tested according to Section 9.4.4.2.

At each sampling location, the Geosynthetic Contractor shall take two types of samples. First, two specimens for field testing should be taken. Each of these samples shall be cut to a size 1 inch wide by 12 inches long, with the seam centered parallel to the width. The distance between these two samples shall be 30 inches. If both samples pass the field test described in Section 9.4.5.3, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches wide by 30 inches long with the seam centered lengthwise. The sample shall be cut into two parts and distributed as follows:

1. One 12-inch wide by 18-inch long portion for conformance testing by the Geosynthetic CQA Laboratory.
2. One 12-inch wide by 12-inch long portion to the CQA Consultant for archive storage.

Final determination of the sample sizes shall be made at the pre-construction meeting.

9.4.5.3 Field Testing

The two 1-inch wide specimens mentioned in Section 9.4.3.4 and Section 9.4.5.2 shall be tested in the field using a tensiometer for shear and peel adhesion and shall not fail according to the criteria in the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it is non-conforming, the seam should be repaired in accordance with Section 9.4.6.

The CQA Monitor shall witness all field tests and mark all samples and portions with their number. The CQA Monitor shall also log the date and time, ambient temperature, number

of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

9.4.5.4 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Consultant, in a manner that will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The CQA Consultant will be responsible for storing the archive samples. The Geosynthetic CQA Laboratory shall test the samples.

Testing shall include seam strength and peel adhesion (ASTM D 4437 or D 6392). Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values as outlined in the project specifications in at least four of the five specimens tested for each method. Seam testing shall conform to the requirements listed in Tables 9 (HDPE) and 10 (LLDPE) below.

Table 9. Seam testing requirements for HDPE geomembrane liner material.

Seam Property	Units	Frequency[1]	ASTM Method[2]	60-mil Smooth	60-mil Textured
Shear Strength	psi	500 lf of completed seam	D 4437 or D 6392	120	120
Peel Strength - Wedge Weld (Fusion)	psi	500 lf of completed seam	D 4437 or D 6392	90 and FTB	90 and FTB
Peel Strength - Fillet Weld (Extrusion)	psi	500 lf of completed seam	D 4437 or D 6392	78 and FTB	78 and FTB

Note:
FTB = Film tear bond.
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.

Table 10. Seam testing requirements for LLDPE geomembrane liner material.

Seam Property	Units	Frequency[1]	ASTM Method[2]	40-mil Textured	60-mil Textured
Shear Strength	psi	500 lf of completed seam	D 4437 or D 6392	60	90
Peel Strength - Wedge Weld (Fusion)	psi	500 lf of completed seam	D 4437 or D 6392	50 and FTB[3]	75 and FTB[3]
Peel Strength - Fillet Weld (Extrusion)	psi	500 lf of completed seam	D 4437 or D 6392	44 and FTB[3]	66 and FTB[3]

Note:
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.
(3) FTB = Film tear bond.

The Geosynthetic CQA Laboratory shall provide test results within 24 hours of receiving the samples. The CQA Project Manager shall review laboratory test results as soon as they become available and make appropriate recommendations to the CCSWDA PM.

9.4.5.5 Destructive Test Failure

When a sample fails a destructive test, whether that test is conducted by the Geosynthetic CQA Laboratory or by field tensiometer, the Geosynthetic Contractor has two options:

1. The Geosynthetic Contractor can repair the seam between any two passing destructive test locations.
2. The Geosynthetic Contractor can trace the welding path to an intermediate location 10 ft minimum from the point of the failed test in each direction and take a sample with a 1 inch wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 9.4.3.4 may be used as a boundary for the failing seam. In cases exceeding 150 ft of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 9.4.6.

The CQA Monitor shall document all actions taken in conjunction with destructive test failures.

9.4.6 Defects and Repairs

9.4.6.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Monitor for identification of defects, holes, blisters, undispersed raw materials, large wrinkles and any sign of contamination by foreign matter. The Geosynthetic Contractor shall clean the

geomembrane surface prior to examination if the CQA Monitor determines that the amount of dust or mud inhibits examination.

9.4.6.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 9.4.4. Each location that fails the nondestructive testing shall be marked by the CQA Monitor and repaired by the Geosynthetic Contractor. Work shall not proceed with any materials that will cover locations that have been repaired until successful nondestructive and/or laboratory tests are obtained.

When seaming of the geomembrane is completed, and prior to placing overlying materials, the CQA Monitor shall indicate to the CCSWDA PM any large wrinkles that should be cut and reseamed by the Geosynthetic Contractor. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself (i.e., generally a wrinkle that extends one inch from the subgrade). Seams produced while repairing wrinkles shall be nondestructively tested.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the CQA Monitor to ensure that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

9.4.6.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the CCSWDA PM, Geosynthetic Contractor, and CQA Project Manager.

The repair procedures available include:

1. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter;
2. Spot welding, used to repair pinholes, or other minor, localized flaws;
3. Capping, used to repair large lengths of failed seams;
4. Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge; and
5. Removing bad seam and replacing with a strip of new material welded into place.

For any repair method, the following provisions shall be satisfied:

1. Surfaces of the geomembrane, which are to be repaired using extrusion methods, shall be ground no more than one hour prior to the repair.
2. All surfaces shall be clean and dry at the time of repair.
3. All seaming equipment used in repairing procedures shall meet the requirements of the project specifications and this plan.
4. Patches or caps shall extend at least six inches beyond the edge of the defect and all corners of patches shall be rounded with a radius of approximately three inches.

9.4.6.4 Repair Verification

The CQA Monitor shall observe all nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in Section 9.4.4 as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 consecutive ft long require destructive test sampling. Failed tests require that the repair shall be redone and retested until passing test results are obtained.

9.4.7 Geomembrane Protection

The quality assurance procedures indicated in this section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality

assurance of the adjacent materials themselves is covered in separate sections of this plan and the project specifications.

9.4.7.1 Soils

A copy of the project specifications for placement of soils shall be made available for the CQA Consultant. The CQA Project Manager shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F nor above 104°F, unless otherwise specified;
2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane;
3. Equipment used for placing soil shall not be driven directly on the geomembrane; and
4. A minimum thickness of one ft of soil is specified between a light dozer, ground pressure of 5 psi or lighter, and the geomembrane.

In any areas traversed by construction traffic (any vehicles other than deployment equipment approved by the CCSWDA PM) the soil layer shall have a minimum thickness of three ft. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The CQA Consultant shall measure soil thickness and verify that the required thickness is present. The CQA Consultant must also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The CQA Engineer shall inform the CCSWDA PM if the above conditions are not fulfilled.

9.4.7.2 Sumps and Appurtenances

A copy of the plans and project specifications for sumps and appurtenances shall be given to the CQA Project Manager, and they shall review these plans and verify that:

1. Installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to project specifications;
2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas;
3. The geomembrane has not been visibly damaged while making connections to sumps and appurtenances; and
4. A representative of the CQA Consultant shall be present at all times when the Geosynthetic Contractor is welding geomembrane to appurtenance structures.

The CQA Consultant shall inform the CCSWDA PM in writing if the above conditions are not fulfilled.

9.4.7.3 Concrete

A copy of the project specifications for placement of concrete shall be given to the CQA Project Manager. The CQA Project Manager shall verify that these specifications are consistent with the state-of-practice, including the use of geosynthetic layers between concrete and geomembrane. The CQA Monitor shall verify that geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. The CQA Monitor will also verify that construction methods used are not likely to damage the geomembrane.

9.4.8 Liner Acceptance

The geomembrane liner will be accepted by the CQA Project Manager when:

1. The geomembrane is clean. Brooming and/or washing of the geomembrane surface shall be required if the amount of surface dust or mud inhibits inspection;
2. The entire installation is finished, or an agreed upon subsection of the installation is finished;
3. All documentation of installation is completed;

4. Verification of the adequacy of all field seams and repairs, and associated testing is complete; and
5. Daily field notes and sketches of the limits of each day's work are submitted to the CQA Monitor.

If the accepted area of geomembrane has not been covered within a reasonable time, as determined by the CQA Project Manager, then the CQA Consultant may re-inspect the area.

9.5 Record Drawings

The CQA Consultant shall arrange to have the completed geomembrane liner surveyed. The survey shall be conducted in accordance with Section 2 of this plan and shall include the location of anchor trenches, limits of geomembrane liner, destructive tests, and other information that the CQA Project Manager deems appropriate.

10. GEOSYNTHETIC CLAY LINER

10.1 Definition and Applicability

A geosynthetic clay liner (GCL) is a relatively thin layer of processed clay (typically bentonite) either bonded to a geomembrane or fixed between two sheets of geotextile. The bentonite is affixed to the synthetic materials in a number of ways to form the GCL system. With geomembranes, the clay is affixed using an adhesive. In geotextile configurations, adhesives, stitch bonding, needle punching, or a combination of these are used. This section of the CQA Plan refers to GCLs manufactured with two sheets of geotextile. Specific product information is included in the project specifications.

10.2 Quality Control Documentation

Prior to the installation on any GCL, the GCL Manufacturer or Geosynthetic Contractor shall provide the CQA Consultant with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the geotextile and bentonite used to fabricate the GCL.
2. A specification for the GCL that includes all properties published by the Manufacturer measured using the appropriate test methods.
3. Written certification that the Manufacturer guarantees minimum values given in the specification.
4. Quality control (QC) certificates for the GCL, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. Sampling and testing frequency shall conform to ASTM D 5889 and at a minimum, results shall be given for:
    a. Geotextile manufacturing QC tests:
        i. Fabric weight,
        ii. Grab tensile strength and grab tensile elongation,
        iii. Puncture resistance,

iv. Apparent opening size, and

v. Trapezoid tear strength.

Frequency: Minimum of one test per 100,000 sf and minimum of one test per lot.

b. Bentonite manufacturing QC tests:

i. Free swell,

ii. Fluid loss, and

iii. Bentonite content.

Frequency: Minimum of one test per 50,000 tons or minimum of one test per lot.

c. GCL manufacturing QC tests:

i. Mass per unit area - every 40,000 sf,

ii. Tensile and peel strength - every 40,000 sf,

iii. Index flux – weekly, and

iv. Permeability – weekly.

The Manufacturer shall identify all rolls of GCL with the following:

1. Manufacturer's name,
2. Product identification,
3. Lot number,
4. Roll number, and
5. Roll dimensions.

The CQA Project Manager shall review these documents and shall report any discrepancies with the above requirements to the CCSWDA PM. The CQA Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications;
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable;

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it;
4. Roll packages are appropriately labeled;
5. Certified minimum roll properties meet the project specifications; and
6. Project specifications and the CQA Plan were submitted to the Geosynthetic Contractor.

10.3 Conformance Testing

10.3.1 Sampling Procedures

If possible, the CQA Consultant shall arrange to have conformance test samples sent from the Manufacturer to the Geosynthetic CQA Laboratory prior to shipment of the materials. Otherwise, upon delivery of the rolls of GCL, the CQA Monitor shall ensure that conformance test samples are obtained.

Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 3 ft long by the roll width. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, the CQA Monitor may designate a lot based upon a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of not less than one per 100,000 sf of GCL. These samples shall then be forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance with the project specifications.

10.3.2 Conformance Tests

At a minimum, the following tests shall be performed:

1. Bentonite content,
2. Bentonite swell index,

3. Grab strength,
4. Peel strength,
5. Internal shear strength, and
6. Permeability.

The GCL material shall meet the requirements presented in Table 11. Other conformance tests may be required by the project specifications.

Table 11. Conformance testing requirements for GCL material.

Property	Units	Frequency[1]	ASTM Method[2]	Minimum Required Value
Bentonite Swell Index	mL/2g	100,000 sf	D 5890	24
Bentonite Fluid Loss	mL	100,000 sf	D 5891	18
Bentonite Mass/Area	lb/ft^2	100,000 sf	D 5993	0.75
GCL Tensile Strength	ppi	100,000 sf	D 6768	50
GCL Peel Strength	ppi	100,000 sf	D 6496	3.5
GCL Index Flux	$m^3/m^2/sec$	100,000 sf	D 5887	1×10^{-8}
GCL Hydraulic Conductivity	cm/sec	100,000 sf	D 5887	5×10^{-9}
GCL Hydrated Internal Shear Strength	psf	100,000 sf	D 6243	500

Note:
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.

10.3.3 Test Results

All conformance tests shall be reviewed and accepted or rejected by the CQA Project Manager prior to the deployment of the GCL. The CQA Project Manager shall examine all results from laboratory conformance testing and shall report any nonconformance to the CCSWDA PM. The CQA Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that the failing tests may be the result of the Geosynthetic CQA Laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic CQA Laboratory. Alternatively, the Manufacturer may have the sample retested at two different Owner-approved Geosynthetic CQA Laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic CQA Laboratory's results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CCSWDA PM.

10.4 GCL Installation

10.4.1 Handling

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. GCL rolls shall be shipped and stored in relatively watertight wrappings, which shall not be removed until shortly before deployment.

The CQA Monitor shall observe rolls upon delivery at the site. Any apparently damaged or improperly wrapped rolls shall be reported to the CCSWDA PM. The Geosynthetic Contractor shall ensure that the GCL rolls are not damaged during handling.

10.4.2 Surface Preparation

Surfaces to receive GCL shall be smooth and free of litter, sharp protrusions, and large stones. The Geosynthetic Contractor shall provide a subgrade acceptance form to the CQA Monitor for each area that GCL is placed. The Geosynthetic Contractor Supervisor and the CQA Monitor shall sign the forms.

10.4.3 Deployment

Unless otherwise specified in the Project Specifications, the GCL shall be installed as follows:

1. GCL rolls should be taken to the working area in their original packaging. Care should be taken when cutting the packaging as to not damage the GCL.

2. GCL rolls should be placed such that the side with the printed product name faces up.
3. Equipment that could damage the GCL shall not be allowed to travel directly on it. Lightweight vehicular traffic may be allowed on the GCL with prior approval from the CQA Project Manager.
4. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.
5. Care must be taken to minimize the extent that the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL.
6. The GCL shall be placed such that seams are parallel to the direction of the slope. Seams shall be extended at least 3 ft beyond the toe of the slope.
7. All GCL panels should lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.
8. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, geomembrane, or a temporary waterproof cover. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The CQA Project Manager, CQA Monitor, or GCL supplier should be consulted for specific guidance if premature hydration occurs.
9. Place GCL in anchor trenches as shown on the project drawings.

10.4.4 GCL Seaming

Unless otherwise specified in the Project Specifications, the GCL panels shall be seamed in the following manner:

- Longitudinal GCL panels shall have an overlap of 6 inches. End-to-end panels shall have an overlap of 24 inches.
- Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.
- Seams at the ends of panels shall be constructed such that they are “shingled” in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

- Granular sodium bentonite shall be placed between GCL panels at all seams. The underlying edge of each panel shall be exposed and then a continuous bead of granular bentonite shall be applied along the edge of the panel within the overlap zone. The bentonite shall be applied at a minimum rate of 0.25 pound per linear foot.

10.5 Defects and Repairs

10.5.1 Identification

If a defect is identified in the GCL, the CQA Monitor shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, and a review of records, and other means that the CQA Project Manager deems appropriate.

10.5.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Geosynthetic Contractor and CCSWDA PM. The parties shall assess the problem, review alternative solutions, contact the CQA Project Manager and implement an action plan.

10.5.3 Repair Procedures

If the GCL is damaged (torn, punctured, or perforated) during installation, it shall be repaired prior to covering. GCL damages may be repaired by placing a GCL patch over the damaged area. The GCL patch shall be obtained from a new GCL roll and shall be cut such that a minimum overlap of 12 inches is achieved around all of the damaged area. Dry bentonite shall be placed around the damaged area prior to placement of the patch. The patch may be affixed with an adhesive to minimize displacement during cover placement.

10.6 Protection

The GCL shall be covered with materials as shown on the project drawings. Direct vehicular traffic with the GCL panels should be avoided. However, lightweight, low ground pressure vehicles may be used to facilitate the installation of the overlying materials. The CQA Project Manager should be consulted prior to use of any machinery over GCL.

10.7 Record Drawings

The CQA Consultant shall arrange to have the completed GCL surveyed. The survey shall be conducted in accordance with Section 2 of this Plan and shall include the location of anchor trenches, limits of GCL, and other information that the CQA Project Manager deems appropriate.

11. GEOTEXTILES

11.1 Definition and Applicability

Geotextiles are used in protection and filtering applications in lining systems and may be included as a filter above the leachate drainage layer for the Landfill. This section is applicable to nonwoven geotextiles made of polyester or polypropylene.

This section does not describe procedures for applications such as erosion control or reinforcement. In addition, it does not apply to nonwoven geotextiles made of other materials or woven geotextiles.

11.2 Quality Control Documentation

Prior to the installation on any geotextile, the Manufacturer or Geosynthetic Contractor shall provide the CQA Consultant with the following information:

- Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the project specifications.
- A specification for the geotextile that includes all properties published by the Manufacturer measured using the appropriate test methods.

The CQA Project Manager shall review these documents and shall report any discrepancies with the above requirements to the CCSWDA PM. The CQA Project Manager shall verify that:

- Property values certified by the Manufacturer meet all of its guaranteed specifications.
- Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

11.3 Conformance Testing

11.3.1 Sampling Procedures

If possible, the CQA Consultant shall arrange to have conformance test samples sent from the Manufacturer to the Geosynthetic CQA Laboratory prior to shipment of the materials. Otherwise, upon delivery of the rolls of geotextile, the CQA Monitor shall ensure that conformance test samples are obtained.

Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 3 ft long by the roll width.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of not less than one per 100,000 sf of geotextile. These samples shall then be forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance with the project specifications.

11.3.2 Conformance Tests

At a minimum, the following tests shall be performed:

- Mass per unit area,
- Puncture strength, and
- Apparent opening size.

Other conformance tests may be required by the project specifications.

11.3.3 Test Results

All conformance tests shall be reviewed and accepted or rejected by the CQA Project Manager prior to the deployment of the geotextile. The CQA Project Manager shall examine all results from laboratory conformance testing and shall report any nonconformance to the CCSWDA PM. The CQA Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that the failing tests may be the result of the CQA Laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested at the Geosynthetic CQA Laboratory. Alternatively, the

Manufacturer may have the sample retested at two different Owner-approved Geosynthetic CQA Laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic CQA Laboratory's results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CCSWDA PM.

11.4 Geotextile Deployment

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall not be removed until shortly before deployment.

The CQA Monitor shall observe rolls upon delivery at the site. Any apparently damaged or improperly wrapped rolls shall be reported to the CCSWDA PM.

The Geosynthetic Contractor shall ensure that geotextiles are not damaged during handling. The geotextile shall be deployed as described below:

1. On slopes, the geotextile shall be securely anchored and rolled down the slope in such manner as to continually keep the geotextile in tension.
2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Geotextiles shall be cut with a sharp object such as scissors, hook blade or other devices as approved by the CCSWDA PM. If the geotextile overlies other geosynthetic materials, care shall be taken not to damage the other materials.
4. The Geosynthetic Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane (if used), cause clogging of drains or filters, or hamper subsequent seaming.

The CQA Monitor shall note any noncompliance and report it to the CCSWDA PM.

11.5 Seaming Procedures

Geotextiles shall be overlapped a minimum of three inches prior to seaming. In general, no horizontal seams shall be allowed on side slopes (seams along, across, the slope) except as part of a patch. When horizontal seams are necessary, adjacent seams shall be offset in adjacent panels and shall be “shingled” downhill.

On slopes steeper than 10:1 (horizontal: vertical), all geotextiles shall be continuously sewn. Spot sewing is not allowed. On bottoms and slopes shallower than 10:1, geotextiles shall be continuously sewn or thermally bonded with approval of the CCSWDA PM.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. The color of the sewing thread shall contrast the background color of the geotextile to facilitate inspection. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved by the CCSWDA PM and the CQA Project Manager.

The CQA Monitor shall note any nonconformance and report it to the CCSWDA PM.

11.6 Defects and Repairs

11.6.1 Identification

If a defect is identified in the geotextile, the CQA Monitor shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, and a review of records and other means that the CQA Project Manager deems appropriate.

11.6.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Geosynthetic Contractor and CCSWDA PM. The parties shall assess the problem, review alternative solutions, contact the CQA Project Manager and implement an action plan.

11.6.3 Repair Procedures

The final decision as to the appropriate repair shall be agreed upon between the CCSWDA PM, Geosynthetic Contractor, and the CQA Project Manager.

Any holes or tears in the geotextile shall be repaired using the following two procedures:

1. *Side Slopes* – a patch made from the same geotextile material shall be thermally bonded or sewn into place in accordance with the project specifications.
2. *Non-Side Slope Areas* – a patch made from the same geotextile material shall be thermally bonded or sewn into place with a minimum of 12-inch overlap in all directions.

In either case, care shall be taken to remove any soil or other material that may have penetrated the torn geotextile.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

11.7 Geotextile Protection

All soil materials placed on top of the geotextile shall be deployed in such a manner as to ensure:

- The geotextile and underlying lining materials are not damaged,
- Minimal slippage of the geotextile on the underlying layers occurs, and
- No excess tensile stresses occur in the geotextile components.

Any noncompliance with these guidelines or the project specifications shall be noted by the CQA Monitor and reported to the CCSWDA PM.

12. GEOCOMPOSITE

12.1 Definition and Applicability

Geocomposites are composites of geotextiles and geonets, and are used as filter and drainage media in lining systems. This section is applicable to drainage geocomposites made of polyester or polypropylene nonwoven geotextiles and HDPE geonet. The geotextiles are bonded to both sides of the geonet. This specific type of geocomposite shall be specified in the project specifications.

12.2 Quality Control Documentation

Prior to the installation on any geocomposite, the geocomposite Manufacturer or Geosynthetic Contractor shall provide the CCSWDA PM with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the geotextile and geonet used to fabricate the geocomposite.
2. Copies of dated quality control certificates issued by the geotextile and the geonet supplier. These shall contain the results of the quality control tests performed on the geotextile components in the Section 11 and this section.
3. A specification for the geocomposite that includes all properties published by the Manufacturer measured using the appropriate test methods.
4. Written certification that the Manufacturer guarantees minimum values given in the specification.
5. Quality control certificates for the geocomposite, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. At a minimum, results shall be given for:
    - Mass per unit area,
    - Thickness,
    - Geotextile-geonet adhesion, and

- Transmissivity.

Unless otherwise specified in the project specifications, the quality control tests shall be performed in accordance with the test methods for at least every 40,000 sf of geocomposite produced, except for transmissivity, which shall be at a rate of one test per 120,000 sf.

The Manufacturer shall identify all rolls of geocomposite with the following:

- Manufacturer's name,
- Product identification,
- Roll number, and
- Roll dimensions.

The CQA Project Manager shall review these documents and shall report any discrepancies with the above requirements to the CCSWDA PM. The CQA Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications,
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable,
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it,
4. Roll packages are appropriately labeled,
5. Certified minimum roll properties meet the project specifications, and
6. Project specifications and this Plan were submitted by the CCSWDA PM to the Geosynthetic Contractor.

12.3 Conformance Testing

12.3.1 Sampling Procedures

If possible, the CQA Consultant shall arrange to have conformance test samples sent from the Manufacturer to the Geosynthetic CQA Laboratory prior to shipment of the materials.

Otherwise, upon delivery of the rolls of geocomposite, the CQA Monitor shall ensure that conformance test samples are obtained.

Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 3 ft long by the roll width. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, the CQA Monitor may designate a lot based upon a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of not less than one per 100,000 sf of geocomposite. These samples shall then be forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance with the project specifications.

12.3.2 Conformance Tests

At a minimum, the following tests shall be performed:

- Thickness,
- Transmissivity,
- Ply adhesion, and
- Tensile strength.

The geocomposite material should meet the general requirements listed in Table 12 below. Other conformance tests may be required by the project specifications.

Table 12. Conformance testing requirements for geocomposite material.

Property	Units	Frequency[1]	ASTM Method[2]	Minimum Required Value
Geotextile[3]				
Fabric Weight	oz/sy	100,000 sf	D 5261	6
Grab Strength	lbs	100,000 sf	D 4632	160
Grab Elongation	%	100,000 sf	D 4632	50
Trapezoidal Tear Strength	lbs	100,000 sf	D 4533	65
Flow Rate or Permittivity	sec^{-1}	100,000 sf	D 4491	1.3
AOS	Sieve Size	100,000 sf	D 4751	70
Geonet[4]				
Polymer Density	g/cm^3	100,000 sf	D 1505	0.94
Carbon Black Content	%	100,000 sf	D 4218	2.0
Thickness	mils		D 5199	175
Transmissivity[5]	m^2/s		D 4716	1×10^{-3}
Peak Tensile Strength	lb/in		D 7179	32
Geocomposite[6]				
Transmissivity[5]				
Double-sided	m^2/s	100,000 sf	D 4716	9.0×10^{-5}
Single-sided	m^2/s	100,000 sf	D 4716	1.0×10^{-4}
Adhesion	ppi	100,000 sf	D 7005	1.0

Note:
(1) Frequency of testing may be amended by permit conditions, APCEC regulations, and project specifications.
(2) Latest version of testing shall be used.
(3) Geotextile tests shall be performed prior to adhesion to geonet.
(4) Geonet tests shall be performed prior to adhesion to geotextile.
(5) Gradient of 0.1 normal load of 10,000 psf, water at 70˚F between steel plates for 15 minutes.
(6) Tests performed on completed geocomposite material.

12.3.3 Test Results

All conformance tests shall be reviewed and accepted or rejected by the CQA Project Manager prior to the deployment of the geocomposite. The CQA Project Manager shall examine all results from laboratory conformance testing and shall report any nonconformance to the CCSWDA PM. The CQA Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that the failing tests may be the result of the Geosynthetic CQA Laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic CQA Laboratory. Alternatively, the Manufacturer may have the sample retested at two different Owner-approved Geosynthetic CQA Laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic CQA Laboratory's results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CCSWDA PM.

12.4 Geocomposite Deployment

During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall not be removed until shortly before deployment.

The CQA Monitor shall observe rolls upon delivery at the site. Any apparently damaged or improperly wrapped rolls shall be reported to the CCSWDA PM.

The Geosynthetic Contractor shall ensure that the geocomposite is not damaged during handling. The geocomposite shall be deployed as described below:

1. On slopes, the geocomposite shall be securely anchored and rolled down the slope in such manner as to continually keep the geocomposite in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

2. In the presence of wind, all geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. The geocomposite shall be cut with a sharp object such as scissors, hook blade or other devices as approved by the CCSWDA PM. Care shall be taken not to damage any underlying geosynthetics.
4. The Geosynthetic Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
5. During placement of the geocomposite, care shall be taken not to entrap, in or beneath the geotextile portion of the material, stones, excessive dust, or moisture that could damage the geomembrane (if used), cause clogging of drains or filters, or hamper subsequent seaming.

The CQA Monitor shall note any noncompliance and report it to the CCSWDA PM.

12.5 Seaming Procedures

At a minimum, the following requirements for joining the adjacent geocomposite shall be met:

1. The geonet portion of the geocomposite between adjacent rolls shall be overlapped by at least 4 inches.
2. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
3. The plastic ties shall be installed every 5 ft along the length at adjacent rolls, every 6 inches within the anchor trench and every 6 inches along end-to-end seams.
4. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch. When horizontal seams are necessary, they shall be offset in adjacent panels and shall be “shingled” downhill.
5. The overlapping geotextiles shall temporarily seamed with a heat-fusing lyster gun.

The CQA Monitor shall note any nonconformance and report it to the CCSWDA PM.

12.6 Defects and Repairs

12.6.1 Identification

If a defect is identified in the geocomposite, the CQA Monitor shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Monitor shall determine the extent of the deficient area by additional tests, observations, and a review of records and other means that the CQA Project Manager deems appropriate.

12.6.2 Notification

After determining the extent and nature of the defect, the CQA Monitor shall promptly notify the Geosynthetic Contractor and CCSWDA PM. The parties shall assess the problem, review alternative solutions, contact the CQA Project Manager and implement an action plan.

12.6.3 Repair Procedures

The final decision as to the appropriate repair shall be agreed upon between the CCSWDA PM, Geosynthetic Contractor, and the CQA Project Manager.

If the hole or tear width is less than 50% of the width of the roll, the damaged area shall be repaired as follows:

- A patch shall be placed extending 1 ft beyond the edges of the hole or tear.
- The patch shall be secured to the original geonet portion of the geocomposite by tying every 6 inches. Tying devices shall be as indicated in Section 12.5 of this Plan.

If the hole or tear width across the roll is equal to or more than 50% of the width of the roll, the damaged area shall be cut and the two portions of the geocomposite shall be joined as indicated in Section 12.5 of this Plan.

The CQA Monitor shall observe any repair and report any noncompliance with the above requirements in writing to the CCSWDA PM.

12.7 Geocomposite Protection

All soil materials placed on top of the geocomposite shall be deployed in such a manner as to ensure:

- The geocomposite and underlying lining materials are not damaged,
- Minimal slippage of the geocomposite on the underlying layers occurs, and
- No excess tensile stresses occur in the geocomposite components.

Any noncompliance with these guidelines or the project specifications shall be noted by the CQA Monitor and reported to the CCSWDA PM.