

Section III—Geosynthetic Clay Liner Construction Quality Assurance

1. GEOSYNTHETIC CLAY LINER MANUFACTURE AND DELIVERY

1.1 Labeling

The CQA monitor will verify and document that the geosynthetic clay liner (GCL) manufacturer has labeled each roll of GCL as specified in the Technical Specifications.

The CQA monitor will examine GCL rolls upon delivery and deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the GCL.

1.2 Transportation and Handling

The CQA monitor will observe and document that the type of GCL handling equipment used by the installer is consistent with handling equipment identified in the Technical Specifications.

Upon delivery at the site, the CQA monitor conducts a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA monitor will indicate to the CQA certifying engineer:

- Any rolls that should be unrolled to allow for their inspection
- Any rolls, or portions thereof, that should be rejected and removed from the site because they have severe flaws
- Any rolls that include minor repairable flaws.

1.3 Storage

The CQA monitor will verify and document that storage of the GCL is in accordance with the Technical Specifications.

1.4 Quality Assurance Conformance Testing

Either at the manufacturers' plant or upon delivery of the rolls of GCL, the CQA monitor will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the Technical Specifications.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft², whichever is greater. These samples will be tested for:

- Bentonite Moisture Content ASTM D4643
- GCL Permeability ASTM D5084
- GCL Interface Shear Strength ASTM D5321.

SECTION III—GEOSYNTHETIC CLAY LINER CONSTRUCTION
QUALITY ASSURANCE

- Bentonite Mass per Unit Area ASTM D5993
- Swell Index Test ASTM D5890.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 ft along the length of the roll. Unless otherwise specified, samples will be 1.5-ft (minimum) long by the roll width. The CQA monitor will mark the machine direction on the samples with an arrow.

The CQA monitor will examine all results from laboratory conformance testing and will compare the results to the specifications presented in the Technical Specifications. In addition, the CQA monitor will report any non conformance to the CQA certifying engineer as soon as practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction subcontractor will be required to replace the roll (or rolls) of GCL not in conformance with the specifications with a roll that meets the requirements of the Technical Specifications.
- The CQA monitor will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed samples and tested by the Geosynthetics CQA Laboratory. These 10 samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of GCL on-site and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory.
- The CQA monitor will document actions taken in conjunction with conformance test failures and report all actions to the certifying engineer.

2. GEOSYNTHETIC CLAY LINER INSTALLATION

2.1 Earthworks

The construction subcontractor responsible for GCL installation will be required to certify in writing that the surface on which the GCL will be installed is acceptable. The certificate of acceptance will be required to be given by the construction subcontractor to the CQA monitor, who will then verify to the CQA certifying engineer that the deployment surface is accepted immediately prior to commencement of GCL installation in the area under consideration.

After the surface on which the GCL is to be installed has been accepted by the construction subcontractor, it will be the CQA monitor's responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the Technical Specifications, require repair work. If the CQA certifying engineer requires repair work, it will be the responsibility of the construction subcontractor to repair the underlying layer.

2.1.1 Anchor Trenches

The CQA monitor will verify and document that the anchor trench backfill meets the requirements of the Technical Specifications and that the backfill is placed in accordance with the Technical Specifications.

2.2 Geosynthetic Clay Liner Deployment

2.2.1 Field Panel Identification

A field panel is the unit area of GCL that is to be placed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The field inspector will verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the CQA certifying engineer and the construction subcontractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the construction subcontractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA monitor will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.2 Field Panel Placement

2.2.2.1 Installation Schedule. The CQA monitor will evaluate significant changes in the schedule proposed by the construction subcontractor and advise the CQA certifying engineer on the acceptability of that change. The CQA monitor will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the construction subcontractor in accordance with the Technical Specifications.

SECTION III—GEOSYNTHETIC CLAY LINER CONSTRUCTION QUALITY ASSURANCE

The field inspector will record the identification code, location, and date of installation of each field panel.

2.2.2.2 Weather Conditions. The CQA monitor will verify and document that GCL is not placed during inclement weather conditions as specified within the Technical Specifications. Additionally, the CQA monitor will verify and document that the existing underlying layer has not been damaged by weather conditions.

2.2.2.3 Damage. The field inspector will visually observe each panel, after placement, for damage. The field inspector will advise the CQA monitor which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected by the CQA monitor will be marked, and their removal from the work area will be documented by the field inspector.

2.2.2.4 Seam Overlap and Bentonite Seal. The field inspector will observe and document that the seam overlaps and bentonite material placed between panels along the seams meets specification guidelines. The field inspector will verify overlap width and will observe bentonite seal placement.

2.3 Defects and Repairs

2.3.1 Identification

All seams and non-seam areas of the GCL will be inspected by the field inspector for evidence of defects, holes, contamination of geotextiles, displaced panels, premature hydration, and any sign of contamination by foreign matter. The field inspector will observe and document repair procedures described below.

2.3.2 Repair Procedures

Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer.

2.3.2.1 Rip and Tear Repair (Flat Surfaces). Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 in. on all edges.

Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal ft of edge spread in a continuous 6-in. fillet.

2.3.2.2 Rip and Tear Repair (Slopes). Damaged GCL material on slopes shall be repaired by the same procedures above, however, the overlapped edges of the patch should be wide enough to ensure the patch will keep its position during backfill or cover operations.

2.3.2.3 Displaced Panels. Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

2.3.2.4 Premature Hydration. If the GCL is subjected to premature hydration, the construction subcontractor shall notify the CQA certifying engineer and design engineer for a site-specific

SECTION III—GEOSYNTHETIC CLAY LINER CONSTRUCTION
QUALITY ASSURANCE

determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design dependent upon the degree of damage.

Section IV—Geomembrane Construction Quality Assurance

1. GEOMEMBRANE MANUFACTURE AND DELIVERY

1.1 Labeling

The CQA monitor will verify and document that the geomembrane manufacturer has labeled each roll of geomembrane as specified in the Technical Specifications.

The CQA monitor will examine geomembrane rolls upon delivery and deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the geomembrane.

1.2 Inspection

Upon delivery at the site, the CQA monitor will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA monitor will indicate to the CQA certifying engineer:

- Any rolls that should be unrolled to allow for their inspection
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws
- Any rolls that include minor repairable flaws.

1.3 Storage

The CQA monitor will verify and document that storage of the geomembrane is in accordance with the Technical Specifications.

1.4 Quality Assurance Conformance Testing

Either at the manufacturers' plant or upon delivery of the rolls of geomembrane, the CQA monitor will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the Technical Specifications.

Conformance samples will be taken by the CQA monitor across the entire width of the roll and will not include the first 3 ft. Unless otherwise specified, samples will be 1.5-ft (minimum) long by the roll width. The CQA monitor will mark the direction of the machine used to cut the samples with an arrow.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft² whichever is greater. These samples will be tested for:

- Specific gravity
- Thickness
- Yield strength and yield elongation

SECTION IV—GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

- Tensile strength and tensile elongation at break
- Carbon black content
- Carbon black dispersion
- Puncture resistance.

Test shall be conducted in accordance with the test procedure presented in the Technical Specifications.

The CQA monitor will examine all results from laboratory conformance testing and will report any non conformance after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA monitor:

- The construction subcontractor will be required to replace the roll (or rolls) of geomembrane in non conformance with the Technical Specifications with a roll that meets the Technical Specifications.
- The CQA certifying engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These 10 samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on-site and every roll subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory.

2. GEOMEMBRANE INSTALLATION

2.1 Earthwork

2.1.1 Surface Preparation

The construction subcontractor will be required to certify in writing that the surface on which the geomembrane will be installed is acceptable.

The certificate of acceptance will be required to be given by the construction subcontractor to the CQA monitor, who will then verify to the CQA certifying engineer that the subgrade is accepted immediately prior to commencement of geomembrane installation in the area under consideration.

After the surface on which the geomembrane is to be installed has been accepted by the construction subcontractor, it will be the CQA monitor's responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the Technical Specifications, require repair work. If the CQA certifying engineer requires repair work, it will be the responsibility of the construction subcontractor to repair the underlying layer.

2.1.2 Anchor Trenches

The CQA monitor will verify and document that the anchor trench backfill meets the requirements of the Technical Specifications and that the backfill is placed in accordance with the Technical Specifications.

2.2 Geomembrane Deployment

2.2.1 Layout Drawing

The construction subcontractor will be required to produce layout drawings that show the geomembrane panel configuration, dimensions, details, seam locations, etc. The layout drawings must be approved by the CQA certifying engineer prior to the installation of the geomembrane.

2.2.2 Field Panel Identification

A field panel is the unit area of geomembrane that is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The field inspector will verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the CQA monitor and the construction subcontractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the construction subcontractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA monitor will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.3 Field Panel Placement

2.2.3.1 Location. The field inspector will verify and document that field panels are installed at the locations and positions indicated in the construction subcontractor's layout plan, as approved or modified by the CQA certifying engineer.

2.2.3.2 Installation Schedule. The CQA monitor will evaluate significant changes in the schedule proposed by the construction subcontractor and advise the CQA certifying engineer on the acceptability of that change. The CQA monitor will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the construction subcontractor in accordance with the Technical Specifications.

The field inspector will record the identification code, location, and date of installation of each field panel.

2.2.3.3 Weather Conditions. The CQA monitor will verify and document that geomembrane is not placed during inclement weather conditions as specified within the Technical Specifications.

Additionally, the CQA monitor will verify and document that the underlying layer has not been damaged by weather conditions.

2.2.3.4 Damage. The field inspectors will visually observe each panel, after placement and prior to seaming, for damage (e.g., holes, blisters, and creases). The field inspector will advise the CQA monitor which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected by the CQA certifying engineer will be marked, and their removal from the work area will be documented by the field inspector.

2.3 Field Seaming

2.3.1 Seam Layout

The CQA certifying engineer will verify and document that the seam layout shown on the Panel Layout Drawing (Part 2.2.1) is consistent with the Technical Specifications. No panels may be seamed in the field without the CQA certifying engineer's approval. In addition, seams not specifically shown on the seam layout drawing may not be made without the CQA certifying engineer's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon by the construction subcontractor and CQA certifying engineer.

2.3.2 Seaming Equipment and Products

Processes approved by the Technical Specifications for field seaming are: (i) extrusion seaming; and (ii) fusion seaming. Proposed alternate processes will be required to be documented and submitted to the CQA certifying engineer for approval. Only seaming apparatus that the CQA certifying engineer has specifically approved by make and model will be used. The construction subcontractor will be required to use a pyrometer to ensure that accurate temperatures of the extrudate and seamer nozzle are being achieved.

The extrusion seaming apparatus will be equipped with gauges indicating the temperatures of the extrudate and nozzle. The construction subcontractor will be required to provide to the CQA certifying

SECTION IV—GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

engineer the manufacturers' certification that the extrudate is compatible with the Technical Specifications and is comprised of the same resin as the geomembrane.

The field inspector will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusion seaming apparatus speeds. Ambient temperatures will be measured as specified in the Technical Specifications.

2.3.3 Seam Preparation

The CQA certifying engineer will verify and document that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material
- Preparation of seams is in accordance with the Technical Specifications.

2.3.4 Weather Conditions for Seaming

The CQA monitor will verify and document that weather conditions for seaming are within the limits specified in the General Conditions.

2.3.5 Trial Seams

The construction subcontractor will be required to make trial seams on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The construction subcontractor will be required to make and test trial seams at the frequency and in accordance with the methods specified in the Technical Specifications.

The field inspector will observe all trial seam procedures. The successful trial seam sample will be assigned a number and marked accordingly by the field inspector, who will log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete and the liner has been accepted by the CQA certifying engineer.

2.3.6 Nondestructive Seam Continuity Testing

2.3.6.1 Introduction. Except as otherwise noted in the Technical Specifications, the construction subcontractor will nondestructively test all field seams over their full length in accordance with the Technical Specifications. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted before sunrise or after sunset unless the construction subcontractor demonstrates to the CQA Certifying Officer that the construction subcontractor has the capabilities to perform continuity testing under reduced light conditions.

The field inspector will:

- Observe the continuity testing
- Record location, date, test unit number, name of tester, and outcome of all testing
- Document and inform the construction subcontractor of any required repairs.

SECTION IV—GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

The construction subcontractor will be required to complete any required repairs in accordance with the Technical Specifications.

The field inspector will:

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

The field inspector will verify and document the procedures specified in the Technical Specifications where seams cannot be nondestructively tested.

The location, date of visual observation, name of tester, and outcome of the test or observation will be recorded by the field inspector and reported to the CQA certifying engineer.

2.3.7 Destructive Seam Testing

2.3.7.1 Concept. Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

2.3.7.2 Location and Frequency. The field inspector will select locations where seam samples will be cut out for laboratory testing. The test frequency and locations will be established as follows:

- Samples will be collected at a minimum frequency of one test location per 500 ft of seam length (this minimum frequency is to be determined as an average taken throughout the entire landfill and evaporation ponds)
- Test locations will be determined during seaming at the field inspector's discretion; selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The construction subcontractor will not be informed in advance of the locations where the seam samples will be taken.

2.3.7.3 Sampling Procedure. The construction subcontractor will be required to cut samples as directed by the field inspector as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The field inspector will:

- Observe sample cutting
- Assign a number to each sample and mark it accordingly
- Record the sample number and location on the panel layout drawing
- Record the reason for taking the sample at this location (e.g., routine testing, suspicious feature of the geomembrane, etc.).

SECTION IV—GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

All holes in the geomembrane resulting from destructive seam sampling will be covered by the construction subcontractor immediately after sampling and repaired in accordance with the repair procedures described in the Technical Specifications. The continuity of the new seams in the repaired area will be nondestructively tested according to the Technical Specifications.

2.3.7.4 Size of Samples. At a given sampling location, two types of samples will be required to be taken by the construction subcontractor.

First, two specimens for field testing will be taken. Each of these specimens will be 1 in. wide by 6 to 12 in. long, with the seam centered parallel to the width. The distance between these two specimens will be approximately 42 in. If both specimens pass the field test described in the Technical Specifications, a sample for laboratory testing will be taken.

The sample for laboratory testing will be required to be taken between the two specimens for field testing. The destructive sample will be 12 in. wide by 42 in. long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- One portion to the construction subcontractor, 12 in. long
- One portion to the CQA certifying engineer for archive storage, 12 in. long
- One portion to the CQA certifying engineer for CQA Laboratory testing, 18 in. long

Final determination of the sample sizes will be made at the preconstruction meeting.

2.3.7.5 Field Testing. The two 1-in.-wide specimens specified above will be required to be tested in the field, by the construction subcontractor, by tensiometer for peel and should not fail in the seam. If any field test sample fails to pass, the procedures outlined in the Technical Specifications will be required to be followed.

The CQA monitor will observe field tests and mark all samples and portions with their number, date, and time.

2.3.7.6 Geosynthetic Construction Quality Assurance Laboratory Testing. Laboratory destructive test samples will be packaged and shipped to the CQA Laboratory by the CQA monitor in a manner that will not damage the test sample. The CQA monitor will store the archive samples until the completion of the project. Laboratory destructive test samples will be tested by the Geosynthetics CQA Laboratory.

Testing will include “Shear Strength” and “Peel Strength” (ASTM D443) with 1-in.-wide strip, tested at 2 in. per minute. The minimum acceptable values to be obtained in these tests are those indicated in the Technical Specifications. At least five specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear). At least four out of five of the specimens must pass.

The Geosynthetics CQA Laboratory will provide test results verbally to the CQA certifying engineer in a timely manner after they receive the samples. The CQA certifying engineer will review laboratory test results as soon as they become available, and inform the CQA certifying engineer of the test results.

2.3.7.7 Procedures for Destructive Test Failure. The procedures specified within the Technical Specifications will be required whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the construction subcontractor's laboratory (if required), or by field tensiometer. The CQA certifying engineer will verify and document that one of the options specified within the Technical Specifications is followed.

The CQA certifying engineer will document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non-seam areas of the geomembrane will be inspected by the field inspector engineer for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be required to be clean at the time of examination. The geomembrane surface will be required to be broomed or washed by the construction subcontractor if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non-seam areas will be required to be either non-destructively tested using the methods described in the Technical Specifications, or repaired as appropriate as determined by the CQA certifying engineer. Each location that fails the non-destructive testing will be marked by the CQA monitor and will be required to be repaired by the construction subcontractor. Materials should not be placed over geomembrane locations that have been repaired until the CQA monitor has approved the repair.

2.4.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA monitor will visually inspect the geomembrane for wrinkles. The CQA monitor will indicate to the construction subcontractor which wrinkles, if any, should be cut and resealed. The seam thus produced will be tested like any other seam.

2.4.4 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, will be repaired by the construction subcontractor in accordance with the applicable method specified within the Technical Specifications.

2.4.5 Testing of Repairs

Each repair will be located and logged by the field inspector. Each repair will be non-destructively tested using the methods described in the Technical Specifications as appropriate. Repairs that pass the non-destructive test will be considered as an adequate repair. Large caps may be of sufficient extent to require destructive testing, at the discretion of the CQA certifying engineer. Failed tests will require the repair to be redone and retested until passing test results are obtained. The field inspector will observe the non-destructive testing of repairs and will document the date of the repair and test outcome.

2.5 Appurtenances

The field inspector will verify and document that:

- Installation of the geomembrane around, and connection of geomembrane to, appurtenances have been made according to the Technical Specifications
- Extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas
- The geomembrane has not been visibly damaged while being connected to appurtenances.

The field inspector will inform the CQA certifying engineer if the above conditions are not fulfilled.

Section V—Separation Or Cushion Geotextile Construction Quality Assurance

1. GEOTEXTILES

1.1 Labeling

The CQA monitor will verify and document that the geotextile manufacturer has labeled all rolls of geotextile with the information specified in the Technical Specifications.

The CQA monitor will examine rolls upon delivery and any deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the geotextile.

1.2 Shipment and Storage

The CQA monitor will observe rolls of geotextile upon delivery at the site and any deviation from the requirements specified within the Technical Specifications will be reported to the CQA certifying engineer. Any damaged rolls will be rejected by the CQA certifying engineer and required to be repaired or replaced by the construction subcontractor.

1.3 Conformance Testing

Either at the manufacturers' factory or upon delivery of the geotextile rolls, the CQA monitor will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the Technical Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 ft along the length of the roll. Unless otherwise specified, samples will be 1.5 ft (minimum) long by the roll width. The CQA monitor will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft², whichever is greater. These samples will be tested for:

- Mass per unit area
- Grab strength
- Tear strength
- Puncture strength
- Permittivity.

(Note: All tests should be conducted in accordance with the test methods listed in the Technical Specifications.)

If the geotextile is being used as a filter or separator, the samples will also be tested for apparent opening size.

SECTION V—SEPARATION OR CUSHION GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

The CQA monitor will examine all results of laboratory conformance testing and report any non conformance to the CQA certifying engineer as soon as results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction subcontractor will be required to replace the roll (or rolls) of geotextile not in conformance with the specifications with a roll that meets the requirements of the Technical Specifications.
- The CQA monitor will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These 10 samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on-site and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of all such tests are to be borne by the construction subcontractor.

The CQA monitor will document actions taken in conjunction with conformance test failures and report all actions taken to the CQA certifying engineer.

1.4 Handling and Placement

The construction subcontractor will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged in any way. The CQA monitor will verify and document compliance with the following:

- Just prior to geotextile placement, the layer that underlies the geotextile, if it is a geosynthetic, is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system.
- In the presence of excessive wind, the geotextile is weighted with sandbags (or equivalent weight approved by the CQA monitor).
- Geotextile is kept under tension to minimize the presence of wrinkles in the geotextile. If necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles.
- Geotextile is cut using a geotextile cutter approved by the geotextile manufacturer and the CQA monitor. If in place, special care is taken to protect other materials (such as underlying geosynthetics) from damage that could be caused by the cutting of the geotextiles.
- The construction subcontractor takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.
- During placement of geotextiles, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying layers, generate clogging of drains or filters, or hamper subsequent seaming.

SECTION V—SEPARATION OR CUSHION GEOTEXTILE
CONSTRUCTION QUALITY ASSURANCE

- Geotextile is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA monitor.

The CQA monitor will document any noncompliance with the above requirements and report them to the CQA certifying engineer.

1.5 Seams and Overlaps

The field inspector will verify and document that all geotextile seams are oriented, overlapped, and sewn in accordance with the Technical Specifications.

The construction subcontractor will be required to pay close attention at seams to ensure that no protective soil layer material could be inadvertently placed beneath the geotextile.

Sewing will be required to be performed as required in the Technical Specifications.

1.6 Repair

The field inspector will verify and document that any holes or tears in the geotextile are repaired in accordance with the requirements of the Technical Specifications.

The field inspector will document any noncompliance with the above requirements and report it to the CQA certifying engineer.

Section VI—Geocomposite Construction

1. QUALITY ASSURANCE

****To be completed in subsequent submittals****

2. GEOCOMPOSITES

2.1 Labeling

The CQA monitor will verify and document that the geocomposite manufacturer has labeled all rolls of geocomposite as specified within the Technical Specifications.

The CQA monitor will examine rolls upon delivery and any deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the geocomposite.

2.2 Shipment and Storage

The CQA monitor will observe rolls of geocomposite upon delivery at the site and any deviation from the requirements of the Technical Specifications will be reported to the CQA certifying engineer. Any damaged rolls will be rejected by the CQA monitor and be required to be repaired or replaced by the construction subcontractor.

2.3 Conformance Testing

Either at the manufacturers' plant or upon delivery of the geocomposite rolls, the CQA monitor will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the Technical Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 ft. Unless otherwise specified, samples will be 1.5-ft long (minimum) by the roll width. The CQA monitor will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft², whichever is greater. These samples will be tested for: peel strength (ASTM F904); and hydraulic transmissivity, in accordance with the text methods presented in the specification.

The CQA monitor will examine all results from laboratory conformance testing and will report any non conformance to the CQA certifying engineer as soon as the results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction subcontractor will be required to replace the roll (or rolls) of geocomposite not in conformance with the specifications with a roll that meets the requirements of the Technical Specifications.
- The CQA monitor will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These 10 samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on-site and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the construction subcontractor.

The CQA monitor will document actions taken in conjunction with conformance test failures and report all actions to the CQA certifying engineer.

2.4 Handling and Placement

The construction subcontractor will be required to handle all geocomposite in such a manner as to ensure it is not damaged. The CQA monitor will verify and document compliance with the following:

- Just prior to geocomposite placement, the layer that will underlie the geocomposite is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the underlying layers or clog the drainage system.
- In the presence of excessive wind, the geocomposite is weighted with sandbags (or equivalent weight approved by the CQA certifying engineer).
- Geocomposite is kept under tension to minimize the presence of wrinkles in the geocomposite. If necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles.
- Geocomposites are cut using a geocomposite cutter approved by the geocomposite manufacturer and the CQA monitor. If in place, special care is taken to protect other materials from damage that could be caused by the cutting of the geocomposites.
- The geosynthetics construction subcontractor takes all necessary precautions to prevent damage to the underlying layers during placement of the geocomposite.
- Geocomposite is not welded to geomembranes.
- During placement of clean geocomposite, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the geocomposite is carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.
- Geocomposite is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA certifying engineer and the CQA certifying engineer.

The CQA monitor will document any noncompliance with the above requirements and report it to the CQA certifying engineer.

2.5 Seams and Overlaps

The components of the geocomposite (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. The field inspector will document that the geocomposite is overlapped and secured or seamed in accordance with the Technical Specifications.

2.6 Repair

The field inspector will verify that any holes or tears in the geocomposite are repaired in accordance with the Technical Specifications.

SECTION VI—GEOCOMPOSITE CONSTRUCTION

The field inspector will observe any repair, document any noncompliance with the above requirements, and report the noncompliance to the CQA certifying engineer.

3. SURVEYING

The CQA certifying engineer, in conjunction with the surveyor, will be required to prepare an “as-built” Record Drawing for geomembrane installations. It will include the surveyed location of field panels, seams (factory and field), repairs, and test locations.

The CQA results (Record Drawing and Certification of Construction work) will be submitted to the ICDF PM for final review and approval prior to proceeding with construction of any subsequent liner system components.

Section VII—Polyethylene Pipe and Fittings

1. LABELING

The field inspector will verify that the pipe is labeled with the information specified in the Technical Specifications. Any deviations from the labeling requirements will be reported to the CQA certifying engineer prior to pipe installation.

1.1 Shipment and Storage

The field inspector will verify and document that the pipe and fittings are stored in accordance with the Technical Specifications.

The field inspector will visually inspect the pipe upon delivery at the site and any deviations from the requirements of the Technical Specifications will be reported to the CQA certifying engineer.

1.2 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

1.3 Handling and Laying

The field inspector will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the Technical Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the field inspector. The field inspector will verify and document that cracks, damage, or defects are not present in the pipe and fittings in excess of that allowed by the Technical Specifications.

The field inspector will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the field inspector has observed the condition of the pipe. The field inspector will document any deviation from the above requirements and report it to the CQA certifying engineer.

1.4 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by the butt-fusion process. Butt-fusion refers to the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.

The field inspector will spot-monitor butt fusion welding operations to ensure that the construction subcontractor follows the Technical Specifications.

The CQA certifying engineer will document any noncompliance with the above requirements and report it to the field inspector.

1.5 Surveying

A professional land surveyor registered in the State of Idaho will provide the CQA Surveys. The CQA surveyor will independently survey the final elevation of the invert of all polyethylene leachate collection pipe (excluding laterals).

The results of the survey will be compiled in a report signed by the CQA surveyor and the CQA certifying engineer and will be reviewed by the ICDF PM. The ICDF PM and the CQA certifying engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

Section VIII—Construction Quality Assurance Documentation

1. DOCUMENTATION

A major function of CQA is to properly and adequately document the work. This section describes the minimum required documentation. The CQA certifying officer may recommend to the STR/construction coordinator additional documentation for performing CQA tasks that are for certification. In addition, the CQA certifying officer shall prepare forms, field data sheets, sample labeling schemes, and chain-of-custody procedures and submit them to the STR/construction coordinator and ICDF PM for approval prior to construction. Once approved, this CQA Plan shall be amended to include the approved forms and procedures using the CID process described in Section 5.5.

1.1 Daily Reports

Daily reports shall be completed by the CQA monitor and field inspectors when they are on-site. All CQA personnel shall be assigned field books by the CQA certifying officer, which shall be labeled with a unique number. The CQA certifying officer shall coordinate with the WAG 3 quality engineer to ensure the field book numbering complies with the BBWI requirements. The CQA monitor and field inspectors, including the CQA certifying officer, shall record all field observations and the results of field tests either in their assigned field book or on BBWI-approved field data sheets. When not in use, all field books will be left with the CQA certifying officer. After each book is filled (or at the end of the project), the field book shall be returned to the CQA certifying officer and routed to the project files.

Each page of the field book shall be numbered, dated, and initialed by CQA personnel. At the start of a new work shift, CQA personnel shall list the following information at the top of the page:

- Job name
- Job number
- Date
- Name
- Weather conditions
- Page number (if pages are not pre-numbered).

The remaining individual entries shall be prefaced by an indication of the time at which they occurred. If the results of test data are being recorded on separate sheets, it shall be noted in the field book. Entries in the field book shall include, but not be limited to, the following information:

- Reports on any meetings held and their results
- Equipment and personnel being used in each location, including construction subcontractors
- Descriptions of areas being observed and documented

SECTION VIII—CONSTRUCTION QUALITY
ASSURANCE DOCUMENTATION

- Descriptions of materials delivered to the site, including any quality verification (vendor certification) documentation
- Descriptions of materials incorporated into construction
- Calibrations, or recalibrations, of test equipment, including actions taken as a result of recalibration
- Decisions made regarding use of material and/or corrective actions to be taken in instances of substandard quality
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item.

At the end of each day, field CQA personnel shall summarize the day's activities on a daily field monitoring report form. The field report shall include a brief summary of the day's activities and highlight any unresolved issues that must be addressed by the CQA certifying officer or by CQA personnel the following day. In addition, the summary report shall reference the field book number and page numbers that cover that day's activities. The summary field reports shall be turned into the CQA certifying officer at the end of each day for approval.

The daily field monitoring report shall be filled out in triplicate. The individual initiating the report shall attach three copies of the field book notes for that day. The three copies shall be distributed as follows:

- Original shall be filed in field office
- One copy transmitted to the CQA certifying officer
- One copy transmitted to the STR/construction coordinator.

The CQA certifying officer shall review and initial each summary field report before distributing to the project quality records and the STR/construction coordinator.

1.2 Inspection Data Sheets

All observed field and laboratory test data shall be recorded on an inspection data sheet. At a minimum, each inspection data sheet shall include the following information:

- Unique identifying sheet number for cross-referencing and document control
- Description of the inspection activity
- If appropriate, location of the inspection activity or location from which the sample was obtained
- Type of inspection activity and/or procedure used (reference to standard method when appropriate)
- Any recorded observation or test data, with all necessary calculations
- Results of the inspection activity and comparison with specification requirements

SECTION VIII—CONSTRUCTION QUALITY
ASSURANCE DOCUMENTATION

- Identification of any personnel involved in the inspection activity
- Signature of the individual(s) performing the CQA monitor activity and concurrence by the CQA certifying officer.

Forms used for the data sheets shall be prepared and submitted to the STR/construction coordinator and ICDF PM in accordance with this section. The data sheets shall include, but are not limited to, the forms listed below:

- Sample log
- Compaction test result log
- Soil test result summary form
- Equipment calibration log.

1.3 Record Drawing Maintenance

The construction subcontractor will maintain a complete set of Construction Drawings labeled “Red-Line” as-built drawings. At the completion of the project, the as-built drawings will be produced in electronic format and submitted to the CQA certifying officer. The CQA certifying officer will review the completed set of as-built drawings and certify the drawing set as the Record Drawings for the ICDF.

1.4 Non Conformance Reporting

A non conformance is considered to be a deficiency in characteristics, documentation, or procedures that renders the quality of an item or activity unacceptable or indeterminate. If a deficiency cannot be repaired or replaced to the satisfaction of the CQA certifying officer within the guidelines established by this CQA Plan, then such a deficiency shall be considered a non conformance and shall be documented on a NCR form by the CQA certifying officer and referred to the STR/construction coordinator, and/or ICDF PM for disposition and initiation of corrective action processes. All NCR situations shall be brought to the attention of the CQA certifying officer for concurrence prior to initiating the NCR. Other individuals as directed by the ICDF PM shall participate in NCR disposition, resolution, and corrective action processes as needed. All documentation relating to NCR situations shall be retained in the project quality records.

1.5 Construction Interface Document

Requests for changes to the Technical Specifications or Construction Drawings shall be referred to the STR/construction coordinator and initiated on the standard BBWI CID form. Changes shall be completed in accordance with standard BBWI procedures. All design changes shall be approved by the appropriate project team member including, at a minimum, the procurement agent and the ICDF project engineer prior to implementation. Requests for modifications to the CQA Plan shall also be made by completing a CID to the STR/construction coordinator and procurement agent with copies to the WAG 3 quality engineer and ICDF project engineer.

If, during the course of construction, questions arise regarding interpretation of the plans and/or specifications, the STR/construction coordinator shall be contacted by the CQA certifying officer. Any clarification of the drawings shall be documented by a CID or telephone conversation records, and routed

to the ICDF design and construction subcontractor superintendent, and ICDF PM. The CID shall also be routed to the project files.

1.6 Progress Reports

The CQA certifying officer shall prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. At a minimum, this report shall include the following information:

- A unique identifying sheet number for cross-referencing and document control
- The date, project name, location, and other information
- A summary of work activities accomplished during the progress reporting period
- Identification of areas or items inspected and/or tested during the reporting period that are addressed by the report
- A summary of the quality characteristics being evaluated, with appropriate cross-references to specifications and/or drawings
- References to the specifications or drawings defining the acceptance criteria for each inspected characteristic
- A summary of inspection and test results, failures, and retests
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period
- A summary of other problem resolutions and dispositions
- The signature of the CQA certifying officer.

The progress report shall be submitted to the ICDF PM no more than two days after the last reporting day in the progress report. Copies shall also be submitted to the ICDF PM, WAG 3 quality engineer, and STR/construction subcontractor.

1.7 Final Documentation

All daily inspection summary reports, inspection sheets, problem identification and corrective measures reports, acceptance reports, CIDs, NCRs, photographic records, progress reports, drawings, drawing revisions, and other pertinent documentation shall be retained as permanent project quality records. At the completion of the project, a final CQA report that incorporates all such information, along with as-built drawings, shall be prepared by the CQA certifying officer and submitted to the ICDF PM. The CQA certifying officer shall prepare an interim report for Phase 1 construction that shall include the test pad report described in Section 4.4.4.1. A final CQA report shall be completed at the end of the Phase 2 construction that will include and certify both the Phase 1 and Phase 2 construction.

The CQA certifying officer shall coordinate the completion of the as-built record drawings, which shall be generated by a land surveyor licensed in the State of Idaho as described in Section 4.2.3. The as-

built records shall include scale drawings depicting depths, plan dimensions, elevations, and fill thicknesses. The report shall include documentation of each construction component monitored by CQA personnel and shall be signed, stamped, and certified by the CQA certifying officer.

1.8 Storage of Records

During the construction of the ICDF, the CQA certifying officer shall be responsible for all CQA documents. This includes the CQA certifying officer's copy of the design criteria, plans, procedures, and specifications; the CQA Plan; and the originals of all the data sheets and reports. The field records shall be kept in lockable, metal cabinets or on metal shelving within a facility protected by a fire alarm and/or a communication system that provides fire department response and/or fire suppression systems; or, in an Underwriters Laboratory (UL) listed one-hour fire-rated cabinet in accordance with Appendix A Section 1.2.8.4 of MCP-557. At the completion of the project, all completed documents shall be routed to the project quality records in compliance with BBWI's project QA records management requirements, including all the original field books, maintenance of a records index, access control, and duplicate records requirements.

1.9 Storage of Archive Construction Material Samples

The CQA monitor shall be responsible for storing construction material samples during the duration of the project.

The CQA monitor shall coordinate with BBWI on which samples shall be archived at the completion of the project. All samples shall be kept in small containers (i.e., 5 gallon plastic buckets). Each container shall be labeled with the information listed below:

- Project Name
- Date
- Sample I.D.
- Material Type
- Point of Contact.

All samples shall be stored neatly in a cool dry location as approved by the CQA certifying engineer. The CQA certifying engineer shall coordinate with BBWI to determine which sample will be archived at the project completion.

SECTION IX—REFERENCES

- 40 CFR 264.19, 1994, “Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” Section 19, “Construction quality assurance program,” *Code of Federal Regulations*, Office of the Federal Register, July 9, 1999.
- American Society for Testing and Materials, 1997, *1997 Annual Book of ASTM Standards*, Volume 4.08: Soil and Rock (I), American Society for Testing and Materials, Philadelphia, Pennsylvania.
- ASTM, See American Society for Testing and Materials.
- Daniel, D.E. and R.M. Koerner, 1995, *Waste Containment Facilities Guidance for Construction Quality Assurance and Quality Control of Liner and Cover Systems*, American Society of Engineers, New York, NY.
- Daniel, D.E. and C.H. Benson, 1990, “Water Content-Density Criteria for Compacted Soil Liners,” *Journal of Geotechnical Engineering*, American Society of Engineers, Vol. 116, No. 12.
- DOE-ID, 1999, *Final Record of Decision, Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13*, DOE/ID-10660, Rev. 0, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, U.S. Environmental Protection Agency Region 10, and State of Idaho Department of Health and Welfare.
- DOE-ID, 2000, *Geotechnical Report for the Conceptual Design of the INEEL CERCLA Disposal Facility at Waste Area Group 3, Operable Unit 3-13*, DOE/ID-10812, Rev. 0, Department of Energy Idaho Office Operations, Idaho Falls, Idaho.
- DOE-ID, 2001a, “INEEL CERCLA Disposal Facility Specifications for Excavation and Constructing and Testing of Clay Liner and Test Pad,” DOE-ID, SPC-1475, Rev. 0, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.
- DOE-ID, 2001b, “INEEL CERCLA Disposal Facility Construction Quality Assurance Plan for Excavation and Constructing and Testing of Clay Liner and Test Pad,” DOE/ID-10849, Rev. 0, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.
- DOE-ID, 2001c, “Soil Amendment Study,” DOE-ID, EDF-ER-272, Rev. 0, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.
- DOE-ID, 2001__, “Test Pad Post-Construction Report,” (EDF __), *to be completed in subsequent submittals*.
- EPA, 1993, *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93-182, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

SECTION VIII—CONSTRUCTION QUALITY
ASSURANCE DOCUMENTATION