Appendix G. Construction Quality Control Plan

Construction Quality Assurance Plan
Meyers Landfill Intermediate Remedial Design
Operable Unit (OU) 1, Multilayer Cap
El Dorado County, California

January 2009

28-072

Prepared for:

United States Department of Agriculture
Forest Service, Region 5
Lake Tahoe Basin Management Unit
South Lake Tahoe, California

Prepared by:

Engineering/Remediation Resources Group, Inc.
115 Sansome Street, Suite 200
San Francisco, California 94108
(415) 395-9974

Draft
Construction Quality Assurance Plan
Meyers Landfill Intermediate Remedial Design
Operable Unit (OU) 1, Multilayer Cap
El Dorado County, California

Submitted by:
Engineering/Remediation Resources Group, Inc.

Signature	January 29, 2009 Date
Caitlin Gorman Name	Project Manager Title
Signature	January 29, 2009 Date
Peter Loveridge Name	Project Engineer Title

Certification

This document was prepared under the direction and
supervision of a qualified Professional Engineer

Peter Loveridge
P.E., No. C052519

Table of Contents

Table of Contents *(continued)*

Tables

Acronyms and Abbreviations

CQA	construction quality assurance
CQC	construction quality control
ERRG	Engineering/Remediation Resources Group, Inc.
Forest Service	U.S. Department of Agriculture Forest Service
FTB	film tearing bond
LFG	landfill gas
mm	millimeter
OU	Operable Unit
psi	pounds per square inch
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RD	Remedial Design

Section 1. Introduction

Engineering/Remediation Resources Group, Inc. (ERRG) has prepared this Construction Quality Assurance (CQA) Plan for the Remedial Design (RD) for Operable Unit (OU)-1, the Meyers Landfill Site, in El Dorado County, California. This RD is being developed under the U.S. Department of Agriculture Forest Service (Forest Service) Regional Environmental Response Action Contract (AG-91S8-C-06-0056) Activity V, Task 2. The proposed RD for OU-1 includes the design of (1) a new cap system for the landfill that minimizes infiltration through the waste, controls surface water runoff, and controls potential erosion from the cap; (2) a new French drain; and (3) a passive landfill gas (LFG) emissions control system. This plan describes the necessary quality assurance (QA) procedures that are to be undertaken during construction activities associated with implementation of the RD.

1.1. PURPOSE

This CQA Plan is to be used by the CQA organization during construction of the Meyers Landfill cap to ensure that appropriate quality control (QC) and QA procedures are followed during construction.

The CQA Plan is a guidance document that contains general and specific work element requirements to be used to monitor construction. General requirements include organization and responsibilities of CQA personnel, documentation control, and reporting procedures. Specific work elements requiring CQC and CQA include the following:

- Earthwork
  - Clearing and Grubbing
  - Stockpiling and Soil Management
  - Excavations
  - Solid Waste Placement
  - Foundation Layer Placement
  - Geomembrane Subgrade Preparation
  - Drainage Layer and French Drain Materials
  - Cover Layer Placement
  - Vegetative Layer Placement
  - Temporary Erosion and Sediment Controls
  - Road Grading for New Access Road

- Landfill Gas System
  - Well Abandonment
  - Landfill Gas Vents and Perimeter Monitoring Points
- Geosynthetics Installation
  - Nonwoven Geotextile
  - Geomembrane
  - Geocomposite
  - Geogrid
- Other Work Elements
  - Surface water and storm water controls
  - Surface feature protections and landscaping

A final construction after action report will be prepared by the CQC organization following completion of construction. The report will include information generated through the CQC program and will document the extent to which construction was performed in accordance with this plan and the intent of the landfill design.

1.2. CONSTRUCTION QUALITY ASSURANCE ORGANIZATION

The CQA organization has the primary responsibility of implementing and managing the CQA program described in this plan and will document that construction CQC was performed in compliance with the CQC plan, and therefore that the construction was performed in compliance with the design and contract documents. Specific responsibilities for the CQA organization site personnel are presented in Section 2.1, Construction Quality Assurance Personnel and Responsibilities.

1.3. REPORT ORGANIZATION

This CQA Plan is organized as follows:

- Section 1: Introduction, summarizes the purpose of the CQA Plan, the CQA organization, and provides terms, including their definitions, used throughout the plan.
- Section 2: General Requirements, provides an overview of the CQC and CQA program, including CQC and CQA personnel and responsibilities, meetings, document control, construction monitoring, verification of materials quality, and equipment control.
- Section 3: Construction Quality Assurance, describes the CQC and CQA procedures and construction testing.
- Section 4. Earthwork Monitoring and Testing Requirements, summarizes the CQC and CQA requirements for the specific work elements discussed in Section 1.1.
- Section 5. Landfill Gas System Monitoring and Testing Requirements, summarizes the CQC and CQA requirements for the specific work elements discussed in Section 1.1.
- Section 6: Geosynthetics Monitoring and Testing Requirements, describes the CQC and CQA requirements for the different geosynthetic components of the cap (see Section 1.1), as well as the requirements for delivery, conformance testing, installation, repair, and the geogrid.

- Section 7: Other Work Elements Testing Requirements, describes the CQC and CQA requirements for the components of surface water drainage controls (including concrete), protective cages for surface features, as well as landscaping and revegetation requirements
- Section 8: Documentation, provides general requirements for CQC project documentation, including record-keeping, progress reports, photographs, design and specification changes, and the final construction report.

All parties involved in construction activities should be thoroughly familiar with this plan, the project Construction Drawings, and the Construction Specifications.

1.4. TERMS AND DEFINITIONS

Whenever the terms listed below are used, the intent and meaning will be interpreted as indicated.

Construction Manager. The individual or firm responsible for administering the construction contract and providing overall construction management for the project. The construction manager is the primary contact on the project site.

Construction Drawings. The official plans, profiles, typical cross sections, elevations, and details, as well as their amendments and supplemental drawings, which show the locations, character, dimensions, and details of the work to be performed. Construction drawings are also referred to as "plans."

Construction Quality Assurance (CQA). Those actions that ensure a contractor's construction quality control (CQC) is working effectively, and that the end product complies with the QC requirements established by the contract. CQA also includes verifying that the contractor is performing QC requirements of the CQC Plan and project specifications. CQA will be completed by an independent engineering firm that is not affiliated with the construction contractor.

QA Manager. Authorized representative of the CQA Organization and professional engineer registered in the state of California. The QA manager is responsible for certifying that construction was performed in accordance with the intent of the contract documents and design.

QA Monitors. Authorized representative of the CQA Organization, responsible for observing and documenting activities related to CQA during construction.

Construction Quality Control (CQC). CQC encompasses all actions that measure and regulate the characteristics of an item or service to determine conformance with contractual and regulatory requirements. CQC is conducted, at a minimum, by the Contractor. Performance of selected CQC functions may be delegated to subcontractors, but remain the responsibility of the Contractor. CQC oversight will be the responsibility of the Contractor.

QC Manager. On-site authorized representative of the CQC Organization responsible for preparing and maintaining QC documentation, in addition to the QC plans and inspection system. The QC Manager is responsible for ensuring that all specified inspections and tests are performed, and that all field and laboratory data are reviewed and approved or disapproved.

Construction Specifications. The qualitative requirements for products, materials, and workmanship upon which the contract is based. Construction specifications may also be referred to as technical specifications or project specifications in this CQA Plan.

Contract Documents. The official set of documents issued by the contracting entity. This set of documents includes bidding requirements, contract forms, contract conditions, specifications, contract drawings, addenda, and contract modifications.

Contractor. The firm, partnership, or corporation, or any combination, private, municipal, or public, who, as an independent contractor, has entered into a contract to complete the RD.

Design Engineers. The individuals or firms responsible for design and preparation of the project construction drawings and specifications; also referred to as "designers" or "engineers".

Nonconformance. A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of nonconformance include, but are not limited to, physical defects, test failures, and inadequate documentation.

Owner. The implementing party for this project.

Procedure. A document that specifies or describes how an activity is to be performed.

Project Documents. Contractor submittals, construction drawings, record drawings, specifications, shop drawings, CQC and CQA plans, health and safety plan, and project schedule.

Project Manager. Representative of the Contractor with overall responsibility for work performed under assigned task(s). The Project Manager provides project direction and interpretation of scope of work, as well as verification and approval of quantities and work completion.

Record Drawings. Drawings recording the constructed dimensions, details, and coordinates of the project; also referred to as "as-builts."

Subcontractor. The person or persons, firm, partnership, corporation, or any combination, or any combination private, municipal, or public, who as an independent contractor has entered into a contract with the Contractor.

Surveyor. A licensed surveyor in the State of California responsible for checking locations and elevations of the completed work. The surveyor is also responsible for producing stamped as-built drawings for inclusion in the final construction report.

Testing. Verification that an item meets specified requirements by subjecting that item to a set of physical, chemical, environmental, or operating conditions.

Testing Laboratory. A laboratory capable of conducting the tests required by this CQA Plan and within the specifications.

Section 2. General Requirements

2.1. CONSTRUCTION QUALITY ASSURANCE PERSONNEL AND RESPONSIBILITIES

This section discusses the roles of key project CQA personnel, including the QA Manager, Design Engineers, QA Monitors, and the QC Manager, and their primary responsibilities.

2.1.1 Responsibilities of the QA Manager

The QA Manager administers the CQA program. The QA Manager has authority to identify deficiencies and implement corrective action to the CQA program. Key responsibilities of the QA Manager include:

- Reviewing CQC data, submittals, and reports for compliance with the project CQC and CQA Plan.
- Acting as an auditor to verify and document proper and complete implementation of the CQC and CQA programs.
- Approving contractor submittals (requiring government approval).
- Reviewing and approving the final construction report.

The QA Manager reports directly to the Owner.

2.1.2 Responsibilities of the Design Engineers

The Design Engineers represent their organizations and are responsible for site engineering services related to their design. Those services include reviewing contractor submittals, resolving technical issues related to construction, providing interpretation of the drawings and specifications, and approving substantial design modifications and technical revisions, if necessary.

2.1.3 Responsibilities of the QA Monitors

The QA Monitors implement the CQA program under the direction of the QA Manager. The QA Monitors perform all construction monitoring and construction materials testing requested by the QA Manager. The QA Monitors report directly to the QA Manager.

2.1.4 Responsibilities of the QC Manager

The QC Manager implements the CQC program under the direction of the Construction Manager. Key responsibilities of the QC Manager include:

- Overseeing all construction, construction monitoring, and construction materials testing.
- Identifying deficiencies and implementing corrective actions in accordance with the requirements of the CQC Plan.
- Maintaining all documentation and test data summaries related to construction, construction monitoring, and construction materials testing.

The QC Manager has the authority to stop work at any sign of noncompliance. If potential concerns are identified during execution the fieldwork, the QC Manager will consult with the QA Manager who may authorize work to continue upon review. The QC Manager will communicate QC inspection and testing results directly with the Construction Manager and coordinate with the Construction Manager to implement corrective actions, if needed.

2.2. MEETINGS

To facilitate construction and to clearly define construction goals and activities, close coordination between the Owner, Construction Manager, Project Manager, QA Manager, and QC Manager is essential. To meet this objective, pre-construction, progress, weekly, and other meetings will be held. Resolutions and action items from these meetings will be documented by the Owner or designee, unless otherwise specified, and forwarded to all meeting attendees.

2.2.1 Pre-Construction Meeting

Following bid award a pre-construction meeting will be attended by the Owner, Construction Manager, Project Manager, QA Manager, QC Manager, and others as designated by the CQA Organization. The purpose of the meeting will be to:

- Review construction drawings, specifications, CQA/CQC plans, work area security, health and safety procedures, and related issues.
- Provide all attendees with relevant project documents.
- Review responsibilities of each attendee.
- Define lines of communication and authority.
- Establish reporting and documenting procedures.
- Review procedures for handling submittals.
- Review testing equipment and procedures.
- Review procedures for field directives and changes to scope, schedule, and budget.
- Establish testing protocols and procedures for correcting and documenting construction or nonconformance.
- Establish weekly or other regular meetings schedule.
- Discuss work areas, laydown areas, and related items (this task typically includes conducting a site visit as part of the meeting).
- Review the project schedule and critical path items.

The CQC Organization will prepare handouts for all attendees. The meeting will be documented by the CQC Organization. Copies of the minutes will be reviewed by the CQA Organization.

2.2.2 Progress Meeting

Informal progress meetings will be held each morning before the start of work. At a minimum, this meeting will be attended by the QC Manager, Construction Manager, and Contractor. The purpose of this meeting is to:

- Discuss problems and resolutions.
- Review test data.
- Discuss the contractor's personnel and equipment assignments for the day.
- Review the previous day's activities and accomplishments.
- Resolve any outstanding problems or disputes.

2.2.3 Weekly Meeting

Weekly meetings will be held either at the site or by conference call. The QC Manager, QA Manager, Construction Manager, and Contractor's Project Manager will attend with additional support from the Owner and other project team personnel, as needed. The meetings will be held to:

- Review the minutes of previous the meeting; review the schedule and status of work, including work or testing accomplished since the last meeting, rework items identified since the last meeting, and rework items completed since the last meeting
- Review the status of submittals, including submittals reviewed and approved since the last meeting and submittals required in the future
- Review work to be accomplished in the next 2 weeks and documentation required (e.g., establish completion dates for rework items, discuss construction methods and approach to be used to provide construction quality and identify potential problems, discuss status of off-site work or testing; identify documentation required, and resolve QC and production problems)
- Address items that may require revising the QC plan (e.g., changes in QC organization personnel and in procedures).

2.2.4 Other Meetings

As required, other meetings will be held to discuss problems or nonconformance. These meetings will be attended by parties as directed by the QA Manager. If the problem requires a design modification and subsequent change order, the design engineering firm should also be present. The meeting will be documented.

2.3. CONTROL OF DOCUMENTS, RECORDS, AND FORMS

2.3.1 Control of Construction Documents

Contract documents, including specifications, drawings, and change orders, are controlled by the Construction Manager. The Construction Manager will maintain one or more copies of the most current set of construction documents for use by the CQA and CQC Organizations. Upon issuance of new copies or revisions, it is the responsibility of the Construction Manager to notify the Contractor of the revisions, provide revised contract documents, and order the recall of all unrevised copies of the contract documents. The Construction Manager also provides the latest revised set of contract documents to the CQA and CQC Organizations.

2.3.2 Control of As-Built Information

As-built information generated by the Contractor is controlled by the QC Manager. During the progress of work, the QC Manager obtains and initials all as-built information provided by the Contractor, surveyors, or others and compiles all as-built data. At the completion of the project, this information is used in preparing final drawings for the final construction report. The set of as-built drawings must be maintained on site and be clearly marked as such. The QC Manager will provide survey and as-built information to the QA Manager upon request.

2.3.3 Control of Forms

Daily report forms, test report forms, and other project forms are controlled by the QC Manager who maintains a master of each form for copies. Upon issuance of a new form, the QC Manager must recall and remove all superseded copies along with the master and provide new copies for their use. Substantive updates to project forms must be approved by the QA Manager.

2.3.4 Processing Daily Reports

The QC Manager will write a daily record of work progress. Daily reports are submitted to the Construction Manager and are maintained at the site. The daily reports are reviewed by the QA Manager for legibility, clarity, traceability, and completeness. The review must be evidenced by signature.

2.3.5 Processing Test Reports

A test report must be completed by the CQC Organization whenever testing is performed. Test reports are submitted to the Construction Manager and are maintained at the site. Test reports (or summaries) from independent testing laboratories will also be transmitted to the QA Manager for review. The review includes a check for mathematical accuracy, conformance to test requirements, and conformance to specifications, and for clarity, legibility, traceability, and completeness. The review must be evidenced by a signature of the QA Manager.

2.3.6 Processing Project Records

Project records are completed as needed. Use of the project records is limited to the scope for which they are intended. The record must be completed by filling in all of the blanks provided on the form, followed by the signature of the individual completing the form. All project records must be maintained at the site.

2.4. DOCUMENTATION AND CONTROL OF NONCONFORMANCE

2.4.1 Observation of Nonconformance

Whenever a nonconformance is discovered or observed in the construction process, product, job-related materials, documentation, or elsewhere, the QC Manager should first notify the Construction Manager and the QA Manager.

2.4.2 Determining Extent of Nonconformance

Whenever a nonconformance is discovered or observed in the construction process, product, job-related materials, documentation, or elsewhere, the QC Manager, and their organization will determine the extent of the nonconformance. The extent of the deficiency may be determined by additional sampling, testing, observations, review of records, or any other means deemed appropriate. The QA Manager will review all non-conformance assessments made by the CQC Organization.

2.4.3 Documenting Nonconformance

All nonconformance must be documented by the CQC Organization in writing on the daily records, logs, and elsewhere, as appropriate. The documentation must occur immediately upon determining the extent of the nonconformance. For those nonconformances that are considered serious or complex in nature or that require an engineering evaluation, a nonconformance report will be prepared and issued to the QA Manager, in addition to the Construction Manager and the Contractor.

2.4.4 Corrective Measures

For a simple or routine nonconformance, corrective measures will be determined by specification direction or, if none exists, the QC Manager, Construction Manager, Contractor will discuss standard construction methods to correct the deficiency. For nonconformance reports that require an engineering evaluation, the Design Engineers must determine corrective measures. A copy of the nonconformance report, with the Design Engineer's corrective measure determination, will be forwarded to the QA Manager for informational purposes, and to the Construction Manager and for implementation of the corrective action.

2.4.5 Verification of Corrective Measures

Upon notification by the Contractor or Construction Manager that a corrective measure is complete, the QC Manager will verify its completion and report the results of the corrective actions to the QA Manager. The verification must be accomplished by observations or retesting and documented photographically. The QC Manager will provide written documentation of the corrective measures on daily reports, logs,

and forms, and, if applicable, a nonconformance report. The Construction Manager will review and verify the corrective measure. The Design Engineer will review and verify corrective action measures that require an engineering evaluation.

2.5. CONSTRUCTION MONITORING

Before construction begins, the QA Manager will establish a list of monitoring priorities for the CQC Organization. The list will include the various construction activities and the monitoring priority of those activities. The monitoring priorities may change during construction based on contractor performance and owner request. The QA Manager must approve any changes in the monitoring priorities.

2.6. MATERIALS QUALITY VERIFICATION

The CQC Organization may identify material sources, and samples from those materials may be tested to evaluate whether the material meets the project specifications for specific work elements. Definitions and requirements of materials are provided in the technical specifications (see Appendix F of the RD). Test samples will be obtained in accordance with applicable ASTM International standards. Archive samples and test results of the test samples will be maintained and stored at the project site. The CQC Organization will establish and maintain a materials quality verification list. The list will include material sources, sample locations, testing requirements, test results, and verification action items. The QA Manager will review the list as it is updated. The QA Manager may, through on-site QA Monitors, obtain and test samples or certificates of compliance and conformance to verify the results of the CQC Organization's analyses.

2.6.1 Materials Submittals

When sample submittals are required, they will be made available to the both the CQC and CQA Organizations by the contractor. The QA Manager is responsible for review and acceptance material submittals, if those submittals are designated as requiring government approval by the technical specifications. The CQA Organization may use material submittals (submitted by the CQC Organization) to establish the acceptability of materials. Submittals not requiring government approval will be submitted to the QA Manager by the CQC Organization for informational purposes.

2.6.2 Certificates of Compliance and Conformance

The QA Manager may use certificates of compliance and conformance (submitted by the CQC Organization or obtained by the QA Monitor) to establish the acceptability of materials. The certificates generally state that the material is in compliance or conformance with a particular code, standard, or specification. The certificate may be used for acceptance of a product before or instead of testing, if allowed by the specifications.

2.7. EQUIPMENT CONTROL

Before the start of construction, the QC Manager will complete a list of all measuring, sampling, and testing equipment to be used at the site. As new equipment becomes available during the course of the project, it must be added to the list. When more than one type of equipment is available, a unique number will be affixed to each piece to maintain identity. The equipment list is maintained in the project files and contains the following information:

- Type of equipment
- Serial number or identifying number
- Date item received at site
- Use of the equipment
- Date removed from service

Before using a piece of testing equipment, the CQC Organization must calibrate and establish its accuracy. Types of equipment requiring calibration include nuclear gauges, sand cone devices, sand to be used in sand cones, and scales. The calibration procedures and frequencies must be in accordance with manufacturer's instructions or ASTM International standards. Whenever the equipment is suspect or is producing questionable results, it must be removed from service immediately and recalibrated.

The QA Manager will review equipment maintenance and calibration records periodically to verify that the CQC Organization is conforming to the operations and maintenance protocols for the testing equipment.

Section 3. Construction Quality Assurance

3.1. CONSTRUCTION QUALITY ASSURANCE

This section describes CQC procedures for construction operations and the CQA monitoring required to verify the proper implementation of the CQC program. The scope of items with related CQC/CQA requirements includes the following specific work elements:

- Earthwork
  - Clearing and Grubbing
  - Stockpiling and Soil Management
  - Excavations
  - Solid Waste Placement
  - Foundation Layer Placement
  - Geomembrane Subgrade Preparation
  - Drainage Layer and French Drain Materials
  - Cover Layer Placement
  - Vegetative Layer Placement
  - Temporary Erosion and Sediment Controls
  - Road Grading for New Access Road
- Landfill Gas System
  - Well Abandonment
  - Landfill Gas Vents and Perimeter Monitoring Points
- Geosynthetics Installation
  - Nonwoven Geotextile
  - Geomembrane
  - Geocomposite
  - Geogrid
- Other Work Elements
  - Surface water controls
  - Surface feature protections and landscaping

3.2. CONSTRUCTION TESTING

All required construction QC testing methods and procedures are identified in the construction specifications (see Appendix F of the RD).

3.3. TEST FREQUENCIES

Tables G-1, G-2, G-3, and G-4 establish the test frequencies for CQC of earthwork, geomembrane, and concrete. The test frequencies listed establish a minimum number of required tests. Extra testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. Any retests performed as a result of a failing test do not contribute to the total number of tests performed in satisfying the minimum test frequency. The CQA Organization's role partly consists of monitoring the frequency and quality of testing conducted by the CQC Organization, as described in this CQA Plan.

3.3.1 Soil Sample Numbering

The CQC Organization maintains soil sample numbers in a master log maintained at the site. Sample numbers begin with (001) and proceed upward. No sample number can be repeated, and retests of a failing sample are given the original number with a letter suffix (e.g., retests for a failing sample 021 would be: 021A, 021B, etc.). The master log of test samples includes the following information:

- Sample number
- Test(s) to be performed
- Date sampled
- Monitor obtaining sample
- Location sampled
- Location to testing (site vs. off site)
- Date sample sent off site
- Date test results received
- Site testing monitor
- Date testing completed at site
- Test results and remarks

The QA Manager will periodically review the master log of test samples to verify that sample collection and testing are being performed in accordance with project specifications.

3.3.2 Soil Sample Tagging

The CQC Organization is responsible for maintaining sample identification for all soil samples while on site, from time of sampling through completion of testing. The CQC Organization must place a sample tag on the soil sample container immediately upon sampling. The tag must remain with the soil sample throughout processing. The tag contains the following information:

- Sample number
- Material type
- Project name and project number
- Sampling monitor
- Date sampled
- Test(s) to be performed

The QA Manager will periodically inspect sample tags to verify that they conform to the format specified above.

3.3.3 Soil Sample Processing

The CQC Organization is responsible for the timely processing of soil test samples. The QC Manager determines which samples are tested on site and which are tested off site. The QC Manager bases this determination on manpower available, equipment available, complexity of test, and time available for results. For expediency, samples to be tested off site should be shipped the same day as they are collected.

The QA Manager will periodically assess the timeliness and expediency of the CQC Organization's soil sample processing. The QA Manager will make recommendations to the QC Manager regarding soil sample processing deficiencies, if any are discovered.

3.3.4 Field Density Tests

The CQC Organization is responsible for maintaining test numbers and results for field density tests performed by the nuclear moisture density method (ASTM D 6938). All other testing is identified through the sample number (Section 3.3.1). The QC Manager maintains field logbooks that identify soil segments, data tested, person performing the test, and sequential test number. The QA Manager will periodically inspect field logbooks to verify that field test documentation conforms to the requirements described in this CQA Plan. The QA Manager will also observe density testing procedures, and if deemed necessary, may commission independent simultaneous testing to verify the quality of the CQC Organization's testing program.

Each soil segment will have a series of numbers as listed below.

Soil Segment	Test Number Series
Solid Waste	1000 - 1999
Foundation Layer	2000 – 2999
Drainage Layer	3000 - 3999
Cover Layer/Vegetative Layer	4000 – 4999
General Fill	5000 – 5999

No test number can be repeated for a given soil segment, and retests of failing tests must be given a letter suffix along with the original test number (e.g., retests for a failing Test 1201 would be 1201A, 1201B, etc.). Test data and results must be filled out on the field density test form.

3.3.5 Field Density Test Locations

The intention of the CQC program is to provide confidence that the earthwork materials and work conform to the technical specifications. To meet this intent, the CQC Organization will perform density tests of solid waste, foundation layer, drainage layer, cover soils, and any other soil products used during construction. Density tests must be located at various elevations and uniformly dispersed throughout the entire plan dimensions of the fill. Density test locations must be chosen without bias; however, additional testing can be performed in any areas that are suspect, marginal, or appear to be of poor quality. During the progress of the work, the QC Manager will plot density test locations on a drawing to verify that no significant areas are untested.

The CQA Organization will provide confidence that the CQC Organization is adequately evaluating and testing the earthwork materials and work to confirm that project specifications are being met. To achieve this, the CQA Organization will monitor the distribution of field density test locations to confirm that the coverage of the testing meets the requirements identified in the technical specifications.

Section 4. Earthwork Monitoring and Testing Requirements

The following sections list CQC monitoring and testing requirements for earthwork. The CQA Organization will verify that the following monitoring and testing requirements are being fulfilled by the CQC Organization.

4.1. CLEARING AND GRUBBING

- Verify that erosion and sediment control silt fences, straw bale barriers, and other measures are securely in place prior to initiating clearing and grubbing operations in any area.
- Verify that existing plant life designated to remain is protected against damage during construction.
- Consult with Forest Service biologist to ensure that noxious weeds are not spread through the clearing and grubbing process
- Verify that clearing in areas required for site access and execution of the work is complete.
- Verify that vegetation, roots, and highly organic soil within marked areas are removed to a minimum depth of 6 inches (150 millimeters [mm]) below the existing ground surface.
- Verify that all stumps, tree and shrubbery roots, buried logs and any other harmful material is removed to a minimum of 3 feet (900 mm) below the existing ground surface.
- Verify that all stumps and plant life are placed in the site recycling yard.
- Verify that stockpile subgrades are surveyed prior to stockpiling.

4.2. STOCKPILING AND SOIL MANAGEMENT

- Verify stockpile locations, stockpile dimensions, haul routes, material segregation procedures, and erosion, sediment and drainage control measures. Determine and note corrective action items, if applicable.
- Verify that stockpile locations have been cleared, grubbed, and stripped in accordance with the clearing, grubbing, and stripping section of this CQA Plan and the technical specifications.
- Designate the stockpile areas as:
  - Existing Cover Soil Stockpile
  - Debris Stockpile

- During excavation, hauling, and stockpiling operations continually identify and verify material classifications in accordance with ASTM D 2487 and ASTM D 2488, as necessary, to characterize material stockpile designations. Work closely with Contractor's QC personnel to classify materials using the rapid field tests described in ASTM D 2488.
- Verify that stockpiles are constructed with slopes no steeper than 2:1 (horizontal to vertical), and that the top surface maintains a minimum 5 percent grade. Verify slopes and grades using hand-held levels and inclinometers, range poles, and measuring tapes.

4.3. EXCAVATIONS

- Verify that dewatering systems, if any, are operational, and that the static groundwater level is sufficiently drawn down to allow excavations to proceed.
- Verify that construction staking is performed before work, and that survey benchmarks with elevations are secured outside the work area.
- Verify that the contractor has notified the Underground Service Alert to identify and locate underground utilities.
- Verify that excavated materials are segregated into proper stockpiles and placement areas.
- Coordinate with the contractor to perform excavation verification surveys upon completion of excavating operations. Verify corrective action measures, as determined by verification surveys. Verification surveys will also be used to evaluate limits of excavation for measurements and payment applications.

4.4. SOLID WASTE PLACEMENT

- Verify that construction staking is performed before work and that survey bench marks with elevations are secured outside the work area.
- Visually inspect waste to be relocated prior to placement and verify that only acceptable wastes are consolidated on site. Any oversized or non-compactable waste (such as household appliances, automobiles, etc.) or materials that cannot be disposed of on site (such as car batteries, tires, etc.) will be segregated, characterized, profiled, transported, and disposed of at an appropriately permitted recycling or disposal facility.
- Verify that solid waste materials are placed and compacted in 8-inch-thick loose lifts. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Field-verify lines, grades, and dimensions using hand-held levels, range poles, and measuring tapes.
- Coordinate with the Contractor to perform verification surveys at the completion of waste placement operations. Verify corrective action measures, as determined by verification surveys. Verification surveys will also be used to determine the limits of waste for future applications.

4.5. FOUNDATION LAYER PLACEMENT

- Verify that construction staking is performed before work and that survey bench marks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D 2487 and D 2488) to verify that the material source is suitable for the foundation layer. Verify that the material is free of organic and oversized materials. Perform classifications continually during excavation of borrow materials.
- Perform moisture and density relationship testing (ASTM D 1557) to determine the maximum dry density and optimum moisture content of earthfill materials. Perform tests at testing frequencies specified in Table G-1.
- Verify that foundation materials are placed and compacted in 8-inch loose lifts. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear gauge density and moisture tests (ASTM D 6938) to verify that each lift is compacted as required by the technical specifications. Perform tests at testing frequencies specified in Table G-1.
- Verify that soil materials that are too wet for proper compaction per the specifications are properly aerated and processed to bring the moisture content of the material into the acceptable range of the optimum moisture content.
- Verify that soils that are too dry for proper compaction per the specifications are properly moisture conditioned and processed to bring the moisture content into the acceptable range of the optimum moisture content.
- Verify that desiccated lifts are properly repaired or removed before placing subsequent lifts.
- Verify that final foundation layer surface is free of sharp objects or rocks larger than 0.5 inch protruding at the surface that may damage the geomembrane.
- During placement of the foundation layer, field-verify lines, grades, and dimensions using hand-held levels, range poles, and measuring tapes.
- Coordinate with the Contractor to perform verification surveys at the completion of foundation layer operations. Verify corrective action measures, as determined by verification surveys. Verification surveys will also be used to determine the limits of foundation layer for measurement and payment applications.

4.6. GEOMEMBRANE SUBGRADE PREPARATION

- Verify that material source is suitable for the subgrade, is free of organic and oversized materials, and meets the grading requirements of the technical specifications.
- Verify that grade control construction staking is performed prior to work.
- Perform moisture and density relationship testing (ASTM D 1557) to determine the maximum dry density and optimum moisture content of subgrade materials.
- Verify that the top of the subgrade is compacted as required by the technical specifications with nuclear gauge density and moisture tests (ASTM D 6938). Perform tests at testing frequencies specified in Table G-1.

- Verify that angular or sharp rocks and other debris that could damage the geomembrane are removed from the surface of the subgrade. Verify that the subgrade is free of irregularities and is steel drum rolled smooth prior to geosynthetic placement.
- Verify that the final surface provides continuous and intimate contact with the overlying geosynthetic.
- Coordinate with the Contractor to perform subgrade verification surveys upon completion of the subgrade preparation. Verify corrective action measures, as determined by the verification surveys. Verification surveys will also be used to determine the limits of the subgrade preparation for measurement and payment applications.

4.7. DRAINAGE LAYER AND FRENCH DRAIN MATERIALS

- Review the Contractor's approved work plan of proposed methods to place drainage material for a cap drainage layer over geosynthetic installations and for excavation and installation of drainage materials for a French drain. Determine and note corrective action items if applicable.
- Perform sieve analysis (ASTM D 422) to verify that granular drainage materials for the cap drainage layer are in compliance with material gradation requirements of the technical specifications. Perform tests at testing frequencies specified in Table G-3.
- Complete visual inspections of 6-inch perforated high-density polyethylene pipe for use in the French drain to ensure material quality and conformance with Contractor's approved work plan and design drawings.
- Verify that grade control construction staking is performed prior to work.
- Monitor placement of the cap drainage layer to verify that underlying geosynthetics installations are not damaged during placement operations. Mark damaged geosynthetics, and verify that damage is repaired.
- Verify and record material thickness during placement of the cap drainage layer by occasionally digging test holes and checking thickness against grade control stakes.
- Coordinate with the Contractor to perform verification surveys of the cap drainage primary and secondary collection layers upon completion of placement operations. Verify corrective action measures, as determined by the verification surveys. Verification surveys will also be used to determine the limits of the primary and secondary collection layer for measurement and payment applications. Submit copy of verification to the Construction Manager.

4.8. COVER LAYER PLACEMENT

- Verify that construction staking is performed before work, and that survey benchmarks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D 2487 and ASTM D 2488) to verify that the material source is suitable for the cover layer. Verify that the material is free of organic and oversized materials. Perform classifications continually during excavation of borrow materials.
- Perform moisture and density relationship testing (ASTM D 1557) to determine the maximum dry density and optimum moisture content of cover layer soils. Perform tests at testing frequencies specified in Table G-1.

- Verify that cover layer soils are placed and compacted in 12-inch-thick loose lifts. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear gauge density and moisture tests (ASTM D 6938) to verify that each lift is compacted as required by the technical specifications. Perform tests at testing frequencies specified in Table G-1.
- Verify that soil materials that are too wet for proper compaction per specifications are properly aerated and processed to bring the moisture content of the material into the acceptable range of the optimum moisture content.
- Verify that soils that are too dry for proper compaction per specifications are properly moisture conditioned and processed to bring the moisture content into the acceptable range of the optimum moisture content.
- Verify that desiccated lifts are properly repaired or removed before placing subsequent lifts.
- Verify that final cover layer surfaces are free of ruts, gouges, and other features that might contribute to erosion and sediment runoff.
- During cover layer operations, field-verify lines, grades, and dimensions using hand-held levels, range poles, and measuring tapes.
- Coordinate with the Contractor to perform verification surveys at the completion of cover layer operations. Verify corrective action measures, as determined by verification surveys. Verification surveys will also be used to determine the limits of cover soils for measurement and payment applications.

4.9. VEGETATIVE LAYER PLACEMENT

- Verify that construction staking is performed before work, and that survey benchmarks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D 2487 and ASTM D 2488) to verify that the material source is suitable for the vegetative layer. Verify that the material is free of organic and oversized materials. Perform classifications continually during excavation of borrow materials.
- Perform moisture and density relationship testing (ASTM D 1557) to determine the maximum dry density and optimum moisture content of earthfill materials. Perform tests at testing frequencies specified in Table G-1.
- Verify that earthfill materials are placed and compacted in 8-inch-thick loose lifts. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear gauge density and moisture tests (ASTM D 6938) to verify that each lift is compacted as required by the technical specifications. Perform tests at testing frequencies specified in Table G-1.
- Verify that soil materials that are too wet for proper compaction per specifications are properly aerated and processed to bring the moisture content of the material into the acceptable range of the optimum moisture content.

- Verify that vegetative soils that are too dry for proper compaction per specifications are properly moisture conditioned and processed to bring the moisture content into the acceptable range of the optimum moisture content.
- Verify that desiccated soils are properly repaired or removed before placing subsequent lifts.
- Verify that final vegetative layer surfaces are free of ruts, gouges, and other features that might contribute to erosion and sediment runoff.
- During vegetative layer operations, field-verify lines, grades, and dimensions using hand-held levels, range poles, and measuring tapes.
- Coordinate with the Contractor to perform verification surveys at the completion of vegetative operations. Verify corrective action measures as determined by verification surveys. Verification surveys will also be used to determine the limits of earthfills for measurement and payment applications.

4.10. TEMPORARY EROSION AND SEDIMENT CONTROL

- Verify that the Contractor has prepared Owner-approved erosion and sediment control plans. Secure and review a copy of the plans to verify that the contractor is implementing practices and procedures described therein. Verify that all erosion and sediment control facilities are approved by the Owner before beginning site earthwork.
- Verify that all temporary erosion and sediment control facilities (e.g., sediment basin, straw bale barriers, erosion control wattles, and silt fences) are in place and operational prior to construction. Note additional erosion control opportunities and bring to the attention of the construction manager.
- Verify that disturbed ground surfaces are stabilized at the end of each workday. Verify that ground surfaces are immediately roughened by dozer track-walking upon reaching final grade. Verify that the dozer track imprints are perpendicular to the slope.
- Verify that permanent soil stabilization and erosion and sediment controls are implemented upon reaching final grade.
- Verify that silt fence materials comply with product requirements of the technical specifications.
- Verify that silt fence lines are at a constant elevation for each continuous length of fence.
- Verify that a trench is excavated along the silt fence line, if required by the specifications.
- Verify that fence posts are evenly spaced and securely driven into the ground along the downslope side of the excavated trench.
- Verify that the filter fabric and wire mesh support are securely fastened together and to the fence post.
- Verify that the filter fabric and wire mesh ends are joined by overlapping a minimum of 6 inches.
- Verify that the filter fabric extends into the trench a minimum of 4 inches.
- Verify that the trench is backfilled with soil.
- Verify that erosion control wattles comply with the product requirements of the technical specifications.
- Verify that the erosion control wattles are placed along the contour, perpendicular to the slope.

- Verify that the wattles are set into the trench a minimum of 2 inches, with no gap between the soil and bottom of wattle.
- Verify that wooden stakes have been used to fasten the wattles to the soil at 4-foot intervals

4.11. ROAD GRADING FOR NEW ACCESS ROAD

- Verify that construction staking is performed before work, and that survey benchmarks with elevations are secured outside the work area.
- Perform moisture and density relationship testing (ASTM D 1557) to determine the maximum dry density and optimum moisture content for road materials.
- If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear gauge density and moisture tests (ASTM D 6938) to verify that each lift is compacted as required by the technical specifications. Perform tests at testing frequencies specified in Table G-1.
- Verify that soil materials that are too wet for proper compaction per specifications are properly aerated and processed to bring the moisture content of the material into the acceptable range of the optimum moisture content.
- Verify that soils that are too dry for proper compaction per specifications are properly moisture conditioned and processed to bring the moisture content into the acceptable range of the optimum moisture content.
- Verify that desiccated lifts are properly repaired or removed before placing subsequent lifts.
- Verify that final road surfaces are free of ruts, gouges, and other features that might contribute to erosion or undermine the roadway.
- Coordinate with the Contractor to perform verification surveys at the final road. Verify corrective action measures, as determined by verification surveys.

Section 5. Landfill Gas System Monitoring and Testing Requirements

The following sections list CQC monitoring and testing requirements for the landfill gas system. The CQA Organization will verify that the following monitoring and testing requirements are being fulfilled by the CQC Organization.

5.1. WELL ABANDONMENT

- Review the Contractor's approved work plan of proposed methods for well abandonment. Ensure compliance with state of California and El Dorado County regulations, including all relevant sections of (1) California Water Code Division 7, Chapter 10; (2) California Health and Safety Code Division 104, Part 9.5; (3) California Water Well Standards Bulletins 74-81 and 74-90; and (4) the standards specified by the El Dorado County Department of Environmental Management.
- Determine and note corrective action items if applicable.
- Verify abandonment is by over-drilling, removing all casing and filter pack, and grouting with an appropriate sealing material.
- Verify that wells are sounded immediately prior to destruction to ensure they are free of obstructions.
- Verify removal of all material (e.g., annular seal, casing, screen, filter pack, etc.) within the original borehole.
- Verify complete backfilling of borehole with impervious sealing material. Acceptable sealing materials include neat cement, sand-cement grout, or concrete.
- Verify placement of sealing material by tremie pipe or equivalent method in one continuous operation.

5.2. LANDFILL GAS VENTS AND PERIMETER MONITORING POINTS

- Review the Contractor's approved work plan of proposed methods to install LFG vents and perimeter monitoring points. Determine and note corrective action items if applicable.
- Verify depth of LFG and perimeter monitoring point screens.
- Complete visual inspections of slotted polyvinyl chloride (PVC) (for use in LFG and perimeter monitoring point screens) and solid PVC pipe (for portion of LFG and monitoring point vent above the screen) to ensure material quality, dimensions, and conformance with Contractor's approved work plan.

- Complete visual inspections of gravel or sand pack material for all LFG vents and perimeter monitoring points to ensure conformance with Contractor's approved work plan.
- For LFG vents installed within the waste footprint, review product data (shop drawings) and shop test results for geomembrane penetrations and penetration details to verify conformance with specifications and ensure no leaks. Verify installation and testing of geomembrane seams, as discussed in Section 6.2, Geomembrane.
- Verify installation of LFG vents and perimeter monitoring points in accordance with Contractor's approved work plan.

Section 6. Geosynthetics Monitoring and Testing Requirements

The objectives of the geosynthetics CQC program are to (1) ensure that proper construction techniques and procedures are used and (2) ensure that the project is completed in accordance with the project construction drawings and technical specifications. The intents of the CQA program are to (1) verify that the CQC Organization is monitoring the installation of the geosynthetics in accordance with project specifications, (2) identify and define problems that may occur during installation and (3) verify that these problems are corrected before construction is complete.

This section describes CQC procedures for the installation of geosynthetic components. The CQA Organization will verify that the following monitoring and testing requirements are being fulfilled by the CQC Organization.

The following types of geosynthetics will be used for this project:

- Nonwoven geotextiles in various applications
- 60-mil double-sided textured linear low-density polyethylene geomembrane
- Geocomposite for the drainage layer
- Geogrid in the vegetative layer

CQC for the installation of geosynthetics will be performed to verify that geosynthetics are installed in accordance with the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, the CQC Organization will (1) review the contractor's QC submittals, (2) perform material conformance testing, (3) monitor construction testing, and (4) monitor installations. Conformance testing refers to activities that take place before installation of geosynthetics. Construction testing includes activities that occur during installation of geosynthetics.

All CQC testing will be conducted in accordance with this CQA Plan, the project CQC Plan, and the project construction drawings and specifications. If a discrepancy exists in the testing requirements, the document that requires the most stringent testing will govern.

6.1. NONWOVEN GEOTEXTILES

6.1.1 Delivery

During delivery of nonwoven geotextiles, the CQC Organization will:

- Verify that equipment used to unload the rolls will not damage the geotextile.
- Verify that rolls are wrapped in impermeable and opaque protective covers.
- Verify that care is used to unload the rolls.
- Verify that all documentation required by the specifications has been received.
- Verify that each roll is marked or tagged with the following information: manufacturer's name, project identification, lot number, roll number, and roll dimensions. Log this information on the geosynthetic receipt form.
- Verify that the geosynthetic receipt form is completed.
- Verify that materials are stored in a location that will protect the rolls from exposure to ultraviolet light, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or harmful conditions. Any damaged rolls may be rejected. Verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls, which do not have proper manufacturer's documentation, must also be stored at a separate location, until all documentation has been received and approved.

6.1.2 Conformance Testing

Testing Frequency. The CQC Organization will obtain geotextile conformance test samples for every 100,000 square feet and a minimum of one per batch or lot of material delivered to the site. The CQC Organization will collect samples of the material at the site, or an independent third party will collect samples at the manufacturing plant under the direction of the CQC Organization. The CQC Organization will forward the samples to the testing laboratory for the following conformance tests:

- Mass per unit area (ASTM D 5261)
- Grab strength (ASTM D 4632)
- Puncture resistance (ASTM D 4833)
- Permittivity (ASTM D 4491)
- Apparent opening size (ASTM D4751)
- Ultraviolet stability (ASTM D 4355)

The QC Manager will review all test results and report any nonconformance to the Construction Manager and the QA Manager.

Sampling Procedure. Samples will be collected from across the entire roll width and will be 3 feet long. Samplers must mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

6.1.3 Geotextile Installation

Surface Preparation. Before installation of the geotextile, the CQC Organization will:

- Verify that all lines and grades have been verified by the contractor.
- Verify that the subgrade has been prepared in accordance with the earthwork specifications and that, if placed over a geomembrane, the geomembrane installation and all associated documentation has been completed.
- Verify that soil or geomembrane surfaces do not contain protrusions that could damage the geotextile.
- Verify that no excessively soft areas exist in the soil surface that could damage the geotextile.
- Verify that all construction stakes have been removed.

Geotextile Placement and Seaming. During geotextile placement and seaming operations, the CQC Organization will:

- Observe the geotextile as it is deployed and record all defects and defect corrective actions (e.g., panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- Verify that equipment used does not damage the geotextile by handling, equipment transit, leakage of hydrocarbons, or other means.
- Verify that crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Verify that the geotextile is securely anchored in an anchor trench and is temporarily anchored to prevent movement by the wind.
- Verify that adjacent panels are overlapped and seamed in accordance with the specifications.
- Verify that the geotextile was not exposed to direct sunlight for more than 5 days.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.

The QC Manager must inform both the QA Manager and Construction Manager if the above conditions are not met.

6.1.4 Repairs

Repair procedures include:

- Patching – used to repair large holes, tears, and small defective areas.
- Removal – used to replace large defective areas where the preceding method is not appropriate.

6.2. GEOMEMBRANE

6.2.1 Delivery

Upon delivery of geomembrane, the CQC Organization will:

- Inspect the geomembrane rolls for damage during shipping and handling. Identify damaged materials and verify that damaged materials are set aside.
- Verify that the geomembrane is stored in accordance with the specifications and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage.
- Verify that all manufacturing documentation required by the specifications has been received.
- Verify that the geosynthetics receipt log form has been completed for all geomembrane materials received.

Damaged geomembrane may be rejected. If rejected, verify that material is removed from the site or stored at a location, separate from accepted geomembrane. Geomembrane that does not have proper manufacturer's documentation must be stored at a separate location, until all documentation has been received, reviewed, and accepted.

6.2.2 Conformance Testing

Testing Frequency. One geomembrane sample will be collected for every 100,000 square feet of material supplied and a minimum of one per lot or batch. The CQC Organization will collect samples of the material at the site, or an independent third party will collect samples at the manufacturing plant under the direction of the CQC Organization. The samples will be forwarded to an independent testing laboratory for the following conformance test:

- Thickness (ASTM D 5199)
- Density (ASTM D 1505)
- Carbon black content (ASTM D 1603)
- Carbon black dispersion (ASTM D 5596)
- Tensile properties (ASTM D 6693)
- Tear resistance (ASTM D 1004)
- Puncture resistance (ASTM D 4833)
- Oxidative induction time (ASTM D 3895)

Direct Shear Testing (ASTM D 5321). Perform three-point direct shear testing (minimum one test per project or material type) per ASTM D 5321 as described in the Construction Specifications. The QC Manager will review all conformance test results and report any nonconformances to the CQA Engineer and the Construction Manager.

Sampling Procedure. Samples will be collected across the entire roll width. Samples may be cut for shipping purposes, but a minimum of 5 square feet must be sent to the testing laboratory. Samplers must mark the machine direction and the manufacturer's roll identification number on the sample (each piece). Samplers will also assign a conformance test number to the sample and mark the sample with that number.

6.2.3 Geomembrane Installation

Surface Preparation. The soil surface must be prepared in accordance with the technical specifications. Before installation of the geomembrane, the subgrade will be inspected by the QC Manager and geosynthetics contractor. The CQA Organization must verify the following:

- All lines and grades for soil surface have been verified by the Contractor.
- The soil surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- The soil surface does not contain stones or other objects that could damage the geomembrane.
- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- No excessively soft areas exist.
- The soil surface is not saturated, and no standing water is present.
- The soil surface has not desiccated.
- All construction stakes have been removed, and no debris, rocks, or any other objects are in or on the soil surface.
- The geosynthetics contractor has certified in writing that the surface on which the geomembrane will be installed is acceptable.

Panel Placement. Before installing any of the geomembrane, the Contractor must submit drawings in accordance with the technical specifications. The drawings will show the proposed layout of the panels, including panel identification numbers, field seams, and any other details that do not conform to the construction drawings.

The QC Manager will maintain an up-to-date panel layout drawing that shows the following: (1) roll numbers, (2) panel numbers, (3) seam numbers, (4) test locations, (5) repair locations, and (6) nondestructive testing information.

During placement of the panel, the CQC Organization will:

- Record panel numbers and dimensions on the panel and seam log.
- Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (e.g., panel rejected, patch installed, extrudate placed over the defect, etc.) on the repair sheet. Verify that corrective actions are made in accordance with the specifications.
- Verify that equipment used during deployment operations does not damage the geomembrane. Verify that equipment used on the geomembrane does not leak hydrocarbons onto the geomembrane or that corrective measures are taken to prevent leakage.
- Verify that the surface beneath the geomembrane has not deteriorated since previous acceptance. Verify that no stones, construction debris, or other items are beneath the geomembrane that could damage the geomembrane.

- Verify that the geomembrane is not dragged across an unprotected surface. If the geomembrane is dragged across an unprotected surface, the geomembrane must be inspected for scratches and repaired or rejected, if necessary.
- Record weather conditions, including temperature, wind speed and direction, and humidity. Verify that the geomembrane is not deployed in the presence of excess moisture (e.g., fog, dew, mist, etc.). In addition, verify that the geomembrane is not placed when the air temperature is less than 40 °F or when standing water or frost is on the ground.
- Verify that crews working on the geomembrane do not smoke, wear shoes that could damage the liner, or engage in activities that could damage the geomembrane.
- Verify that methods used to deploy the geomembrane minimize wrinkles, and that panels are anchored to prevent movement by the wind. Verify that the contractor corrects any damage resulting to or from windblown geomembrane.
- Verify that no more panels are deployed than can be seamed on the same day.

The QC Manager must inform both the Contractor and the QA Manager if any of the above conditions are not met.

Field Seaming. Before the start of geomembrane welding and during welding operations, each welder and welding apparatus will be tested in accordance with the specifications to verify that the equipment is functioning properly. One trial weld will be taken before the start of work and one at mid-shift. The trial weld sample will be 3 feet long and 12 inches wide, with the seam centered lengthwise. The QC Manager will observe all welding operations and verify that the Contractor quantitatively tests each trial weld for peel adhesion (ASTM D 6392) and bonded seam strength (ASTM D 6392)[1]. The purpose of peel and shear tests is to evaluate seam strength and to evaluate long-term performance. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel adhesion measures the strength of the bond created by the welding process. The results of the peel and shear tests will be recorded on the trial weld form. Trial welds must be completed under conditions similar to those under which the panels will be welded. Trial welds must meet specified requirements for peel and shear, and the failure must be ductile or a film tearing bond (FTB) for a wedge weld. An FTB means the test specimen breaks at the edge of the outside of the seam, but not in the same seam. If at any time the QC Manager judges that welding apparatus is not functioning properly, a trial weld must be performed. Another trial weld must be performed if wide changes in temperature (~30 °F), humidity, or wind speed occur. The trial weld must be allowed to cool to ambient temperature before it is tested.

During geomembrane welding operations, the CQA Organization will:

[1] Peel adhesion tests will be referred to as "peel" and bonded seam strength tests will be referred to as "shear" in this CQA Plan.

- Verify that the contractor has the number of welding apparatuses and spare parts necessary to perform the work.
- Verify that equipment used for welding will not damage the geomembrane.
- Verify that extrusion welders are purged before beginning a weld so that all heat-degraded extrudate is removed from the nozzle of the welder.
- Verify that seam grinding is completed less than 1 hour before seam welding and the upper sheet is beveled (extrusion welding only).
- Verify that the ambient temperature measured 6 inches above the geomembrane surface is between 40 °F and 110 °F.
- Verify that the ends of extrusion welds that are more than 5 minutes old are ground to expose new material before restarting a weld.
- Verify that contact surfaces of the panels are clean and free of dust, grease, dirt, debris, and moisture before welding.
- Verify that welds are free of dust, rocks, and other debris.
- Verify that cross seams are ground to a smooth incline before welding (fusion welding only).
- Verify that all seams are overlapped a minimum of 3 inches (75 mm) or in accordance with manufacturer's recommendations, whichever is more stringent.
- Verify that solvents or adhesives are not present in the seam area.
- Verify that procedures used to temporarily hold the panels together do not damage the panels and do not preclude CQC testing.
- Verify that strips of geomembrane, wide enough and long enough to protect the hot wedge welder from running on the subgrade, are placed below the geomembrane. These strips may be as long as the seam itself or shorter and moved with the seaming equipment. If necessary, a firm material such as a flat board or similar hard surface may be placed directly under the weld overlap to achieve firm support.
- Verify that panels are being welded in accordance with the plans and specifications.
- Verify that no free moisture is in the weld area.
- Measure surface temperature of the panels every 2 hours.

6.2.4 Construction Testing

Nondestructive Seam Testing. The purpose of nondestructive geomembrane testing is to detect discontinuities or holes in the seams. Nondestructive geomembrane tests include vacuum and air pressure testing. Nondestructive testing must be performed over the entire length of the seam.

It is the Contractor's responsibility to perform all nondestructive testing as part of the QC program. The CQC Organization's responsibility is to observe and document that the Contractor's QC testing is in compliance with the specifications and to document seam defects and repairs.

Nondestructive testing procedures are described below.

- For welds tested by vacuum method, the weld is placed under suction using a vacuum box constructed with rigid sides, a transparent top for viewing the seams, a neoprene rubber gasket attached to the bottom of the rigid sides, a vacuum gauge on the inside, and a valve assembly attached to a vacuum hose connection. The box is placed over a seam section that has been thoroughly saturated with a soapy water solution (1 oz. soap to 1 gallon water). The rubber gasket on the bottom of the box must fit snugly against the soaped seam section of the panel to ensure a leak-tight seal. A vacuum pump is energized, and the vacuum box pressure is reduced to approximately 5-psi gauge. Any pinholes, porosity, or nonbonded areas are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time must not be less than 30 seconds.
- Air pressure testing is used to test double seams that have enclosed air space between them. Both ends of the air channel must be sealed. A pressure feed device, usually a needle equipped with a pressure gauge, is inserted into one end of the channel. Air is then pumped into the channel to a minimum pressure of 30 psi. A 2-minute relaxing period is allowed for the pressure to stabilize. The air chamber must sustain the pressure for an additional 5 minutes without losing more than 3 psi. Following a passed pressure test, the opposite end of the tested seam must be punctured to release the air. The pressure gauge must return to zero; if not, a blockage is likely in the seam channel. Locate the blockage and test the seam on both sides of the blockage. The penetration holes must be sealed after testing.

During nondestructive testing, the CQC Organization will:

- Review technical specifications regarding test procedures.
- Verify that equipment operators are fully trained and qualified to perform their work.
- Verify that test equipment meets project specifications.
- Verify the entire length of each seam is tested in accordance with the specifications.
- Observe all continuity testing and record results on the panel and seam log and the panel layout drawing.
- Verify that all testing is completed in accordance with the project specifications.
- Identify any failed areas by marking the area with a waterproof marker compatible with the geomembrane, inform the contractor of any required repairs, and record the repair on the panel and seam log.
- Verify that all repairs are completed and tested in accordance with the project specifications.
- Record all completed and tested repairs on a repair sheet and the panel layout drawing.

Destructive Seam Sampling Procedures and Field Testing. Destructive seam samples will be collected at intervals of at least one test per 1,500 lineal feet of geomembrane seams. However, additional samples will be collected if the QC Manager suspects that a seam does not meet the specification requirements. Reasons for collecting additional samples may include, but are not limited to:

- Wrinkling in seam area
- Excess crystallinity
- Suspect seaming equipment or techniques

- Weld contamination
- Insufficient overlap
- Adverse weather conditions
- Failing tests

The QC Manager selects the locations from where seam samples will be cut for destructive laboratory testing, as follows:

- A minimum of one test per 1,500 feet of seam length, which is an average frequency for the entire installation; individual samples may be collected at greater or lesser intervals. The testing frequency will be increased if welding operations are conducted in temperatures below 40 °F. This increase will be agreed upon by the Construction Manager, QA Manager, and Contractor.
- A maximum frequency must be agreed to by the Construction Manager, QC Manager, and Contractor at the pre-construction meeting. However, if the number of failed samples exceeds 5 percent of the tested samples, this frequency may be increased at the discretion of the QA Manager. Samples collected as the result of failed tests do not count toward the total number of required tests.

The QC Manager will not inform the contractor in advance of selecting the destructive sample locations.

The Contractor will remove specimens and samples at locations identified by the QC Manager and field test the specimens for peel and shear before the samples are shipped off site for laboratory testing. During sampling procedures the QC Manager will:

- Observe sample cutting.
- Mark each specimen and sample with an identifying number that contains the seam number, destructive sample test number, welder, and date and time welded.
- Record sample locations on the panel layout drawing and panel-seam logs
- Record the sample locations, weather conditions, and reasons samples were collected (e.g., random sample, visual appearance, result of a previous failure, etc.) in the destructive seam test form.

At each location, obtain two seam specimens that are 42 inches apart. The specimens should be 2 inches wide and 12 inches long, with the weld centered across the length of the specimen. The Contractor must test these samples for failure in the field using a tensiometer capable of quantitatively measuring shear and peel strengths. For double wedge welding, the Contractor must test both welds. The CQA Engineer will observe the tests. Geomembrane seam specimens pass when the break is a ductile FTB. A film tearing bond means the test specimen breaks at the edge of the outside of the seam, but not in the seam. In addition, the seam strength must meet the specified values.

If one or both of the 2-inch specimens fails in either peel or shear, the Contractor can, at their discretion, (1) reconstruct the entire seam between passed test locations or (2) collect another test sample 10 feet from the point of the failed test and repeat this procedure. If the second test passes, the Contractor can

either reconstruct or cap strip the seam between the two passed test locations. If subsequent tests fail, the sampling and testing procedure is repeated, until the length of the poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly and appropriate corrective action must be taken immediately.

Once the field test specimens have passed, a sample must be recovered for laboratory testing from between the passing field specimen locations. The sample must be 42 inches long and 12 inches wide, with the weld centered along the length of the sample. The sample must be divided into three sections: one 12-inch by 12-inch section for the Contractor, one 12-inch by 18-inch section for laboratory testing, and one 12-inch by 12-inch section for the Owner to archive. Results of field testing will be recorded on the destructive seam tests form and the panel and seam log.

Third Party Laboratory Testing. All CQC destructive samples must be shipped to the testing laboratory to verify seam quality. The laboratory will test five specimens from each sample in each method used. Minimum test values are presented in the specifications. The testing laboratory must provide test results within 24 hours, in writing or via telephone, to the QC Manager. Certified test results are to be provided within 5 days.

The QC Manager must immediately notify the QA Manager and Construction Manager in the event of failed test results.

If the laboratory test fails in either peel or shear, the Contractor must either reconstruct the entire seam or recover additional samples at least 10 feet on either side of the failed sample for retesting. This process is repeated until passed tests bracket the failed seam section. All seams must be bounded by locations from which passing samples have been taken. Laboratory testing governs seam acceptance. In no case can field testing of repaired seams be used for final acceptance.

6.2.5 Repairs

Portions of geomembrane panels and seams that contain (1) a flaw, (2) a destructive test, or (3) nondestructive test cuts of holes must be repaired in accordance with the specifications. The CQC Organization must locate and record all repairs on the repair sheet and panel layout drawing. Acceptable repair techniques include the following:

- Patching – used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, and destructive sample locations.
- Abrading and Rewelding - used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than 2 inches in diameter.
- Spot Welding - used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

- Capping – used to repair failed welds or to cover seams where welds cannot be nondestructively tested.
- Removal – used to replace area with large defects where preceding methods are not appropriate. Also used to remove excess material (e.g., wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal shall be patched or capped.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than 1 hour before the repair.
- Verify acceptance of the repair procedures, materials, and techniques by the QC Manager in advance of the specific repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and round all corners of material to be patched. Bevel the top edges of patches before extrusion welding.

6.2.6 Wrinkles

During placement of materials over the geomembrane, temperature changes or creep may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over must be repaired either by cutting out excess material or, if possible, by allowing the geomembrane to contract by temperature reduction. In no case can material be placed over the geomembrane, which could result in the geomembrane folding. The CQC Organization must monitor geomembrane for wrinkles and notify the QA Manager and Construction Manager if wrinkles are being covered by soil. The QC Manager is then responsible for documenting corrective action to remove the wrinkles.

6.2.7 Folded Material

All folded geomembrane must be removed.

6.2.8 Geomembrane Anchor Trench

The geomembrane anchor trench should be left open until seaming is completed. Expansion and contraction of the geomembrane should be accounted for in the liner placement. The anchor trench should be filled in the morning when temperatures are coolest to reduce bridging of the geomembrane.

6.2.9 Geomembrane Acceptance

The Contractor retains all ownership and responsibility for the geomembrane until acceptance by the Owner. In the event the Contractor is responsible for placing cover over the geomembrane, the Contractor retains all ownership and responsibility for the geomembrane until all required documentation is complete and the cover material is placed. After panels are placed, seamed, tested successfully and repairs made, the completed installation will be walked by the QC Manager and Contractor. Any damage or defect found during this inspection will be repaired properly by the Contractor. The installation will

not be accepted until it meets the requirements of both parties. In addition, the geomembrane will be recommended for QA Manager acceptance by the QC Manager only when the following activities have been completed:

- The installation is finished.
- All seams have been inspected and verified to be acceptable, and all required laboratory and field tests have been completed and reviewed.
- All required Contractor-supplied documentation has been received and reviewed.
- All as-built record drawings have been completed and verified by the CQC Manager to show the true panel dimensions, the locations of all seams, trenches, pipes, appurtenances, and repairs.

6.2.10 Qualifications

Installer Experience and Qualifications. Proper layout, seaming, and testing of the geomembrane requires skill and experience. As such, the integrity of the geomembrane is dependent upon the installers. To ensure a minimum level of experience and expertise, the following experience standards, which are established in the specifications, will be followed.

Manufacturer, Fabricator, and Installer. The specifications list prequalified manufacturer, fabricator, and installer companies for each geomembrane type. Substitutions to the prequalified list will be considered; however, substitutions must be submitted in accordance with the construction contract. The QC Manager must verify qualifications of the manufacturer, fabricator, and installer through review of engineer-approved project submittal.

Installation Superintendent. The installation field superintendent must have been responsible for the completed installation of a minimum of 5,000,000 square feet of polyethylene geomembrane in the past 5 years, using the type of seaming techniques and apparatus proposed for use on this project. A resume with references and phone numbers of satisfactory installations is required. Any superintendent proposed for this project must be present whenever geomembrane is installed.

Welders. Welders are welding machine operators that have demonstrated expertise on previous geomembrane installations. Each welder must have successfully welded a minimum of 1,000,000 square feet of polyethylene geomembrane within the past 3 years. A resume for this work, with references and phone numbers, is required.

CQC Geosynthetics Inspector Qualifications. CQC Geosynthetics Inspectors (members of the CQC Organization) must have provided CQC services on a minimum of 1,000,000 square feet of polyethylene installations or be level II-certified in geosynthetics installations by National Institute for Certification in Engineering Technologies. They must provide verification of this experience by reference in a current resume presented at the pre-construction meeting.

6.3. GEOCOMPOSITE

6.3.1 Delivery

During delivery of geocomposite material, the CQC Organization will:

- Verify that equipment used to unload the rolls will not damage the geocomposite.
- Verify that care is used to unload the rolls.
- Verify that all documentation required by the specifications has been received.
- Verify that each roll is marked or tagged with the following information: manufacturer's name, project identification, lot number, roll number, and roll dimensions. Log this information on the geosynthetic receipt form.
- Verify that the geosynthetic receipt form is completed.
- Verify that materials are stored in a location that will protect the rolls from exposure to ultraviolet light, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or harmful conditions.

Any damaged rolls may be rejected. Verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geocomposite rolls that do not have proper manufacturer's documentation must also be stored at a separate location, until all documentation has been received and approved.

6.3.2 Conformance Testing

Testing Frequency. The CQC Organization will obtain geocomposite drainage layer conformance test samples for every 100,000 square feet of material and a minimum of one per batch or lot delivered to the site. The CQC Organization will collect samples of the material at the site, or an independent third party will collect samples at the manufacturing plant under the direction of the QC Manager. The geotextile component will be tested as discussed in Section 6.1.2. The CQA Organization will forward the samples to the testing laboratory for the following conformance tests:

- Density (ASTM D 1505)
- Thickness (ASTM D 5199)
- Tensile strength (ASTM D 5035)
- Carbon black content (ASTM D 1603)

The QC Manager will review all test results and report any nonconformance to the QA Manager and the Construction Manager.

Sampling Procedure. Samples will be collected across the entire roll width and will be 3 feet long. Samplers must mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

6.3.3 Geocomposite Installation

Surface Preparation. Before geocomposite installation, the CQC Organization will:

- Verify that all lines and grades have been verified by the contractor.
- Verify that the underlying geomembrane has been prepared in accordance with the specifications, and that all associated documentation has been completed.
- Verify that soil or geomembrane surfaces do not contain protrusions that could damage the geocomposite.
- Verify that no excessively soft areas exist in the soil surface that could damage the geocomposite.
- Verify that all construction stakes have been removed.
- Verify that all aspects of surface preparation have been performed according to the specifications.

Geocomposite Placement and Seaming. During geocomposite placement, the CQC Organization will:

- Observe the geocomposite as it is deployed and record all defects and defect corrective actions (e.g., panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- Verify that equipment used does not damage the geocomposite by handling, equipment transit, leakage of hydrocarbons, or other means.
- Verify that crews working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite.
- Verify that the geocomposite is securely anchored to prevent movement by the wind.
- Verify that adjacent panels are overlapped and seamed in accordance with the specifications.
- Examine the geocomposite after installation to ensure that no potentially harmful foreign objects are present.

The QC Manager must inform both the QA Manager and Contractor if the above conditions are not met.

6.3.4 Repairs

Repair procedures include:

- Patching – used to repair large holes, tears, and small defective areas.
- Removal – used to replace large defective areas where the preceding method is not appropriate.

Repair procedures will be performed per specifications.

6.4. GEOGRID

6.4.1 Delivery

During delivery of geogrid, the CQC Organization will:

- Verify that equipment used to unload the rolls will not damage the geogrid.
- Verify that rolls are wrapped in impermeable and opaque protective covers.

- Verify that care is used to unload the rolls.
- Verify that all documentation required by the specifications has been received.
- Verify that each roll is marked or tagged with the following information: manufacturer's name, project identification, lot number, roll number, and roll dimensions. Log this information on the geosynthetic receipt form.
- Verify that the geosynthetic receipt form is completed.
- Verify that materials are stored in a location that will protect the rolls from exposure to ultraviolet light, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or harmful conditions.

Any damaged rolls may be rejected. Verify that rejected material is removed from the site or stored at a location separate from the accepted rolls. Geogrid rolls that do not have proper manufacturer's documentation must also be stored at a separate location, until all documentation has been received and approved.

6.4.2 Conformance Testing

Testing Frequency. The CQC Organization will obtain geogrid conformance test samples for every 200,000 square feet and a minimum of one per batch or lot of material delivered to the site. The CQC Organization will collect samples of the material at the site, or an independent third party will collect samples at the manufacturing plant under the direction of the QC Manager. The CQC Organization will forward the samples to the testing laboratory for the following conformance tests:

- Tensile strength (ASTM D 6637)
- Tensile modulus (ASTM D 6637)
- Ultimate tensile strength (ASTM D 6637)

The QC Manager will review all test results and report any nonconformance to the QA Manager and the Construction Manager.

Sampling Procedure. Samples will be collected across the entire roll width and will be 3 feet long. Samplers must mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

6.4.3 Geogrid Installation

Surface Preparation. Before geotextile installation, the CQC Organization will:

- Verify that all lines and grades have been verified by the contractor.
- Verify that the subgrade has been prepared in accordance with the earthwork specifications, and that all associated documentation has been completed.
- Verify that soil surfaces do not contain protrusions that could damage the geogrid.

- Verify that no excessively soft areas exist in soil surfaces that could damage that geogrid.
- Verify that all construction stakes have been removed.

Placement. During geogrid placement, the CQC Organization will:

- Observe the geogrid as it is deployed and record all defects and defect corrective actions (e.g., panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- Verify that equipment used does not damage the geogrid by handling, equipment transit, leakage of hydrocarbons, or other means.
- Verify that crews working on the geotextile do not smoke, wear shoes that could damage the geogrid, or engage in activities that could damage the geogrid.
- Verify that the geogrid has been placed with machine direction parallel to the slope.
- Verify that adjacent panels are positioned edge-to-edge with no overlap and fastened in accordance with the specifications.
- Verify that the geogrid was not exposed to direct sunlight for more than 5 days.
- Examine the geogrid after installation to ensure that no potentially harmful foreign objects are present.

Penetrations. For any penetrations through the geogrid, the CQC Organization will:

- Verify that only transverse members of the geogrid have been cut and the load longitudinal members have been spread around penetration; or for larger penetrations, additional geogrid has been spliced on either side of the penetration to compensate for any longitudinal tensile members that had to be cut.

The QC Manager must inform both the QA Manager and the Construction Manager if the above conditions are not met.

6.4.4 Repairs

Geogrid damaged during placement and covering will be removed and replaced.

Section 7. Other Work Elements Monitoring and Testing Requirements

The following sections list CQC monitoring and testing requirements for:

- Surface water and storm water controls
- Surface feature protections and landscaping

The CQA Organization will verify that the following monitoring and testing requirements are being fulfilled by the CQC Organization.

7.1. SURFACE WATER AND STORM WATER CONTROLS

- Verify that the grading and sloping of all drainage ditches is in accordance with project specifications and drawings.
- Verify that concrete-lined drainage ditches are constructed in accordance with project specifications and drawings
- Review and approve concrete mixture proportions, sources of materials, and all test results.
- Verify supplier's test reports for concrete aggregates showing the materials meet project specifications
- Verify concrete mix tests conform to ASTM A 820/A 820M, exhibiting the 28-day compressive strength of 3,000 psi per project specifications
- Verify certificates for Synthetic (Polypropylene) Fiber Reinforcement
- Verify curing materials and forming compounds conform with project specifications
- Verify batching and mixing or ready mix is accomplished in accordance with applicable provisions of ASTM C 94/C 94M, as described in project specifications.
- Verify concrete slump testing in accordance with ASTM C 172 (maximum slump of 4 inches) and frequency, in accordance with project specifications (see Table G-4).
- Verify cylinder testing in accordance with ASTM C 31, strength testing, and test frequency (see Table G-4).

7.2. SURFACE FEATURE PROTECTIONS AND LANDSCAPING

- Verify all surface feature protections are constructed in accordance with project specifications and drawings
- Verify that chain-link fence enclosures and gate materials conform to project specifications
- Verify that concrete foundation materials conform to project specifications

- Review and approve materials certificates of compliance for seed, mulch, binder, and fertilizer, in accordance with project specifications
- Verify that seed application and timing (seasonal) is completed in accordance with project specifications
- Conduct final inspection within 7 days of the vegetation establishment period, in accordance with project specifications

Section 8. Documentation

The CQC plan depends on thorough monitoring and documentation of all construction activities. Therefore, the CQC Organization will document that all QC requirements have been addressed and satisfied. Documentation will consist of daily record-keeping, weekly progress reports, photographs, design and specification changes, and a final construction report. Templates of all CQC report forms will be included in the CQC Plan, to be prepared by the CQC Organization. The QA Manager will review all CQC documentation to verify that the quality standards identified in the construction specifications are being met.

8.1. DAILY RECORD-KEEPING

At a minimum, daily records will consist of a daily record of construction progress, observation and test data sheets, and nonconformance and corrective measure reports, as needed. Daily records will be submitted to the QA Manager for review on a weekly basis.

8.1.1 Daily Record of Construction Progress

The daily field report will summarize ongoing construction activities and discussions with the Contractor. The Construction Manager and the QC Manager will prepare the daily field reports. At a minimum, the report will include the following:

- Date, project name, project number, and location
- A unique number for cross-referencing and document control
- Weather data
- A description of all ongoing construction for the day in the area of the monitor's responsibility
- An inventory of equipment used by the Contractor
- Items of discussion and names of parties involved in discussions
- A brief description of tests and observations, identified as passing of failing, or, in the event of failure, a retest
- Areas of nonconformance and corrective actions, if any (nonconformance and corrective action form to be attached)
- Summary of materials received and quality documentation
- Follow-up information on previously reported problems or deficiencies
- Record of any site visitors
- Signature of Construction Manager or QC Manager

8.1.2 Observation and Test Data Sheets

Observation and test data sheets should include the following information, as is appropriate for the form being used:

- Date, project name, and location
- A unique number for cross-referencing and document control
- Weather data, as applicable
- A reduced scale site plan showing sample and test locations
- Test equipment calibrations, if applicable
- A summary of test results identified as passing, failing, or, in the event of a failed test, retest
- Completed calculations
- Signature of the QC Manager

8.1.3 Nonconformance Reports

In the event of a nonconformance event, a nonconformance verification report form will be included with the daily report. Procedures for implementing and resolving any nonconformities to the contract are outlined in Section 2.4 of this CQA Plan.

8.2. WEEKLY PROGRESS REPORTS

The QC Manager will prepare weekly progress reports summarizing construction and QA activities. The reports will contain, at a minimum, the following information:

- The date, project name, and location
- A summary of work activities completed in the last week, and those expected to be performed in the next week
- A summary of deficiencies and defects and resolutions
- Ongoing summary of changed work and change orders to the work
- The signature of the QC Manager
- On a monthly basis, the report will include a summary of on-site and third party laboratory test results

8.3. PHOTOGRAPHS

Construction activities will be photographed by the CQC Organization and Construction Manager. Photographs will include any significant problems encountered and corrective actions, as well as to document the progress of construction. The photographs will be identified by number, location, time, date, and photographer. The photographer should document the subject or the photograph, either on the back of the picture, or in a photograph log. Hard copies of the captioned photographs will be appended to the daily reports and provided to the QA Manager on a weekly basis. The digital files for the photographs (on compact disc) will be provided to the QA Manager upon completion of the project.

8.4. DESIGN AND SPECIFICATION CHANGES

Design and specification changes may be required during construction. Design and specification changes will only be made with written agreement of the Design Engineer, Owner, and Contractor. These changes will be made by change order to the contract. When change orders are issued, they will be prepared by the Construction Manager. The Construction Manager will distribute change orders for signature and execution to the required parties.

8.5. FINAL CONSTRUCTION REPORT

At the completion of the project, the QC Manager and the Contract Manager will prepare and submit a final construction report to the QA Manager and the Owner. This report will document that the work has been performed in compliance with the construction drawings and specifications.

At a minimum, the report will contain:

- A summary of all construction activities
- A summary of all laboratory and field test results
- Sampling and testing location drawings
- A description of significant construction problems and the resolution of these problems
- A list of changes from the construction drawings and specifications and the justifications for these changes
- As-built record drawings
- A statement of compliance with the construction contract documents and design intent signed and stamped by the QC Manager, a professional engineer registered in the state of California

The as-built record drawings will accurately locate the constructed location of all work items, including the location of piping, anchor trenches, etc. All surveying and base maps required for the development of the record drawings will be prepared by the Contractor. The QC Manager must review and verify that as-built are correct. As-built record drawings will be included in the final construction report. The QA Manager will review the final construction report, including the as-built drawings, on behalf of the Owner.

Tables

ERRG

Table G-1. Testing Frequencies for Earthwork Construction of Multilayer Cap[1]

Test Method	Frequency
Nuclear Gauge Density and Moisture (ASTM D 6938)	One per 10,000 square feet per lift
Compaction Curves (ASTM D 1557)	Every 5,000 cubic yards
Identification of Soils (Unified Soil Classification System) (ASTM D 2487)	Every 5,000 cubic yards or one per change in material, whichever occurs first
Description and Identification of Soils (Visual-Manual Procedure) (ASTM D 2488)	Continual during excavation of borrow materials, as needed to identify change in material
Oven Moisture Content (ASTM D 2216)	As necessary to check nuclear method
Surveying	50-foot grid and at all grade breaks

Notes:

(1) These tests will be performed at stated frequencies and at each material or source change.

(2) For general fill in trenches, the frequency shall be 1 test per 100 linear feet of trench.

Table G-2. Additional Testing Frequencies for Construction of Specific Cover Layers

Material	Testing Requirement	Reference	Criteria
Top Lift of Foundation Soil	Sieve Analysis	ASTM D 422	1 sieve analysis per 5,000 cy
Sand Drainage Layer	Sieve Analysis	ASTM D 422	1 sieve analysis per 5,000 cy
First Lift of Cover Soil	Sieve Analysis	ASTM D 422	1 sieve analysis per 5,000 cy

Table G-3. QA Testing Frequencies for Construction of Geomembrane

Test Method	Frequency
Conformance Testing[1]	
Thickness (ASTM D 5199)	1 per 100,000 square feet
Density (ASTM D 1505)	1 per 100,000 square feet
Carbon Black Content (ASTM D 1603, mod.)	1 per 100,000 square feet
Carbon Black Dispersion (ASTM D 5596)	1 per 100,000 square feet
Tensile Properties: Strength at Break (each direction) (ASTM D 6693)	1 per 100,000 square feet
Tensile Properties: Elongation at Break (each direction) (ASTM D 6693)	1 per 100,000 square feet
Tear Resistance (ASTM D 1004)	1 per 100,000 square feet
Puncture Resistance (ASTM D 4833)	1 per 100,000 square feet
Oxidative Induction Time (ASTM D 3895)	1 per 100,000 square feet
Field Seaming Trial Welds	
Peel Strength (ASTM D 6392)	Two per day per welding machine
Shear Strength (ASTM D 6392)	Two per day per welding machine
Nondestructive Field Testing	
Vacuum Testing	Continual along all extruded seams and repairs
Air Pressure Testing	Continual along all double fusion seams and repairs
Destructive Field Testing	
Destructive Testing (ASTM D 6392)	1 per every 1,500 linear feet of seam length
Direct Shear Test	
LLDPE against Geocomposite (ASTM D 5321)	One 3-point direct shear, vertical stress no more than 1,000 psf
LLDPE against sand (90% compaction and 2% over opt. moisture content; ASTM D 5321)	One 3-point direct shear, vertical stress no more than 1,000 psf

Note:

1. Conformance testing to be performed on-site samples collected for QA. Manufacturer testing requirements and frequencies are listed in the Construction Specifications (Appendix F of the RD).

Table G-4. Testing Frequencies for Concrete

Test Method	Frequency
Conformance Testing	
Batch Plant	1 per batch
Field Testing	
Slump Testing	Once at commencement of concrete placement, and as a minimum, each batch and every 10 cubic yards of concrete, whichever is greater
Strength Testing	One cylinder at 7 days and two cylinders at 28 days. Strength testing once at commencement of concrete placement and once per 100 cubic yards of concrete.