Addendum No. 2

Request for Bids for the South Cap Closure
Phase II Construction at the Franklin County Sanitary Landfill

Posted: April 6, 2026

This Addendum No. 2 shall be considered part of the RFB for the South Cap Closure Phase II Construction at the Franklin County Sanitary Landfill and is intended to correct, change, and/or add to the documents as described below. Please make sure to complete the Addenda Acknowledgement form included in the *Required Documents*.

Listed below is an additional question received with an answer from SWACO:

Question #3: *We did NOT see any QA/QC plan for the geosynthetics. Do you have them?*

Answer: The QA/QC plan is attached to this Addendum 2.

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Attachment: Construction Quality Assurance/Quality Control Plan

CAD drawings are available for download on SWACO's website

The deadline for questions relating to this RFB is 4:00 p.m., Friday, April 10, 2026.

Bids are due no later than 1:30 p.m., April 17, 2026.

+ + This completes Addendum No. 2 + +
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CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

Prepared For:

FRANKLIN COUNTY SANITARY LANDFILL

Prepared By:

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CEC Project 316-058

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REVISED JULY 2017
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FRANKLIN COUNTY SANITARY LANDFILL
CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

SECTION SUMMARY

Section I	General
Section II	Soils Construction Quality Assurance
Section III	Geosynthetic Clay Liner Construction Quality Assurance
Section IV	Geomembrane Construction Quality Assurance
Section V	Geocomposite Construction Quality Assurance
Section VI	Geotextile Construction Quality Assurance
Section VII	High Density Polyethylene Pipe and Fittings Construction Quality Assurance
Section VIII	Surveying Construction Quality Assurance
Section IX	Construction Quality Assurance Documentation

TABLES

Table 1	Minimum Test Frequencies for Soil and Aggregate Components
Table 2	Geosynthetic Clay Liner QA/QC Testing
Table 3	60 mil HDPE Smooth/Textured Geomembrane QA/QC Testing
Table 4	40 mil LLDPE Textured Geomembrane QA/QC Testing
Table 5	40 mil HDPE Textured Geomembrane QA/QC Testing
Table 6	Final Cover System Double Sided Geocomposite QA/QC Testing
Table 7	6 oz/sy MARV Nonwoven Geotextile QA/QC Testing
Table 8	16 oz/sy MARV Nonwoven Geotextile QA/QC Testing
Table 9	Minimum Internal/Interface Shear Strengths

SECTION I

GENERAL

SECTION I
GENERAL
TABLE OF CONTENTS

1.0 INTRODUCTION....1

2.0 SCOPE OF THE CQA/QC PLAN....4

3.0 DEFINITIONS AND USE OF TERMS....6
- **3.1 Definitions Relating To CQA....6**
- **3.2 Use of Terms....6**
- **3.3 References to Standards....7**
- **3.4 Units....7**

4.0 RESPONSIBILITY AND AUTHORITY....8
- **4.1 Regulatory Agency....8**
- **4.2 Owner....8**
- **4.3 Project Manager....9**
- **4.4 Design Engineer....9**
- **4.5 CQA Consultant....9**
- **4.6 Soils CQA Laboratory....10**
- **4.7 Geosynthetics CQA Laboratory....10**
- **4.8 Earthwork Contractor....11**
- **4.9 Soils Supplier....11**
- **4.10 Resin Supplier....11**
- **4.11 Geosynthetics Manufacturer....12**
- **4.12 Geosynthetics Installer....12**
- **4.13 Pipe Manufacturer....12**
- **4.14 Pipe Installer....12**
- **4.15 Transporter....12**

5.0 QUALIFICATIONS OF KEY PERSONNEL AND ORGANIZATIONS....14
- **5.1 CQA Consultant....14**
- **5.2 Soils CQA Laboratory....14**
- **5.3 Geosynthetics CQA Laboratory....15**
- **5.4 Earthwork Contractor....15**
- **5.5 Geosynthetics Manufacturer....15**
- **5.6 Geosynthetics Installer....16**
- **5.7 Pipe Manufacturer....16**
- **5.8 Pipe Installer....16**
- **5.9 Transporter....16**

6.0 PROJECT MEETINGS....17
- **6.1 Resolution Meeting....17**
- **6.2 Pre-Construction Meeting....18**
- **6.3 Progress Meetings....19**
- **6.4 Problem or Work Deficiency Meeting....19**

SECTION I
GENERAL

1.0 INTRODUCTION

This Construction Quality Assurance/Quality Control Plan (CQA/QC Plan) has been prepared for the Franklin County Sanitary Landfill in Franklin County, Ohio. This CQA/QC Plan is provided as required in Ohio Administrative Code (OAC) 3745-27-06(C)(9)(c) and contains the information specified in OAC 3745-27-08. In addition to the regulations, the following technical references were used during plan preparation:

- USEPA Seminar Publication - Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025, May 1991.
- USEPA Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.
- USEPA Technical Guidance Document: Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, EPA/530-SW-86-031, October 1986.
- GRI GN4 Standard, July 9, 2020, “Test Methods, Required Properties and Testing Frequency for Biplanar Geonets and Biplanar Geonet Composites.”
- GRI GCL3 Standard Specification, November 21, 2019, “Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).”
- GRI Test GM13, March 17, 2021, “Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.”
- GRI Test Method GM17, March 17, 2021, “Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.”
- GRI Test Method GM19a, March 18, 2021, “Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers.”
- GRI Test Method GM9, January 10, 2013, “Cold Weather Seaming of Geomembranes.”

- GRI Test Method 29, December 16, 2013, “Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and/or Nondestructive Testing.”
- GRI Test Method GT12(a), March 3, 2016, "Test Methods and Properties for Non-Woven Geotextiles Used as Protection (or Cushioning) Materials."
- GRI Test Method GT13(a), June 20, 2017, “Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate.”
- GRI Test Method GCL 3, March 28, 2016, “Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)”
- GRI Test Method GM19, February 12, 2015, “Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.”
- Ohio EPA Guidance Document #665, “Use of Best Fit Line of Optimums (BFLO) for Recompacted Soil Liner Construction”, December 2014.
- Ohio EPA Guidance Document, “Use of Settlement Plates for Confirmation of Cap Construction”, August 2023.
- Ohio EPA Policy Document, “Use of Shredded Tires in Landfill Construction”, October 2014.

The purpose of the CQA/QC Plan is to present the principles and practices of quality management that will be implemented during the construction of the engineered components at the facility including the liner/leachate collection system, final cover system, landfill gas extraction system, and permanent groundwater quality control structures. Quality management involves the performance of both quality assurance and quality control activities to verify that the construction meets design criteria, plans, and specifications.

Prior to the initiation of construction activities, the specific parties involved will review this CQA/QC Plan and modify it as necessary. Any revisions to the CQA/QC Plan will be submitted to the Ohio Environmental Protection Agency (Ohio EPA) for approval.

The remainder of this section, Section I, presents general information including the following:

- The scope of the plan;
- Definitions used;
- The responsibility and authority of the parties involved in construction;
- Qualifications of the organizations and key personnel involved in implementing the CQA/QC Plan; and
- A description of project meetings to be held.

2.0 SCOPE OF THE CQA/QC PLAN

The CQA/QC Plan contains the following components included in OAC Rule 3745-27-08 and the site-specific design:

- In-situ Foundation Preparation;
- Structural Fill;
- Added Geologic Material;
- Recompacted Soil Liner;
- Geosynthetic Clay Liner;
- Flexible Membrane Liner;
- Leachate Collection System; and
- Final Cover System.

The CQA/QC Plan includes the information specified in OAC Rule 3745-27-06 (C)(9)(c) including:

- Surveying;
- Calibration of testing equipment;
- Sampling and testing procedures to be used in the field and in the laboratory;
- Testing frequency;
- Parameters and sample locations; and
- Procedures to follow if a test fails.

Responsibility, authority, and personnel qualifications are discussed in Section I of the CQA/QC Plan. Monitoring activities, sampling strategies, and testing requirements are presented for the soil and aggregate components of the baseliner/leachate collection and final cover system in Section II, Soils Construction Quality Assurance. The following sections discuss the placement, monitoring activities, sampling strategies, and testing of geosynthetic components of the

baseliner/leachate collection and final cover systems; Section III, Geosynthetic Clay Liner Construction Quality Assurance; Section IV, Geomembrane Construction Quality Assurance; Section V, Geocomposite Construction Quality Assurance; and Section VI, Geotextile Construction Quality Assurance. Monitoring activities and testing requirements are presented for the piping in the leachate collection system in Section VII, High-Density Polyethylene Pipe and Fittings Construction Quality Assurance.

Section VIII, Surveying Construction Quality Assurance, presents details for surveying to be performed throughout the construction of the engineered components to determine constructed dimensions. Section IX addresses the documentation required to adequately report the CQA activities. Quality Assurance/Quality Control Testing Tables are included following the text.

3.0 DEFINITIONS AND USE OF TERMS

The following provides general information regarding specific terms, references, and units as used in the CQA/QC Plan.

3.1 Definitions Relating To CQA

In the context of this CQA/QC Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

- Construction Quality Assurance (CQA): A planned and systematic pattern of means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.
- Construction Quality Control (CQC): Those actions that provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements.

3.2 Use of Terms

In the context of this CQA/QC Plan, the terms CQA and CQC are used as follows:

- CQA refers to means and actions employed by the CQA Consultant (see Section I, Sub-section 4.5) to assess conformity of construction with the CQA/QC Plan, Drawings, and Specifications. The CQA Consultant is a party independent from the Owner and Contractors.
- CQC refers to those actions taken by manufacturer, supplier, and contractor to meet the requirements for materials and workmanship as stated in the CQA/QC Plan, Construction Drawings, and Specifications.

3.3 References to Standards

The CQA/QC Plan includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS), the Standards for Flexible Membrane Liners of the National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other relevant guidelines.

3.4 Units

Properties and dimensions given in the CQA/QC Plan are expressed in Standard U.S. units and/or the International System of Units (SI).

4.0 RESPONSIBILITY AND AUTHORITY

The principal parties involved in the CQA of the construction of the engineered components include the Regulatory Agency, Owner, Project Manager, Design Engineer, CQA Consultant, Soils CQA Laboratory, Geosynthetics CQA Laboratory, Earthwork Contractor, Soils Supplier, Resin Supplier, Geosynthetics Manufacturer, Geosynthetics Installer, Pipe Manufacturer, Pipe Installer, and Transporter. The general responsibilities and authorities of each of these parties are described in the following paragraphs. The responsibility and/or authority of a given party may be modified or expanded as dictated by specific project needs during pre-construction meetings. The changes shall be incorporated into the CQA/QC Plan and submitted to the Regulatory Agency for approval prior to construction.

4.1 Regulatory Agency

The Regulatory Agency (Ohio EPA) provides authorization for construction based on review and acceptance of the PTI Application of which this CQA/QC Plan is a part. The Regulatory Agency must have approved the PTI Application for the project before construction can begin. As construction progresses, the Regulatory Agency has the responsibility and authority to review and accept or reject design revisions or requests for variance submitted by the Owner. The Regulatory Agency also has the responsibility and authority to review CQA documentation during and after construction to confirm that the CQA/QC Plan was followed and that construction met the requirements of the Drawings and Specifications.

4.2 Owner

The Owner is responsible for the design of the landfill, including the engineered components and related items. This responsibility includes compliance with the PTI Application and the submission of CQA documentation demonstrating that the facility was constructed in conformance with the Drawings and Specifications. The Owner is responsible for the surveying to be conducted but may designate the Design Engineer or CQA Consultant to perform the work.

The Owner has the authority to select and dismiss parties charged with design, CQA, and construction activities. The Owner also has the authority to accept or reject design plans and specifications, CQA/QC Plans, reports and recommendations of the CQA Consultant, and the materials and workmanship of contractors.

4.3 Project Manager

The Project Manager is the official representative of the Owner and is responsible for coordinating field activities. He has authority to direct contractors hired by the Owner and is responsible for communications between the Owner, Design Engineer, CQA Consultant, Earthwork Contractor, Geosynthetics Installer**,** and Regulatory Agency.

4.4 Design Engineer

The Design Engineer's primary responsibility is for a design that fulfills the requirements of the Owner and the Regulatory Agency. It is the Design Engineer's responsibility to provide the Drawings and Specifications necessary to construct the facility in accordance with all applicable laws and regulations. During construction, the Design Engineer may be requested to modify elements of the design due to unforeseen site conditions or changes in construction methodology.

4.5 CQA Consultant

The CQA Consultant is responsible for observing and documenting activities related to the CQA of the construction of the baseliner/leachate collection, final cover, permanent groundwater control, and landfill gas control systems as outlined in the CQA/QC Plan. The CQA Consultant is represented by a Certifying Engineer and on-site CQA Monitoring Personnel as appropriate.

In general, the responsibilities and authorities of the CQA Consultant include:

- Scheduling, coordinating, and performing CQA activities;
- Performing independent on-site observation of the work in progress to assess compliance with Drawings and Specifications;
- Determining that test equipment meets testing and calibration requirements, and that tests are conducted according to standardized procedures defined in the CQA/QC Plan;
- Recording and maintaining test data accurately;
- Identifying CQC-tested work that should be accepted, rejected, or further evaluated;
- Documenting that corrective measures are implemented;
- Documenting and reporting CQA activities;
- Collecting data needed for CQA Documentation as defined in Section IX; and
- Maintaining open lines of communications with the other parties involved in the construction.

4.6 Soils CQA Laboratory

The Soils CQA Laboratory is independent from the Soils Supplier and Earthwork Contractor, and is responsible for performing the laboratory testing required by the CQA/QC Plan to determine specific characteristics of the soils. The Soils CQA Laboratory is also responsible for providing adequate documentation of analytical results, test methods followed, and testing equipment used.

4.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is independent from the Geosynthetics Manufacturer, and Geosynthetics Installer, and is responsible for conducting quality assurance tests on samples of geosynthetics. The Geosynthetics CQA Laboratory cannot be provided by any party involved with the manufacturer, fabrication, or installation of any of the geosynthetics components.

4.8 Earthwork Contractor

The Earthwork Contractor may be responsible for:

- Preparation of the subbase;
- Placement of the structural fill, added geologic material, recompacted soil liner and protective cover layer components of the liner/leachate collection systems;
- Preparation and completion of the geosynthetics anchor trenches (unless otherwise specified);
- Dewatering of surface water from placed soils, geosynthetics, and anchor trenches (unless otherwise specified); and
- Placement of the intermediate cover (unless otherwise specified), recompacted soil barrier, and vegetative cover/frost protection layer components within the final cover system.

It is the responsibility of the Earthwork Contractor that the construction be performed using the procedures and equipment necessary to produce results in conformance with the CQA/QC Plan, Drawings, and Specifications. If the Earthwork Contractor uses a subcontractor, the Earthwork Contractor retains responsibility for the quality of the work performed.

4.9 Soils Supplier

The Soils Supplier delivers soils to the Earthwork Contractor. The Owner or Earthwork Contractor may be the Soils Supplier.

4.10 Resin Supplier

The Resin Supplier produces and delivers the resin to the Geosynthetics Manufacturer.

4.11 Geosynthetics Manufacturer

The Geosynthetics Manufacturer is responsible for the production of the geosynthetics, which include the Geosynthetic Clay Liner (GCL), Flexible Membrane Liners (FML), geocomposite, and geotextile.

4.12 Geosynthetics Installer

The Geosynthetics Installer is responsible for unloading from shipment, storage, field handling, placing, seaming, field testing, temporarily securing (against wind), and other aspects of the geosynthetics installation. If specified, the Geosynthetics Installer may also be responsible for the preparation and completion of any anchor trenches.

4.13 Pipe Manufacturer

The Pipe Manufacturer is responsible for the production of the piping used in the leachate collection, leachate transmission, and gas extraction systems.

4.14 Pipe Installer

The Pipe Installer is responsible for unloading from shipment, storage, field handling, placing, joining, field testing, temporarily securing (against flotation), and other aspects of the pipe installation. The Pipe Installer is also responsible for the excavation and backfilling of the excavation. The Pipe Installer may be the Earthwork Contractor.

4.15 Transporter

The Transporter transports the geosynthetics, including GCL, geomembranes, geotextiles, and geocomposite between the manufacturing plant and the site, and/or between the manufacturing plant and the fabrication plant, and/or between the fabrication plant and the site. The Transporter

also is responsible for transporting the pipe to the site. The Transporter may be the Geosynthetics Manufacturer, Pipe Manufacturer, Pipe Installer, or an assigned party of any of these.

5.0 QUALIFICATIONS OF KEY PERSONNEL AND ORGANIZATIONS

The following qualifications shall be required of the key personnel and organizations involved in CQA and/or CQC for the construction of the liner/leachate collection and final cover systems and other related work.

5.1 CQA Consultant

The CQA Consultant shall be a qualified engineering firm with experience in construction quality assurance and quality control, particularly on projects involving similar liner/leachate collection, final cover, permanent groundwater control, and gas extraction systems. The CQA Consultant shall be capable of assigning technically qualified personnel to the project, including a supervising CQA engineer and CQA monitors, as needed. The person designated as the Certifying Engineer should possess an engineering degree and should be a Professional Engineer registered in the state of the Regulatory Agency.

The corporate qualifications to be presented by the CQA Consultant include:

- Brief corporate history;
- Proof of insurance;
- Summary of the firm's relevant experience; and
- Resumes of personnel proposed for assignment to the project.

5.2 Soils CQA Laboratory

The Soils CQA Laboratory shall be a qualified laboratory with experience in performing laboratory tests to determine soils characteristics as required by this CQA/QC Plan. The Soils CQA Laboratory shall demonstrate that it follows the standard test methods listed in the CQA/QC Plan and maintains the appropriate, calibrated equipment to perform the tests. The Soils CQA Laboratory shall also demonstrate to the Project Manager and CQA Consultant that it adheres to a

formal in-house QA/QC program and can provide the required analytical documentation and reports.

5.3 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory shall be a qualified laboratory with experience in performing laboratory tests to determine geosynthetics characteristics as required by this CQA/QC Plan. The Geosynthetics CQA Laboratory shall demonstrate that it follows the standard test methods listed in the CQA/QC Plan and maintains the appropriate, calibrated equipment to perform the tests. The Geosynthetics CQA Laboratory shall also demonstrate to the Project Manager and CQA Consultant that it adheres to a formal in-house QA/QC program and can provide the required analytical documentation and reports.

5.4 Earthwork Contractor

The Earthwork Contractor shall be qualified to construct the soils portions of the engineered components. The Earthwork Contractor shall be capable of assigning the personnel and equipment required to perform the work within the schedule and according to the Specifications and Drawings.

5.5 Geosynthetics Manufacturer

The Geosynthetics Manufacturer must be able to demonstrate that they have completed projects of similar size and scope. The Geosynthetics Manufacturer shall be able to provide sufficient production capacity and qualified personnel to meet the demands of the Specifications. The Geosynthetics Manufacturer shall demonstrate to the Project Manager and CQA Consultant that it adheres to a formal in-house QA/QC program and can provide the required geosynthetics documentation.

5.6 Geosynthetics Installer

The Geosynthetics Installer shall be trained and qualified to install geosynthetics. The Geosynthetics Installer must be able to demonstrate that they have completed projects of similar size and scope. The Geosynthetics Installer will designate one representative as his Superintendent, who will represent the Geosynthetics Installer at all site meetings and be responsible for acting as the Geosynthetics Installer's spokesperson on site. For flexible membrane liner (geomembrane) installations exceeding 10,000 square feet, the Geosynthetics Installer must also be able to provide at least one welding technician that has seamed a minimum of 1 million square feet of geomembrane in accordance with OAC 3745-27-08(D)(10)(e). This welding technician must be on-site during geomembrane installation.

5.7 Pipe Manufacturer

The Pipe Manufacturer shall be able to provide sufficient production capacity and qualified personnel to meet the demands of the project. The Pipe Manufacturer shall demonstrate to the Project Manager and CQA Consultant that it adheres to a formal in-house QA/QC program and can provide the required pipe documentation.

5.8 Pipe Installer

The Pipe Installer must be trained and qualified to install the piping required for the project.

5.9 Transporter

All personnel responsible for the loading, transport, and unloading of the geosynthetics and piping must be fully aware of the consequences of damage to the geosynthetics and piping, and familiar with handling and transport constraints required by the Manufacturer.

6.0 PROJECT MEETINGS

To achieve a high degree of quality during construction/installation, clear, open channels of communication are essential. To that end, meetings are critical.

6.1 Resolution Meeting

Following the completion of the design, Drawings and Specifications for the project and the Regulatory Agency's approval of the PTI Application and prior to construction of the liner/leachate collection, final cover, permanent groundwater control, or landfill gas extraction systems, a Resolution Meeting may be held. This meeting may include the parties to be involved, including the Project Manager, Design Engineer, CQA Consultant, Regulatory Agency (if appropriate), and Contractors.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate problems that might cause difficulties and delays in construction, and present the CQA/QC Plan to the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all parties present at the Resolution Meeting.

The meeting shall include the following activities:

- Distribute relevant documents;
- Review critical design details of the project;
- Review the site-specific CQA/QC Plan;
- Make appropriate modifications to the CQA/QC Plan to include CQA activities that are necessary or update test methods;
- Determine quality control procedures, especially on methods for determining acceptability of the soils and geosynthetics comprising the liner/leachate collection and final cover systems;
- Select testing equipment and review protocols for testing and placement of soil materials;

- Confirm the methods for documenting and reporting, and for distributing documents and reports; and
- Confirm the lines of authority and communication.

The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to the parties involved. The Resolution Meeting may be combined with the Pre-Construction Meeting described below.

6.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. At a minimum, the meeting shall be attended by the Design Engineer, the CQA Consultant, the Earthwork Contractor, the Geosynthetics Installer, and the Project Manager.

Specific topics considered for this meeting include:

- Make additional appropriate modifications to the CQA/QC Plan if needed;
- Review the responsibilities of each party;
- Review lines of authority and communication;
- Review methods for documenting and reporting, and for distributing documents and reports;
- Establish protocols for testing;
- Establish protocols for handling deficiencies, repairs, and retesting;
- Review the time schedule for operations;
- Review repair procedures;
- Conduct a site walk-around to determine that preparation for construction is proceeding on schedule; and
- Review material storage location and soil and aggregate stockpile locations (if any).

The meeting shall be documented by a person designated at the beginning of the meeting, and a meeting summary shall be transmitted to the parties involved.

6.3 Progress Meetings

Progress meetings may be held as necessary between the CQA Consultant, the Earthwork Contractor, the Geosynthetics Installer, the Project Manager, the Regulatory Agency, and other involved parties. Items to discuss include current progress, planned activities for the next week, and changes to the work. The CQA Consultant will log problems, decisions, or questions arising at this meeting in the daily report. Matters requiring action raised in this meeting shall be reported to the appropriate parties.

6.4 Problem or Work Deficiency Meeting

A special meeting may be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting may be attended by the affected contractors, the Project Manager, Regulatory Agency (if appropriate), and the CQA Consultant. If the problem requires a design modification, the Design Engineer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency;
- Review alternative solutions; and
- Implement an action plan to resolve the problem or deficiency.

The meeting shall be documented by a person designated at the meeting and, if appropriate, minutes shall be transmitted to the parties involved.

SECTION II

SOILS CONSTRUCTION QUALITY ASSURANCE

SECTION II
SOILS
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 INTRODUCTION....1
1.1 Section Format....2
1.2 Responsibilities....2
1.3 Surveying and Documentation....2

2.0 TEST METHODS AND SAMPLING REQUIREMENTS....3

3.0 IN-SITU FOUNDATION....4

4.0 STRUCTURAL FILL....5
4.1 Soil Structural Fill....5
4.1.1 Rock Structural Fill....6

5.0 ADDED GEOLOGIC MATERIAL....7
5.1 Material Acceptance Criteria....7
5.1.1 Construction Quality Evaluation Criteria....7
5.1.2 Monitoring Program for Construction of AGM....8

6.0 RECOMPACTED SOIL LINER....10
6.1 MATERIAL ACCEPTANCE CRITERIA....10
6.2 RSL TEST PAD....11
6.3 CONSTRUCTION QUALITY EVALUATION CRITERIA....12
6.4 MONITORING PROGRAM FOR CONSTRUCTION OF RSL....13

7.0 LEACHATE COLLECTION/PROTECTIVE COVER LAYER....16
7.1 Tire Shred Testing....17
7.2 Tire Shred Test Pits....17
7.2.1 Contingency Plan....17
7.3 Tire Shred Storage....18

8.0 COARSE AGGREGATE AROUND PIPES....20

9.0 RECOMPACTED SOIL BARRIER LAYER....21

10.0 ENGINEERED SUBBASE....23

11.0 TRANSITIONAL COVER....25

12.0 VEGETATIVE COVER/CAP PROTECTION LAYER....26

13.0 POTENTIAL PROBLEMS AND DEFICIENCIES....28

13.1 Notification 28
13.2 Repairs and Retesting..... 29
13.3 Layer Thickness 29

SECTION II

SOILS CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

This section of the CQA/QC Plan addresses the CQA and CQC activities associated with the soil and aggregate components of the liner/leachate collection and final cover systems. This includes materials selection and evaluation, laboratory testing requirements, field testing requirements, and resolution of problems. The soil and aggregate components of the liner/leachate collection system are as follows:

- In-situ Foundation;
- Structural Fill;
- Added Geologic Material;
- Recompacted Soil Liner;
- Protective Cover Layer; and
- Coarse Aggregate around pipes.

The soil and aggregate components of the final cover system are as follows:

- Recompacted Soil Barrier
- Engineered Subbase;
- Transitional Cover; and
- Frost Protection/Vegetative Layer.

The soil and aggregate components shall meet requirements related to material characteristics and construction quality. Both field and laboratory tests shall be performed prior to construction to evaluate if the characteristics of soil and aggregate from proposed sources meet the material acceptance requirements. Throughout construction, additional field and laboratory testing shall be

performed to evaluate if the placed material meets the requirements with regard to material acceptance and construction quality.

1.1 Section Format

A summary of the test methods and requirements is provided for use in conjunction with the text. The following information is then presented for each soil and aggregate component of the liner/leachate collection and final cover systems:

- Criteria which must be met with regard to material acceptance and construction quality;
- Field and laboratory testing to be performed to determine that the criteria are met; and
- Construction monitoring activities to be performed to assess construction quality.

The section concludes with a discussion of the resolution of potential problems and deficiencies.

1.2 Responsibilities

The Earthwork Contractor shall be responsible for construction of soil and aggregate components of the liner/leachate collection and final cover systems. The CQA Consultant shall be responsible for both the soil and aggregate CQA and CQC activities described in the CQA/QC Plan. The Soils CQA Laboratory shall perform the laboratory testing.

1.3 Surveying and Documentation

Two other elements of the CQA/QC Plan shall be performed in conjunction with the CQA and CQC activities described in this section are surveying and documentation which are discussed in Sections VIII and IX, respectively.

2.0 TEST METHODS AND SAMPLING REQUIREMENTS

Table 1 presents information regarding the laboratory and field test methods that shall be used to determine material characteristics and evaluate construction quality for soil and aggregate components of the liner/leachate collection and final cover systems. The table includes the test frequency, sample locations, sample size, and the acceptance criteria.

Three types of sampling strategies shall be used for the various soil and aggregate components:

- As required by the CQA Consultant to evaluate material characteristics prior to the use of the material in construction and to confirm that those characteristics do not change significantly during construction (i.e., no longer meet specifications or require changes in construction methodology).
- For specific bulk volumes of material in stockpiles (e.g., 1 sample per 1,500-cubic yards).
- Using a grid pattern to establish sampling points on nodes or sampling blocks. For example: "On a 100-foot grid" means that a grid pattern with line spacing of 100-feet shall be superimposed on a plan of the area to be sampled. Each node (intersection of perpendicular grid lines) represents a sample location.

Grid pattern sampling strategies shall be used on placed material and offer several advantages over sampling strategies which require that samples be collected on a "per acre" or "per 10,000-square feet" basis:

- Grid patterns can be superimposed and sampling locations plotted on plans for the areas to be sampled prior to construction. Sampling can thus be conducted systematically.
- Samples and sample locations can be labeled in accordance with the grid pattern thus increasing the effectiveness of documentation.
- The size of the sampling block can be increased to decrease the frequency of sampling without changing the grid pattern.
- Sample frequency terminology can be used and applied consistently.

3.0 IN-SITU FOUNDATION

The surface of the in-situ foundation (subbase) will be prepared in accordance with OAC 3745-27-08(D)(5). The surface will consist of soils that are free of debris, solid waste**,** rocks greater than 6 inches in diameter, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas. The subbase soils shall be resistant to internal erosion (seepage piping failure). The surface shall be able to bear the weight of the landfill and its construction and operations without causing or allowing failure of the liner to occur through settling. The surface shall not have abrupt changes in grade that may result in damage to geosynthetics. The subbase will be proof rolled using a compactor or other heavy equipment prior to placement of the next soil component. The surface of the subbase will be hard, uniform, and smooth and will be compacted to the specifications included in Table 1. Table 1 also provides the testing required for unconsolidated stratigraphic units that have not been anticipated and are more susceptible to slope failure or internal erosion than the units that were reported in the PTI Application.

4.0 STRUCTURAL FILL

Structural fill will be placed in accordance with the requirements of OAC 3745-27-08(D)(6). Structural fill may be used to establish the base of added geologic material or recompacted soil layer elevations, construct berms, roads, sedimentation basins, channels, etc. Structural fill shall be durable rock (for rock fills only), free of debris, foreign material, and deleterious material, not comprised of solid waste. Both soil and rock structural fill will be utilized. Soil or rock structural fill may be utilized beneath the portions of the cell floor. Soil or rock structural fill may be used to construct the perimeter berm.

Prior to placement of the structural fill, the surface of the underlying soil shall consist of soils that are free of debris, ~~rocks greater than 6 inches in diameter,~~ vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas. The underlying soil will be proof rolled using a compactor or other heavy equipment prior to placement of the next soil component. The surface of the underlying soil will be hard, uniform, and smooth.

Structural fill shall be determined to have adequate strength to satisfy bearing capacity and slope stability strength requirements. The finished surface of the structural fill shall be uniform and smooth prior to placing the recompacted soil liner. The surface shall not have any abrupt changes in grade that may result in damage to the composite liner system. Prior to placement of the recompacted soil liner, the surface of the subbase shall be prepared as described in Subsection 3.0, In-Situ Foundation. Surveying shall be performed to determine that finished dimensions are as specified in the design. Details regarding surveying are presented in Section VIII of the CQA/QC Plan.

4.1 SOIL STRUCTURAL FILL

Soil structural fill shall be placed in uniform layers not to exceed 12-inches in uncompacted thickness. Each lift of soil structural fill shall be rolled and compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of the Modified Proctor

maximum dry density. Moisture conditioning shall be conducted as necessary to preserve the homogeneity of the soil and to obtain uniform moisture content throughout the soil mass.

Refer to Table 1 for the specific test methods of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the material acceptance evaluation of soil structural fill.

4.1.1 Rock Structural Fill

Rock structural fill shall consist of well-graded crushed or excavated rock that can provide a range of rock sizes such that smaller rock particles will fill the voids between larger rock particles. The material shall have a maximum particle size of 24-inches and be placed in uniform layers not to exceed 24-inches in uncompacted thickness.

Each lift of rock structural fill shall be compacted until a visual observation of non-movement is achieved. Moisture may be added to improve the material placement and compaction as approved by the CQA Consultant. No laboratory testing will be performed for rock structural fill.

5.0 ADDED GEOLOGIC MATERIAL

The material to be used as added geologic material (AGM) in the liner system shall meet material acceptance and construction evaluation criteria as detailed in the following paragraphs and as required by OAC Rule 3745-27-08(D)(7). In addition, a rigorous monitoring program shall be implemented during the construction of the AGM layer.

5.1 Material Acceptance Criteria

The physical characteristics of the material to be used in the AGM layer shall be evaluated through visual observation and field and laboratory classification testing both before and during construction. The classification testing shall include determination of the moisture/density relationship, Atterberg limits, grain size analysis, and permeability. If the piezometric surface of an underlying aquifer or a zone of saturation is above the top of the AGM, a pinhole dispersion test must be performed to determine if the AGM soil is dispersive. The material acceptance criteria for the AGM as required in OAC 3745-27-08(D)(7) are as follows:

- Permeability less than or equal to 1×10^{-5} cm/sec. Note that permeability testing is not required if soil classifies as a low plasticity clay (CL), a silty clay (ML-CL), a high plasticity clay (CH), a clayey sand (SC), or a clayey gravel (GC).

Refer to Table 1 for the specific test methods of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the material acceptance evaluation of the AGM layer.

5.1.1 Construction Quality Evaluation Criteria

Prior to placement of the AGM, the surface of the subbase shall be prepared as described in Subsection 3.0, In-Situ Foundation. All lifts of the AGM shall be placed in uniform layers not to exceed 12-inches in uncompacted thickness. The lift depth shall be determined by visual

observation or by survey. Soil clods shall be broken down to a maximum of 12-inches. Moisture conditioning shall be conducted to preserve the homogeneity of the soil and to obtain a relatively uniform moisture content throughout the soil mass. The moisture content of the AGM layer shall be field tested during placement and compaction. Each lift shall be scarified prior to placing the subsequent lift to sufficiently bond it to the previous lift.

Each lift of the AGM shall be compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of Modified Proctor maximum dry density and at a moisture content of not less than two (2) percent below or more than four (4) percent above the optimum moisture content. The finished surface of the AGM layer shall be uniform and smooth. Surveying shall be performed to document that finished dimensions are as specified in the design; details regarding surveying are presented in Section VIII of the CQA/QC Plan.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the evaluation of the AGM layer.

5.1.2 Monitoring Program for Construction of AGM

Visual monitoring of the construction of the AGM shall consist of observing and documenting the following:

- Identification of changes in material characteristics causing a change in construction specifications;
- Adequate spreading of AGM to obtain complete coverage and loose lift thickness;
- Removal of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas;
- Adequate clod-size reduction;
- Mixing of water to obtain uniform distribution;
- Proper adjustment of the water content of the in-place material in the event of prolonged rain or drought during construction;

- Prevention of significant water loss and desiccation cracking before and after compaction;
- Use of compaction equipment of the proper type, configuration, and weight;
- Appropriate equipment speed and number of equipment passes used for compaction;
- Uniformity of coverage by compaction equipment, particularly at fill edges, in equipment turn-around areas, and on slopes;
- Use of sufficient methods to tie lifts together;
- Proper repair of penetrations resulting from the use of density and moisture probes using bentonite;
- Sealing the working surface when work is stopped for a period of time or precipitation is expected by compacting the surface and sloping it to allow run-off of precipitation;
- Timely placement of protective covers to prevent desiccation of AGM material between the installation of lifts or after completion of AGM;
- Prevention of accidental damage to installed portions of the AGM; and
- Observation and documentation of activities to correct conditions not meeting Specifications for the construction of the AGM.

The CQA Consultant shall monitor the in-place moisture content and density of the AGM using a nuclear density gauge. For each lift, the density and moisture shall be tested at a frequency of five tests per acre as required by OAC 3745-27-08(D)(7)(h) (tested on a 100-foot grid superimposed on the construction area). All penetrations will be filled with bentonite.

Construction activities for installation of the AGM shall be documented on a daily basis. CQA personnel shall maintain daily summary reports with supporting data sheets and, when appropriate, problem identification and corrective measures reports. Documentation activities are addressed in Section IX of the CQA/QC Plan.

The CQA Consultant shall approve the installation of the AGM prior to the placement of structural fill. Approval shall be based on the CQA monitoring activities performed during construction of the AGM layer.

6.0 RECOMPACTED SOIL LINER

The material to be used in the recompacted soil liner (RSL) in the liner system shall meet material acceptance and construction evaluation criteria as detailed in the following paragraphs and as required by OAC Rule 3745-27-08(D)(8). In addition, a rigorous monitoring program shall be implemented during the construction of the RSL layer.

6.1 MATERIAL ACCEPTANCE CRITERIA

The physical characteristics of the material to be used in the RSL layer shall be evaluated through visual observation and field and laboratory classification testing both before and during construction. The classification testing shall include determination of the moisture/density relationship, Atterberg Limits, grain size analysis, and permeability. If the piezometric surface of an underlying aquifer or a zone of saturation is above the top of the RSL, a pinhole dispersion test must be performed to determine if the RSL soil is dispersive.

The material acceptance criteria for the RSL as required in OAC 3745-27-08(D)(8)(g) include the following:

- Permeability less than or equal to 1×10^{-7} cm/sec;
- One hundred percent of material with a maximum particle size of 2-inches;
- Not less than 90 percent of material, by weight, with a particle size less than 0.75-inches;
- Loose lifts of 8 inches or less; and
- If the piezometric surface of an underlying aquifer or a zone of saturation is above the top of the RSL, the soil must classifies as slightly dispersive (ND3) or nondispersive (ND2, ND1) as determined by the pinhole dispersion test.

Refer to Table 1 for the specific test methods of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the material acceptance evaluation of the RSL layer. The acceptance criteria include the requirements established by

previously constructed test pads and may be revised based on future test pad construction results. The acceptance criteria also include requirements established using the Best Fit Line of Optimums (BFLO).

Results of pre-construction testing of the borrow soils performed on representative samples shall be submitted to the Ohio EPA no later than seven days prior to the intended use of the material in the construction of the RSL.

6.2 RSL TEST PAD

Test pads shall be constructed in accordance with OAC Rule 3745-27-08(E). A test pad shall be constructed for each borrow source to establish construction details or verify or amend the construction details proposed in the approved permit. A test pad shall be constructed prior to the construction of the sanitary landfill component that the test pad will model and will be constructed as many times as necessary to meet the permeability requirement. In addition, a test pad shall be constructed whenever there is a significant change in soil material properties as required in the regulations. The test pads shall be used to evaluate the following:

- Material handling and placement requirements;
- Lift thickness;
- Water content necessary to achieve the desired compaction;
- Compaction equipment type, weight, and number of passes; and
- Field permeability.

The results of test pad construction may be used to verify or amend construction details proposed in the approved permit for the site. Test pads shall be constructed using the same material, equipment, and procedures to be used in the construction of the RSL. A test pad plan shall be prepared by the Design Engineer, if necessary. The test pad will have dimensions of at least three (3) times the width of the compaction equipment and two (2) times the length of the compaction equipment including power equipment and attachments. The test pad will consist of at least four

(4) lifts (each lift not to exceed 8 inches in uncompacted thickness) with the thickness of the test pad being no less than 30-inches. In-situ density and moisture testing will be performed at least three (3) times per lift, and all penetrations will be repaired with bentonite. The construction of the test pad shall be closely monitored, and the following tests shall be performed at a frequency of at least twice per lift:

- Maximum dry density and optimum moisture content;
- Grain size distribution with hydrometer; and
- Atterberg limits.

Following the construction of the test pad, a determination of permeability through field testing shall be performed. Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the test pad.

6.3 CONSTRUCTION QUALITY EVALUATION CRITERIA

Prior to placement of the RSL, the surface of the subbase shall be prepared as described in Subsection 3.0, In-Situ Foundation. All lifts of the RSL shall be placed in uniform layers not to exceed 8-inches in uncompacted thickness (or as determined by the applicable test pad report). The lift depth shall be determined by visual observation or by survey. The minimum total thickness of the RSL shall be 3-feet or 2 feet when used in conjunction with a Geosynthetic Clay Liner. The RSL shall be adequately protected from damage due to desiccation, freeze/thaw cycles, wet/dry cycles, and the intrusion of objects during construction and operation. In addition the RSL shall be free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, soft areas, and not comprised of solid waste. Soil clods shall be broken down to 3-inches or half the lift thickness, whichever is less. Moisture conditioning shall be conducted to preserve the homogeneity of the soil and to obtain a relatively uniform moisture content throughout the soil mass. The moisture content of the RSL layer shall be field tested during placement and

compaction. Each lift shall be scarified prior to placing the subsequent lift to sufficiently bond it to the previous lift.

When comparing to a test pad, each lift of the RSL shall be compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of Modified Proctor maximum dry density and at a moisture content of at or above optimum to a moisture and density that meets or exceeds the Best Fit Line of Optimums (BFLO). The compaction specifications may be modified based on the results of the test pad. When comparing to the BFLO, each lift of RSL shall be compacted to a moisture content and dry density that meets or exceeds the BFLO. The finished surface of the RSL layer shall be uniform and smooth. Surveying shall be performed to document that finished dimensions are as specified in the design; details regarding surveying are presented in Section VIII of the CQA/QC Plan.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the evaluation of the RSL layer. The acceptance criteria for the RSL may be modified based on test pad results.

6.4 MONITORING PROGRAM FOR CONSTRUCTION OF RSL

Visual monitoring of the construction of the RSL shall consist of observing and documenting the following:

- Identification of changes in material characteristics causing a change in construction specifications;
- Adequate spreading of RSL to obtain complete coverage and loose lift thickness;
- Removal of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas;
- Adequate clod-size reduction;
- Mixing of water to obtain uniform distribution;

- Proper adjustment of the water content of the in-place material in the event of prolonged rain or drought during construction;
- Prevention of significant water loss and desiccation cracking before and after compaction;
- Use of compaction equipment of the proper type, configuration, and weight;
- Appropriate equipment speed and number of equipment passes used for compaction;
- Uniformity of coverage by compaction equipment, particularly at fill edges, in equipment turn-around areas, and on slopes;
- Use of sufficient methods to tie lifts together;
- Proper repair of penetrations resulting from the use of density and moisture probes using bentonite;
- Sealing the working surface when work is stopped for a period of time or precipitation is expected by compacting the surface and sloping it to allow run-off of precipitation;
- Timely placement of protective covers to prevent desiccation of RSL material between the installation of lifts or after completion of RSL;
- Prevention of accidental damage to installed portions of the RSL; and
- Observation and documentation of activities to correct conditions not meeting Specifications for the construction of the RSL.

The CQA Consultant shall monitor the in-place moisture content and density of the RSL using a nuclear density gauge. For each lift, the density and moisture shall be tested at a frequency of five tests per acre as required by OAC 3745-27-08(D)(8)(j) (tested on a 100-foot grid superimposed on the construction area). All penetrations will be filled with bentonite.

Construction activities for installation of the RSL shall be documented on a daily basis. CQA personnel shall maintain daily summary reports with supporting data sheets and, when appropriate, problem identification and corrective measures reports. Documentation activities are addressed in Section IX of the CQA/QC Plan.

The CQA Consultant shall approve the installation of the RSL prior to the placement of the overlying geosynthetics. Approval shall be based on the CQA monitoring activities performed during construction of the RSL layer.

7.0 LEACHATE COLLECTION/PROTECTIVE COVER LAYER

Coarse-grained soils or tire shreds will be used in the construction of the leachate collection/protective cover/filter (protective cover) layer. The protective cover layer shall be placed above the geosynthetics in the liner/leachate collection system to protect the underlying composite liner system from intrusion of objects during construction and operation.

Special care shall be taken to avoid damaging the underlying liner/leachate collection system when placing the protective cover layer. Prior to placement of the protective cover layer on the side slopes, the geosynthetic anchor trenches shall be properly backfilled and compacted. The CQA Consultant shall be present as necessary during protective cover layer placement to determine that no damage to the underlying RSL or geosynthetics materials occurs and that no unacceptable materials are placed. During placement of the protective cover layer, care shall be taken such that large wrinkles do not develop in the geomembrane or geocomposite. The leachate collection/protective cover layer shall not be placed over wrinkles in the geomembrane that are greater than 4 inches in height per OAC 3745-27-08(D)(12)(a)(vii).Wrinkles that may form will be repaired as required by the CQA Consultant.

The protective cover layer shall be placed and spread to the required thickness using a low ground pressure dozer or other suitable earth moving equipment with a maximum ground pressure of 8 psi. The protective cover layer installation shall proceed upslope, perpendicular to slope contours, only. At no time will equipment be permitted to install protective cover material down slope. Precautions shall be taken to make sure that at least 3-feet of material is provided for trucks to run on when bringing protective cover material to the work area. Any damage to the leachate collection/protective cover layer due to erosion shall be repaired within two weeks, weather permitting.

The operators of all equipment used in transporting or spreading the material shall be advised to use gradual turns and stop/starts. Refer to Table 1 for a summary of the laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the protective cover layer.

7.1 Tire Shred Testing

If tire shreds are used as leachate collection material, gradation and permeability testing shall be performed on representative samples of tire shreds. Carbonate content testing is not proposed due to the non-carbonate nature of rubber tires. Refer to Table 1 for a summary of the laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the tire shred leachate collection layer.

7.2 Tire Shred Test Pits

If tire shreds are used as leachate collection material in the geomembrane lined area, the 60-mil geomembrane shall be investigated to determine that no damage has occurred to the geomembrane by the placement and spreading of the tire shreds. Test pits are not required in the separatory liner area where a geomembrane is not installed. The Ohio EPA will be notified of the test pit investigation to confirm the test pit locations. At least one (1) test pit per acre of liner construction shall be excavated at areas representative of cell construction. Each test pit shall be hand dug through the tires to expose the cushion geotextile above the geomembrane. The test pits shall be large enough to expose at least 3-feet x 3-feet of the geomembrane. The non-woven geotextile shall be carefully cut and peeled back in order to expose the geomembrane. The geomembrane will be investigated for damage, punctures, or embedded wires from the tire shreds. Each test pit will be documented and photographed. Upon completion of the investigation, the geotextile shall be repaired. The construction certification report shall include the locations of the test pits and the findings of the inspection of the geomembrane.

7.2.1 Contingency Plan

The following presents the contingency plan to be followed in the event that damage to the geomembrane is found during test pit excavation.

- The degree of damage to the geomembrane will be determined at each test pit. Any damage that punctures the geomembrane or penetrates the geomembrane so that less than 40-mil of the 60-mil geomembrane thickness remains will be considered significant damage that requires further action.
- At any test pit where damage is found as described above, three additional test pits will be excavated surrounding the area of the original test pit.
- If damage to the geomembrane is found in the additional test pits, the above procedure will be repeated until no further damage is found.
- After the limits of damage to the geomembrane are determined, the tire shreds and geotextile will be removed in the area bound by the test pits where damage was documented. The exposed area of geomembrane will be investigated to determine if additional damage is present.
- The damaged geomembrane will be repaired using multiple extrusion-welded patches or one large patch as determined by the CQA consultant. All patches shall be vacuum tested in accordance with Section IV, subsection 5.7.1.
- Once vacuum testing is completed, the geotextile will be repaired.
- The owner may propose in writing alternatives for remediation of liner damaged by tire shreds for consideration by the regulatory agency. The alternatives may be implemented if approved by the regulatory agency.

7.3 Tire Shred Storage

OAC 3745-27-78(E)(1) authorizes the beneficial use of shredded scrap tires for civil engineering applications in a solid waste landfill. To accomplish this, the facility will temporarily store tire shreds on-site as described here. Tire shreds shall be stored at the facility in storage piles (windrows) that meet the requirements of OAC 3745-27-65 (F). Tire shreds which are larger than tire derived chips (TDC) (size-reduced scrap tires where the maximum size of 95 percent of the shreds are less than 4-inches in any dimension) shall be stored in piles no greater than 2,500-square feet in basal area, limited to 14-feet in height with fire lanes of 137-feet. Tire shreds which meet the TDC size requirement will be stored in piles not to exceed 250-feet long and 50-feet wide, limited to 14-feet in height with fire lanes of 137-feet. Corridors shall be kept free from

obstructions that could limit access in the event of an emergency. An area extending 200-feet from the outside perimeter of the pile(s) will be clear of any sources of ignition. Piles will not be located near or below power lines. The facility will have equipment and material on-site to isolate, maintain, suffocate, etc. any fire that could ignite.

8.0 COARSE AGGREGATE AROUND PIPES

The coarse aggregate placed around the leachate collection pipes shall be rounded, non-carbonate stones meeting the requirements of the American Association of State Highway and Transportation Officials (AASHTO) No. 57 gradation or equivalent. The coarse aggregate shall not contain organics, frozen material, foreign objects, or other deleterious materials.

Refer to Table 1 for a summary of the laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the coarse aggregate.

9.0 RECOMPACTED SOIL BARRIER LAYER

An 18-inch thick recompacted soil barrier (RSB) layer will be constructed as part of the composite cap of the final cover system and will be placed over the entire area of waste placement. The material used in the construction of RSB layer shall meet the material acceptance and construction evaluation criteria as detailed in the following paragraphs and as required by OAC Rule 3745-27-08 (D)(21).

Results of pre-construction testing of the borrow soils performed on representative samples shall be submitted to the Ohio EPA no later than seven days prior to the intended use of the material in the construction of the RSB.

Prior to placement of the RSB, the surface of the intermediate cover shall be prepared and proof rolled. The surface shall be free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas.

The 18-inch thick RSB shall be placed in 8-inch thick maximum loose lifts. The RSB shall be free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, soft areas, and not comprised of solid waste. Soil clods shall be broken down to 3 inches or half the lift thickness, whichever is less. Moisture conditioning may be conducted to preserve the homogeneity of the soil and to obtain a relatively uniform moisture content throughout the soil mass. The RSB will be compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of the Modified Proctor maximum dry density at a moisture content of at or above the optimum moisture content. The placed RSB will be compacted to a maximum dry density and minimum soil moisture content not less than used in the laboratory permeability test. For each lift, the density and moisture shall be tested at a frequency of five (5) tests per acre as required by OAC 3745-27-08(D)(21)(j). All penetrations will be filled with bentonite.

The surface of the RSB shall have no abrupt changes in grade that may result in damage to the geosynthetics. Surveying shall be performed to document that finished dimensions are as specified

in the design. Alternately, settlement plates may be used to determine the thickness of the RSB. Details regarding surveying are presented in Section VIII of the CQA/QC Plan. The CQA Consultant shall approve the installation of the RSB prior to the placement of any overlying geosynthetics.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the RSB.

10.0 ENGINEERED SUBBASE

A 12-inch thick engineered subbase layer will be constructed as part of the composite cap of the final cover system when the final cover system option that includes a GCL is utilized. The material used in the construction of engineered subbase layer shall meet the material acceptance and construction evaluation criteria as detailed in the following paragraphs and as required by OAC Rule 3745-27-08 (D)(22). The criteria for the engineered subbase are as follows:

- Minimum installed thickness of 12-inches; and
- Free of debris, foreign, and deleterious material.

Prior to placement of the engineered subbase, the surface of the intermediate cover shall be prepared and proof rolled. The surface shall be free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas. Alternatively, if transitional cover has already been installed, a demonstration acceptable to Ohio EPA may be prepared to show that the transitional cover can function as the engineered subbase.

The 12-inch thick engineered subbase shall be placed in 8-inch thick maximum loose lifts. Soil clods shall be broken down to a size that does not exceed the lift thickness. The engineered subbase will be compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of the Modified Proctor maximum dry density. For each lift, the density and moisture shall be tested at a frequency of five (5) tests per acre as required by OAC 3745-27-08(D)(22)(h). All penetrations will be filled with bentonite.

The surface of the engineered subbase shall have no abrupt changes in grade that may result in damage to the geosynthetics. Surveying shall be performed to document that finished dimensions are as specified in the design. Details regarding surveying are presented in Section VIII of the CQA/QC Plan. The CQA Consultant shall approve the installation of the engineered subbase prior to the placement of any overlying geosynthetics.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the engineered subbase.

11.0 TRANSITIONAL COVER

The material used in the transitional cover shall meet the material acceptance and construction evaluation criteria as detailed in this section. A transitional cover may be placed within 120 days of a portion of the facility reaching final elevations, in lieu of installing the final cover system.

Prior to placement of the transitional cover, the ground surface shall be stripped of vegetation and proof rolled. The 24-inch thick transitional cover shall be placed in one or more uniform lifts so that the thickness and slopes meet the design specifications. The surface of the transitional cover shall be prepared to allow for vegetation growth. The transitional cover shall be of sufficient thickness and fertility to support vegetation, and be seeded as soon as practicable. Healthy grasses or other vegetation shall form a complete and dense vegetative cover within one year of soil placement. Surveying shall be performed to verify that finished dimensions are as specified in the design. Details regarding surveying are presented in Section 8 of the CQA Plan. Instead of survey, test pits may be excavated to determine the thickness of the transitional cover. Samples will be collected to determine the soil characteristics.

Notification and documentation of transitional cover construction shall be completed in accordance with OAC 3745-27-19(H)(2). On-site inspection personnel shall maintain summary reports with supporting inspection data sheets and, when appropriate, problem identification and corrective measures reports.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, and acceptance criteria for the transitional cover.

12.0 VEGETATIVE COVER/CAP PROTECTION LAYER

The vegetative cover/cap protection layer (vegetative cover) for the final cover system shall meet the performance and design standards in OAC Rule 3745-27-08(D)(25). The vegetative cover layer shall have a thickness of 30-inches. The upper portion of the layer shall consist of final cover soil able to support vegetation and be reasonably free of large particles, frozen materials, foreign objects, and organics. The physical characteristics of the materials shall be evaluated through visual observation both before and during placement of the vegetative cover layer.

The vegetative cover layer shall be placed in one or more uniform lifts so that thickness and slopes meet the design specifications. During placement of the vegetative cover, care shall be taken such that wrinkles do not develop in the underlying geomembrane and geocomposite. The vegetative cover shall not be placed over wrinkles in the geomembrane and that are greater than 4 inches in height. The CQA Consultant shall be present, as necessary, during vegetative cover layer placement to determine that no damage to the underlying geosynthetics occurs and that no unacceptable materials are placed.

The vegetative cover layer shall be placed and spread to the required thickness using a low ground pressure dozer or other suitable earth moving equipment. Equipment used for spreading the soil material shall be low ground pressure dozers or backhoes that result in low contact pressure to the geosynthetics under the vegetative cover layer. The vegetative cover layer installation shall proceed upslope only; at no time will equipment be permitted to install vegetative cover material down slope. Precautions shall be taken to make sure that at least 3-feet of soil material is provided for trucks to run on when bringing vegetative cover material to the work area. The operators of all equipment used in transporting or spreading the soil material shall be advised to use gradual turns and stop/starts.

The final surface of the vegetative cover shall be scarified, seeded, mulched, and fertilized as required to establish a dense vegetative growth. Surveying shall be performed to document that finished final cover dimensions are as specified in the design. Alternately, settlement plates may

be used to determine the thickness of the vegetative cover. Details regarding surveying are presented in Section VIII of the CQA/QC Plan.

Refer to Table 1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the vegetative cover layer.

13.0 POTENTIAL PROBLEMS AND DEFICIENCIES

During construction, the frequency of testing may be increased at the discretion of the CQA Consultant or the Owner when visual observations of construction performance indicate a potential problem. Additional testing shall be considered when:

- The compaction equipment slips during compaction of soils;
- The material is at improper and/or variable moisture content;
- Dirt-clogged teeth of the compaction equipment are used to compact the material;
- Desiccation has occurred or the soils are saturated;
- The compaction equipment may not have used optimum ballast;
- The materials differ substantially from those specified; or
- The degree of compaction is doubtful.

If a defect is detected within a soil component of either the liner or final cover systems, the CQA Consultant shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.

13.1 Notification

The CQA Consultant shall notify the Earthwork Contractor immediately upon discovering the defect. After determining the extent and nature of the defect, the CQA Consultant shall notify the Project Manager as necessary.

13.2 Repairs and Retesting

The Earthwork Contractor shall correct the deficiency to the satisfaction of the CQA Consultant and Owner. The CQA Consultant shall conduct appropriate retests after the work deficiency has been corrected. Retests recommended by the CQA Consultant must document that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

13.3 Layer Thickness

Surveying, as described in Section VIII, shall be the primary method of documenting the thickness of all soil components in the liner and final cover systems. Soil layers that require documentation include in-situ foundation, AGM, structural fill, RSL, protective cover layer, RSB, engineered subbase, and vegetative cover.

SECTION III

GEOSYNTHETIC CLAY LINER CONSTRUCTION QUALITY ASSURANCE

SECTION III
GEOSYNTHETIC CLAY LINER
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 GEOSYNTHETIC CLAY LINER MANUFACTURING 1
1.1 Sodium Bentonite 1
1.2 Primary Backing Material 1
1.3 Finished Product 2
1.4 Manufacturer Qualifications 2

2.0 CERTIFICATION OF PROPERTY VALUES 3
2.1 QC Testing 3
2.2 QC Test Failure Procedure 3
2.3 Certification Documentation 3

3.0 DELIVERY 5
3.1 Packaging and Labeling 5
3.2 Transportation and Handling 5
3.3 Storage 6

4.0 CONFORMANCE TESTING OF DELIVERED GCL 7
4.1 Sampling Procedures 7
4.2 Test Results 7
4.3 Conformance Test Failure 7

5.0 HANDLING AND INSTALLATION 9
5.1 Handling 9
5.2 Earthwork 9
5.3 Geosynthetic Clay Liner Installation 10
5.4 Backfilling of Anchoring Trench 13

SECTION III
GEOSYNTHETIC CLAY LINER
CONSTRUCTION QUALITY ASSURANCE

1.0 GEOSYNTHETIC CLAY LINER MANUFACTURING

The GCL material and installation shall comply with OAC Rule 3745-27-08(D)(9). The geosynthetic clay liner (GCL) shall be prefabricated in a manufacturing facility with a layer of natural sodium bentonite (bentonite) between two layers of nonwoven geotextile. The geotextiles and any adhesives that may be used in the manufacturing shall not interfere with the swelling, self-healing, or low permeability characteristics of the bentonite.

1.1 Sodium Bentonite

The primary component of the GCL shall be a high quality sodium bentonite (montmorillonite). The bentonite shall be applied to the geotextile at the minimum rate specified in Table 2.

1.2 Primary Backing Material

The primary backing material shall be a nonwoven geotextile and perform the following functions:

- Protect the bentonite from displacement during shipping, handling and placement of cover material;
- Support the normal load and improve the slope stability properties of the liner system;
- Protect the bentonite from exposure to humidity changes and other factors which may cause shrinkage or desiccation; and
- Provide a degree of protection against puncture.

1.3 Finished Product

The finished product shall have the following properties:

- Minimum bentonite content as specified in Table 2; and
- Maximum hydraulic conductivity as specified in Table 2.

Six and twelve-inch overlap marks shall be marked longitudinally on the GCL by the Manufacturer to assist in obtaining the proper overlap.

Prior to rolling, the finished product shall be visually inspected over 100 percent of the surface area of the GCL to detect deficiencies in the uniformity of the bentonite. Regions of the product in which a bentonite deficiency is noted shall be removed from the production line.

The product shall be rolled around a core that is structurally sound and can support the weight of the roll without excessive bending or buckling under normal handling conditions.

1.4 Manufacturer Qualifications

Manufacturer of the GCL shall have a minimum of three (3) years of continuous experience in the manufacture of similar GCL products.

2.0 CERTIFICATION OF PROPERTY VALUES

2.1 QC Testing

The GCL shall be subject to quality control (QC) testing to assure that the materials provided meet the minimum performance requirements. The bentonite and geotextile backings shall be tested in accordance with the Manufacturer's QC program and meet the Manufacturer's minimum published standards and frequencies as well as those listed in Table 2. This testing shall be performed by the Manufacturer. In most cases, sampling can be carried out on sacrificial portions of the material. Consequently, repair of sampled locations will not be required.

2.2 QC Test Failure Procedure

Samples not satisfying the specifications will result in the rejection of the applicable rolls. At the Manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and/or to qualify individual rolls.

2.3 Certification Documentation

Prior to shipment, the GCL Manufacturer shall provide the Project Manager and the CQA Consultant with quality control certificates and a list of the applicable rolls. The quality control certificate shall be signed by a responsible party employed by the GCL Manufacturer, such as the production manager.

The quality control certificate shall include:

- Roll numbers and identification;
- Sampling procedure; and
- Results of all quality control tests, including a description of test methods used (ASTM or other test procedure references).

The CQA Consultant will:

- Document that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it;
- Review the quality control certificates and document that the certified roll properties meet the specifications; and
- Submit the results of pre-construction shear strength testing to the appropriate Ohio EPA district office no later than seven days prior to the intended use of the material.

3.0 DELIVERY

3.1 Packaging and Labeling

The finished GCL shall be completely wrapped and adequately secured with a durable opaque protective cover in order to provide protection from ultraviolet degradation of the geotextile and excessive loss and/or gain of moisture during shipping and storage. The central core shall be accessible for handling. The GCL rolls shall be marked or tagged with the following information:

- Manufacturer's name;
- Product identification;
- Lot or batch number;
- Roll number;
- Roll weight; and
- Roll dimensions.

The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

3.2 Transportation and Handling

Transportation of the GCL is the responsibility of the GCL Manufacturer, Geosynthetics Installer, or Transporter, as directed by the Geosynthetic Installer. All handling on site is the responsibility of the Geosynthetics Installer.

The GCL shall be shipped in accordance with the GCL Manufacturer's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Consultant shall review all rolls for defects and for damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Project Manager any

rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected and removed from the site because of severe flaws.

3.3 Storage

The Geosynthetic Installer shall be responsible for the storage of the GCL on site. The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should protect the GCL from vandalism, passage of vehicles, precipitation, etc.

The rolls of GCL shall be stored in their original, unopened, wrapped cover in a clean dry area. The GCL shall be protected from precipitation, excessive heat or cold, puncture, or other damaging or deleterious conditions. The rolls shall not be stacked more than three rolls high or as recommended by the Geosynthetics Manufacturer, due to the possibility of thinning of the product at points of contact. Any additional procedures required by the GCL Manufacturer shall be the Geosynthetics Installer's responsibility.

The CQA Consultant will confirm that:

- Handling equipment is adequate and does not pose any risk of damage;
- storage of the GCL ensures adequate protection against precipitation, dirt, traffic, and other sources of damage; and
- The GCL is handled with care.

4.0 CONFORMANCE TESTING OF DELIVERED GCL

4.1 Sampling Procedures

GCL sampling for conformance testing may take place at the GCL manufacturing plant by the GCL Manufacturer, Geosynthetics CQA Laboratory, a representative of the Owner, or the CQA Consultant. The samples shall then be forwarded to the Geosynthetics CQA Laboratory. Conversely, the CQA consultant may retrieve GCL samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory. The Geosynthetic CQA Laboratory will conduct the conformance testing to ensure conformance to the specifications and the list of guaranteed properties.

Sample locations shall be selected in accordance with the sampling frequency. Samples shall be taken across the entire width of the roll and will be at least 3-feet wide. The sample shall be clearly marked and indicate the roll number from which the sample was taken.

4.2 Test Results

The CQA Consultant will examine all results from the laboratory conformance testing and shall report any non-conformance to the Project Manager. The minimum standards for the GCL are given in Table 2.

4.3 Conformance Test Failure

The following procedure shall apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory. The GCL Manufacturer or CQA Consultant shall remove conformance samples for testing by the Geosynthetic CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to the Specifications. If either of these samples fails, testing will proceed on samples from the closest numerical roll to the failed roll until rolls are tested that conform to the Specifications.

The GCL Manufacturer shall replace any roll of GCL that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

5.0 HANDLING AND INSTALLATION

5.1 Handling

The Geosynthetics Installer shall handle GCL in such a manner as to minimize damage to the GCL and comply with the following:

- The equipment or tools used for handling, trafficking, or other operations shall not cause damage to the GCL;
- Personnel working on the GCL shall not smoke, wear damaging shoes, or engage in activities which will cause damage to the GCL; and
- The equipment used to deploy the GCL shall not cause damage to the RSL.

5.2 Earthwork

5.2.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the surface of the RSL according to the specifications in Section II. Prior to deploying GCL, the CQA Consultant shall document that:

- A Surveyor has documented all lines and grades of the RSL; and
- The requirements of Section II, Soils Construction Quality Assurance, are satisfied.

The Geosynthetics Installer shall provide, in writing, that the surface on which the GCL shall be installed is acceptable. The Certificate of Acceptance shall be given by the Geosynthetic Installer to the CQA Consultant or Project Manager prior to commencement of GCL installation in the area under consideration.

After the underlying soil has been accepted by the Geosynthetics Installer, it shall be the CQA Consultant's and/or the Geosynthetics Installer's responsibility to indicate to the Project Manager

any change in underlying soil condition that may require repair work. If the CQA Consultant concurs with the Geosynthetics Installer, then the Project Manager shall ensure that the underlying soil is repaired.

5.2.2 Anchoring System

Anchor trenches shall be excavated by the Earthwork Contractor (unless otherwise specified) to the lines and widths shown on the design drawings, prior to GCL placement. The CQA Consultant shall determine that the anchor trenches have been constructed according to design drawings.

Slightly rounded corners shall be provided in the trenches where the GCL adjoins the trench so as to avoid sharp bends in the GCL. Backfilling of the anchor trenches shall be done in accordance with Sub-section 5.4.

5.3 Geosynthetic Clay Liner Installation

As each GCL roll is moved from the storage area the labels shall be removed by the Geosynthetics Installer and submitted to the CQA Consultant.

The GCL rolls shall be brought to the area to be lined in accordance with the GCL Manufacturer's recommendations such that the GCL roll is fully supported across its length. A front-end loader with a pipe and spreader bar or similar devices shall be used to prevent the roll from sagging and lifting chains or slings from damaging the edges. A "stinger" bar of sufficient strength may also be used, if it is long enough and provides adequate support along the length of the GCL roll. Dragging of the GCL panels over the surface shall be minimized.

The CQA Consultant will document that the following conditions are satisfied by the Geosynthetics Installer:

- Equipment does not damage the GCL or underlying soil by handling, trafficking, excessive heat, leakage of machine operating fuels or oils, or other means.
- The GCL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. Stretching of the GCL to fit shall not be allowed.
- The GCL shall be straightened to smooth out creases or irregularities in the panels.
- The underlying soil is free of entrapped stones, debris, and moisture.
- No heavy equipment shall drive directly on the GCL.
- If white colored geotextile is used to encapsulate the bentonite, precautions, such as sunglasses, shall be taken against "snowblindness" of personnel.
- The GCL shall not be installed on a saturated subbase or standing water.
- The GCL shall not be installed during precipitation, high winds, or other conditions that may cause hydration of or damage to the GCL.
- The GCL is adequately protected from damage due to desiccation and erosion.

Geomembrane installation shall immediately follow the GCL installation. The Geosynthetics Installer shall obtain approval of the CQA Consultant prior to placing geomembrane. All GCL that is placed during a day's work shall be covered with geomembrane before the Installer leaves the site at the end of the day. All geomembrane seams shall be welded after each geomembrane panel is placed. Temporary heat sealing of the seam alone is not acceptable unless approved by the Owner's Representative and CQA Consultant. All geomembrane defects and destructive sample locations shall be immediately repaired so as to minimize exposure of the GCL.

5.3.1 Overlaps

All GCL seams shall be overlapped in accordance with the manufacturer's recommendation. Generally, along the length of the panel, the overlap shall be a minimum of 6-inches, and along the width of the panel, the overlap shall be a minimum of 12-inches. The edges of the GCL panels shall be adjusted to smooth out any wrinkles, creases, or "fishmouths" in order to maximize contact with the underlying panel.

If temperatures are higher than 85-degrees Fahrenheit and humidity is low, contraction may occur soon after placement. In order to account for the possibility of contraction under these conditions, the overlaps may be increased at the discretion of the Geosynthetic Installer and CQA Consultant. However, a minimum overlap of 6 inches along the length of the panel and 12-inches along the width at the panel immediately prior to installation of the geomembrane must be maintained at all times. The overlaps shall not be nailed or stapled to the underlying materials.

After panels are placed, proper overlap orientation shall be established and the edge of the panel shall be pulled back to expose the overlap zone. Any soil or deleterious material present in the overlap zone shall be removed. If required by the GCL Manufacturer, a fillet of granular bentonite, or other sealing material acceptable to the Manufacturer shall be poured in a continuous manner along the overlap zone at a rate of at least 1/4-pound per linear foot or as required by the manufacturer, and around a repair prior to the placement of a patch.

5.3.2 Repair

Any holes or tears in the GCL shall be repaired by placing a patch cut from the same type of GCL over the hole. The patch shall overlap the edges of the hole or tear by at least 1-foot in all directions. If required by the GCL Manufacturer, a fillet of granular bentonite shall be poured in a continuous manner along the overlap zone at a rate of at least 1/4-pound per linear foot or as required by the manufacturer. The patch may be secured with a water-based adhesive approved by the Manufacturer.

Care shall be taken to remove any soil or other material that may have penetrated the torn GCL. Patches shall not be nailed or stapled.

5.3.3 Materials In Contact With GCL

The Geosynthetics Installer shall place all material above the GCL in such a manner so that the GCL is not damaged. Low ground pressure equipment may operate directly on the GCL if approved by the Manufacturer, Owner, and CQA Consultant. The low ground pressure equipment

shall have a maximum ground pressure of eight (8) psi or shall be the acceptable pressure allowed by the geosynthetics manufacturer when operating directly on the GCL. In areas of heavy vehicle traffic, such as access ramps, the soil thickness above the GCL shall be at least 3-feet.

5.4 Backfilling of Anchoring Trench

Anchor trenches shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. Anchor trenches shall be backfilled and compacted in specified lifts.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The CQA Consultant will observe the backfilling operation and advise the Project Manager of any problems.

SECTION IV

GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

SECTION IV
GEOMEMBRANE
CONSTRUCTION QUALITY ASSURANCE
ABLE OF CONTENTS

1.0 MANUFACTURER'S DOCUMENTATION....3
1.1 Raw Material....3
1.2 Certification of Property Values....3

2.0 DELIVERY....5
2.1 Packing and Labeling....5
2.2 Transportation and Handling....5
2.3 Storage....6

3.0 CONFORMANCE TESTING OF DELIVERED GEOMEMBRANES....7
3.1 Sampling Procedures....7
3.2 Test Results....7
3.3 Conformance Test Failure....7

4.0 HANDLING AND PLACEMENT....9
4.1 Handling....9
4.2 Installation Schedule....9
4.3 Field Panel Identification....9
4.4 Weather Conditions....10
4.5 Method of Placement....11
4.6 Damage....11

5.0 SEAMING AND TESTING....13
5.1 Seaming Strategies....13
5.2 Seaming Equipment and Products....14
5.2.1 Extrusion Welder....14
5.2.2 Fusion Welder....15
5.3 Seam Preparation....15
5.4 Weather Conditions for Seaming....16
5.5 Trial Seams....16
5.6 Seaming Procedure....18
5.6.1 Extrusion Seaming....18
5.6.2 Fusion Seaming Process....19
5.7 Non-Destructive Seam Continuity Testing....20
5.7.1 Vacuum Testing....21
5.7.2 Air Pressure Testing (For Double Hot Wedge Seam Only)....22
5.7.3 Spark Testing....23
5.8 Destructive Testing....24

5.8.1 Location and Frequency 24
5.8.2 Sampling Procedure 24
5.8.3 Size of Samples 25
5.8.4 Field Testing 25
5.8.5 Geosynthetics CQA Laboratory Testing 26
5.8.6 Geosynthetics Installer's Laboratory Testing 26
5.8.7 Procedures for Destructive Test Failure 26
5.9 Defects, Repairs, and Retests **27**
5.9.1 Defects 27
5.9.2 Repairs 28
5.9.3 Retests 29
5.10 Electrical Conductivity Integrity Testing **29**

6.0 GEOSYNTHETICS CERTIFICATION/ACCEPTANCE **30**

7.0 MATERIALS IN CONTACT WITH GEOMEMBRANES **31**
7.1 Geotextile **31**
7.2 Geocomposite **31**
7.3 Appurtenances **31**
7.4 Backfilling of Anchor Trench **32**
2.1 Labeling **4**
2.2 Transportation and Handling **4**
2.3 Storage **4**

SECTION IV
GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

1.0 MANUFACTURER'S DOCUMENTATION

The geomembrane material and installation shall comply with OAC Rule 3745-27-08(D)(10). Prior to delivery, the Geosynthetics Manufacturer shall provide documentation that demonstrates that the property values of the material meet the project requirements. Delivered rolls of geomembrane must be appropriately labeled. Sixty-mil smooth or textured high density polyethylene (HDPE) will be used in the liner system. Forty-mil textured HDPE or 40-mil textured linear low density polyethylene (LLDPE) will be used in the final cover systems.

1.1 Raw Material

The polyethylene shall be an unmodified HDPE or LLDPE containing no plasticizers, fillers, chemical additives, reclaimed polymers, or extenders. Resins used during the manufacturing shall conform to either the resin/geosynthetics manufacturing specifications or to the specified values in Tables 3, 4, and 5, whichever are more stringent.

1.2 Certification of Property Values

The Geosynthetics Manufacturer shall provide the Project Manager with a list of guaranteed minimum average roll values (MARV) for the types of geomembrane to be supplied. The Geosynthetics Manufacturer shall supply the resin quality control certificates provided by the Resin Manufacturer. The Geosynthetics Manufacturer shall provide to the Project Manager quality control certification for each roll of geomembrane shipped to the site confirming that each roll meets or exceeds the guaranteed minimum requirements of the Geosynthetics Manufacturer. The QC certifications shall contain results of the manufacturer's CQC testing ensuring that the physical properties of the final product are in accordance with the manufacturer's specifications and that of Tables 3, 4, and 5.

The CQA Consultant shall examine the manufacturer's certifications and CQC testing results to confirm that the property values meet or exceed the specified values. Deviations shall be reported to the Project Manager.

2.0 DELIVERY

2.1 Packing and Labeling

The geomembrane rolls shall be protected from damage during shipment of the rolls. The central core shall be accessible for handling. The Geosynthetics Manufacturer shall identify all rolls of geomembrane with the following information:

- Manufacturer's name;
- Product identification, including thickness and material type;
- Lot number;
- Roll number;
- Roll weight; and
- Roll dimensions.

The geomembrane roll number or lot number shall directly correspond to the resin identification.

In addition, if any special handling of the geomembrane is required, it shall be so marked on the outside covering of the geomembrane roll. The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.2 Transportation and Handling

Transportation of the geomembrane is the responsibility of the Geomembrane Manufacturer, Geosynthetics Installer, or Transporter as directed by the Geosynthetic Installer. All handing on the site is the responsibility of the Geosynthetic Installer.

The CQA Consultant will confirm that:

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

The geomembrane shall be shipped in accordance with the Geosynthetic Manufacturer's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Consultant shall review all rolls for defects and damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Project Manager any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

2.3 Storage

The Geosynthetics Installer shall be responsible for the storage of the geomembrane on-site. The Project Manager shall provide storage space in one or more locations such that on-site transportation and handling are minimized. Storage space shall protect the geomembrane from vandalism, passage of vehicles, etc.

The geomembrane shall be stored on a prepared surface no more than three rolls in height or as recommended by the Geosynthetics Manufacturer. The CQA Consultant shall inspect the storage areas to verify that the surface is smooth, flat, and free of rocks or other objects that could cut or puncture the liner. The CQA Consultant shall also document that storage of the geomembrane provides adequate protection against dirt, impact, and other sources of damage.

3.0 CONFORMANCE TESTING OF DELIVERED GEOMEMBRANES

Geomembrane sampling for conformance testing may take place at the geomembrane manufacturing plant by the Geomembrane Manufacturer, the Geosynthetics CQA Laboratory, or a representative of the Owner or the CQA Consultant. The samples shall be forwarded to the Geosynthetics CQA Laboratory. Conversely, the CQA consultant may retrieve geomembrane samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project specifications.

3.1 Sampling Procedures

Sample locations shall be selected in accordance with the sampling frequency. Samples shall be taken across the entire width of the roll and shall not include the first 3-feet. Unless otherwise specified, samples shall be 3-feet long by the roll width. Samples of geomembrane shall be taken at the frequencies listed in Tables 3, 4, and 5. The sample shall be clearly marked and indicate the roll number from which the sample was taken.

3.2 Test Results

The CQA Consultant shall examine the results of laboratory conformance testing and shall report any non-conformance to the Project Manager. The minimum standards for the geomembrane are given in Tables 3, 4, and 5.

3.3 Conformance Test Failure

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

- The Geosynthetics Manufacturer or CQA Consultant shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both

sides of the failed roll. These two samples must conform to the Specifications. If either of these samples fail, testing will proceed on samples collected from the closest numerical roll to the failed roll until rolls are located that conform to the Specifications.

- The Geosynthetics Manufacturer shall replace any roll of geomembrane that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

4.0 HANDLING AND PLACEMENT

4.1 Handling

The Geosynthetic Installer shall handle geomembrane in such a manner as to minimize damage to the geomembrane and comply with the following:

- The equipment or tools used for handling, trafficking, or other operations shall not cause damage to the geomembrane;
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in activities that will cause damage to the geomembrane;
- The equipment used to deploy the geomembrane shall not cause damage to the GCL and/or recompacted soil liner; and
- To prevent geomembrane uplift by wind, sand bags or tires shall be placed as frequently along the edges as deemed necessary.

4.2 Installation Schedule

Geomembrane installation shall immediately follow GCL installation. The Geosynthetics Installer shall obtain approval from the CQA Consultant prior to placing the field panels. Field panels shall be placed one at a time and each field panel shall be seamed on the same day as placement. The panels shall be shingled from the highest elevation toward the lowest elevation. Up-slope panels shall be shingled over down-slope panels to direct flow over the seam and not into the seam. When in position, the field panels shall be checked for any physical damage caused either during manufacture or during installation.

4.3 Field Panel Identification

A field panel is the unit area of geomembrane that is to be seamed in the field. The CQA Consultant shall document that the Geosynthetics Installer labels each field panel with an "identification code"

(alphanumeric). This identification code will be decided upon by the CQA Consultant and Geosynthetics Installer during the pre-construction meeting. The CQA Consultant may consider using P (for Panel) as an identification code. A seam between P1 and P2 may be identified as S 1/2 (Seam 1/2), where 1 and 2 are unique identifications for panels. It will be the responsibility of the Geosynthetics Installer to mark each field panel with the original roll number, date, and time of deployment. The roll number shall be conspicuously marked.

The CQA Consultant will document the correspondence between roll numbers and field panel identification codes. The field panel identification code will be used for all quality assurance records.

4.4 Weather Conditions

Geomembrane placement and welding shall not proceed at an ambient temperature below 32 ºF or above 110ºF unless the Geosynthetics Installer can provide documentation to the Project Manager that the resulting seam meets or exceeds the required seam properties as set forth in Tables 3, 4, and 5. In addition, the seaming procedure shall not cause any physical or chemical modifications to the geomembrane that will generate short or long term damage. Geomembrane placement shall not be performed during significant precipitation, in an area of ponded water, or in the presence of excessive winds.

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

The Geosynthetics Installer shall deploy the geomembrane from the higher elevation to the lower elevation. The CQA Consultant shall note non-compliance and report it to the Project Manager.

4.5 Method of Placement

The CQA Consultant shall document that the following conditions are satisfied by the Geosynthetics Installer:

- Any equipment used does not damage the geomembrane or underlying GCL by handling, trafficking, excessive heat, leakage of machine operating fuels or oils, or other means.
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels).
- When deployed over a GCL, geomembrane deployment on the underlying GCL shall be by hand or lightweight vehicle as approved by the CQA Consultant. The underlying GCL will be clean and free of debris.
- No personnel working on the geomembrane will smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
- The method used to unroll the geomembrane does not cause scratches or crimps in the geomembrane and does not damage the underlying soils and/or GCL.
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (In case of high winds, continuous loading by adjacent sand bags, or soil is recommended along edges of panels to minimize risk of wind flow under the panels).
- Direct contact with the geomembrane is minimized, i.e., the geosynthetics are protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected.

The CQA Consultant shall inform the Project Manager if the above conditions are not satisfied.

4.6 Damage

The CQA Consultant and Geosynthetics Installer shall inspect each geomembrane panel for damage prior to seaming. The CQA Consultant shall advise the Project Manager what panel or

portions of panels shall be rejected. Damaged panels or portions of damaged panels that have been rejected shall be marked and their removal from the work area recorded by the CQA Consultant. Repairs to geomembrane shall be made according to procedures described in Section 5.9.2.

5.0 SEAMING AND TESTING

5.1 Seaming Strategies

The Geosynthetics Installer shall provide the Project Manager with the panel layout drawings. The Project Manager, CQA Consultant, and the Geosynthetics Installer shall agree on the proposed layout before deployment of the geomembrane.

The layout drawings shall meet the following requirements as far as practicable:

- Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope.
- If the area to be lined is an unusual geometric shape, the Geosynthetics Installer shall minimize the number or length of seams.
- For horizontal seams running perpendicular to the slope (i.e., on the floor), a distance of at least 10-feet shall be maintained from the toe and/or crest of slope.

The Geosynthetics Installer shall avoid seaming areas with wrinkles and "fishmouths." Before seaming can start, the Geosynthetics Installer shall confirm the following:

- The panels of the geomembrane have a finished overlap of a minimum of 3-inches for extrusion seaming and 4-inches for fusion seaming, or otherwise matching the Geosynthetic Installer's equipment. Sufficient overlap shall be provided to allow peel tests to be performed on the seam.
- No solvent or adhesive is used.
- 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 welding apparatus shall be controlled such that the geomembrane is not damaged.

The seams shall be marked with a seam numbering system compatible with the panel numbering system that shall be agreed upon at the Pre-construction meeting. Labeling of the seams shall include, seam identification, weld start time, weld equipment, equipment settings, weld technician, and all data related to the CQC testing of the seam integrity.

5.2 Seaming Equipment and Products

Approved processes for field seaming are extrusion welding and hot wedge (fusion) welding. Proposed alternate processes shall be documented and submitted to the Project Manager for approval. Only apparatus that have been specifically approved by make and model shall be used. The Geosynthetic Installer shall maintain spare operable seaming apparatus on-site.

The CQA Consultant will also confirm that:

- Equipment used for seaming is not likely to damage the geomembrane;
- The electric generator is placed on a base such that no damage occurs to the geomembrane from puncture or leaking fluids;
- A smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage; and
- The geomembrane is protected from damage in heavily traffic areas.

5.2.1 Extrusion Welder

The extrusion welder shall be equipped with gauges giving the relevant temperatures of the apparatus at the nozzle and extruder barrel. The extrusion welder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. The Geosynthetics Installer shall certify that the extrudate is compatible with and is comprised of the same resin as the geomembrane and shall provide documentation regarding the extrudate to the Project Manager and the CQA Consultant.

5.2.2 Fusion Welder

The fusion welding apparatus shall be equipped with gauges giving the applicable temperatures. Pressure settings shall be verified by the Geosynthetic Installer prior to each seaming period. A double-wedge fusion welder produces a double seam with an enclosed air space between the seams. The Geosynthetics Installer shall prevent build-up of moisture between the sheets. A moveable protective sheet may be used as required directly below each overlap of geomembrane that is to be seamed. The CQA Consultant shall log ambient temperatures, seaming apparatus temperatures, and speeds.

5.3 Seam Preparation

The CQA Consultant shall confirm that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, oils, greases, debris of any kind, and foreign material;
- Seams are aligned with the proper overlap and the fewest possible number of wrinkles and fishmouths;
- If seam overlap grinding is required, the process is completed according to the Geosynthetics Manufacturer's instructions within 30-minutes of the seaming operation, and in a way that does not damage the geomembrane;
- The abrasion does not extend more than 0.25-inches on either side of the extrusion seam;
- The procedure used to temporarily bond seams together does not damage the geomembrane; and
- Solvents or adhesives shall not be used unless the product is approved in writing by the Project Manager.

5.4 Weather Conditions for Seaming

The normally required weather conditions for seaming are the same as those for deploying geomembrane discussed in Section 4.4, which are as follows:

- Unless authorized in writing by the Project Manager, no seaming shall be attempted at an ambient temperature below 35°F or above 110°F; and
- The geomembrane shall be dry and protected from wind.

If the Geosynthetics Installer wishes to use methods which may allow seaming at ambient temperatures below 32°F or above 110°F, the Geosynthetics Installer shall demonstrate that such methods produce seams which are entirely equivalent to seams produced within the acceptable ambient temperature range, and that the overall quality of the geomembrane is not adversely affected. GRI Test Method 9 “Cold Weather Seaming of Geomembranes” provides guidelines for seaming in cold temperatures and can be used for guidance if needed. Typical cold weather seaming procedures include taking additional trial seams and destructive seam samples. The Geosynthetics Installer is required to provide documentation that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. If these requirements are met, the temperatures in the above quality assurance procedure shall be modified accordingly.

The CQA Consultant shall document that those weather conditions are fulfilled and shall advise the Project Manager if they are not.

5.5 Trial Seams

Trial seams shall be made on fragments of geomembrane liner to document that seaming equipment and conditions are adequate. Such trial seams shall be made at the beginning of each seaming period for each operator/equipment combination used in the seaming period. A trial seam shall also be made in the event that the equipment is turned off, or an operator changes or if the

CQA Consultant requests. Additional trial seams may be requested during cold weather conditions. Trial seams shall be made under the same conditions as actual seams.

The Geosynthetics Installer shall provide a tensiometer for on-site peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM specifications, and accompanied by evidence of recent calibration. The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of 2-inches per minute. It shall be equipped with a gauge that measures the force in pounds exerted between the jaws and have a digital readout.

The trial seam sample shall be the dimensions required by the Geosynthetics Installer with the seam centered lengthwise. Seam overlap shall be approximately 3-inches for extrusion welds and 4-inches for fusion welds or as required by Geosynthetic Installer equipment. Refer to Tables 3, 4, and 5 for the trial seam test method, test frequency and acceptance criteria.

In each type of test, all specimens shall meet the minimum strength requirements. If a trial seam fails, the entire operation should be repeated. If the additional trial seam fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

The CQA Consultant shall observe all trial seam procedures. All trial seams shall be assigned a number and marked accordingly by the CQA Consultant. The CQA Consultant shall log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself shall be cut into two pieces, one to be retained in the Owner's archives, one to be given to the Geosynthetics Installer.

5.6 Seaming Procedure

5.6.1 Extrusion Seaming

Unless otherwise specified, the general seaming procedure for extrusion seaming used by the Geosynthetics Installer shall be as follows:

- The upper sheet is lowered and laid flat against the lower sheet and all surface sheen in the area to be seamed must be removed. Sand paper coarser than No. 80 is unacceptable, because it can leave deep grooves in the weld area that represent potential stress points or leak channels. All material dust generated by grinding the liner sheets must be wiped or blown away from the seaming zone.
- Grind marks should never be deeper than 10-percent of the sheet thickness. Optimally, they should be about 5-percent of the sheet thickness. The only purpose of grinding is the removal of oxide layers and dirt from the liner surfaces, and the roughening of their interface for the extrudate.
- Grinding marks should not extend beyond 1/4-inches of either side of the extrudate after its placement. For example, if the final extrudate bead width is 1.5-inches, the width of the grinding trail should not exceed 2inches.
- Seaming must take place no more than 30-minutes after grinding, so that surface oxide layers do not reappear where the extrudate must be placed.
- A hot air device (often called a "liester") may be used to temporarily bond or "tack" the two sheets together, ahead of the extrusion welder. The hot air device prepares the seam for the extrusion welder by heating the ground surface and by creating a light bond between the two sheets, securing their position. The hot air gun is not meant to create a final seam. No heat distortion should be evident on the sheets.
- The extrusion welder's barrel shall be purged of all heat-degraded extrudate before starting a seam. This must be done every time the extruder is restarted after two or more minutes of inactivity. The purged extrudate shall not be discharged onto the surface of previously

placed liner, prepared soils, or installed GCL where it would eventually form a hard lump under the liner and cause stress concentrations.

- The center of the extrudate shall pass directly along the edge of the upper liner, at sufficient width to completely cover the edge and most of the outlying grind marks, at least to within 1/4-inch of their extremity.
- The extrudate should be approximately twice the specified sheet thickness, measured from the top of the bottom sheet to the top or "crown" of the extrudate.
- Where possible, inspect the underside of the lower liner for heat distortion. This can be done at the end of seams, and wherever samples are cut out of the seam. A slight amount of thermal "puckering" on relatively thin liners (less than 50-mil) is acceptable. It indicates that the heat penetrated entirely through the sheet. However, if the underside is greatly distorted, either lower the temperature or increase the rate of seaming. Any change in the welding procedure requires replacement trial seams to be prepared.
- If the seaming process must be interrupted at mid-seam, the extrudate should trail off gradually, not terminate in a large mass of solidified extrudate. Where such welds are abandoned long enough to cool, they must be ground prior to continuing with new extrudate over the remainder of the seam. Grind where the extrudate trail-off begins. This restart procedure must be followed for patches, pipes, fittings, and appurtenances.

5.6.2 Fusion Seaming Process

Unless otherwise specified, the general seaming procedures for fusion seaming used by the Geosynthetics Installer shall be as follows:

- The fusion seaming apparatus should be properly positioned for making the desired single or dual weld seam.
- Ambient variables such as temperature, cloud cover, and wind speed may make it necessary to vary the temperature of the wedge. It may be useful to document wedge temperatures used successfully in a variety of ambient conditions, so that the hot wedge can be more accurately adjusted if new conditions develop.

- The drive motor should be off when positioning the welding machine to seam. Place the machine where the sheets overlap. Guide the overlapped material between the idlers and the wedge, and into the drive/nip rollers. When continuing a weld that has been abandoned mid-seam, the liners must be spread where the seam leaves off and loaded into the respective sides of the machine. Raise the machine a few inches, load the bottom sheet first, and then load the top sheet. When the nip rollers engage and the wedge is in position, turn on the drive motor. Immediately engage the sheets when they are between the nip rollers to prevent an imminent melt-through. Move the hot wedge into position and lock it.
- The operator must constantly monitor the temperature controls, as well as the completed seam passing out of the machine. Occasional adjustments in temperature or speed may be necessary to maintain a consistent weld. Visual inspection and constant hand testing by the peel method (or other) is also recommended.

5.7 Non-Destructive Seam Continuity Testing

The Geosynthetics Installer shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), spark test, or other approved method. The testing shall be carried out to the accepted standards of the industry. The purpose of non-destructive tests is to check the seams for leaks. It does not provide any information on seam strength or quality of bonding. Non-destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Non-destructive testing shall be performed during daylight hours unless the Geosynthetics Installer demonstrates capabilities to do so in night hours.

The CQA Consultant shall:

- Observe all non-destructive testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and
- Inform the Geosynthetics Installer and Project Manager of any test failures and required repairs.

The Geosynthetics Installer shall complete any required repairs in accordance with Section 5.9.2.

The CQA Consultant shall:

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

The Geosynthetics Installer shall use the following procedures at locations where seams cannot be non-destructively tested, such as double hot wedge segments that are short or areas where extrusion beads do not permit the vacuum box to completely seal:

- All such seams shall be cap-stripped with the same geomembrane; and
- Each cap strip shall be vacuum tested in accordance with Section 5.7.1.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the CQA Consultant.

5.7.1 Vacuum Testing

The equipment shall be comprised of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a gauge to indicate chamber vacuum;
- A steel vacuum tank and pump assembly equipped with a vacuum gauge and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections;
- A bucket and wide brush, mop or spray assembly; and
- A soapy solution.

The following procedures shall be followed:

- Energize the vacuum pump;
- Wet a strip of geomembrane approximately 12-inches by 48-inches with a soapy solution;
- Place the box over the wet area;
- Close the bleed valve and open the vacuum valve;
- Ensure that a leak tight seal is created;
- At a vacuum of at least 5-psi, for a period of approximately 10-seconds, examine the geomembrane through the viewing window for the propagation of soap bubbles;
- Close the vacuum valve and open the bleed valve, move the box over the adjoining area with a minimum 3-inches overlap, and repeat the process;
- All areas where soap bubbles appear shall be marked and repaired in accordance with Section 5.9.2; and
- Vacuum tested seams shall be recorded.

5.7.2 Air Pressure Testing (For Double Hot Wedge Seam Only)

The equipment shall be comprised of the following:

- An air pump (manual or motor driven) equipment with pressure gauge capable of generating a minimum pressure of 30-pounds per square inch (psi);
- A rubber hose with fittings and connections; and
- Hollow needle and clamp assembly or other approved pressure feed device.

The following procedures shall be followed:

- Seal one end of the seam to be tested;
- Insert needle or other approved pressure feed device into the air channel created by the fusion weld;

- Energize the air pump to a pressure of 30 to 35-psi, close valve, and hold pressure for approximately 5-minutes;
- If loss of pressure exceeds 3-psi, or does not stabilize, locate faulty area and repair in accordance with Section 5.9.2;
- Release air pressure by puncturing seam at opposite end of where pressure is applied to assure there is no blockage in the air channel and verify that the full seam has been pressurized;
- Remove needle or other approved pressure feed device and seal; and
- Pressure tested seams shall be recorded.

5.7.3 Spark Testing

For those extrusion welded seams that are unable to be tested by a vacuum box, the spark test method shall be used. The spark test method utilizes a 24 gauge copper wire placed 1/8-inch under the top sheet overlap and a holiday detector operating at 20,000 volts.

The testing activities shall be performed by the Geosynthetics Installer by placing the electrically conductive wire beneath the seam prior to welding. A trial seam containing a non-welded segment shall be subject to a calibration test to ensure that such a defect (non-welded segment) will be identified under the planned machine settings and procedures.

Upon completion of the weld, enable the spark tester and hold approximately 1 inch above the weld moving slowly over the entire length of the weld in accordance with ASTM D6365. If there is no spark, the weld is considered to be leak free.

A spark indicates a hole in the seam. The faulty area shall be located, repaired, and retested by the Geomembrane Installer.

Care shall be taken if flammable gases are present in the area to be tested.

5.8 Destructive Testing

Destructive testing of seams shall be performed at locations selected by the CQA Consultant. The purpose of these tests is to evaluate seam strength and bonding efficiency, which indicates seam durability. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

5.8.1 Location and Frequency

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

- A minimum average frequency of one test location per 1,000 -feet of seam length per seaming device for each type of seaming. This minimum frequency is to be determined as an average taken throughout the entire facility for each type of seaming. Additional samples may be obtained during cold weather seaming.
- Test locations shall be random and shall be selected during seaming by the CQA Consultant. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples shall be taken.

5.8.2 Sampling Procedure

Samples shall be cut by the Geosynthetics Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material.

The CQA Consultant shall:

- Select sample locations;
- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly;
- Record the sample location on the as-built layout drawing; and
- Record any special reason for taking the sample at this location (e.g., suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired by capping in accordance with repair procedures described in Section 5.9.2. The continuity of the new seams in the repaired area shall be tested according to Section 5.7.

5.8.3 Size of Samples

At a given sampling location, a destructive sample shall be cut from the seam by the Geosynthetic Installer. The destructive sample shall be the dimensions required by the Geosynthetics Installer for field testing and Geosynthetics CQA Laboratory for laboratory testing with the seam centered lengthwise. Typical dimensions of the samples are 12 by 36 inches. The seam shall then be distributed as follows:

- One portion to be tested onsite by the Geosynthetics Installer;
- One portion to the Owner for archive storage; and
- One portion for Geosynthetics CQA Laboratory testing.

5.8.4 Field Testing

Five 1-inch wide samples, or "bones" shall be tested by the Geosynthetic Installer in the field for peel strength using a tensiometer. The results of field testing shall meet the acceptance criteria shown on Tables 3, 4, and 5. If any field test sample fails, then the procedures outlined in Section

5.8.7 shall be followed. If the field test sample passes, the sample shall be sent to the Geosynthetics CQA Laboratory for testing.

The CQA Consultant shall document all field tests and mark all 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, and pass or fail description.

5.8.5 Geosynthetics CQA Laboratory Testing

Destructive test samples being forwarded to the geosynthetics CQA laboratory shall be packaged and shipped under the responsibility of the CQA Consultant in a manner that will not damage the test sample. The Project Manager shall be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetics CQA Laboratory. The Geosynthetics CQA Laboratory shall be selected by the Project Manager.

The Geosynthetics CQA Laboratory shall provide test results no more than 24-hours after they receive the samples. The CQA Consultant shall review laboratory test results as soon as they become available and make appropriate recommendations to the Project Manager. Refer to Tables 3, 4, and 5 for the test method and acceptance criteria.

5.8.6 Geosynthetics Installer's Laboratory Testing

If performed, the Geosynthetics Installer's laboratory test results shall be presented to the Project Manager and the CQA Consultant for review.

5.8.7 Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Geosynthetics Installer's laboratory, or by field testing. The Geosynthetics Installer has two options:

- The Geosynthetics Installer can reconstruct the seam between any two passed destructive seam test locations; or
- The Geosynthetics Installer can trace the seaming path to an intermediate location at least 10-feet in both directions from the point of the failed test. Check the next seam welded using the same welding device if required to obtain additional sample (i.e., if one side of the seam is less than 10-feet long). A small sample for an additional field test at each location shall be taken. If these additional samples pass tensiometer testing, then full destructive laboratory samples are taken. If these destructive laboratory samples pass the tests, then the seam is reconstructed between these locations by capping. If either sample fails, the process is repeated to establish the segment in which the seam should be reconstructed.

If a fusion type seam fails destructive testing and the Geosynthetics Installer chooses to repair the seam, it shall be repaired as described in Section 5.9.2.

All acceptable seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150-feet of reconstructed seam, a seam sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined in this Section must be repeated. The CQA Consultant shall document all actions taken in conjunction with destructive test failures.

5.9 Defects, Repairs, and Retests

5.9.1 Defects

The CQA Consultant shall visually monitor each panel and seam for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The geomembrane shall be clean at the time of the inspection. Any defects or damage shall be logged on deficiency forms. The actions taken to resolve or correct the problem along with non-destructive

test results shall also be recorded on the form. Geomembrane shall not be covered at locations that have been repaired until test results with passing values are available.

5.9.2 Repairs

Any portion of the geomembrane failing a destructive or non-destructive test shall be repaired. Prior to repairing a problem area, the CQA Consultant and the Geosynthetics Installer shall agree on the repair method to be used. If no concurrence is reached, the Project Manager's decision shall be final. The procedures available include:

- Patching - used to repair holes and tears, along with tees, and wyes at the ends of a seam, and contamination by foreign matter;
- Buffing and re-welding - used to repair small sections of extruded seams;
- Spot welding or seaming - used to repair minor localized flaws; and
- Capping - used to repair large lengths of seams or panels.

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired shall be abraded no more than 30-minutes prior to the repair;
- All surfaces must be clean and dry at the time of the repair;
- All seaming equipment used in repair procedures must be approved;
- The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Project Manager and CQA Consultant; and
- Patches or caps shall extend at least 6-inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3-inches.

5.9.3 Retests

Each repair shall be non-destructively tested unless the CQA Consultant deems otherwise. If a repair passes the non-destructive test, it shall be documented as satisfactory by the CQA Consultant. Failed tests shall require the repair to be redone and retested until a passing test results.

5.10 Electrical Conductivity Integrity Testing

In accordance with OAC 3745-27-08(D)(10)(h)(iv), electrical conductivity integrity testing (also referred to as electrical leak location testing) of the geomembrane in the baseliner system must be conducted. Electrical leak location testing shall be conducted following placement of the leachate collection/protective cover layer in accordance with ASTM D7007 or ASTM D8265 unless it is unable to be performed due to isolation limitations, construction sequencing issues, or due to unique properties of materials used for the leachate collection/protective cover layer. These ASTM test methods cannot be performed if the tire shreds are placed as the leachate collection layer because of their insulating property. In the case that electrical leak location testing is unable to be performed after the leachate collection layer/protective cover layer is placed, the electrical leak location testing must be performed on the exposed geomembrane in accordance with ASTM D7002, ASTM D7703, ASTM D7240, or ASTM D7953. Defective areas or seams identified during the test shall be repaired as discussed in Section 5.9. The CQA consultant shall document the results of the test and note defective areas and repairs. After repairs are made based on the initial electrical leak location testing, additional leak location testing is not required.

6.0 GEOSYNTHETICS CERTIFICATION/ACCEPTANCE

The Geosynthetics Installer, and Geosynthetics Manufacturers, shall retain all ownership and responsibility for the geosynthetic materials until they are accepted by the Owner.

The geosynthetics system shall be accepted by the Owner when:

- The installation is finished;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;
- Geosynthetics Installer's representative furnishes the Project Manager with documentation that the geomembrane was installed in accordance with the Geosynthetics Manufacturer’s recommendations as well as the Drawings and Specifications; and
- All documentation of installation is completed including the CQA Consultant's final report.

The CQA Consultant shall document that installation has proceeded in accordance with this CQA/QC Plan for the project except as noted to the Project Manager.

7.0 MATERIALS IN CONTACT WITH GEOMEMBRANES

The quality assurance procedures indicated in this Section are only intended to assess that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures are necessary to determine that systems built with these materials shall be constructed in such a way to enable proper performance.

7.1 Geotextile

The CQA Consultant shall document that the geotextile is installed in accordance with the procedures described in Section VI, Geotextile Construction Quality Assurance, of this CQA/QC Plan. Care shall be exercised so as not to damage the geomembrane during placement of the geotextile.

7.2 Geocomposite

The CQA Consultant shall document that the geocomposite is installed in accordance with the procedures described in Section V, Geocomposite Construction Quality Assurance, of this CQA/QC Plan. Care shall be exercised so as not to damage the geomembrane during placement of the geocomposite.

7.3 Appurtenances

A copy of the Specifications and Drawings prepared by the Design Engineer for appurtenances shall be given by the Project Manager to the CQA Consultant for review.

The CQA Consultant shall document that:

- Installation of the geomembrane in appurtenance areas, and connection of geomembrane to appurtenances have been made according to Specifications;

- Extreme care is taken while seaming around appurtenances, and that non-destructive testing using appropriate methods is performed;
- The geomembrane has not been visibly damaged while making connections to appurtenances; and
- The Project Manager is informed if the above conditions are not fulfilled.

7.4 Backfilling of Anchor Trench

Anchor trenches shall be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. Anchor trenches shall be backfilled as outlined in Sub-Section 5.4 of Section III of this CQA/QC Plan.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The CQA Consultant shall observe the backfilling operation and advise the Project Manager of any problems.

SECTION V

GEOCOMPOSITE CONSTRUCTION QUALITY ASSURANCE

SECTION V
GEOCOMPOSITE
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 INTRODUCTION....1
1.1 Certification of Property Values.... 1
1.2 Labeling 2

2.0 SHIPMENT AND STORAGE....3
2.1 Packaging and Labeling 3
2.2 Transportation and Handling.... 3
2.3 Storage 4

3.0 CONFORMANCE TESTING OF DELIVERED GEOCOMPOSITE....5
3.1 Sampling Procedures.... 5
3.2 Test Results.... 5
3.3 Conformance Test Failure 6

4.0 HANDLING....7

5.0 INSTALLATION AND REPAIR....8
5.1 Installation.... 8
5.2 Repair.... 9

6.0 PLACEMENT OF MATERIALS ON GEOCOMPOSITE....10

SECTION V
GEOCOMPOSITE
CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

A double-sided geocomposite consisting of a geonet with geotextile bonded to both sides will be installed within the final cover system of the landfill as the drainage layer and may be installed as the leachate collection layer as part of an optional baseliner system design. A geocomposite may also be used in the underdrain system.

Prior to delivery, the Geocomposite Manufacturer shall provide to the Project Manager quality control certification for the geocomposite delivered to the site confirming that the material meets the guaranteed minimum requirements of the Geocomposite Manufacturer as well as those listed in Table 6. The geotextile shall be a non-woven polypropylene or polyester material. The geonet shall consist of two or more traverse strands of high density polyethylene. The geocomposite shall be free of oil, grease and other foreign materials.

1.1 Certification of Property Values

The Geocomposite Manufacturer shall provide the Project Manager with a list of guaranteed minimum average roll values (MARV) for the type of geocomposite to be supplied. The Geosynthetics Manufacturer shall provide to the Project Manager quality control certification for each roll of geocomposite shipped to the site confirming that each roll meets or exceeds the guaranteed minimum requirements of the Geosynthetics Manufacturer. The QC certifications shall contain results of the manufacturer's CQC testing ensuring that the physical properties of the final product are in accordance with the manufacturer's specifications and that of Table 6. Prior to use in the manufacturing of the geonet, raw material resins used in the manufacturing of the geonet shall be tested by the resin manufacturer or geosynthetics manufacturer. Results of all resin testing

shall conform to either the resin/geosynthetics specifications or to the specified values in Table 6, whichever is more stringent.

The CQA Consultant shall examine manufacturer's certifications and CQC testing results to confirm that the property values meet or exceed those specified in Table 6. Deviations shall be reported to the Project Manager.

1.2 Labeling

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

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

In addition, if any special handling of the geocomposite is required, it shall be so marked on the top surface of the geocomposite, e.g., “This Side Up.” The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.0 SHIPMENT AND STORAGE

2.1 Packaging and Labeling

The finished geocomposite shall be completely wrapped and adequately secured with a durable opaque cover in order to provide protection from ultraviolet degradation of the geotextile, precipitation, mud, dirt dust, puncture, cutting, or any other damaging or deleterious conditions during shipping and storage. The central core shall be accessible for handling. The geocomposite rolls shall be marked or tagged with the following information:

- Manufacturer's name;
- Product identification;
- Lot or batch number;
- Roll number;
- Roll weight; and
- Roll dimensions.

The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.2 Transportation and Handling

Transportation of the geocomposite is the responsibility of the Geocomposite Manufacturer, Geosynthetics Installer, or Transporter, as directed by the Geosynthetic Installer. All handling on site is the responsibility of the Geosynthetics Installer.

The CQA Consultant will confirm that:

- Handling equipment used on the site is adequate and does not damage the geocomposite; and

- The geocomposite is handled with care.

The geocomposite shall be shipped in accordance with the Geocomposite Manufacturer's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Consultant shall review all rolls for defects and for damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Project Manager any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

2.3 Storage

The Geosynthetic Installer shall be responsible for the storage of the geocomposite on site. The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should protect the geocomposite from vandalism, passage of vehicles, precipitation, etc.

The rolls of geocomposite shall be stored in their original, unopened, wrapped cover in a clean dry area. The geocomposite shall be protected from mud, dirt, dust, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The rolls shall not be stacked more than six rolls high or as recommended by the Geosynthetics Manufacturer, due to the possibility of thinning of the product at points of contact. Any additional procedures required by the Geocomposite Manufacturer shall be the Geosynthetics Installer's responsibility.

3.0 CONFORMANCE TESTING OF DELIVERED GEOCOMPOSITE

The Geocomposite Manufacturer shall remove samples of geotextile for testing by the Geosynthetics CQA Laboratory to confirm that the geotextile used in the geocomposite meets the requirements for material acceptance. The geotextile samples shall be removed before the geotextile is bonded to the geonet.

Geocomposite sampling for conformance testing may take place at the geocomposite manufacturing plant by the Geocomposite Manufacturer, the Geosynthetics CQA Laboratory, a representative of the Owner, or the CQA Consultant. The samples shall be forwarded to the Geosynthetics CQA Laboratory. Conversely, the CQA consultant may retrieve geocomposite samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project specifications. The CQA Consultant will document that the delivered geocomposite meets the requirements in Table 6 for material acceptance.

3.1 Sampling Procedures

Samples of geotextile shall be taken from the rolls of geotextile used in the geocomposite to be delivered to the site. Samples shall be taken across the entire width of the roll and shall be taken prior to the geotextile being bonded to the geonet. Samples of geocomposite shall be taken across the entire width of the roll and will not include the first 3 linear feet. Unless otherwise specified, all samples shall be 3-feet long by the roll width. The machine direction shall be marked on the samples with an arrow. Samples of geotextile and/or geocomposite shall be taken at the rates specified in Table 6.

3.2 Test Results

The CQA Consultant shall examine results from laboratory conformance testing and shall report non-conformance to the Project Manager.

3.3 Conformance Test Failure

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

- The Geosynthetics Installer shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the Specifications. If either of these samples fail, testing will proceed on samples from the closest numerical roll to the failed roll until rolls are located that conform to the Specifications.
- The Geosynthetics Installer shall replace the roll of geocomposite that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

4.0 HANDLING

As each geocomposite roll is moved from the storage area, the labels shall be removed by the Geosynthetics Installer and submitted to the CQA Consultant. The Geosynthetics Installer shall handle geocomposite in such a manner as to minimize damage to the geocomposite and comply with the following:

1 The equipment or tools used for handling, trafficking, or other operations shall not cause damage to the geocomposite;
2 Personnel working on the geocomposite shall not smoke, wear damaging shoes, or engage in activities which will cause damage to the geocomposite; and
3 The equipment used to deploy the geocomposite shall not cause damage to the underlying layers.

5.0 INSTALLATION AND REPAIR

5.1 Installation

The surfaces on which the geocomposite will be placed shall be free of objects which may damage the material. The CQA Consultant shall visually monitor the surface prior to geocomposite installation and document the findings. The Geosynthetics Installer shall remove all materials that may potentially damage the geocomposite. Prior to and during installation, the Geosynthetics Installer shall observe the following:

- Equipment does not damage the geocomposite or underlying materials by handling, trafficking, excessive heat, leakage of machine operating fuels or oils, or other means.
- Care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the material. If dirt, excessive dust, and/or stones are entrapped in the geocomposites, the geocomposites shall be cleaned prior to placement of material on it.
- Tying devices shall be placed every 5-feet along the slope, every 2-feet across the slope, every 6-inches in the anchor trench, and every 10-feet on horizontal surfaces.
- Horizontal seams on slopes shall be staggered.
- The material overlap for butted panels on slopes shall be a minimum of 2-feet. The tie spacing for butted panels on the slopes shall be two (2) rows at 12-inch spacing. Ties in the two (2) rows shall be offset.
- Geocomposite shall be placed parallel to the slope.
- Wrinkles and “fishmouths” shall be eliminated before sewing of the top geotextile can begin.
- All geotextiles bonded to the geonet shall have a minimum 2-inch overlap at the seams. Only the top seams shall be sewn. Sewn seams shall be “prayer” type with a double lock stitch using polymeric thread.
- The minimum geonet overlap on seams shall be 4-inches.

- The geonet overlaps shall be secured by tying using strings, plastic fasteners, or polymer braid. Tying devices will be of any visible color other than black for easy observation. Metallic devices are not allowed.
- If white colored geotextile is used on the geocomposite, precautions, such as sunglasses, shall be taken against "snow blindness" of personnel.
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geocomposite shall be placed to prevent uplift by wind.
- The geocomposite shall be anchored as shown on the Drawings.

The CQA Consultant shall note any non-compliance and report it to the Project Manager.

5.2 Repair

Damaged geocomposite shall be repaired by overlapping the damaged area with a patch taken from the same type of geocomposite. The damaged area shall be overlapped on all sides a minimum of 6-inches and secured in place with ties every 6-inches around the circumference of the patch.

6.0 PLACEMENT OF MATERIALS ON GEOCOMPOSITE

The placement of materials on geocomposite shall be such that:

- The geocomposite is not damaged;
- Minimal slippage of the geocomposite on the underlying layer occurs;
- No excess tensile stresses occur within the geocomposite;
- Heavy equipment used for placing the overlying soil material will not be driven directly on the geocomposite;
- Lightweight vehicles may travel directly over the geocomposite if approved by the Manufacturer, Owner, and CQA Consultant; and
- In areas of heavy vehicle traffic, the soil thickness shall be a minimum of 3-feet.

Non-compliance shall be noted by the CQA Consultant and reported to the Project Manager.

SECTION VI

GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

SECTION VI
GEOTEXTILE
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 INTRODUCTION....1
1.1 Certification of Property Values.... 1
1.2 Labeling 1

2.0 SHIPMENT AND STORAGE....3
2.1 Packaging and Labeling 3
2.2 Transportation and Handling.... 3
2.3 Storage 4

3.0 CONFORMANCE TESTING OF DELIVERED GEOTEXTILE 5
3.1 Sampling Procedures.... 5
3.2 Test Results.... 5
3.3 Conformance Test Failure 5

4.0 HANDLING AND PLACEMENT 7

5.0 INSTALLATION AND REPAIR....8
5.1 Installation.... 8
5.2 Repair.... 8

6.0 PLACEMENT OF MATERIALS ON GEOTEXTILE 10

SECTION VI
GEOTEXTILE
CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

A geotextile will be installed within the liner/leachate collection system of the landfill as a cushion layer. A 6-oz/sy nominal nonwoven geotextile shall be utilized if a granular leachate drainage material is utilized and a 16-oz/sy nominal nonwoven geotextile shall be utilized if tire chips are used as leachate drainage material. The geotextile shall be a nonwoven polypropylene or polyester material and shall be free of oil, grease, and other foreign materials.

1.1 Certification of Property Values

The Geotextile Manufacturer shall provide the Project Manager with a list of guaranteed minimum average roll values (MARV) for each type of geotextile to be supplied. Prior to delivery, the Geotextile Manufacturer shall provide to the Project Manager quality control certification for the geotextile delivered to the site confirming that the material meets the Specifications.

The CQA Consultant shall examine manufacturer's certifications and CQC testing results to confirm that the property values meet those specified in Tables 7 and 8. Deviations shall be reported to the Project Manager.

1.2 Labeling

The Geotextile Manufacturer shall identify all rolls of geotextile with the following:

- Manufacturer's name;
- Product identification;
- Lot number;

- Roll number;
- Roll weight; and
- Roll dimensions.

The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.0 SHIPMENT AND STORAGE

2.1 Packaging and Labeling

The finished geotextile shall be completely wrapped and adequately secured with a durable opaque polyethylene protective cover in order to provide protection from ultraviolet degradation of the geotextile, precipitation, mud, dirt dust, puncture, cutting, or any other damaging or deleterious conditions during shipping and storage. The central core shall be accessible for handling. The geotextile rolls shall be marked or tagged with the following information:

- Manufacturer's name;
- Product identification;
- Lot or batch number;
- Roll number;
- Roll weight; and
- Roll dimensions.

The CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.2 Transportation and Handling

Transportation of the geotextile is the responsibility of the Geotextile Manufacturer, Geosynthetics Installer, or Transporter, as directed by the Geosynthetic Installer. All handling on site is the responsibility of the Geosynthetics Installer.

The CQA Consultant will confirm that:

- Handling equipment used on the site is adequate and does not damage the geotextile; and
- The geotextile is handled with care.

The geotextile shall be shipped in accordance with the Geotextile Manufacturer's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Consultant shall review all rolls for defects and for damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Project Manager any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

2.3 Storage

The Geosynthetic Installer shall be responsible for the storage of the geotextile on site. The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should protect the geotextile from vandalism, passage of vehicles, precipitation, etc. The rolls of geotextile shall be stored in their original, unopened, wrapped cover in a clean dry area. The geotextile shall be protected from mud, dirt, dust, excessive heat or cold, puncture, cutting, solar degradation, or other damaging or deleterious conditions. The rolls shall not be stacked more than six rolls high or as recommended by the Geosynthetics Manufacturer, due to the possibility of thinning of the product at points of contact. Any additional procedures required by the Geotextile Manufacturer shall be the Geosynthetics Installer's responsibility.

3.0 CONFORMANCE TESTING OF DELIVERED GEOTEXTILE

Conformance sampling may take place at the geotextile manufacturing plant by either the Geotextile Manufacturer, Geosynthetics CQA Laboratory, a representative of the Owner, or the CQA Consultant. The samples shall then be forwarded to the Geosynthetics CQA Laboratory for testing. Conversely, the CQA consultant may retrieve geotextile samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project requirements in Tables 7 and 8 for material acceptance.

3.1 Sampling Procedures

Samples of geotextile shall be taken from the rolls of geotextile to be delivered to the site. Samples of geotextile shall be taken across the entire width of the roll and will not include the first 3 linear feet. Unless otherwise specified, all samples shall be 3-feet long by the roll width. The machine direction shall be marked on the samples with an arrow. Samples of geotextile shall be taken at the rates specified in Tables 7 and 8.

3.2 Test Results

The CQA Consultant shall examine results from laboratory conformance testing and shall report non-conformance to the Project Manager.

3.3 Conformance Test Failure

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

- The Geosynthetics Manufacturer or CQA Consultant shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the Specifications. If either of

these samples fail, testing will proceed on samples collected from the closest numerical roll to the failed roll until rolls are located that conform to the Specifications.

- The Geosynthetics Manufacturer shall replace any roll of geotextile that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

4.0 HANDLING AND PLACEMENT

The Geosynthetics Installer shall handle geotextile in such a manner as to minimize damage to the geotextile and comply with the following:

- In the presence of wind, all geotextile will be weighted with sandbags or the equivalent.
- Geotextile will deployed in a manner to minimize the presence of wrinkles in the geotextile.
- Geotextile will be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage, which could be caused by the cutting of geotextile.
- The Geosynthetics Installer shall take necessary precautions to prevent damage to underlying layers during placement of the geotextile.
- During placement of geotextile, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the material. If dirt, excessive dust, and/or stones are entrapped in the geotextile, the geotextile shall be cleaned prior to placement of material on it.
- After installation, a visual examination of the geotextile will be carried out over the entire surface to ensure that no potentially harmful foreign objects, such as needles, are present.
- If white geotextile is used, precautions, such as sunglasses, shall be taken against “snow blindness” of personnel.

The CQA Consultant shall note non-compliance and report it to the Project Manager.

5.0 INSTALLATION AND REPAIR

5.1 Installation

The surfaces on which the geotextile will be placed shall be free of objects that may damage the material. The CQA Consultant shall visually inspect the surface prior to geotextile installation. The Geosynthetics Installer shall remove all materials that may potentially damage the geotextile. Prior to and during installation, the Geosynthetics Installer and CQA Consultant shall observe the following:

- All geotextiles shall be continuously sewn (i.e. spot sewing is not allowed). Geotextiles shall be overlapped at a minimum of 6-inches prior to seaming. Thermal bonding shall be allowed only after verbal or with approval of the Project Manager.
- There shall be no horizontal seams on side slopes steeper than 20% (i.e. seams shall be along, not across, slopes steeper than 5H:1V), except as part of a patch, unless approved by the Design Engineer.
- The Geosynthetics Installer shall pay particular attention at seams to ensure that no protective cover material could be inadvertently inserted beneath the cushion geotextile which overlies the geomembrane.
- Geotextile sewing shall be done using polymeric thread.
- The geotextile shall be anchored as shown on the Drawings.

The CQA Consultant shall note any non-compliance and report it to the Project Manager.

5.2 Repair

Any holes or tears in the geotextile shall be repaired as follows:

- On slopes steeper than 20%. A patch made from the same geotextile shall be seamed into place no closer than 1-inch from any edge. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.
- On slopes less than or equal to 20%. A patch made from the same geotextile shall be spot-seamed in place with a minimum of 24-inches overlap in all directions.

6.0 PLACEMENT OF MATERIALS ON GEOTEXTILE

The placement of materials on geotextile shall be such that:

- The geotextile is not damaged;
- Minimal slippage of the geotextile on the underlying layer occurs;
- No excess tensile stresses occurs within the geotextile;
- Equipment used for placing the overlying soil material shall not be driven directly on the geotextile;
- A minimum thickness of 1-foot of soil shall be required between a low ground-pressure dozer and the geotextile;
- A minimum thickness of 2-feet of soil shall be required between light-weight rubber-tired vehicles and the geotextile; and
- In areas of heavy vehicle traffic, the soil thickness shall be a minimum of 3-feet.

Non-compliance shall be noted by the CQA Consultant and reported to the Project Manager.

SECTION VII

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS CONSTRUCTION QUALITY ASSURANCE

SECTION VII
HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 MANUFACTURER'S DOCUMENTATION....1
- **1.1 Raw Materials 1**
- **1.2 Pipe 1**
- **1.3 Fittings 2**
- **1.4 Certification of Property Values.... 2**

2.0 DELIVERY 4
- **2.1 Labeling 4**
- **2.2 Transportation and Handling.... 4**
- **2.3 Storage 4**

3.0 JOINING 6
- **3.1 Joining Process Preparation 6**
- **3.2 Butt Fusion Weather Conditions.... 6**
- **3.3 Butt Fusion Procedures 7**

4.0 NON-DESTRUCTIVE TESTING....9

1.0 INTRODUCTION....1

2.0 SURVEY CONTROL....2

3.0 SURVEYING PERSONNEL 3

4.0 PRECISION AND ACCURACY 4

5.0 LINES AND GRADES 5

6.0 FREQUENCY AND SPACING....6

7.0 TOLERANCES....7

SECTION VII
HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS
CONSTRUCTION QUALITY ASSURANCE

1.0 MANUFACTURER'S DOCUMENTATION

1.1 Raw Materials

High-density polyethylene (HDPE) pipe and fittings will be used in the leachate collection and transport system and the gas extraction system. Raw materials used for the manufacture of HDPE pipe and fittings shall be extra high molecular weight, high-density ethylene/hexene copolymer PE 3408 polyethylene resin. The resin shall meet the specifications of ASTM D3350 with cell classification of PE: 345434C and ASTM D1248 with pipe grade resin Type III, Class C, Category 5, grade P34 polyethylene compound.

1.2 Pipe

The pipe shall be manufactured to the dimensions and tolerances specified in ASTM F714. Additionally the pipe shall be inspected per industry accepted manufacturer standards for the following:

- Diameter;
- Wall thickness;
- Concentricity;
- Quick burst pressure and ductility;
- Joint length;
- Straightness;
- Ovality;
- Toe-in; and
- Overall workmanship inspection on inner diameter (ID) and outer diameter (OD).

The pipe shall not contain recycled compound except that generated in the HDPE Pipe Manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects. The pipe shall also be identical in color, density, melt index, and other physical properties throughout. Perforations shall be prefabricated to size, orientation, and spacing specified in the drawings.

1.3 Fittings

The standard HDPE fittings shall be standard commercial products manufactured by injection molding, or by extrusion and seaming, or shall be fabricated from HDPE pipe conforming to the Sub-section above. The fittings shall be fully pressure tested by the HDPE Pipe Manufacturer to provide a working pressure equal to the pipe for 50 years service at 73.4 °F with an included 2:1 factor of safety. The fittings shall be manufactured from the same resin type, grade, and cell classification as the pipe itself. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from cracks, holes, foreign inclusions, voids, or other deleterious defects. The fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The minimum "quick-burst" strength of the fittings shall not be less than that of the pipe with which the fittings are to be used.

1.4 Certification of Property Values

The HDPE Pipe Manufacturer’s certification shall include the following:

- Resin Supplier’s name;
- Specific resin used;
- Copies of Resin Supplier’s certifications;
- Property sheet listing pipe properties;

- List of quantities and descriptions of materials, other than base resin, that comprise the pipe;
- Sampling procedures and results of testing; and
- Certification of the minimum property values listed on the property sheet.

The CQA Consultant shall confirm that the property values certified by the HDPE Pipe Manufacturer meet all the Specifications. The CQA Consultant shall also confirm that the proper test methods and documentation procedures were used.

2.0 DELIVERY

2.1 Labeling

The HDPE Pipe Manufacturer shall identify the segments of pipe with the following:

- Nominal size;
- SDR value;
- Pressure rating;
- Type or trade name of pipe; and
- Material Classification.

The CQA Consultant shall examine the pipe upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.2 Transportation and Handling

Transportation of the HDPE pipe is the responsibility of the HDPE Pipe Manufacturer, Earthwork Contractor, or Transporter. All handling on site is the responsibility of the Earthwork Contractor.

The pipe shall be transported in a manner designed to deliver the pipe to the project neatly, intact, and without physical damage. The pipe shall be properly supported, stacked, and restrained during transport such that the pipe is not nicked, gouged, or physically damaged. The CQA Consultant shall examine the pipe for defects and damage upon delivery to the site.

2.3 Storage

The Earthwork Contractor shall be responsible for the storage of the HDPE pipe on-site. The Project Manager shall provide storage space in one or more locations such that on-site

transportation and handling are minimized. The storage space shall protect the pipe from theft, vandalism, passage of vehicles, etc.

Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the HDPE Pipe Manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

Sections of pipe with cut or gouges greater than 10 percent of the wall thickness of the pipe shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method.

3.0 JOINING

As many sections of HDPE pipe should be joined into continuous lengths above ground on the job site as possible. The joining method shall be the butt fusion method and shall be performed in strict accordance with the HDPE Pipe Manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the HDPE Pipe Manufacturer including, but not limited to, temperature requirements of 440 °F, alignment, and 75 psi interfacial fusion pressure.

Butt fusion joining shall be 100 percent efficient, offering a joint weld strength equal to or greater than the tensile strength of the HDPE pipe. Socket fusion shall not be used except for tie-in locations. Extrusion welding or hot gas welding of HDPE pipe shall not be used in the force main construction or in fabrications where shear or structural strength is important. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion in strict accordance with the HDPE Pipe Manufacturer's recommendations.

3.1 Joining Process Preparation

All pipes, fittings, and fusion joints shall be examined by the CQA Consultant and the Pipe Installer. The Pipe Installer shall insure that pipes and fittings are not broken, cracked, or otherwise contain damaged or unsatisfactory material. Prior to fusion, the Pipe Installer shall ensure that the fusion surface area is clean and free of moisture, dust, dirt, debris, and foreign material.

3.2 Butt Fusion Weather Conditions

Joining HDPE pipe using the butt fusion method shall not proceed at an ambient temperature below 32 °F unless the Pipe Installer can document to the Project Manager that the resulting joint weld strength is equal to or greater than the tensile strength of the pipe.

3.3 Butt Fusion Procedures

It is important during the butt fusion process to maintain the proper temperature of the heater plate. The Pipe Installer shall check the temperature with a tempilstik or pyrometer for the correct surface temperature. Unless otherwise specified, the general butt fusion procedures used by the Pipe Installer are as follows:

- Install pipe in machine, allowing pipe ends to protrude 1 to 2-inches past face of jaw.
- Clean pipe ends inside and out with a clean cotton cloth to remove dirt, water, grease and other foreign materials.
- Square (face) the pipe ends using facing tool of the fusion machine and do not touch the newly faced surfaces with hands, as perspiration and body oils could contaminate the joint area resulting in a weakened joint.
- Check the line-up of the pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. If any adjustment is made to the clamps following facing, the facing unit should be re-installed and the pipe ends given several turns with the cutter before continuing with the fusion process.
- Insert clean heater plate between aligned ends, and bring both ends firmly in contact with plate but do not apply pressure while achieving melt pattern.
- Allow pipe end to heat, soften, and form a melt bead to the approximate width recommended by the HDPE Pipe Manufacturer based on pipe diameter. The melt bead should be the same size on both pipe ends and should be uniformly sized around the pipe.
- Carefully move the pipe ends away from the heater plate after achieving the proper melt bead on both pipe ends. If the softened material sticks to the plate, discontinue the joint, allow to cool, and start the fusion process from the beginning.
- Quickly bring the pipe ends together with the pressure recommended by the HDPE Pipe Manufacturer. The force applied will cause each bead to rollback onto the pipe. Insufficient rollback is one indication of a faulty joint.

- While maintaining pressure used in making the joints, allow the joint to cool for 30 to 90 seconds per inch of pipe diameter before removing from machine. The joint is cool when the bead feels hard and your finger can remain comfortably on the bead.
- Remove fused pipe from fusion machine and allow to cool at least 20 minutes after removal before subjecting it to testing, bending, or backfilling stresses.

The CQA Consultant and Pipe Installer shall examine all joints following removal from fusion machine. Fused segments of pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable type chokers must be avoided. Nylon slings are preferred. Spreader bars are recommended when lifting long fused sections. Care must be exercised to avoid cutting or gouging the pipe.

4.0 NON-DESTRUCTIVE TESTING

All solid wall HDPE joints must be non-destructively tested. Leachate collection and gas extraction system pipe joints shall be tested using either the low or high air pressure test. The hydrostatic pressure test may also be used if approved by the Project Manager. Other non-destructive tests may be used if all of the following conditions are satisfied:

- The Pipe Installer can document its effectiveness;
- The method is approved by the HDPE Pipe Manufacturer; and
- The method is approved by the Project Manager.

The Project Manager and CQA Consultant shall determine the effectiveness and validity of the proposed test method.

The low air pressure test shall be performed in accordance with the HDPE Pipe Manufacturer's recommendations and in accordance with current industry standards. The Pipe Installer shall follow all safety requirements. The general procedures for the low air pressure test are as follows:

- The pipe shall be placed in the trench and sufficient backfill installed between joints to prevent movement.
- A maximum length shall be tested separately as construction progresses and before the trench is completely backfilled, unless approved by the Owner.
- Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested and shall be able to resist internal test pressure without requiring external bracing or blocking. All air shall pass through a single control panel that has a header and gauges to record pressure in the plug and in the pipe. Two individual hoses will be used to connect the control panel to the pneumatic plugs and sealed line and one hose will be used to connect the sealed line to the control panel for monitoring air pressure in the sealed line.

- All pneumatic plugs shall be seal tested prior to actual testing. Lay a length of pipe on ground and seal it with the plugs to be tested. Inflate the plugs to 25 psi and the pipe to 5 psi. Plugs are satisfactory if they withstand the pressure without bracing.
- To test the fused pipe, place the seal tested plugs into the line at each test section end and inflate to 25 psi. Introduce low air pressure into the sealed line until the air pressure is 4 psi. Allow at least 2 minutes for the air pressure to stabilize. The minimum air pressure shall be 3.5 psi after stabilization. After the stabilization period, disconnect the air hose from the control panel to the air supply. The line pressures may be adjusted based on pipe diameter and HDPE Pipe Manufacturer's recommendations. The Pipe Installer must receive prior approval from the Project Manager to adjust pressures.
- The line being tested is acceptable if there is no pressure drop over 10 minutes. Every mechanical joint will be inspected while under pressure, and any joint that shows any leakage shall be repaired and then retested. Leaks may be found using a mild soap and water solution

The high air pressure test shall be performed in accordance with the HDPE Pipe Manufacturer’s recommendations and in accordance with current industry standards. The Pipe Installer shall follow all safety requirements. The general procedures for the high air pressure test are as follows:

- The pipe shall have sufficient backfill installed between joints to prevent movement.
- To test the fused pipe, weld an end cap to the one end of the pipe and a valve and pressure gauge to the other end. Introduce high air pressure into the pipe through the valve into the sealed line until the air pressure is 30 psi. Allow at least 2 minutes for the air pressure to stabilize. After the stabilization period, disconnect the hose line from the valve.
- The line being tested is acceptable if there is a maximum pressure drop of 1.5 psi over 1 hour. Every mechanical joint will be inspected while under pressure, and any joint that shows any leakage shall be repaired and then retested. Leaks may be found using a mild soap and water solution.

The CQA Consultant shall record the beginning pressure, end pressure, start time, and end time of each test. The CQA Consultant shall report any non-conformance of testing methods to the Project Manager.

SECTION VIII

SURVEYING CONSTRUCTION QUALITY ASSURANCE

SECTION VIII
SURVEYING
CONSTRUCTION QUALITY ASSURANCE
TABLE OF CONTENTS

1.0 INTRODUCTION.....1

2.0 SURVEY CONTROL.....2

3.0 SURVEYING PERSONNEL.....3

4.0 PRECISION AND ACCURACY.....4

5.0 LINES AND GRADES.....5

6.0 FREQUENCY AND SPACING.....6

7.0 TOLERANCES.....7

8.0 DOCUMENTATION.....8

SECTION VIII
SURVEYING CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

Surveying of lines and grades is conducted on an ongoing basis during construction of the landfill components. Surveying is to provide documentation for record drawings and determine quantities of materials. CQA surveying is essential to ensure that the landfill components are properly constructed. The surveying conducted at the site shall be part of the construction quality assurance program.

2.0 SURVEY CONTROL

At least three (3) permanent benchmarks shall be established on separate sides of the landfill facility within easy access to the limits of solid waste placement.

The construction of the benchmarks shall be in accordance with OAC Rule 3745-27-08(D)(1), which specifies that benchmarks shall be at least as stable as a poured concrete monument ten inches in diameter installed to a depth of forty-two inches below the ground surface. Each constructed survey mark shall include a corrosion resistant metallic disk which indicates horizontal and vertical coordinates of the survey mark and shall contain a magnet or ferromagnetic rod to allow identification through magnetic detection methods.

Settlement plates may be used during placement of the final cover system to determine the thickness of RSB and/or cap protection layer. The settlement plates shall be placed on the surface in a grid pattern. The settlement plates may be metal or wood. For the RSB, a rod can be driven through the layer to determine the RSB thickness. For the cap protection layer, the settlement plate will have a threaded vertical rod that can be removed after documentation of the layer thickness. Penetration holes will be backfilled with bentonite.

3.0 SURVEYING PERSONNEL

The survey crew will consist of a Senior Surveyor and as many Surveying Assistants as are required to satisfactorily undertake the requirements for the work. Surveying personnel shall be experienced in the provision of these services, including detailed, accurate documentation.

All Surveying Construction Quality Assurance shall be performed under the direct supervision of a qualified Land Surveyor, who may be the Senior Surveyor.

4.0 PRECISION AND ACCURACY

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.01 feet and with a setting accuracy of 20 sec. (5.6×10^{-3} degrees).

5.0 LINES AND GRADES

The following surfaces shall be surveyed to document the lines and grades achieved during construction.

The survey of the baseliner/leachate collection system should at least include:

- Surface of subgrade;
- Surface of the added geologic material;
- Surface of the structural fill;
- Surface of recompacted soil liner;
- Geomembrane panel and destructive sample locations;
- Surface of leachate collection/protective cover; and
- Leachate piping alignment.

The survey of the cap system should at least include:

- Surface of the intermediate cover;
- Surface of recompacted soil barrier or engineered subbase layer;
- Geomembrane panel and destructive sample locations; and
- Surface of the vegetative layer.

Other landfill components to be surveyed include the gas extraction system and permanent groundwater control structure.

6.0 FREQUENCY AND SPACING

All surveying will be carried out as soon as possible upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. In addition, spot checks during construction will be necessary to assist the Contractor in complying with the required grades.

The following spacings and locations will be provided, as a minimum, for survey points:

- Surfaces with slopes less than 10 percent will be surveyed on a square grid not wider than 100 feet;
- On slopes greater than 10 percent, a square grid not wider than 100 feet will be used, but in any case, a line at the crest, midpoint, and toe of the slope will be taken; and
- A line of survey points no farther than 100 feet apart will be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope).

7.0 TOLERANCES

Acceptable survey tolerances between the design and as-built elevations and coordinates shall be 0.2 feet on elevations and 0.2 feet on coordinates. The minimum required thickness of the surveyed layers shall be maintained.

8.0 DOCUMENTATION

All field survey notes will be retained by the Senior Surveyor. A copy of these notes will be given to the Owner or CQA Consultant at the end of each day or surveying task. The results from the field surveys will be documented on a set of Survey Record Drawings. These drawings shall show the final elevations of the surfaces surveyed in Sub-section 5.0.

SECTION IX

CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

SECTION IX
CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION
TABLE OF CONTENTS

1.0 INTRODUCTION....1

2.0 DAILY RECORDKEEPING....2
2.1 Memorandum of Discussion with Contractors 2
2.2 Observation Logs and Testing Data Sheets 2
2.3 Construction Problem and Solution Data Sheets.... 3

3.0 PHOTOGRAPHIC REPORTING DATA SHEETS 5

4.0 DESIGN AND/OR SPECIFICATIONS CHANGES.... 6

5.0 PROGRESS REPORTS 7

6.0 DOCUMENTATION REPORT 8

7.0 STORAGE OF RECORDS 9

SECTION IX
CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

1.0 INTRODUCTION

An effective CQA/QC Plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished by the documentation of quality assurance activities. The CQA Consultant will document that quality assurance requirements have been addressed and satisfied.

The CQA Consultant will provide the Project Manager with signed field activity logs, data sheets, and forms to document that all monitoring activities have been carried out. The CQA Consultant will also maintain at the job site a complete file of the Plans and Specifications, a CQA/QC Plan, checklists, test procedures, daily logs, and other pertinent documents.

2.0 DAILY RECORDKEEPING

Standard reporting procedures will include preparation of a daily report that, at a minimum, will consist of:

- Field notes, including memoranda of meetings and/or discussions with the Earthwork Contractor, Geosynthetics Installer, or other Contractor;
- Observation logs, and testing data sheets; and
- Construction problem and solution data sheets.

This information shall be regularly submitted to and reviewed by the Project Manager.

2.1 Memorandum of Discussion with Contractors

A memorandum shall be prepared as necessary, summarizing discussions between the CQA Consultant and the Contractors. At a minimum, the memorandum will include the following information:

- Date, project name, location, and other identification;
- Name of parties involved in the discussion;
- Relevant subject matter or issues;
- Activities planned and scheduled; and
- Signature of the CQA Consultant.

2.2 Observation Logs and Testing Data Sheets

Observation logs and testing data sheets shall be prepared daily. When necessary, these logs and data sheets will include the following information:

- An identifying sheet number for cross referencing and document control;

- Date, project name, location, and other identification;
- Data on weather conditions;
- A reduced-scale Site Plan showing work areas and test locations;
- Descriptions and locations of ongoing construction;
- Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- Locations where tests and samples were taken;
- A summary of test results;
- Calibrations or recalibrations of test equipment, and actions taken as a result of calibration;
- Off-site materials received, including quality verification documentation;
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
- The CQA Consultant's signature.

2.3 Construction Problem and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, and must include the following information, where available:

- An identifying sheet number for cross-referencing and document control;
- A detailed description of the situation or deficiency;
- The location and probable cause of the situation or deficiency;
- How and when the situation or deficiency was found or located;
- Documentation of the response to the situation or deficiency;
- Final results of any responses;
- Any measures taken to prevent a similar situation from occurring in the future; and
- The signature of the CQA Consultant and signature of the Project Manager indicating concurrence.

The Project Manager shall be made aware of any significant recurring non-conformance with Specifications. The Project Manager will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications. These changes shall be submitted to the Design Engineer for approval. When this type of evaluation is made, the results shall be documented, and any revision to procedures or Specifications shall be approved by the Owner and Design Engineer.

3.0 PHOTOGRAPHIC REPORTING DATA SHEETS

Photographic reporting data sheets, where used, shall be cross-referenced with observation logs and testing data sheets and/or construction problem and solution data sheets when appropriate.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. These records shall be presented to the Project Manager upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress, problems, and mitigation activities.

4.0 DESIGN AND/OR SPECIFICATIONS CHANGES

Design and/or specifications changes may be required during construction. In such cases, the CQA Manager will notify the Project Manager and the Design Engineer. The Project Manager will notify the Ohio EPA prior to implementing design and/or specification changes that require their approval.

5.0 PROGRESS REPORTS

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

- A unique identifying sheet number for cross-referencing and document control;
- The date, project name, location, and other information;
- A summary of work activities during progress reporting period;
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period; and
- A summary of test results, failures, and retests.

Progress reports will be distributed to all involved parties.

6.0 DOCUMENTATION REPORT

At the completion of the work, the CQA Manager will submit to the Project Manager a Construction Documentation Report. This report will document that the work has been performed in compliance with the approved Permit, Plans, and Specifications, and that sampling and testing, except as properly authorized, has been implemented. The summary document will provide the necessary supporting information.

The report shall be in accordance with OAC Rule 3745-27-08(H), which requires the following:

- Narrative section that identifies engineering components constructed including a summary of specifications in the approved Permit to Install;
- Any alterations or other changes from the approved Permit to Install Application;
- Results of all testing;
- Survey Results;
- Documentation demonstrating that any oil or gas wells that have been identified within the limits of solid waste placement have been properly plugged and abandoned in accordance with Chapter 1509. of the Revised Code prior to any construction in the area of the well(s);
- Record drawings showing plan views, cross-sections, and details;
- Information regarding facility survey marks;
- Qualifications of testing personnel; and
- A notarized statement from the Owner that the report is true and accurate, and contains the information required by OAC Rule 3745-27-08(H) and the CQA/QC Plan.

The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings shall be done by a qualified land surveyor. These documents shall be prepared by the CQA Consultant and included as part of the CQA/QC Plan documentation.

7.0 STORAGE OF RECORDS

All data sheet originals, especially those containing signatures, should be stored by the Project Manager in a safe depository. Other reports may be stored by any standard method that will allow for easy access.

TABLES

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
IN-SITU FOUNDATION	Density/Moisture Relationship (ASTM D698 or D1557)	1 per material type for each unconsolidated stratigraphic unit that has not been anticipated and that may be susceptible to slope failure.	N/A	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	1 test per 200-ft grid only on each unconsolidated stratigraphic unit that has not been anticipated and that may be susceptible to slope failure.	$\geq$ 95% of Standard Proctor maximum dry density or $\geq$ 90% of Modified Proctor maximum dry density	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings	3 tests per material type for each unconsolidated stratigraphic unit that has not been anticipated and that may be susceptible to slope failure.	See Table 9 for required shear strength.	N/A
	Classification of Dispersive Clay Soils by Pinhole Test (ASTM D4647)	Perform if piezometric surface is above depth of excavation. Minimum of 3 Tests per stratigraphic unit.	Classifies as slightly dispersive (ND3) or nondispersive (ND2, ND1). (Remold to in-place density and moisture).	5-10 lb
SOIL STRUCTURAL FILL	Density/Moisture Relationship (ASTM D698 or D1557)	1 per 10,000 cu.yd.	N/A	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	$\geq$ 95% of Standard Proctor maximum dry density or $\geq$ 90% of Modified Proctor maximum dry density	N/A
	Lift Depth	Placed Material	Visual $\leq$ 12-inches uncompacted thickness	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings or Direct Shear Test (ASTM D3080)	Each unconsolidated stratigraphic unit that has not been anticipated and that may be susceptible to slope failure.	See Table 9 for required shear strength.	N/A
ROCK STRUCTURAL FILL	Particle Size	Placed Material	Visual 100% < 24-inches	N/A
	Lift Depth	Placed Material	Visual < 24-inches uncompacted thickness	N/A
	Compaction	Placed Material	Visual Observation of non-movement	N/A

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
ADDED GEOLOGIC MATERIAL	Sieve and Hydrometer Analysis (ASTM D6913 and D7928)	1 per 3,000 cu.yd.	Testing required to determine whether permeability test is required.	5-10 lb
	Unified Soil Classification (ASTM D2487)	1 per 3,000 cu. yd.	Testing required to determine whether permeability test is required.	5-10 lb
	Atterberg Limits (ASTM D4318)	1 per 3,000 cu. yd.	Testing required to determine whether permeability test is required.	5-10 lb
	Density/Moisture Relationship 2 (ASTM D698 or D1557)	1 per 10,000 cu.yd.	N/A	50 lb
	Specific Gravity 3 (ASTM D854)	1 per 10,000 cu.yd.	N/A	5-10 lb
	Permeability: Flexible Wall Permeameter (ASTM 5084)	1 per 10,000 cu.yd.	Permeability < 1 x 10^{-5} cm/sec (Permeability testing not required if soil classifies as a low plasticity clay (CL), a silty clay (ML-CL), a high plasticity clay (CH), a clayey sand (SC), or a clayey gravel (GC)).	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	> 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density with a moisture content no less than 2% below or more than 4% above optimum moisture content; or Compaction to a moisture content and dry density that meets or exceeds the best fit line of optimums.	N/A
	Lift Depth	Placed Material	< 12 inches uncompacted thickness	N/A
	Total Thickness	Placed Material	Required thickness to provide a minimum of 15-feet of separation from UAS as verified by survey	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings	One sample per material type	See Table 9 for required shear strength.	N/A
	Classification of Dispersive Clay Soils by Pinhole Test (ASTM D4647)	Perform if piezometric surface is above top of AGM. Minimum of 1 / 50,000 cu. yd.	Classifies as slightly dispersive (ND3) or nondispersive (ND2, ND1). (Remold to in-place density and moisture).	5-10 lb

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
RECOMPACTED SOIL LINER (See Note 1)	Sieve and Hydrometer Analysis (ASTM D6913 and D7928)	1 per 1,500 cu.yd.	100% < 2-inch, 90% < 3/4-inch, or as modified by test pad results.	5-10 lb
	Unified Soil Classification (ASTM D2487)	1 per 1,500 cu.yd.	Correlation with test pad results	5-10 lb
	Atterberg Limits (ASTM D4318)	1 per 1,500 cu.yd.	Correlation with test pad results	5-10 lb
	Density/Moisture Relationship 2 (ASTM D698 or D1557)	1 per 1,500 cu.yd.	Correlation with test pad results	50 lb
	Specific Gravity 3 (ASTM D854)	1 per 1,500 cu.yd. or 1 per 12,000 cu. yd.	N/A	5-10 lb
	Permeability: Flexible Wall Permeameter (ASTM 5084)	1 per 10,000 cu.yd.	Permeability < 1 x 10^{-7} cm/sec	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	> 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density with a moisture content at or above optimum, or as modified by test pad; or Compaction to a moisture content and dry density that meets or exceeds the best fit line of optimums.	N/A
	Moisture Content (ASTM D2216)	Prior to RSL placement at discretion of CQA firm.	N/A; To confirm nuclear density gauge moisture correction.	Varies
	Lift Depth	Placed Material	< 8-inches uncompacted thickness or as modified by test pad.	N/A
	Total Thickness	Placed Material	Required thickness verified by survey	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings	One sample per material type, per construction event	See Table 9 for required shear strength.	N/A

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
	Classification of Dispersive Clay Soils by Pinhole Test (ASTM D4647)	Perform if piezometric surface is above top of RSL. Minimum of 1 / 50,000 cu. yd.	Classifies as slightly dispersive (ND3) or nondispersive (ND2, ND1). (Remold to in-place density and moisture).	5-10 lb
TEST PAD	Sieve and Hydrometer Analysis (ASTM D6913 and D7928)	2 per lift	Prior to placement: 100% < 2-inch, 90% < 3/4-inch, or as modified by test pad results.	5-10 lb
	Unified Soil Classification (ASTM D2487)	2 per lift	Prior to placement.	5-10 lb
	Atterberg Limits (ASTM D4318)	2 per lift	Prior to placement.	5-10 lb
	Density/Moisture Relationship 2 (ASTM D698 or D1557)	2 per lift	Prior to placement.	50 lb
	Specific Gravity 3 (ASTM D854)	2 per lift	Prior to placement.	5-10 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	3 tests per lift	> 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density with a moisture content at or above optimum, or as modified by test pad; or Compaction to a moisture content and dry density that meets or exceeds the best fit line of optimums.	N/A
	Field Permeability: Boutwell Two-Stage Permeameter (ASTM D6391)	Test Pad: 5 test locations per test pad	Permeability < 1 x 10^{-7} cm/sec	N/A
	Lift Depth	As required to maintain consistent lift thickness	Visual, < 8-inches uncompacted depth	N/A
	Overall Size	Construction survey layout according to design of pad and a final as-built survey	A minimum three times the width and two times the length of the compaction equipment. The test pad will have a minimum thickness of 30-inches.	N/A
ANCHOR TRENCH BACKFILL	Maximum Particle Size	Placed Material	Field observation - material less than 2-inches	N/A
COMPONENT	**REQUIRED TEST**	**MINIMUM FREQUENCY**	**ACCEPTANCE CRITERIA**	**SAMPLE SIZE**

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
GRANULAR LEACHATE COLLECTION LAYER	Wash Sieve Analysis (ASTM C136)	1 per 3,000 cu. yd.	Not more than 5% of the material by weight passing through the #200 sieve.	50 lbs
	Carbonate Content (ASTM D3042) @ pH=4.0 or with optional 6 molar HCl solution	1 per 10,000 cu. yd.	< 5%, < 15% when using 6 molar HCl solution	50 lbs
	Permeability (ASTM D2434)	1 per 3,000 cu. yd.	Phases H3-H8: Permeability > 1 x 10^{-2} cm/sec	50 lbs
			Separatory Liner: Permeability > 0.2 cm/sec	
	Total Thickness	Placed Material	Phases H3-H8: > 15 inches (underlain by 6 oz/sy geotextile). Required thickness verified by survey	N/A
			Separatory Liner: > 12-inches. Required thickness verified by survey	N/A
	Visual Observation	Placed Material	The granular leachate collection layer shall not be placed over wrinkles in the flexible membrane liner that are greater than 4 inches in height.	N/A
	Shear Strength (ASTM D3080)	One sample per material type	See Table 9 for required shear strength.	50 lbs
TIRE SHRED LEACHATE COLLECTION LAYER	Wash Sieve Analysis (ASTM C136)	1 per 3,000 cu. yd.	Material free of debris, plant materials, large wires, and other foreign matter. 100% passing 6-inch sieve with not more than 5% of the material by weight passing through the #200 sieve.	50 lbs
	Permeability (ASTM D2434)	1 per 3,000 cu. yd.	Phases H3-H8: Permeability > 1 x 10^{-2} cm/sec under a load of 15,000 psf	15 gal
			Separatory Liner: Permeability > 0.2 cm/sec under a load of 10,000 psf	15 gal
	Test Pits	Excavate 1 per acre	See Section II, Sub-Section 7.1 of the CQA/QC Plan	N/A
	Total Thickness	Placed Material	> 24-inches. Required thickness verified by survey	N/A
PROTECTIVE COVER PLACED ABOVE BASELINER	Sieve Analysis (ASTM D422)	1 per 3,000 cu. yd.	Not more than 5% of the material by weight passing through the #200 sieve.	50 lbs
	Carbonate Content (ASTM D3042) pH=4.0	1 per 10,000 cu. yd.	< 5%	50 lbs

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
GEOCOMPOSITE DRAINAGE LAYER	Permeability (ASTM D2434)	1 per 10,000 cu. yd.	Permeability > 1 x 10^{-3} cm/sec	50 lbs
	Total Thickness	Placed Material	> 12-inches. Required thickness verified by survey	N/A
SUMP AGGREGATE	Sieve Analysis (ASTM D422)	1 per 3,000 cu. yd.	AASHTO No. 3 or equivalent with not more than 5% of the material by weight passing through the #200 sieve.	50 lbs
	Permeability (ASTM D2434)	1 per 3,000 cu. yd.	Permeability > 1 x 10^{-2} cm/sec	50 lbs
	Carbonate Content (ASTM D3042) pH=4.0	1 per 3,000 cu. yd.	< 5%	50 lbs
COARSE AGGREGATE AROUND PIPE	Wash Sieve Analysis (ASTM C117/ASTM C136)	1 per 3,000 cu. yd.	AASHTO No. 57 or equivalent with not more than 5% of the material by weight passing through the #200 sieve.	50 lbs
	Permeability (ASTM D2434)	1 per 3,000 cu. yd.	Permeability > 1 x 10^{-2} cm/sec	50 lbs
	Carbonate Content (ASTM D3042) pH=4.0	1 per 10,000 cu. yd.	< 5%	50 lbs

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
RECOMPACTED SOIL BARRIER (See Note 1)	Sieve and Hydrometer (ASTM D6913 and D7928)	1 per 1,500 cu.yd.	80% ≤ No. 4	5-10 lb
	Unified Soil Classification (ASTM D2487)	1 per 1,500 cu.yd.	Prior to placement.	5-10 lb
	Density/Moisture Relationship (ASTM D698 or D1557)	1 per 1,500 cu.yd.	Prior to placement.	50 lb
	Specific Gravity (ASTM D854)	1 per 1,500 cu.yd.	N/A	5-10 lb
	Permeability: Flexible Wall Permeameter (ASTM 5084)	1 per 10,000 cu.yd.	Permeability < 1 x 10^{-6} cm/sec For testing: > 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density with a moisture content at or above optimum	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	> 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density with a moisture content at or above optimum, or as modified by test pad; Compacted to a maximum dry density and minimum soil moisture content not less than used in the recompacted laboratory permeability test; or Compaction to a moisture content and dry density that meets or exceeds the best fit line of optimums.	N/A
	Moisture Content (ASTM D2216)	At discretion of CQA firm.	N/A; To confirm nuclear density gauge moisture correction.	Varies
	Lift Depth	Placed Material	< 8 inches uncompacted depth	N/A
	Total Thickness	Placed Material	Minimum 18-inches. Required thickness verified by survey or direct measurement using settlement plates.	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings	One sample per material type	See Table 9 for required shear strength.	N/A

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	ACCEPTANCE CRITERIA	SAMPLE SIZE
ENGINEERED SUBBASE	Density/Moisture Relationship (ASTM D698 or D1557)	1 per 10,000 cu.yd.	N/A	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	> 95% of Standard Proctor maximum dry density or > 90% of Modified Proctor maximum dry density	N/A
	Lift Depth	Placed Material	Visual < 8-inches uncompacted thickness	N/A
	Total Thickness	Placed Material	Minimum 12-inches. Required thickness verified by survey or direct measurement using settlement plates	N/A
VEGETATIVE COVER /CAP PROTECTION LAYER	Visual Observation	Placed Material	Reasonably free of debris, plant materials, and foreign objects.	N/A
	Total Thickness	Placed Material	> 30 inches verified through survey or direct measurement	N/A
	Sieve and Hydrometer Analysis (ASTM D6913 and D7928)	1 per material type	(2 to 3) * d85 > AOS of the geotextile component of the Final Cover Geocomposite (see Table 6) where d85 =the diameter at which 85 percent of the protective layer soil particles are finer	5-10 lb
	Density/Moisture Relationship (ASTM D698)	1 per 10,000 cu. yd.	Prior to placement.	50 lb
	Permeability: Flexible Wall Permeameter (ASTM D5084)	1 per 10,000 cu.yd.	Have a maximum permeability in accordance with the final slope stability calculations. Permeability $\leq 1.0 \times 10^{-4}$ cm/sec. Permeability must be tested at 90% of the maximum dry density determined in accordance with ASTM D698, with a moisture content within 1% of optimum.	50 lb

TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE COMPONENTS

	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D 6938)	Placed Material: 1 test per acre at 12-inch depth	Compacted to a density and moisture representative of the permeability test.	N/A
	Total Thickness	Placed Material	> 30 inches verified through survey or direct measurement using settlement plates.	N/A
	Visual Observation	Placed Material	The vegetative cover layer shall not be placed over wrinkles in the flexible membrane liner that are greater than 4 inches in height.	N/A
	Direct Shear Test (ASTM D3080)	1 per material type	See Table 9 for required shear strength.	50 lb
TRANSITIONAL COVER LAYER	Visual Observation	During Placement	Shall not contain large objects in such quantities as may interfere with its application and intended purpose.	N/A
	Sieve and Hydrometer Analysis (ASTM D1140 or D6913)	1 test per 3,000 cu. yd.	Minimum 12% particles by weight passing through the #200 sieve.	
	Total Thickness	Placed Material	> 24 inches verified through survey or direct measurement such as test pits.	N/A

Notes: (1) Results of pre-construction testing of the borrow soils performed on representative samples intended for use in the recompacted soil liner or recompacted soil barrier shall be submitted to the Ohio EPA no later than seven days prior to the intended use of the material during construction.
(2) If the use of the Best Fit Line of Optimums is proposed, both standard and modified Proctor tests will performed on alternating samples.
(3) This testing is only required if the use of the Best Fit Line of Optimums is proposed. Specific gravity testing is required at a frequency of 1 per 1,500 cu. yds. If the soils are determined to be relatively uniform, the specific gravity can be tested at a frequency of 1 per 12,000 cu. yds.
4. Specific gravity testing required for during use of the Best Fit Line of Optimum (BFLO) can be reduced from 1,500 cu. yds. to 12,000 cu. yds. if the soils are uniform.

TABLE 2
GEOSYNTHETIC CLAY LINER
QA/QC TESTING

PROPERTY	TEST METHOD	REQUIRED QA/QC TESTING VALUE	QC TEST FREQUENCY (2)	QA TEST FREQUENCY
Bentonite Content @ 0 Percent Moisture (lbs/ft^2)	ASTM D5993	0.75	1 per 50,000 ft^2	100,000 ft^2
Permeability (cm/sec) (max.)	ASTM D5887	5×10^{-9}	See Note 3	N/A
Internal and Interface Shear Strength Testing	ASTM D6243	See Table 9	N/A	See Table 9

NOTES:

(1) The GCL shall have a non-woven geotextile on both sides.

(2) Results of preconstruction testing for the internal shear strength, and interface shear strength of the geosynthetic clay liner material performed on representative samples shall be submitted to the Ohio EPA Central District Office no later than seven days prior to the intended use of the material.

(3) Testing shall be completed at the manufacturer's standard test frequency.

(4) The interface and internal shear strength testing of the GCL must be tested at least twice prior to using a new material at the facility, and once per construction event thereafter if at higher risk of slope failure than the other interfaces.

TABLE 3
60 mil HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES** (1)	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
THICKNESS (mil)	ASTM D5994	51 lowest individual of 10 values 54 lowest individual for 8 of 10 values 57 minimum average	Each Roll	Every 100,000 sf
ASPERITY HEIGHT (textured only) (mil) (min. avg.)	ASTM D7466	See Note 3	See Note 2	Every 100,000 sf
SHEET DENSITY (g/cm^3) (min. avg.)	ASTM D1505 Or ASTM D792	0.940	See Note 2	Every 100,000 sf
TENSILE PROPERTIES (min. avg.) (each direction) • Yield Strength (lb/in) • Yield Elongation (%) • Break Strength (lb/in) • Break Elongation (%)	ASTM D6693 Type IV	126 12 90 100	See Note 2	Every 100,000 sf
CARBON BLACK CONTENT (allowable range in %)	ASTM D1603 Or ASTM D4218	2.0 – 3.0 %	See Note 2	Every 100,000 sf
CARBON BLACK DISPERSION (acceptable levels)	ASTM D5596	9 in Categories 1 or 2, and 1 in Category 3	See Note 2	Every 100,000 sf
PUNCTURE RESISTANCE (min. avg.) (lb)	ASTM D4833	90	See Note 2	Every 100,000 sf
TEAR RESISTANCE (min. avg.) (lb)	ASTM D1004	42	See Note 2	Every 100,000 sf

Notes: (1) Required values are from GRI Test Method GM 13, Standard Specification "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes".
(2) Testing shall be completed at the manufacturer's standard testing frequency.
(3) The required asperity height value for QA testing shall be equivalent to the minimum average asperity height of the material used during preconstruction interface shear strength testing (herein "Shear Tested Value"). The average value reported for QA testing may be less than the Shear Tested Value if the following criteria are met: 8 out of 10 individual readings must be equal to or greater than the Shear Tested Value minus 3 mils. The lowest individual reading must be greater than or equal to the Shear Tested Value minus 4 mils.

TABLE 3
60 mil HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES (1)**	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
OXIDATIVE INDUCTION TIME • Standard (min. avg.) or • High Pressure (min. avg.)	ASTM D3895 ASTM D5885	100 min 400 min	See Note 2	See Note 3
OVEN AGING AT 85ºC • Standard OIT (min. avg. % retained after 90 days) or • High Pressure OIT (min. avg. % retained after 90 days)	ASTM D5721 ASTM D3895 ASTM D5885	55% 80%	Certify Each Formulation	See Note 3
UV RESISTANCE • High Pressure OIT (min. avg. % retained after 1600 hours)	ASTM D7238 ASTM D5885	50%	Certify Each Formulation	See Note 3
STRESS CRACK RESISTANCE	ASTM D5397 Or ASTM D1693	200 hours Or 1500 hours	Per GRI GM 10	See Note 3
INTERFACE SHEAR STRENGTH	ASTM D5321	See Table 9	See Note 3	See Table 9
GEOMEMBRANE RESIN				
DENSITY (min.) (g/ml)	ASTM D1505/D792	0.932	Each Resin Batch	See Note 3
MELT FLOW INDEX (g/10 min) (max.)	ASTM D1238	1.0	Each Resin Batch	See Note 3

Notes: (1) Required values are from GRI Test Method GM 13, Standard Specification for "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE)
Smooth and Textured Geomembranes".
(2) Testing shall be completed at the manufacturer's standard testing frequency.
(3) Not Required

TABLE 3
60 mil HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

INSTALLATION TESTING SUMMARY				
PROPERTY	**TEST METHOD**	**SAMPLE SIZE**	**FIELD TEST FREQUENCY**	**ACCEPTANCE CRITERIA[2]**
TRIAL SEAM TESTING[1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 test per welder/machine combination; and prior to each seaming period	The average of the 3 tests shall be greater than 91 lb/in with one result being less than 91 lb/in but greater than 73 lb/in. Three (3) out of three (3) tests shall not fail in adhesion unless seam incursion is less than 25% (AD or AD-BRK). Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 test per welder/machine combination; and prior to each seaming period	The average of the 3 tests shall be greater than 78 lb/in with one result being less than 78 lb/in but greater than 63 lb/in. Three (3) out of three (3) tests shall not fail in adhesion (AD1, AD2, AD-BRK, or AD-WLD). Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
DESTRUCTIVE SEAM TESTING [1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 per 1,000 lf of seaming per device	The average of the 5 tests shall be greater than 91 lb/in with one result being less than 91 lb/in but greater than 73 lb/in. Five (5) out of five (5) tests shall not fail in adhesion unless seam incursion is less than 25% (AD or AD-BRK). Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 per 1,000 lf of seaming per device	The average of the 5 tests shall be greater than 78 lb/in with one result being less than 78 lb/in but greater than 63 lb/in. Five (5) out of five (5) tests shall not fail in adhesion (AD1, AD2, AD-BRK, or AD-WLD). Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
NON-DESTRUCTIVE SEAM TESTING:				
AIR-PRESSURE	GRI GM6		Every Fusion Welded Seam	No more than 3 psi drop with initial pressure of 30 to 35 psi for 5 minutes.
VACUUM	ASTM D5641		Every Extrusion Weld	Examine weld for 10 seconds with minimum vacuum of 3 psi.

Notes: (1) For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed.
(2) Accepted specifications for breaks and unacceptable break codes obtained from the standard specifications in GRI-GM19.
(3) Additional trial seam and destructive sample testing may be required in cold weather conditions. Refer to GRI-GM9 for cold weather seaming recommendations.
(4) For installations exceeding ten thousand square feet, at least one welding technician having seamed a minimum of one million square feet of flexible membrane liner shall be present during installation.

TABLE 3
60 mil HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

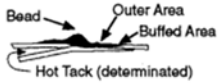
INSTALLATION TESTING SUMMARY				
PROPERTY	**TEST METHOD**	**SAMPLE SIZE**	**FIELD TEST FREQUENCY**	**ACCEPTANCE CRITERIA**
OPTIONAL LEAK LOCATION SURVEY:				
GEOMEMBRANE LEAK LOCATION SURVEY	ASTM D7007		To be performed on geomembrane in locations where an aggregate drainage layer is installed above the FML	Electrical leak location methods may be used as a final quality assurance measure as determined by SWACO. Any leaks detected will be repaired using approved methods.

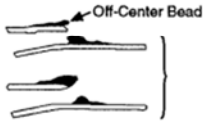
TABLE 3
60 mil HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

ASTM D 6392 LOCATION OF SEAM STRENGTH TESTING BREAK CODES FOR SEAMS TESTED IN SHEAR AND PEEL

EXTRUSION WELDED SEAMS

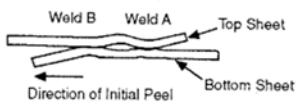
Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD1	Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area.
	AD2	Failure in adhesion.
	AD-WLD[1]	Break through the fillet.
	SE1	Break at seam edge in the bottom sheet (applicable to shear only).
	SE2	Break at seam edge in the top sheet (applicable to shear only).
	SE3	Break at seam edge in the bottom sheet (applicable to peel only).
	BRK1	Break in the bottom sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	BRK2	Break in the top sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	AD-BRK	Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet.
	HT	Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack.
	SIP	Separation in the plane of the sheet.

FUSION WELDED SEAMS

Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD	Adhesion Failure
	BRK	Break in sheeting. Break can be in either top or bottom sheet
	SE1	Break in outer edge of seam. Break can be in either top or bottom sheet.
	SE2	Break at inner edge of seam through both sheets.
	AD-BRK	Break in first seam after some adhesion failure. Break can be in either top or bottom sheet.
	SIP	Separation in the plane of the sheet. Break can be in either top or bottom sheet.

TABLE 4
40 MIL LLDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES[(1)]**	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
THICKNESS (mil)	ASTM D5994	34 lowest of 10 individual values 36 lowest individual for 8 of 10 values 38 minimum average	Each Roll	Every 100,000 sf
ASPERITY HEIGHT (mil) (min. avg.)	ASTM D7466	QC: Average ≥ Shear Tested Value minus 3 mils QA: Refer to Note 3	See Note 2	Every 100,000 sf
SHEET DENSITY (g/cm^3) (max.)	ASTM D1505 Or ASTM D792	0.939	See Note 2	Every 100,000 sf
TENSILE PROPERTIES (min. avg.) (each direction) • Break Strength (lb/in) • Break Elongation (%)	ASTM D6693 Type IV	 60 250	See Note 2	Every 100,000 sf
CARBON BLACK CONTENT (allowable range in %)	ASTM D1603 Or ASTM D4218	2.0 – 3.0 %	See Note 2	Every 100,000 sf
CARBON BLACK DISPERSION (acceptable levels)	ASTM D5596	9 in Categories 1 or 2, and 1 in Category 3	See Note 2	Every 100,000 sf
PUNCTURE RESISTANCE (avg. min.) (lb)	ASTM D4833	44	See Note 2	Every 100,000 sf
TEAR RESISTANCE (avg. min.) (lb)	ASTM D1004	22	See Note 2	Every 100,000 sf

TABLE 4
40 MIL LLDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES(1)**	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
OXIDATIVE INDUCTION TIME • Standard (avg. min.) or • High Pressure (avg. min.)	ASTM D3895 ASTM D5885	100 min 400 min	See Note 2	See Note 4
OVEN AGING AT 85ºC • Standard OIT (min. avg. % retained after 90 days) or • High Pressure OIT (min. avg. % retained after 90 days)	ASTM D5721 ASTM D3895 ASTM D5885	35% 60%	Certify Each Formulation	See Note 4
UV RESISTANCE • High Pressure OIT (min. avg. % retained after 1600 hours)	ASTM D7238 ASTM D5885	35%	Certify Each Formulation	See Note 4
AXI-SYMMETRIC BREAK RESISTANCE STRAIN	ASTM D5617	30%	Certify Each Formulation	See Note 4
INTERFACE SHEAR STRENGTH	ASTM D5321	See Table 9	See Note 4	See Table 9
GEOMEMBRANE RESIN				
DENSITY (max.) (g/ml)	ASTM D1505/D792	0.926	Each Resin Batch	See Note 4
MELT FLOW INDEX (g/10 min) (max.)	ASTM D1238	1.0	Each Resin Batch	See Note 4

Notes: (1) Required values are from GRI Test Method GM 17, Standard Specification for "Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene Smooth and Textured Geomembranes".
(2) Testing shall be completed at the manufacturer's standard testing frequency.
(3) The required asperity height value for QA testing shall be equivalent to the minimum average asperity height of the material used during preconstruction interface shear strength testing (herein "Shear Tested Value"). The average value reported for QA testing may be less than the Shear Tested Value if the following criteria are met:

TABLE 4
40 MIL LLDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

8 out of 10 individual readings must be equal to or greater than the Shear Tested Value minus 3 mils. The lowest individual reading must be greater than or equal to the Shear Tested Value minus 4 mils.

(4) Not Required.

TABLE 4
40 MIL LLDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

INSTALLATION TESTING SUMMARY				
PROPERTY	**TEST METHOD**	**SAMPLE SIZE**	**FIELD TEST FREQUENCY**	**ACCEPTANCE CRITERIA[2]**
TRIAL SEAM TESTING[1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 test per welder/machine combination; and prior to each seaming period	The results of 3 of 3 tests shall be greater than 50 lb/in. AD is not an acceptable break code. AD-BRK is an acceptable break code if seam incursion is less than 25%. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 test per welder/machine combination; and prior to each seaming period	The results of 3 out of 3 tests shall be greater than 44 lb/in. AD1, AD2, AD-BRK, and AD-WLD break codes are not acceptable. Separation-in-plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
DESTRUCTIVE SEAM TESTING[1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 per 1,000 lf of seaming per device	The results of 5 out of 5 tests shall be greater than 50 lb/in. AD is not an acceptable break code. AD-BRK is an acceptable break code if seam incursion is less than 25%.Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 per 1,000 lf of seaming per device	The results of 5 out of 5 tests shall be greater than 44 lb/in. AD1, AD2, AD-BRK and AD-WLD break codes are not acceptable. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel criteria are met. Refer to schematic on Page 4 for break codes.
NON-DESTRUCTIVE SEAM TESTING:				
AIR-PRESSURE	GRI GM6		Every Fusion Welded Seam	No more than 3 psi drop with initial pressure of 30 to 35 psi for 5 minutes.
VACUUM	ASTM D5641		Every Extrusion Weld	Examine weld for 10 seconds with minimum vacuum of 5 psi.

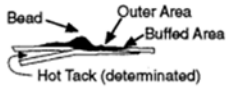
Installation Notes:
(1) For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed.
(2) Accepted specifications for breaks and unacceptable break codes obtained from the standard specifications in GRI-GM19.
(3) Additional trial seam and destructive sample testing may be required in cold weather conditions. Refer to GRI-GM9 for cold weather seaming recommendations.
(4) For installations exceeding ten thousand square feet, at least one welding technician having seamed a minimum of one million square feet of flexible membrane liner shall be present during installation.

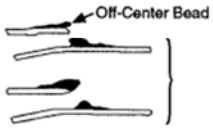
TABLE 4
40 MIL LLDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

ASTM D 6392 LOCATION OF SEAM STRENGTH TESTING BREAK CODES FOR SEAMS TESTED IN SHEAR AND PEEL

EXTRUSION WELDED SEAMS

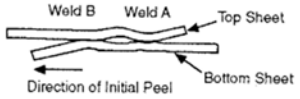
Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD1	Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area.
	AD2	Failure in adhesion.
	AD-WLD[1]	Break through the fillet.
	SE1	Break at seam edge in the bottom sheet (applicable to shear only).
	SE2	Break at seam edge in the top sheet (applicable to shear only).
	SE3	Break at seam edge in the bottom sheet (applicable to peel only).
	BRK1	Break in the bottom sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	BRK2	Break in the top sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	AD-BRK	Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet.
	HT	Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack.
	SIP	Separation in the plane of the sheet.

FUSION WELDED SEAMS

Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD	Adhesion Failure
	BRK	Break in sheeting. Break can be in either top or bottom sheet
	SE1	Break in outer edge of seam. Break can be in either top or bottom sheet.
	SE2	Break at inner edge of seam through both sheets.
	AD-BRK	Break in first seam after some adhesion failure. Break can be in either top or bottom sheet.
	SIP	Separation in the plane of the sheet. Break can be in either top or bottom sheet.

TABLE 5
40 MIL HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES**[(1)]	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
THICKNESS (mil)	ASTM D5994	34 lowest individual of 10 values 36 lowest individual for 8 of 10 values 38 minimum average	Each Roll	Every 100,000 sf
ASPERITY HEIGHT (mil) (min. avg.)	ASTM D7466	QC: Average ≥ Shear Tested Value minus 3 mils QA:See Note 3	See Note 2	Every 100,000 sf Both sides of Geomembrane
SHEET DENSITY (g/cm^3) (min. avg.)	ASTM D1505 Or ASTM D792	0.940	See Note 2	Every 100,000 sf
TENSILE PROPERTIES (min. avg.) (each direction) • Yield Strength (lb/in) • Yield Elongation (%) • Break Strength (lb/in) • Break Elongation (%)	ASTM D6693 Type IV	 84 12 60 100	See Note 2	Every 100,000 sf
CARBON BLACK CONTENT (allowable range in %)	ASTM D1603 Or ASTM D4218	2.0 – 3.0 %	See Note 2	Every 100,000 sf
CARBON BLACK DISPERSION (acceptable levels)	ASTM D5596	9 in Categories 1 or 2, and 1 in Category 3	See Note 2	Every 100,000 sf
PUNCTURE RESISTANCE (avg. min.) (lb)	ASTM D4833	60	See Note 2	Every 100,000 sf
TEAR RESISTANCE (avg. min.) (lb)	ASTM D1004	28	See Note 2	Every 100,000 sf

TABLE 5
40 MIL HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES(1)**	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
OXIDATIVE INDUCTION TIME • Standard (avg. min.) or • High Pressure (avg. min.)	ASTM D8117 ASTM D5885	100 min 400 min	See Note 2	See Note 4
OVEN AGING AT 85ºC • Standard OIT (min. avg. % retained after 90 days) or • High Pressure OIT (min. avg. % retained after 90 days)	ASTM D5721 ASTM D8117 ASTM D5885	55% 80%	Certify Each Formulation	(3) See Note 4
UV RESISTANCE • High Pressure OIT (min. avg. % retained after 1600 hours)	ASTM D7238 ASTM D5885	50%	Certify Each Formulation	(4) See Note 4
STRESS CRACK RESISTANCE	ASTM D5397 Or ASTM D1693	500 hours Or 1500 hours	Per GRI GM 10	(5) See Note 4
INTERFACE SHEAR STRENGTH	ASTM D5321	See Table 9	See Note 4	See Table 9
GEOMEMBRANE RESIN				
DENSITY (min.) (g/ml)	ASTM D1505/D792	0.932	Each Resin Batch	(6) See Note 4
MELT FLOW INDEX (g/10 min.) (max.)	ASTM D1238	1.0	Each Resin Batch	(7) See Note 4

Physical Property Notes:

(1) Required values are from GRI Test Method GM 13, Standard Specification for "Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene Smooth and Textured Geomembranes".

(2) Testing shall be completed at the manufacturer's standard testing frequency.

(3) The required asperity height value for QA testing shall be equivalent to the minimum average asperity height of the material used during preconstruction interface shear strength testing (herein "Shear Tested Value"). The average value reported for QA testing may be less than the Shear Tested Value if the following criteria are met: 8 out of 10 individual readings must be equal to or greater than the Shear Tested Value minus 3 mils. The lowest individual reading must be greater than or equal to the Shear Tested Value minus 4 mils.

(4) Not Required.

TABLE 5
40 MIL HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

INSTALLATION TESTING SUMMARY				
PROPERTY	**TEST METHOD**	**SAMPLE SIZE**	**FIELD TEST FREQUENCY**	**ACCEPTANCE CRITERIA[2]**
TRIAL SEAM TESTING[1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 test per welder/machine combination; and prior to each seaming period	The results of 3 out of 3 tests shall be greater than 60 lb/in. AD is not an acceptable break code. AD-BRK is an acceptable break code if seam incursion is less than 25%. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 test per welder/machine combination; and prior to each seaming period	The results of 3 out of 3 tests shall be greater than 52 lb/in. AD1, AD2, AD-BRK, and AD-WLD break codes are not acceptable. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
DESTRUCTIVE SEAM TESTING[1]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 per 1,000 lf of seaming per device	The results of 5 out of 5 tests shall be greater than 60 lb/in. AD is not an acceptable break code. AD-BRK is an acceptable break code if seam incursion is less than 25%. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 per 1,000 lf of seaming per device	The results of 5 out of 5 tests shall be greater than 52 lb/in. Separation in plane (SIP) failure is only acceptable if strength, shear elongation, and peel separation criteria are met. Refer to schematic on Page 4 for break codes.
NON-DESTRUCTIVE SEAM TESTING:				
AIR-PRESSURE	GRI GM6		Every Fusion Welded Seam	No more than 3 psi drop with initial pressure of 30 to 35 psi for 5 minutes.
VACUUM	ASTM D5641		Every Extrusion Weld	Examine weld for 10 seconds with minimum vacuum of 5 psi.

Installation Notes:
(1) For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed.
(2) Accepted specifications for breaks and unacceptable break codes obtained from the standard specifications in GRI-GM19.

TABLE 5
40 MIL HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

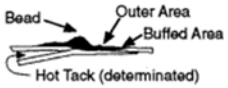
(3) Additional trial seam and destructive sample testing may be required in cold weather conditions. Refer to GRI-GM9 for cold weather seaming recommendations.
(4) For installations exceeding ten thousand square feet, at least one welding technician having seamed a minimum of one million square feet of flexible membrane liner shall be present during installation.

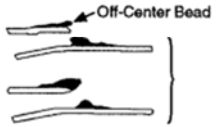
TABLE 5
40 MIL HDPE TEXTURED GEOMEMBRANE
QA/QC TESTING

ASTM D 6392 LOCATION OF SEAM STRENGTH TESTING BREAK CODES FOR SEAMS TESTED IN SHEAR AND PEEL

EXTRUSION WELDED SEAMS

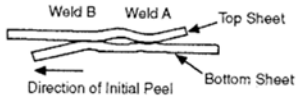
Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD1	Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area.
	AD2	Failure in adhesion.
	AD-WLD[1]	Break through the fillet.
	SE1	Break at seam edge in the bottom sheet (applicable to shear only).
	SE2	Break at seam edge in the top sheet (applicable to shear only).
	SE3	Break at seam edge in the bottom sheet (applicable to peel only).
	BRK1	Break in the bottom sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	BRK2	Break in the top sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	AD-BRK	Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet.
	HT	Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack.
	SIP	Separation in the plane of the sheet.

FUSION WELDED SEAMS

Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD	Adhesion Failure
	BRK	Break in sheeting. Break can be in either top or bottom sheet
	SE1	Break in outer edge of seam. Break can be in either top or bottom sheet.
	SE2	Break at inner edge of seam through both sheets.
	AD-BRK	Break in first seam after some adhesion failure. Break can be in either top or bottom sheet.
	SIP	Separation in the plane of the sheet. Break can be in either top or bottom sheet.

TABLE 6
UNDERDRAIN, BASELINER, AND FINAL COVER SYSTEM DOUBLE SIDED GEOCOMPOSITE QA/QC TESTING

PROPERTY	TEST METHOD	UNDERDRAIN AND BASELINER REQUIRED VALUES	FINAL COVER SYSTEM REQUIRED VALUES	MANUFACTURER QC TEST FREQUENCY	QA TEST FREQUENCY
GEONET COMPONENT:					
THICKNESS (mil) (min.)	ASTM D5199	250	300	See Note 1	1 per 250,000 sf
DENSITY (g/cm^3) (min.)	ASTM D792 or ASTM D1505	0.94 (g/cm^3)	0.94 (g/cm^3)	See Note 1	1 per 250,000 sf
CARBON BLACK CONTENT (%) (min.)	ASTM D1603 or ASTM 4218	2.0 - 3.5 %	2.0 - 3.5 %	See Note 1	1 per 250,000 sf
GEOTEXTILE COMPONENT:					
MASS PER UNIT AREA (oz/sy) (min.)	ASTM D5261	7.0	5.0	See Note 1	1 per 250,000 sf
APPARENT OPENING SIZE (Sieve)	ASTM D4751	70 - 140	70 - 140	See Note 1	1 per 250,000 sf
PERMITTIVITY (sec^{-1}) (min.)	ASTM D4491	1.20	1.20	See Note 1	1 per 250,000 sf
GRAB STRENGTH(2) (lbs) (min.)	ASTM D4632	160	160	See Note 1	1 per 250,000 sf
TRAPEZOIDAL TEAR(2) (lbs) (min.)	ASTM D4533	65	65	See Note 1	1 per 250,000 sf
CBR PUNCTURE STRENGTH (lbs) (min.)	ASTM D6241	320 for Elongation >50%	320 for Elongation >50%	See Note 1	1 per 250,000 sf

TABLE 6
UNDERDRAIN, BASELINER, AND FINAL COVER SYSTEM DOUBLE SIDED GEOCOMPOSITE QA/QC TESTING

UV RESISTANCE (%) (min.) At 500 hours of exposure	ASTM D7238	70	70	Certify	N/A
GEOCOMPOSITE:					
TRANSMISSIVITY (m^2/sec) (min.)	ASTM D4716	6.1×10^{-4} (See Note 4)	7.3×10^{-4} (See Note 5)	See Note 1	1 per 500,000 sf (4,5)
INTERFACE SHEAR STRENGTH (min)	ASTM D5321	See Table 9	See Table 9	N/A	See Table 9

Notes: (1) Testing shall be completed at the manufacturer's standard testing frequency.
(2) Minimum values measured in machine and cross machine direction.
(3) The geonet and geotextile components of the double sided geocomposite shall be tested separately for the above parameters.
(4) Transmissivity testing for the baseliner geocomposite shall be performed at a gradient of 0.03, at a normal load of 17,000 psf, and between protective cover and textured geomembrane.
(5) Transmissivity testing for the final cover system geocomposite shall be performed at a gradient of 0.33, at a normal load of 800 psf, and between soil and textured geomembrane.
(6) Puncture strength for geotextiles based on moderate survivability for separator geotextiles as defined in GRI GT-13(a).

TABLE 7
6 OZ/SY NOMINAL NONWOVEN GEOTEXTILE
QA/QC TESTING

PROPERTY	TEST METHOD	REQUIRED VALUES	MANUFACTURER QC TEST FREQUENCY	QUALITY ASSURANCE TEST FREQUENCY
CUSHION MATERIAL				
MASS PER UNIT AREA (oz/sy) (MARV) (min.)	ASTM D5261	5.0	See Note 1	1 per 250,000 sf
GRAB TENSILE STRENGTH (lb) (min.)	ASTM D4632	160	See Note 1	1 per 250,000 sf
TRAPEZOIDAL TEAR (lb) (min.)	ASTM D4533	65	See Note 1	1 per 250,000 sf
CBR PUNCTURE STRENGTH (lb) (min.)	ASTM D6241	320 for Elongation >50%	See Note 1	1 per 250,000 sf
UV RESISTANCE (%) (min.) at 500 hours of exposure	ASTM D4355	70	Certify	N/A
INTERFACE SHEAR STRENGTH (min.)	ASTM D5321	See Table 9	N/A	See Table 9
FILTER MATERIAL (2)				
APPARENT OPENING SIZE (Sieve)	ASTM D4751	70 - 140	See Note 1	1 per 250,000 sf
PERMITTIVITY (sec^{-1}) (min.)	ASTM D4491	1.20	See Note 1	1 per 250,000 sf

Notes: (1) Testing shall be completed at the manufacturer's standard testing frequency.
(2) If a geotextile filter is used, testing for these properties must be done in addition to the cushion material testing.
(3) Required strengths for geotextiles based on moderate survivability for separator geotextiles as defined in GRI GT13(a).

TABLE 7A
8 OZ/SY NOMINAL NONWOVEN GEOTEXTILE
QA/QC TESTING

PROPERTY	TEST METHOD	REQUIRED VALUES	MANUFACTURER QC TEST FREQUENCY	QUALITY ASSURANCE TEST FREQUENCY
CUSHION MATERIAL				
MASS PER UNIT AREA (oz/sy) (MARV) (min.)	ASTM D5261	7.0	See Note 1	1 per 250,000 sf
GRAB TENSILE STRENGTH (lb) (min.)	ASTM D4632	220	See Note 1	1 per 250,000 sf
TRAPEZOIDAL TEAR (lb) (min.)	ASTM D4533	95	See Note 1	1 per 250,000 sf
CBR PUNCTURE STRENGTH (lb) (min.)	ASTM D6241	600	See Note 1	1 per 250,000 sf
UV RESISTANCE (%) (min.) at 500 hours of exposure	ASTM D4355	70	Certify	N/A
FILTER MATERIAL (2)				
APPARENT OPENING SIZE (Sieve)	ASTM D4751	70 - 140	See Note 1	1 per 250,000 sf
PERMITTIVITY (sec^{-1}) (min.)	ASTM D4491	1.30	See Note 1	1 per 250,000 sf

Notes: (1) Testing shall be completed at the manufacturer's standard testing frequency.
(2) If a geotextile filter is used, testing for these properties must be done in addition to the cushion material testing.
(3) Required strengths for geotextiles based on moderate survivability for separator geotextiles as defined in GRI GT13(a).

TABLE 8

16 OZ/SY NOMINAL NONWOVEN GEOTEXTILE

QA/QC TESTING

PROPERTY	TEST METHOD	REQUIRED VALUES	MANUFACTURER QC TEST FREQUENCY	QUALITY ASSURANCE TEST FREQUENCY
MASS PER UNIT AREA (oz/sy) (MARV [(1)]) (min.)	ASTM D5261	15.0	See Note 1	1 per 250,000 sf
GRAB TENSILE STRENGTH (lb) (min.)	ASTM D4632	370	See Note 1	1 per 250,000 sf
TRAPEZOIDAL TEAR (lb) (min.)	ASTM D4533	145	See Note 1	1 per 250,000 sf
CBR PUNCTURE STRENGTH (lb) (min.)	ASTM D6241	900	See Note 1	1 per 250,000 sf
UV RESISTANCE (%) (min.) at 500 hours of exposure	ASTM D4355	70	Certify	N/A
INTERFACE SHEAR STRENGTH (min)	ASTM D5321	See Table 9	N/A	See Table 9

Notes: (1) Testing shall be completed at the manufacturer's standard testing frequency.
(2) Required strength for geotextiles based on requirements for 16 oz/sy geotextile as presented in GRI GT12(a)

TABLE 9
MINIMUM INTERNAL/INTERFACE SHEAR STRENGTHS

		Interface or Material which Internal Shear Strength is to be Measured [2][3]	Normal Stress σ (psf)	Shear Stress[1] τ (psf)
Baseliner System	**Peak Strengths (All Cells)**	Added Geologic Material/Structural Fill (internal)	Drained: Internal Friction angle = 27 degrees	Cohesion = 0 psf
		Recompacted Soil Liner/Separatory Liner Recompacted Soil Liner (internal)	Drained: Internal Friction Angle = 27 degrees Undrained: Internal Friction Angle = 19 degrees	Cohesion = 0 psf Cohesion = 250 psf
		Aggregate Drainage Layer / Protective Cover (internal)	Internal Friction angle = 30 degrees Cohesion = 0 psf	
	Peak Strengths	Recompacted Soil Liner to Geomembrane Recompacted Soil Liner to GCL GCL to Geomembrane Geomembrane to Geotextile or Geocomposite Geotextile or Geocomposite to Aggregate Drainage/ Protective Cover Layer [6]	125 800 5,000 10,000 20,000	63 401 1,600 3,100 5,500
	Post-Peak Strengths (See Note 5)	Recompacted Soil Liner to Geomembrane Geomembrane to Geotextile or Geocomposite Geotextile or Geocomposite to Aggregate Drainage/ Protective Cover Layer [6]	5,000 10,000 20,000	750 1,500 3,750
Final Cover System	**Peak Strengths**	Recompacted Soil Barrier (internal) Vegetative Cover Layer Engineered Subbase	Internal Friction Angle = 27 degrees Cohesion = 0 psf	

TABLE 9
MINIMUM INTERNAL/INTERFACE SHEAR STRENGTHS

		Interface or Material which Internal Shear Strength is to be Measured [2][3]	Normal Stress σ (psf)	Shear Stress[1] τ (psf)
	Peak Strengths	Textured Geomembrane to Recompacted Soil Barrier Double Sided Geocomposite to Textured Geomembrane Engineered Subbase to GCL[4] GCL to Geomembrane[4] Vegetative Cover/Frost Protection Layer to Double Sided Geocomposite	800	400

Notes:

(1) Minimum shear strengths are provided at specified normal loads. Shear stress is calculated using the equation: $\tau = c + [\sigma * \text{Tan}(\phi)]$ where c equals cohesion or adhesion, and ϕ is the friction angle. Any combination of c and ϕ that results in a shear strength $\geq$ the required shear strength is acceptable.

(2) Each interface and internal shear strength will be tested twice prior to using a new material at the facility, and once per construction event thereafter for the interface with the highest risk of slope failure.

(3) As required in OAC 3745-27-08(G), the results of interface and internal shear strength testing results must be submitted to the Ohio.EPA no later than seven days prior to the intended use of the materials.

(4) For internal testing of the GCL, the rate of shear displacement may not exceed 0.10 mm/min, and the material must be hydrated under a normal load of 150 psf until equilibrium is achieved.

(5) Interface shear strength tests of interfaces involving a tire chip drainage layer are not required.

(6) Conformance with the post-peak shear strength requirement is only required for the interface with the lowest peak shear strength.