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PREPARED FOR:
WILKES COUNTY DEPARTMENT OF SOLID WASTE
9219 ELKIN HIGHWAY
ROARING RIVER, NORTH CAROLINA 28669

ROARING RIVER LANDFILL
WILKES COUNTY, NORTH CAROLINA
PERMIT No. 97-04

PHASE 4 EXPANSION

VOLUME 2
CONSTRUCTION PLAN APPLICATION

SECTION III – ENGINEERING PLAN
SECTION IV – CONSTRUCTION QUALITY ASSURANCE PLAN
SECTION V – OPERATIONS PLAN
SECTION VI – CLOSURE & POST CLOSURE PLAN

JANUARY 2011

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CONSTRUCTION QUALITY ASSURANCE PLAN

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VOLUME 2, SECTION IV
CONSTRUCTION QUALITY ASSURANCE PLAN (CQA)

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TABLES

Table 1 - Soil Testing Methods and Frequencies

1.0 INTRODUCTION

1.1 PURPOSE

This plan addresses the construction quality assurance (CQA) procedures and requirements to be employed during construction of the project. The plan is intended to supplement, but not supersede, the Contract Drawings and Specifications; where a conflict arises, the Contract Documents or approved Contract Drawings and Specifications shall govern.

All parties involved in the project should obtain a copy of this plan from the OWNER or ENGINEER. They should also obtain copies of any supplemental CQA documents prepared specifically for the project.

The overall goals of the CQA program are to ensure that proper construction techniques and procedures are employed, and to verify that the materials used meet the approved Contract Specifications. Additionally, the program shall identify and define problems that may occur during construction, allowing corrective activities to be implemented in a timely manner. At the completion of the work, the program requires the certifying CQA Consultant(s) to prepare certification reports indicating that the facility has been constructed in accordance with the approved design standards and Contract Specifications.

1.2 DEFINITIONS

The following definitions are applicable to this plan:

1.2.1 Quality Control

Definition (ASTM D3740): - a planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide quality that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc… is in accordance with the Specifications, and review of usage to determine necessary revisions of Specifications.

In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards, and is in compliance with the Contract Drawings and Specifications. This plan does not address Quality Control procedures, criteria, and/or tests employed by the CONTRACTOR.

1.2.2 Quality Assurance

Definition (ASTM D3740): - a planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc…, this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment.

In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Contract Drawings and Specifications and any additional requirements of this plan.

1.2.3 Layer

A layer is defined as a compacted stratum composed of several lifts constructed without joints.

1.2.4 Lift

A lift is defined as a segment of a layer composed of the maximum thickness of soil permitted to be placed / compacted at one time.

1.3 PARTIES

1.3.1 OWNER

The OWNER is the owner of the solid waste permit, and bears the ultimate responsibility for the facility; the OWNER may or may not also be the Operator of the facility. The OWNER shall contract and manage the CONTRACTOR(s), and the CQA consultant(s) and laboratories. For this project, the Coastal Regional Solid Waste Management Authority is the OWNER.

1.3.2 ENGINEER

The ENGINEER is the official representative of the OWNER, and is responsible for the preparation of the Contract Drawings, Technical Specifications, and CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for the resolution of technical matters that may arise during construction. For this project, the ENGINEER is Joyce Engineering, Inc.

1.3.3 CQA Consultant

The CQA Consultant is independent from the CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing, and documenting activities related to the Quality Assurance of the earthwork and geosynthetic components at the site. The CQA Consultant corresponds with the ENGINEER throughout the project and shall report deviations from the Work and items of non-compliance. The CQA Consultant is also responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in the State in which the project work is conducted.

1.3.4 Soils CQA Laboratory

The Soils CQA Laboratory is independent from the CONTRACTOR(s), and Supplier, responsible for performing the required laboratory testing of the project earthwork components.

1.3.5 Geosynthetic CQA Laboratory

The Geosynthetic CQA Laboratory is independent from the CONTRACTOR(s), Manufacturer, and Installer, responsible for performing the required laboratory testing of the project geosynthetic materials.

1.3.6 CONTRACTOR

The CONTRACTOR has the primary responsibility for ensuring that the work is performed in accordance with the Contract Drawings and Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, procurement, supervision, Construction Quality Control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR is also responsible for informing the OWNER and CQA Consultants of the scheduling and occurrence of all construction activities.

1.3.7 Geomembrane Manufacturer(s)

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin.

1.3.8 Geomembrane Installer(s)

The Geomembrane Installer is responsible for the handling, sorting, placing, seaming, loading and other construction-related aspects of the project geosynthetics. The Installer is also responsible for transportation of the materials to the site, and the protection of the materials once they arrive on site, until the work is accepted by the CONTRACTOR.

1.3.9 Surveyor

The Surveyor is responsible for establishing and maintaining lines and grades and temporary benchmarks throughout all relevant areas of the construction site. The Surveyor shall issue a complete set of Record Drawings certified by a Professional Land Surveyor, licensed in the State in which the project work is conducted.

1.4 COMMUNICATIONS AND MEETINGS

Frequent and open communications are a necessary and essential component of this plan in order to achieve a high degree of coordination, cooperation, and quality in the finished product, and to minimize or avoid delays. It is one goal of this plan to resolve problems at the lowest possible level of authority while maintaining thorough documentation, informing all responsible parties, and obtaining approvals as necessary or appropriate. The documentation requirements of CQA activities are addressed in various sections of this plan. A series of meetings shall be held before, during, and after construction to facilitate planning, progress reports and problem resolution. Minutes are to be kept of all meetings as directed by the ENGINEER. The meetings shall be as follows unless otherwise directed by the OWNER:

- Preconstruction Meeting to be held as directed by the ENGINEER and to be attended by the OWNER or Owner's Representative, CQA Consultant, CONTRACTOR, significant subcontractors and suppliers as designated by the ENGINEER.
- Progress Meetings to be held as directed by the ENGINEER and to be attended by the OWNER or Owner's Representative, CQA Consultant, CONTRACTOR, and representatives of parties actively involved in the construction as designated by the ENGINEER.
- Post-Construction Resolution Meeting to be attended by the OWNER or Owner's Representative, CQA Consultant, CONTRACTOR, significant subcontractors and suppliers as directed by the ENGINEER.

2.0 EARTH MATERIALS

2.1 INTRODUCTION

This section of the plan describes Construction Quality Assurance (CQA) procedures for the installation of the earth material components of the project.

2.2 SCOPE

2.2.1 General

The work addressed under this section shall facilitate proper construction of all earth material components of the project. All work shall be constructed to the lines, grades, and dimensions indicated on the approved Contract Drawings, in accordance with the Contract Specifications, or as required by the OWNER or OWNER's Representative.

2.3 EARTH MATERIALS CQA TESTING

2.3.1 General

Assurance that construction of the earth material components of the project has been performed in accordance with the approved Contract Drawings and Specifications shall be accomplished by use of CQA testing and visual observations.

CQA testing shall consist of the following:

- Construction Quality Evaluation; and
- Special Testing.

2.3.2 Construction Quality Evaluation Testing

Construction quality evaluation shall be performed on all components of earthwork construction at the frequencies shown in Table 1. Criteria to be used for determination of acceptability of the work shall be as identified in the Contract Specifications and as detailed in this plan. Construction evaluation testing shall consist of visual observations of the work, in-place density/moisture content verification, investigations into the adequacy of layer bonding and clod destruction, elevation and thickness monitoring, and special testing. Evaluation of the construction work shall include the following:

- Observations and documentation of the water content, clod size and other physical properties of the soil during processing, placement and compaction;
- Observation and documentation of each compacted lift's ability to accept and bond to subsequent lifts;
- Observation and documentation of the thickness of compacted and loosely placed lifts;
- Observation and documentation of the performance of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc…); and
- Observation and documentation of the effectiveness of the procedures used to prevent desiccation and/or freezing of completed lifts and layers.

The in-place density test methods shall cause minimal delay to the placement of subsequent lifts; therefore, the nuclear method is preferred unless construction sequencing is such that fill placement is not interrupted by sand cone or drive cylinder testing. An acceptable test for soils

used in structural or "controlled fill" applications (i.e. embankments, berms, backfill, soil liner, subgrade, etc.) shall be defined as one, which meets or exceeds the specified minimum density within the specified moisture range.

If there is any question as to the classification of the tested soil, and hence the appropriateness of a given moisture-density plot, a "one-point" Standard Proctor compaction test shall be performed for comparison with the available plots. The optimum moisture content and maximum dry density extrapolated from the one-point test result must fall on or near the plotted line of optimums for the classification of a soil to be confirmed. For controlled fill, the reference maximum dry density can be adjusted to accommodate the one-point data.

Questions concerning the accuracy of any single test shall be addressed by retesting in that or another representative location. Periodic sand cone or drive cylinder testing shall be performed to verify the adequacy of the nuclear gauge testing at the frequencies designated in Table 1. If a conflict exists between the sand cone or drive cylinder testing and the corresponding nuclear density test results, then the sand cone and/or drive cylinder results shall control.

It is important to bond lifts together to the greatest extent possible. Bonding of lifts is enhanced by:

- Ensuring that the surface of the previously compacted lift (or subgrade) is rough before placing the new lift of soil;
- Adding moisture to the previously compacted lift (or subgrade); and
- Using a fully penetrating footed roller.

Evaluation of lift bonding in soil liner and similar applications shall be done by using test pits or auger holes to visually observe the lift interfaces. Alternatively, Shelby tubes pushed through the lift interfaces can be visually inspected for proper lift bonding.

2.3.3 Test Pad

A test pad shall be constructed as outlined in the project specifications to develop and demonstrate construction methods that shall be used to produce a compacted soil liner/cap satisfying the requirements of the specifications.

2.4 DOCUMENTATION/CERTIFICATION

2.4.1 General

The CQA Consultant shall document the activities associated with the construction of the earth material components of the project. Such documentation shall include, as a minimum, daily reports of construction activities and a summary technical report on the construction project.

Documentation and reporting shall meet all requirements of the Contract Specifications and this CQA Plan.

2.4.2 Construction Monitoring

Construction of earth material components of the project shall be monitored and documented by a CQA Consultant. Soils laboratory testing shall be performed and documented by an independent testing laboratory working under the direction of the CQA Consultant.

Written daily documents shall include a record of observations, test data sheets, identification of problems encountered during construction, corrective measures taken, weather conditions, and personnel and equipment on site.

2.4.3 Certification

The CQA Consultant(s) shall prepare a certification report addressing each major item identified above for each phase of construction under their areas of responsibility. Certification reports required by regulatory agencies shall also be prepared and submitted as required.

Certification shall include assessments of compliance with the Contract Drawings and Specifications and the results of the physical sampling and testing. At a minimum, the certification report shall include:

- Copies of all daily CQA field reports;
- Results of all field testing including drawings depicting the locations of construction testing when appropriate;
- Results of all laboratory testing;
- Photographic record of the project including representative photographs of each major construction activity; and
- Certification statement assessing compliance with the Contract Drawings and Specifications, sealed by a professional engineer, licensed in the State in which the project work is conducted.

3.0 GEOSYNTHETICS

3.1 INTRODUCTION

This section of the plan describes Construction Quality Assurance (CQA) procedures for the installation of all geosynthetic components of the project. This section is devoted to Quality Assurance, not to Quality Control. A separate geosynthetic Quality Control manual shall be submitted by the CONTRACTOR in accordance with the Shop Drawings Submittals of the project.

3.2 SCOPE

3.2.1 General

The work addressed under this section shall facilitate proper construction of all geosynthetic components for the project. All work shall be constructed to the lines, grades, and dimensions indicated on the Contract Drawings, in accordance with the Contract Specifications, and as required by the ENGINEER, OWNER, or the CQA Consultant.

The CQA Consultant shall issue a written daily report of activities. These reports shall include observations and test results as well as problems encountered and solutions achieved. Construction reports summarizing significant events, as well as addressing problems and their solutions, shall be submitted to the CQA Consultant.

3.2.2 Installation

The CQA Consultant shall verify that the geosynthetics are installed in accordance with the Contract Drawings and Specifications.

3.3 GEOMEMBRANE MANUFACTURE, FABRICATION, AND DELIVERY

3.3.1 Geomembrane Manufacturing

The geomembrane shall be manufactured from a first quality resin. Only one type of resin (one manufacturer, one resin classification) shall be used to manufacture the geomembrane for this project. In addition, all geomembrane used for this project shall be from the same batch unless otherwise approved in writing by the CQA Consultant and the installer or manufacturer agree to pay for any additional conformance testing required.

3.3.2 Manufacturing

3.3.2.1 Submittals

The CQA Consultant shall verify that:

- The property values certified by the Manufacturer meet all of the Specifications; and
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer's and project specifications

3.3.2.2 Rolls

The CQA Consultant shall verify that the manufacturer's quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it, and review the manufacturer's quality control certificates and verify that the certified roll properties meet the Specifications.

3.3.2.3 Conformance Testing

3.3.2.3.1 In-Plant Material Conformance Test Sampling

The CQA Consultant shall arrange for the CQA Laboratory to sample the geomembrane material in-plant and ship these samples to their laboratory for conformance testing as outlined in the project specifications.

The CQA Consultant shall report any nonconformance of sampling procedures as outlined in the project specifications to the ENGINEER.

The expressed purpose of in-plant Material Conformance Test Sampling is to verify that geomembrane material designated for the OWNER'S project is confirmed as meeting the project Specifications prior to shipment to the site. The Manufacturer shall make available all necessary personnel and equipment to assist the CQA Consultant in retrieving conformance samples of the geomembrane material.

Sampling Procedures

The samples will be taken from selected rolls and cutting full-width, 3 feet long, samples from the outer wrap of the selected roll(s). The outer revolution of geomembrane shall be discarded before the test sample is taken. The sample rolls must be relabeled for future identification. The CQA Consultant shall mark the roll direction on the samples with an arrow.

Unless otherwise specified, samples shall be taken at a rate of one per batch or one per 100,000 ft^2, whichever is the most frequent.

Test Procedures

Conformance testing shall be conducted in accordance with the test methods stated in Tables 1 and 2 of GRI Test Method GM13 (latest version) for HDPE geomembranes and Tables 1 and 2 of GRI Test Method GM17 (latest version) for LLDPE geomembranes and include the following properties:

- Density;

- Carbon black content;
- Carbon black dispersion;
- Melt index;
- Thickness;
- Tensile strength;
- Tear resistance; and
- Asperity height.

3.3.2.4 Test Results

The CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the ENGINEER.

3.3.2.4.1 Procedures in Event of a Conformance Test Failure

The procedures described in the project specifications shall be followed. The CQA Consultant shall document actions taken in conjunction with conformance test failures.

3.3.3 Delivery

3.3.3.1 Transportation and Handling

The CQA Consultant shall verify that:

- Handling equipment used on the site does not damage the geomembrane; and
- The Installer's personnel handle the geomembrane with care.

Upon delivery at the site, the Installer and the CQA Consultant shall conduct a surface observation of all rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected.

- Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- Rolls which include minor repairable flaws.

3.3.3.2 Storage

The CQA Consultant shall verify that the geosynthetic materials staging area is well draining, that the materials are covered, protected and stay dry during storage.

3.4 GEOMEMBRANE INSTALLATION

3.4.1 Earthwork

3.4.1.1 Surface Preparation

The CONTRACTOR shall be responsible for preparing the supporting soil according to the Specifications.

The CQA Consultant shall verify that:

- A qualified land surveyor, licensed in the State in which the project work is conducted, has verified all lines and grades;
- That the supporting soils meet the density specification and provide a firm foundation;
- Surface of the subgrade has been prepared and has been certified as acceptable to the Installer; and
- The surface is generally free of irregularities, rocks, sticks, roots, loose soil, and abrupt changes in grade which may cause damage to the geomembrane and require its repair after deployment;

In general, at any time before and during the geomembrane installation, the CQA Consultant shall indicate to the CONTRACTOR locations, which may not provide adequate support to the geomembrane.

3.4.2 Geomembrane Placement

3.4.2.1 Field Panel Identification

It shall be the responsibility of the CQA Consultant to ensure that each field panel shall be given an "identification code" (number or letter-number) consistent with the layout plan. This field panel identification code should be as simple and logical (manufacturing roll numbers are usually cumbersome and are not related to location in the field).

3.4.2.2 Field Panel Placement

3.4.2.2.1 Location

The CQA Consultant shall verify that field panel installation follows the Installer's layout plan, as approved or modified.

3.4.2.2.2 Installation Schedule

The CQA Consultant shall:

- Evaluate every change in the schedule proposed by the Installer.
- Verify that the condition of the supporting soil has not changed detrimentally during installation.
- Record the identification code, location, and date of installation of each field panel.

3.4.2.2.3 Weather Conditions

Geomembrane placement shall not proceed:

- At ambient temperatures below 40°F or above 104 °F unless authorized by the CQA Consultant.
- During any precipitation, in an area of ponded water, or during excessive winds.

The CQA Consultant shall verify that the above conditions are fulfilled. Additionally, the CQA Consultant shall verify that the supporting soil has not been damaged by weather conditions.

3.4.2.2.4 Method of Placement

The CQA Consultant shall verify that:

- Any equipment used does not damage the geomembrane by handling, trafficking, heat, leakage of hydrocarbons or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement; any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;
- All personnel working on the geomembrane do not smoke, wear shoes which may damage the geomembrane, or engage in other activities which could damage the geomembrane;

- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring using sand bags has been placed to prevent uplift by wind. The loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels;
- All field seaming and installation of appurtenances (sumps, etc.) are done in accordance with the plans and Specifications; and
- Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextile, extra geomembrane, or other suitable materials, in areas where heavy traffic may be expected.

3.4.2.2.5 Damage

The CQA Consultant shall visually examine each panel, after placement and prior to seaming, for damage. Damaged panels or portions of damaged panels, which have been rejected, shall be marked, and their removal from the work area recorded by the CQA Consultant. Repairs shall be made according to procedures described in the project specifications.

As a minimum, The CQA Consultant shall ensure that each panel is placed in such a manner that it is unlikely to be damaged, and any tears, punctures, holes, thin spots, etc., are marked for repair or the panel is rejected.

3.4.3 Field Seaming

3.4.3.1 General Seaming Procedure

The CQA Consultant shall verify that the seaming procedures listed in the project specifications are followed.

- The CQA Consultant shall log all appropriate temperatures and conditions, and shall log and report any non-compliance.
- The CQA Consultant shall observe all trial seam procedures and log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. Additional samples may be cut from the remainder of the trial seam to be archived by the OWNER, and/or tested by the CQA Laboratory or CQA Consultant.

3.4.3.2 Seam Preparation

The CQA Consultant shall verify that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- If seam overlap grinding is required, the process is completed according to the Manufacturer's Specification, and in a way that does not damage the geomembrane; the depth of the abrasion must not exceed 10 percent of the nominal material thickness;
- Seams are aligned without wrinkles and "fishmouths".

3.4.3.3 Weather Conditions for Seaming

The CQA Consultant shall verify that the weather conditions are suitable for seaming or determine if the installation should be stopped or postponed.

3.4.3.4 Overlapping and Temporary Bonding

The CQA Consultant shall verify that:

- The panels of geomembrane have a finished overlap, sufficient to allow peel tests to be performed on the seam;
- No solvent or adhesive is used unless the product is approved in writing by the ENGINEER (samples shall be submitted to the ENGINEER for testing and evaluation); and
- The procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any spot seaming apparatus is controlled such that the geomembrane is not damaged. "Damage" includes a loss in durability).

3.4.4 Nondestructive Seam Continuity Testing

The CQA Consultant shall:

- Observe continuity testing;
- Record location, date, time, name of tester, and outcome of all testing; and
- Inform the Installer of any required repairs.

The Installer shall complete any required repairs in accordance with the project specifications.

The CQA Consultant shall:

- Observe the repair and re-testing of the repair;
- Mark on the geomembrane that the repair has been made; and
- Record location, date, time, name of tester, and outcome of all testing.

3.4.5 Destructive Testing

3.4.5.1 Sampling Procedure

The CQA Consultant shall:

- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly; record the reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

3.4.5.2 Field Testing

The CQA Consultant shall witness field tests and mark samples and portions with their number. The CQA Consultant shall also log the date and time, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, pass or fail description.

3.4.5.3 Construction Quality Assurance Laboratory Testing

Destructive test samples shall be packaged and shipped by the CQA Consultant to the CQA Laboratory. The CQA Consultant shall be responsible for storing the archive samples. Test samples shall be tested by CQA Laboratory.

Testing shall follow GRI Test Method GM19. The minimum acceptable values to be obtained in these tests are those indicated in GRI Test Method GM19.

The CQA Laboratory shall provide test results within 24 hours after they receive the samples. The CQA Consultant shall review laboratory test results as they become available.

3.4.5.4 Destructive Sample Pass/Fail Criteria

The CQA Consultant shall document all laboratory results for destructive samples to assure that they meet the requirements set forth in the project specifications and GRI Test

Method GM19.

3.4.5.5 Procedures for Destructive Test Failure

The CQA Consultant shall document all actions taken in conjunction with destructive test failures to verify that they meet the requirements set forth in the project specifications.

3.4.6 Defects and Repairs

3.4.6.1 Verification of Repairs

The CQA Consultant should observe nondestructive testing of repairs and record the date of the repair and test outcome.

3.4.6.2 Large Wrinkles

The CQA Consultant shall indicate which wrinkles should be cut and repaired by the Installer. The repair thus produced shall be tested like any other repair.

3.4.7 Backfilling of Anchor Trench

The CQA Consultant shall observe the backfilling operation.

3.4.8 Lining System Acceptance

The CQA Consultant shall verify that installation has proceeded in accordance with the CQA Plan for the project.

3.4.9 Materials in Contact with the HDPE Geomembrane

3.4.9.1 Soils

The CQA Consultant shall verify that the Specifications are consistent with the state of practice such as:

- Placement of soils on the geomembrane shall not proceed at an ambient temperature below 40°F nor above 104°F unless otherwise specified;
- A geotextile or other cushion approved by the ENGINEER may be installed between a drainage layer and the geomembrane;
- Equipment used for placing soil shall not be driven directly on the geomembrane;

- A minimum thickness of 1 foot of drainage material is specified between a light dozer (such as a wide pad Caterpillar D-5 or lighter) and the geomembrane;
- A minimum thickness of 4 feet of soil/stone is specified between rubber-tired vehicles and the geomembrane; and
- In heavily trafficked areas such as access ramps, soil/stone thickness should be at least 4 feet.
- Verify the required soil thickness; and that placement of soil is done in such a manner that geomembrane damage is unlikely.

3.4.10 Sumps and Appurtenances

The CQA Consultant shall review the Specifications and verify the use of geosynthetic layers between structures and geomembrane.

The CQA Consultant shall verify that:

- Installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to Drawings and Specifications;
- Welding around appurtenances is complete since neither non-destructive nor destructive testing may be feasible in these areas; and
- The geomembrane has not been visibly damaged while making connections to sumps and appurtenances.

3.5 GEOTEXTILES

3.5.1 Manufacturing

The CQA Consultant shall examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile.

3.5.2 Labeling

The CQA Consultant shall examine rolls upon delivery and note any deviation from the requirements listed in the project specifications.

3.5.3 Shipment and Storage

The CQA Consultant shall observe rolls upon delivery at the site and note any deviation from the requirements listed in the project specifications. Any damaged rolls shall be rejected and replaced at no additional cost to the OWNER.

3.5.4 Conformance Testing

3.5.4.1 Tests

In-Plant Material Conformance Test Sampling

The CQA Consultant shall arrange for the CQA Laboratory to sample the geotextile material in-plant and ship these samples to their laboratory for conformance testing as outlined in the project specifications.

The CQA Consultant shall report any nonconformance of sampling procedures as outlined in the project specifications.

NOTE: All geotextiles used for this project shall be from the same lot unless otherwise approved by the CQA Consultant. The manufacturer or supplier shall perform additional conformance testing, at no additional cost to the OWNER.

3.5.4.2 Sampling Procedures

The samples will be taken from selected rolls by removing the protective wrapping and cutting full-width, 1-m-long (3-ft-long) samples from the outer wrap of the selected roll(s). The outer revolution of geotextile is to be discarded before the test sample is taken. The sample rolls must be relabeled for future identification. Items to be considered are the following:

- The conformance test samples shall be identified by type, style, or lot and roll numbers. The machine direction should be noted on the sample(s) with a waterproof marker.
- A lot is defined as a unit of production, a group of other units, rolls having one or more common properties, and being readily separable from other similar units.
- Unless otherwise stated, sampling should be based on one per lot or one per 100,000 sq ft, whichever is greater.

3.5.4.3 Test Procedures

Conformance testing shall be shall be conducted in accordance with the most recent versions of GRI Test Method GT12(a) for geotextile cushions and GRI Test Method

GT13(a) (moderate survivability) for geotextile separators, and include the following properties:

Mass per unit area
Grab tensile strength
Trapezoidal tear strength
Puncture strength
Permittivity*
Apparent opening size*

*Only if geotextile is to be used as a filter/separator

3.5.4.4 Test Results

The CQA Consultant shall examine all results from laboratory conformance testing.

3.5.4.5 Conformance Test Failure

The CQA Consultant shall document actions taken in conjunction with conformance test failures as outlined in the project specifications.

3.5.5 Handling and Placement

The CQA Consultant shall note any noncompliance to the project specifications.

3.5.6 Seams and Overlaps

The CQA Consultant shall note any noncompliance to the project specifications.

3.5.7 Repair

The CQA Consultant shall observe any repair, note any noncompliance with the requirements listed in the project specifications.

3.5.8 Placement of Soil Materials

The Installer shall place cover soil materials on top of a geotextile in such a manner as to ensure no damage to the geotextile such as slippage on underlying layers, and tensile stresses in the geotextile.

3.6 GEOCOMPOSITE

3.6.1 Manufacturing

The CQA Consultant shall examine all manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed those specified.

3.6.2 Labeling

The CQA Consultant shall examine rolls upon delivery and note any deviation from the requirements listed in the project specifications.

3.6.3 Shipment and Storage

The CQA Consultant shall verify that geocomposite materials are free of soil and dust before installation and shall record the observation of this verification. Washing operations shall be observed by the CQA Consultant.

3.6.4 Conformance Testing

3.6.4.1 Tests

In-Plant Material Conformance Test Sampling

The CQA Consultant shall arrange for the CQA Laboratory to sample the geocomposite material in-plant and ship these samples to their laboratory for conformance testing as outlined in the project specifications.

The CQA Consultant shall report any nonconformance of sampling procedures as outlined in the project specifications.

NOTE: All geocomposite used for this project shall be from the same lot unless otherwise approved by the ENGINEER. The manufacturer or supplier shall perform additional conformance testing, at no additional cost to the OWNER.

As a minimum, the following tests shall be performed on geocomposite:

Geotextile apparent opening size
Geotextile puncture strength
Geocomposite transmissivity

3.6.4.2 Sampling Procedures

The samples will be taken from selected rolls by removing the protective wrapping and cutting full-width, 1-m-long (3-ft-long) samples from the outer wrap of the selected roll(s). The outer revolution of geocomposite is to be discarded before the test sample is taken. The sample rolls must be relabeled for future identification. Items to be considered are the following:

- The conformance test samples shall be identified by type, style, or lot and roll numbers. The machine direction should be noted on the sample(s) with a waterproof marker.
- A lot is defined as a unit of production, a group of other units, rolls having one or more common properties, and being readily separable from other similar units.
- Unless otherwise stated, sampling should be based on one per lot or one per 100,000 sq ft, whichever is greater.

3.6.4.3 Test Results

The CQA Consultant shall examine all results from laboratory conformance testing.

3.6.4.4 Conformance Test Failure

The CQA Consultant shall document actions taken in conjunction with conformance test failures as outlined in the project specifications.

3.6.5 Handling and Placement

The CQA Consultant shall note any noncompliance to the project specifications.

3.6.6 Repair

The CQA Consultant shall observe repairs, note any noncompliance to the project specifications.

3.6.7 Placement of Soil Materials

Any noncompliance to the project specifications shall be noted by the CQA Consultant.

If portions of the geocomposite are exposed, the CQA Consultant shall periodically place marks on the geocomposite and the underlying geomembrane and measure the elongation of the geocomposite during the placement of soil.

3.7 GEOSYNTHETIC CLAY LINER (GCL)

3.7.1 Storage

Geosynthetic clay liner rolls must always be stored in a location where they shall not be exposed to moisture.

3.7.2 Handling & Placement

On slopes, geosynthetic clay liners should be placed with overlap oriented parallel to the maximum slope (i.e. down the slope).

Adjoining panels of geosynthetic clay liners should be overlapped a minimum of six inches (6").

Geosynthetic clay liners should never be installed in standing water or during rain.

Geosynthetic clay liners should always be installed with appropriate side up.

Rolls should be pulled tight to smooth out any creases or folding.

Precautions should be taken to avoid damage to any underlying geosynthetic materials while placing the geosynthetic clay liners.

Cover geosynthetic clay liners with geomembrane or other cover materials after placement to avoid damage from precipitation.

3.7.3 Repairs

Repairs to cuts or tears in installed material should extend a minimum of six inches (6") beyond the area in need of repair. Repair pieces should be held in place until cover material has been placed.

4.0 LEACHATE COLLECTION PIPING

4.1 INTRODUCTION

This section of the plan addresses the quality assurance of the installation of all pipes and manholes used on the project in the leachate collection and removal system (LCRS) including, leachate collection pipes and leachate transmission pipes.

4.2 SCOPE

4.2.1 General

The work addressed under this section shall facilitate proper construction of all LCRS piping installed in or outside the disposal cells on the project. All work shall be constructed to the lines, grades, and dimensions indicated on the project plans, in accordance with the project specifications, or as required by the OWNER and ENGINEER. The CQA Consultant shall issue a written daily report of activities. These reports shall include, as a minimum, observations and test results as well as problems encountered and solutions achieved. Construction reports summarizing significant events, as well as addressing all problems encountered and their solutions, shall be issued weekly to the OWNER and ENGINEER. The format of these reports shall be established at the pre-construction meeting.

4.3 MANUFACTURING AND DELIVERY OF MATERIALS

4.3.1 Pipe, Fittings, and Manholes

It is a requirement of the contract that prior to delivery of materials, the CONTRACTOR shall submit detailed or shop drawings and manufacturer's specifications of all materials to be furnished for the project. These drawings and specifications shall be reviewed by the ENGINEER to determine if the materials meet the requirements of the contract specifications. The submittals shall be either approved or rejected. Rejection shall require a resubmission of the information.

4.3.2 Delivery

Upon delivery, the CQA Consultant shall inspect all pipes, fittings, and other appurtenances for conformity with the specifications and proper storage. The CQA Consultant may prescribe corrective repairs or may reject the material as deemed necessary.

4.4 INSTALLATION OF PIPES AND MANHOLES

4.4.1 Testing

Testing shall be done on sections of pipeline as determined ready for testing by the CQA Consultant.

4.4.1.1 Examination of Materials

All pipes, fittings, manholes, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and the deficiency shall be corrected or the material shall be rejected and replaced as deemed necessary by the CQA Consultant.

4.4.1.2 Alignment and Gradient

The alignment of the pipe shall be surveyed by a surveyor licensed in the State in which the project work is conducted.

Alignment and gradient of gravity leachate pipes between manholes shall also be checked by the CQA Consultant by sighting from one manhole to a bright light held at the next manhole. Should alignment vary horizontally more than 1/4 the diameter of the pipe, that is, sags and rises be found in the grade, the CONTRACTOR shall locate and correct the defective joints to the satisfaction of the CQA Consultant.

4.4.1.3 Leak Testing of Leachate Transmission Lines

4.4.1.3.1 Infiltration Test

Infiltration test shall be performed only when the line is below the water table to provide a minimum of four feet of head above the top of the pipe at the highest elevation being tested. A weir shall be installed in the lower end of the section being tested and measurement of the depth of flow over the weir recorded at 15-minute intervals for one hour.

4.4.1.3.2 Exfiltration Test

Exfiltration test shall be performed after replacement of broken or cracked pipe, repair of defective joints, and verification of the pipe installation for line and grade, and after cleaning and conditioning the pipe free from deposits, joint drippings, extrusions, or from foreign matter of any kind. Each section of line between manholes, or for longer distances if allowed before backfilling, shall be maintained completely full of water for a period of not less than 30 minutes to allow for absorption of water by the sewer. By use of pre-installed riser sections of pipes at manholes if necessary, or by plumbers plugs and riser, a column of water shall then be maintained at least four feet above the uppermost top section of pipe under test for lines with grades of one percent or less, and to one inch above the crown of the upper end of the pipe, for grade between one to five percent, and as the CQA Consultant directs, for greater grades. In case the water table in the trench at the time of the test is above the highest invert of the sewer section under test, the column of water above specified shall be accordingly increased.

4.4.1.3.3 Air Test

Air test shall be performed on all leachate transmission lines with grade greater than five percent as outlined below.

Conduct air test when pipe is clean. Plug line at each manhole with pneumatic balls. Introduce low pressure air into plugged line until internal air pressure reaches 4.0 psig greater than average back pressure of any groundwater pressure that may submerge the pipe. Allow at least two minutes for air temperature to stabilize before readings are taken and timing started.

Portion being tested shall pass if it does not lose air at a rate to cause pressure to drop from 3.6 to 3.0 psig (greater than average back pressure of any groundwater that may submerge the pipe) in less time than listed below:

Pipe Diameter in Inches	Minimum Allowable Minutes 3.6 - 3.0 psig Pressure
8 or less	4.0

In lieu of standard exfiltration test, CONTRACTOR may make air tests on lines.

4.4.1.3.4 Infiltration - Exfiltration Test

Infiltration - exfiltration test shall be made by the CONTRACTOR immediately upon completion of the first run of pipe between two manholes, under the direction of the CQA Representative. The remainder of the sewer installation may be tested as the work progresses or upon completion of the project at the option of the CONTRACTOR.

4.4.1.3.5 Leakage

Acceptance of line shall not be made until test requirements have been met. If leakage is detected, CONTRACTOR shall locate and repair defects until leakage is eliminated.

4.4.1.4 Pipe Bedding and Backfill

The gradation and compaction of pipe bedding shall be tested by the contractor to verify compliance with contract specifications.

4.5 INSTALLATION OF DRAINAGE LAYER

4.5.1 Testing

Hydraulic conductivity and grain size will be tested according to Table 1. Additionally the Contractor shall provide test results, as indicated in the Specifications to ensure density, particle size,

hydraulic conductivity and shear strength meat the required parameters. The CQA consultant will review test result and approve of material prior to placement.

4.5.2 Placement

The Contractor is required to provide surveys in accordance with Specification 01720 to demonstrate that the drainage stone was installed to the specified thickness.

5.0 DOCUMENTATION

5.1 Daily Reports

The CQA Consultant shall complete a daily report and logs on prescribed forms, outlining all of the monitoring activities for that day. The area, panel numbers, and seams completed, and measures taken to protect unfinished areas overnight should be identified. Failed seams or other panel areas requiring remedial action must be identified with regard to nature of action, required repair, and location. Repairs completed must also be identified. Any problems or concerns with regard to operations on site should also be noted.

5.2 Record Drawings

Contractor(s) shall provide Record Drawings of installed components including, as applicable:

- Scaled drawing of the completed installation of geomembrane;
- Panels shown and labeled in their relative locations;
- Location of all destructive test samples;
- Location of all geomembrane repairs;
- Leachate piping;
- Landfill gas wells;
- Landfill gas piping.

The Project Record Drawings shall address each layer of soil liner, geomembrane and drainage layer for landfill liner expansion, or intermediate cover, geomembrane, and final cover soil for landfill closure; and if necessary, another drawing that identifies problems or unusual conditions of the geotextile or geocomposite layers. In addition, applicable cross-sections shall show layouts of geocomposite and geotextile that are unusual or different from the design drawings.

5.3 Final Certification Report

A Final Certification Report shall be prepared by the CQA Consultant and submitted upon completion of the work. This report shall include all reports prepared by the CQA Consultant personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The Final Certification Report shall include as a minimum the following information:

- Personnel involved with the project;
- Scope of work and outline of project;
- Quality assurance methods;
- All test results, including failed ones (destructive and non-destructive, including laboratory tests);
- Descriptions of deviations from the approved plans and of corrections to remediate the deviation;
- Series of color photographs of major project features;
- Certification sealed and signed by a registered Professional Engineer licensed in the State in which the project work is conducted.
- Record Drawings, sealed and signed by a registered Surveyor or Professional Engineer, licensed in the State in which the project work is conducted.

END OF CONSTRUCTION QUALITY ASSURANCE PLAN

TABLES

TABLE 1 - SOIL TESTING METHODS AND FREQUENCIES

Test Method	Fill		Test Pad		Soil Liner/Cap	Drainage Layer	
	Pre-Construction	Construction	Pre-Construction	Construction	Construction	Pre-Construction	Construction
Particle Size Analysis of Soils ASTM D422	One/Material	One/Material(1)	One/Material	NA	NA	NA	1/10,000 CY(2)
Unified Soil Classification System ASTM D2487	One/Material	One/Material(1)	One/Material	NA	NA	NA	NA
Moisture Content of Soil Lab Method ASTM D2216	One/Material	One/Material(1)	One/Material	NA	NA	NA	NA
Atterberg Limits ASTM D4318	One/Material	One/Material(1)	One/Material	NA	NA	NA	NA
Specific Gravity ASTM D854	One/Material	One/Material(1)	One/Material	NA	NA	NA	NA
Standard Proctor ASTM D698	One/Material	One/Material(1)	One/Material	NA	NA	NA	NA
In-place Density by Sand Cone ASTM D1556 or Drive Cylinder ASTM D2937	NA	1/Acre	NA	1/Lift	1/Lift/Acre	NA	NA
In-place Density and Water Content by Nuclear Method ASTM D6938	NA	5/Acre	NA	5/Lift	5/Lift/Acre	NA	NA
Soil Moisture By Direct Heating ASTM D4959	NA	1/Acre	NA	1/Lift	1/Lift/Acre	NA	NA
Undisturbed Hydraulic Conductivity ASTM D5084	NA	NA	NA	1/Lift	1/Lift/Acre	NA	NA
Laboratory Compacted Hydraulic Conductivity ASTM D5084	NA	NA	One/Material	NA	One/Material	NA	One/Material
Two-Stage Field Permeameter ASTM D6391 (VA liner only)	NA	NA	NA	One/TP	NA	NA	NA

NA – Not Applicable
(1) required only if material changes
(2) for each material provided